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Scottish Landfill Tax: lower rate review

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Research completed May 2025

DOI: http://dx.doi.org/10.7488/era/6063

1 Executive summary

The Scottish Landfill Tax (SLfT), introduced in April 2015, was designed to discourage landfill disposal and encourage prevention, reuse, recycling, and energy recovery.

The tax has two rates. The lower rate of SLfT was designed to provide a low-cost disposal route for inert, low-risk materials, such as rocks and soils. A higher standard rate targeted more polluting materials to support environmental goals.

In early 2024, lower-rate materials exceeded standard-rate materials for the first time. Along with shifts in policy priorities and a widening gap between the lower and standard tax rates, this raises questions about whether the lower rate remains aligned with the Scottish Government's environmental objectives.

1.1 Aims

This research provides an initial evidence base to assess the effectiveness of the lower rate and explore whether changes could better support a low-carbon, circular economy. It examines the most common lower-rate materials, their environmental impacts, the feasibility of diversion and options for policy reform.

We conducted quantitative and qualitative data analysis, a literature review and stakeholder engagement.

1.2 Findings

1.2.1 Priority materials

We found that three materials accounted for 77% of all waste landfilled at the lower rate in 2023–24, by weight:

- mechanically-treated fines (small particles from treatment of general construction and demolition waste, municipal recyclate etc.)

- soils and stones from construction waste
- mechanically-treated mineral fines (small particles from treatment of naturally-occurring materials such as rocks and soils, silt, clay, sand and stones, found in quarry, construction and demolition waste etc)

Mechanically-treated fines make up the greatest quantities of all lower-rate materials, despite being intended as a residual output from material recovery processes. Trends raise concerns regarding misclassification and (from our interviews) of intentional production.

Environmental impact analysis, based on the quantities landfilled in Scotland, showed that these three materials also have the highest impacts across indicators such as air pollution, water use and resource scarcity.

The classification of lower-rate materials is complex. The European Waste Catalogue (EWC) codes used by industry do not directly align with SLfT qualifying categories. Moreover, some codes encompass a range of material compositions depending on their source. Mechanically-treated fines are diverse in composition, originating from various construction waste materials. Soils and stones from construction waste, though better defined, also pose classification and compliance challenges. Mechanically-treated mineral fines tend to be more uniform.

1.2.2 Waste prevention and landfill diversion options

Soils and stones are often reused on-site or in restoration, though off-site reuse is constrained by regulation, logistics, and project timing. Options for recovering and re-using mechanically-treated fines are limited, due to contamination and variable composition. The recovery of mechanically-treated mineral fines is easier than the recovery of non-mineral fines but the cost and technical barriers make the use of virgin materials a simpler option.

Upstream measures in the construction sector may have more impact than attempts to recover and re-use waste. Such measures might include improving waste source segregation, designing for reuse and avoiding demolition. While such interventions are technically viable, they are limited in practice by weak incentives, inconsistent standards, and market barriers.

1.2.3 Policy assessment

The SLfT interacts with several fiscal and non-fiscal policies, both existing and on the horizon. These include the upcoming ban on biodegradable municipal waste to landfill; Scottish Aggregates Tax and Digital Waste Tracking, both expected in 2026 (DEFRA, 2023). Based on the assessment of diversion options for the priority materials, we highlighted various fiscal and non-fiscal policy options for future consideration.

1.3 Conclusions

This study suggests the lower-rate SLfT may be only partially aligned with Scotland’s current circular economy, waste prevention and climate goals. While it has supported some diversion of inert waste from landfill, it may also be driving unintended behaviours and limiting investment in recovery. Both fiscal and non-fiscal actions may be needed to address these challenges. The upcoming Scottish Aggregates Tax and wider circular economy policy agenda offer opportunities to align SLfT more closely with long-term environmental objectives.

Key areas for further exploration could include:

- Raising the lower SLfT rate to incentivise application of the waste hierarchy.
- Assigning a new SLfT rate to mechanically-treated fines, to address misclassification and recognise its relatively high environmental impacts.
- Strengthening enforcement and guidance on material classification to reduce compliance risks.
- Build on existing cross-border regulatory and enforcement cooperation to address ongoing challenges such as waste tourism and the evolution of the landfill tax.

This research is relevant to the Scottish Government, Revenue Scotland, SEPA, and others involved in the design or enforcement of fiscal and waste management policy, as well as stakeholders in the construction, demolition and waste processing sectors.

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2 Glossary / Abbreviations table

AGL	The Aggregates Levy, a UK tax on the use of virgin rock, sand, and gravel for commercial purposes such as building roads and houses; to be replaced in Scotland by the Scottish Aggregates Tax from 1 April 2026
BMW	Biodegradable municipal waste
CCL	The Climate Change Levy, a UK tax to encourage reduction in gas emissions and greater efficiency of energy use.
CPF	Carbon Price Floor, a UK policy which imposes a tax on fossil fuels to incentivise investment in low-carbon power generation
C&D	Construction and demolition
C&D fines	Collective term used in this report for mechanically-treated fines (19 12 12) and mechanically-treated mineral fines (19 12 09) due to similar end-of-pipe diversion options and barriers
EPR	Extended producer responsibility, the responsibility of a producer for the environmentally sound management of a product until the end of its life
EWC code	European Waste Catalogue code, used in Scotland and across the UK for classifying waste, and sometimes referred to as the 'list of wastes'
GHG	Greenhouse gas
LCA	Lifecycle analysis, a process of evaluating the effects that a product has on the environment throughout its production, use and disposal
LOI	Loss on ignition testing, introduced by HM Revenue and Customs in 2015, is used to determine the organic content of waste fines, helping prevent misclassification for landfill tax purposes: fines with less than 10% LOI qualify for a lower tax rate
RS	Revenue Scotland
SAT	Scottish Aggregates Tax, due to replace the UK AGL from 1 April 2026
SEPA	Scottish Environment Protection Agency
SLfT	Scottish Landfill Tax

SWEFT	Scottish Waste Environmental Footprint Tool, developed by Zero Waste Scotland, quantifies the environmental impact of household waste on a whole lifecycle basis
WAC	Waste acceptance criteria test is used to assess how waste will behave once landfilled, primarily by analysing leachate to determine suitability for disposal.
WTN	Waste transfer note, a document that details the transfer of waste from one person or organisation to another

3 Introduction

3.1 Research context and aims

The Scottish Landfill Tax (SLfT) was introduced in April 2015, following the devolution of landfill taxation under the Scotland Act 2012. It replaced the UK Landfill Tax in Scotland and was designed to discourage landfill disposal and encourage adherence to the waste hierarchy. This hierarchy prioritises prevention, reuse, recycling, and energy recovery over landfill.

The tax is collected and administered by Revenue Scotland and has two rates. The standard rate, which covers materials more likely to pollute the environment or generate greenhouse gas (GHG) emissions, will be £126.15 per tonne in 2025-26. The lower rate is £4.05 per tonne as of April 2025 (Revenue Scotland, 2024b). The lower rate applies to materials considered to have low GHG emissions, limited pollution risks, and no hazardous properties when landfilled. For instance, ceramics, glass, soil and stones, and various mixtures of inert materials. Both rates were raised incrementally each year from 2015-16 to 2024-25, and increased by around 24% in April 2025-26 (Revenue Scotland, 2024a).

However, there is a large, widening gap between the rates, and the criteria and conditions for setting them have remained unchanged since 2016. This prompts questions about whether the lower rate continues to align with Scotland's evolving environmental priorities. It also offers opportunities for policy development, which this research explores. The timing of this study is particularly relevant: a UK Government consultation on landfill tax reform is underway at the time of the publication of this study, concluding in July 2025 (HM Treasury and HMRC, 2025). Moreover, in 2024, the Welsh Government implemented an increase to its lower rate. These developments signal a wider shift in approach across the UK, and this research aims to inform future decision-making in Scotland as part of that wave of change.

Tonnages of landfilled waste have steadily declined over the past decade, but standard rate materials have dropped fastest. In early 2024, the quantity of lower rate materials exceeded that of standard rate materials for the first time. Figure 1 shows the gap between standard rate material (in orange) and lower rate material (in teal) has narrowed in the last 5 years. The widening gap between the lower and higher tax rates has also increased concerns about whether this is driving waste misclassification and crime. It is hard to determine a clear trend related to the landfilling of lower rate material in the years since 2020.

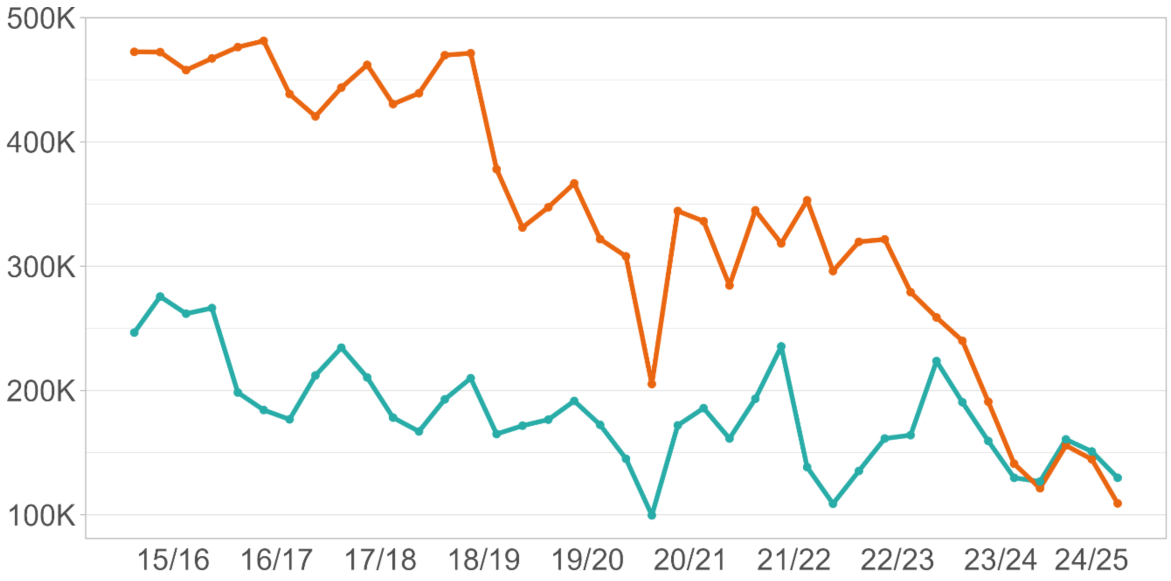

Figure 1: Tonnes of taxable waste declared by quarter in Scotland (source: Revenue Scotland)

The upcoming ban on landfilling biodegradable municipal waste, effective from the end of 2025, is expected to accelerate this trend (Scottish Government, 2022). It is therefore timely to focus in on lower rate materials to assess if SLfT is still serving its purpose. The Scottish Government has committed to explore whether changes may be needed to this or related policy levers, to support progress towards a low-carbon, circular economy (Scottish Government, 2024a).

The SLfT intended to support Scotland's environmental objectives, which include

- Reducing the volume of waste sent to landfill.
- Lowering GHG emissions.
- Minimising pollution risks in landfill environments.
- Promoting the application of the waste hierarchy.

Scotland's waste and resources policies have evolved since the landfill tax was introduced. They are now strongly oriented towards the objectives set out in the Circular Economy (Scotland) Act 2024 and the Circular Economy and Waste Route Map to 2030 (Scottish Government, 2024a). These provide a framework for increasing resource efficiency and reducing reliance on landfill. Specific information on these can be found in Appendix A.

The Route Map commits to developing a residual waste plan to 2045 and reviewing materials currently landfilled to identify alternative management routes by 2027. The SLfT legislation allows for additional lower rates to be created in support of future policy (Scottish Government, 2022).

Scotland's net zero targets and biodiversity strategy were introduced in light of the twin climate and biodiversity crises. They have reinforced the need for waste and resources policies that support decarbonisation across all sectors. Most environmental impacts associated with resource use take place before materials are disposed of. A circular economy, with an emphasis on resource efficiency and waste prevention, is therefore essential for meeting Scotland's environmental objectives. SLfT should be evaluated in this context, considering not only tonnages landfilled but the whole-life environmental impacts of materials.

3.2 Project objective, aims and research questions

The overarching objective of this research is to evaluate the effectiveness of the lower rate of SLfT in supporting Scotland's environmental policy objectives. These policy objectives include reducing the volume of waste sent to landfill, lowering GHG emissions, minimising pollution risks, and encouraging materials to move up the waste hierarchy.

This research supports policy development by assessing whether the lower rate of SLfT remains effective in advancing Scotland's environmental objectives. It also examines whether adjustments to the tax or related policy levers could accelerate progress towards these objectives. Specifically, **this study aims** to:

- evaluate the effectiveness of the lower rate in supporting Scotland's environmental goals;
- identify the lower-rate materials that have the greatest environmental impact;
- explore waste prevention and diversion options for lower-rate materials and their feasibility;
- assess key barriers to reducing reliance on lower-rate landfill disposal;
- examine how the SLfT interacts with other fiscal and non-fiscal waste and environmental management policies and identify areas for future research and policy interventions.

To achieve these aims, the following **research questions** are addressed:

1. Which materials landfilled at the lower rate rank the highest in terms of quantity and negative environmental impacts?
2. What diversion options and alternative treatments exist for these materials, and how feasible are they in light of technical, market, and policy barriers?
3. What are the key barriers to reducing the volume of materials landfilled at the lower rate, and how can they be addressed?
4. How does the SLfT intersect with other fiscal and non-fiscal waste management and environmental policies, and what options exist to strengthen policy?

This report provides an initial evidence base for discussions on potential changes to the lower rate of SLfT. It does not present a cost-benefit analysis of policy options. It highlights the highest-impact materials and presents opportunities to divert from landfill, noting key barriers.

These findings aim to contribute to ongoing policy discussions and future research, in support of Scotland's transition to a low-carbon, circular economy.

3.3 Methodology

This study was conducted from December 2024 to March 2025 by Resource Futures and Aether, in collaboration with a steering group comprising the ClimateXChange research lead and representatives of the Scottish Government, SEPA and Revenue Scotland. It followed a three-stage approach (see Figure 2).

We designed the methodology to provide an initial evidence base to progress policy development. Robust data analysis was used to identify key materials and focus future research. Key materials were determined based on impact.

Figure 2: Research approach

We used quantitative and qualitative data analysis, a literature review, and stakeholder engagement to support this approach. Table 1 below summarises each research stage and corresponding data collection methods. These are further detailed in Appendices 53 and 59.

Table 1: Data collection methods by research stage

Data collection methods	Research stage		
	Prioritisation of materials	**Review of diversion and prevention options**	**Policy assessment**
Weight-based EWC code analysis	X		
Environmental impacts analysis	X		
Desk-based research		X	X
Stakeholder engagement	X	X	X

In the first stage, we assessed tonnage and environmental impacts data on materials landfilled at the lower rate. This enabled us to prioritise the top three material streams.

We analysed tonnage data by EWC code, or groups of codes where necessary. This relied on data obtained from SEPA and Revenue Scotland. To assess environmental impacts, we used the Scottish Waste Environmental Footprint Tool (SWEFT). This covers a range of environmental indicators, including GHG emissions, resource depletion, and pollution potential (Zero Waste Scotland, 2024). We refined our understanding of the top material streams, through engagement with waste management operators, industry experts, policymakers, and the project steering group.

In the second stage, we examined opportunities to move lower-rate materials up the waste hierarchy. A high-level literature review identified prevention, reuse, recycling, and recovery options, assessing their technical feasibility. Stakeholder interviews provided further insights into potential diversion options and barriers to these.

In the final stage, we reviewed how the lower rate of SLfT interacts with related policies. We used desk-based research to review other relevant measures and draw comparisons with landfill taxation in other jurisdictions. Engagement with policymakers and regulators provided insights into how the tax operates in practice. We identified areas where further research is needed to address gaps or unintended consequences.

For the stakeholder engagement, we conducted eight in-depth, semi-structured interviews, and gathered additional insights via email, in January to March 2025. Further details of the methodology, including the stakeholder engagement, can be found in 59.

4 Quantitative data review to determine priority materials

This section sets out how we identified the three highest-impact material streams taxed at the lower rate, which are assessed in more detail in Sections 5 and 6.

We first give a summary of the process for preparing and classifying waste for landfill in Scotland (Section 4.1). We then present findings by weight based on Revenue Scotland and SEPA data (Section 4.3) then on the weighted environmental impact of materials (Section 4.4). This forms the basis for prioritising lower-rate materials summarised in Section 4.5.

4.1 Introduction to classifying and preparing waste for landfill in Scotland

For waste to be landfilled in Scotland, waste producing businesses must follow a structured process to ensure compliance with environmental regulations. This process involves multiple parties, including waste producers, skip operators, transfer station operators, landfill operators, and regulators such as SEPA and Revenue Scotland.

Key steps in preparing waste for landfill include:

- Waste identification – determining the type of waste based on its source, composition, and potential hazards.
- Waste characterisation – including chemical analysis and testing (where required) to assess hazardous properties and biodegradability.
- Waste classification – the waste is assigned a European Waste Catalogue (EWC) code by the waste producer. EWC codes must be included on waste transfer notes (for non-hazardous waste) and hazardous waste consignment notes. These documents accompany waste during its movement and disposal and are checked by waste carriers, site operators, and regulators.
- Pre-treatment and landfill acceptance requirements – including necessary treatment to reduce environmental impact, compliance with landfill permit conditions, and landfill waste acceptance criteria (WAC) testing, where required.

- Documentation and record-keeping – maintenance of records, results and transfer documentation to ensure legal compliance.

Two key documents to support businesses in meeting these obligations are:

- Waste Classification Technical Guidance (WM3) (SEPA *et al*, 2015): The guidance, co-produced by SEPA, Natural Resources Wales, Northern Ireland Environment Agency, and Environment Agency, provides comprehensive instructions on identifying whether waste possesses hazardous properties.
- Criteria and Procedures for the Acceptance of Waste at Landfills (Scotland) Direction 2005 (Scottish Government, 2012a): The document gives criteria and procedures for waste acceptance at landfills, ensuring compliance with environmental standards. WAC are described in the accompanying 'Schedule' to this Direction.

SEPA holds responsibility for governance of compliance and therefore holds national level data on the transfer and treatment of waste into, within, and out of landfills in Scotland. As regulator of the SLfT, Revenue Scotland holds parallel data obtained through tax returns. The anonymised data from Revenue Scotland, alongside SEPA's, underpins the analysis presented in the following section.

While many elements of the landfill preparation process are legal requirements, some practices – such as separating certain materials for recovery – are strongly encouraged by regulators or industry bodies due to viable diversion routes or market demand. These distinctions are important context for the findings presented later in this report.

4.2 Overview of waste data analysis

This section presents a summary of analysis performed on waste tonnages data provided by SEPA, and SLfT returns data from Revenue Scotland which was anonymised for the purposes of this study. The data provided by SEPA and Revenue Scotland are categorised by EWC code (European Commission, 2000). These data insights can be used to help progress policy development.

EWC codes are a list of waste descriptions used in all UK nations and EU member states. However, as explained in detail in Section 5.3, EWC codes do not directly correlate to SLfT rates. EWC codes must be used on waste transfer notes and hazardous waste consignment notes. The submission of waste transfer notes also comes with 'operator descriptions' to further explain the EWC code categorisation. There are around 650 individual codes split across 20 'chapters'. The chapter typically defines the industry or source of waste; however, some definitions are more material- or process-based. Despite the large library of codes, some remain broad in scope. This means that use of the EWC codes within a dataset does not automatically achieve transparency or traceability in terms of material definitions.

For this report, descriptors have been adopted for each EWC code, or group of codes, present within the lower-rate tonnages data provided by Revenue Scotland. These are outlined in Table below.

Table 2: EWC codes within the lower tax rate in Scotland

EWC code/ group of codes[1]	Descriptor
19 12 12	Mechanically-treated fines
17 05 04	Soil and stones from C&D waste
19 12 09	Mechanically-treated mineral fines
19 03 05, 19 05 99, 19 12 05, 19 13 06, 20 01 02, 20 01 99, 20 03 01, 20 03 03, 20 03 99[2]	Mixed household waste and outputs of waste treatment
19 01 12	Incinerator bottom ash and slag
19 01 02, 19 01 11, 19 01 14, 19 01 16, 19 02 09, 19 02 99	Niche materials from incineration, pyrolysis or chemical waste treatment
17 01 07	Mixed minerals (concrete, bricks, tiles, ceramics) from C&D waste
01 04 08, 01 04 09, 01 04 10, 01 05 07, 02 01 03	Niche materials mainly from mining and quarrying
17 01 02, 17 01 03, 17 02 02, 17 05 06, 17 06 04, 17 09 04	Niche materials from C&D waste
06 01 99, 07 01 12, 07 07 12, 10 01 01, 10 01 17, 10 02 01, 10 03 05, 10 11 03	Niche materials from chemical and thermal processes
20 02 02	Soil and stones from municipal waste (gardens, parks, recreation)
12 01 07, 12 01 17, 15 01 07, 16 01 20, 16 03 04, 16 11 02	Mixed niche materials, including from end-of-life vehicles
17 01 01	Concrete

We ranked the data from Revenue Scotland on lower-rate waste to landfill by weight. Data from SEPA for each matching EWC code, or group of codes, was then used to identify the amount of each material landfilled at lower rate as a *proportion* of the total landfilled. This allowed for prioritisation based on overall tonnage of lower rate material. Further information on steps for data cleansing and review is provided in 53.

[1] Some of the data provided by Revenue Scotland was grouped to ensure confidentiality is retained, for example where there is only one operator responsible for a specific code. These grouped codes have been verified by the project team as containing mostly niche materials, and therefore excluded from the shortlist.

[2] This group contains a code for mixed household wastes (20 03 01). An insignificant portion of this code is expected to be landfilled at lower rate. As such, it was assessed separately from the niche materials that make up the remainder of this group (which are more likely to be landfilled under the lower rate).

Results show the largest quantities landfilled in Scotland by material (at both lower and standard rate), in the financial year 2023 to 2024, were soil and stones, mechanically-treated fines and mechanically-treated mineral fines.

It is important to note that the data presented does not account for exemptions, meaning the reported tonnages are likely an underestimate of the actual quantities of waste generated. Exemptions are highlighted later in the report throughout Sections 6 and 7.

Figure 3 below highlights how the ranking changes when considering only materials landfilled at lower rate (in teal) with results for standard rate material also shown (in orange). The top three materials by weight are:

- 19 12 12: Mechanically-treated fines (fine particles left over from mechanical waste processing)
- 17 05 04: Soil and stones (non-hazardous soils and stones from C&D waste)
- 19 12 09: Mechanically-treated mineral fines (fine particles of minerals, e.g. sand and stones, left over from mechanical waste processing)

These three materials make up 77% of the material landfilled at lower rate in 2023-24. The analysis shows that most mechanically-treated fines and mechanically-treated mineral fines are landfilled at the lower rate. In comparison, only a small portion of soil and stones is landfilled at the lower rate.

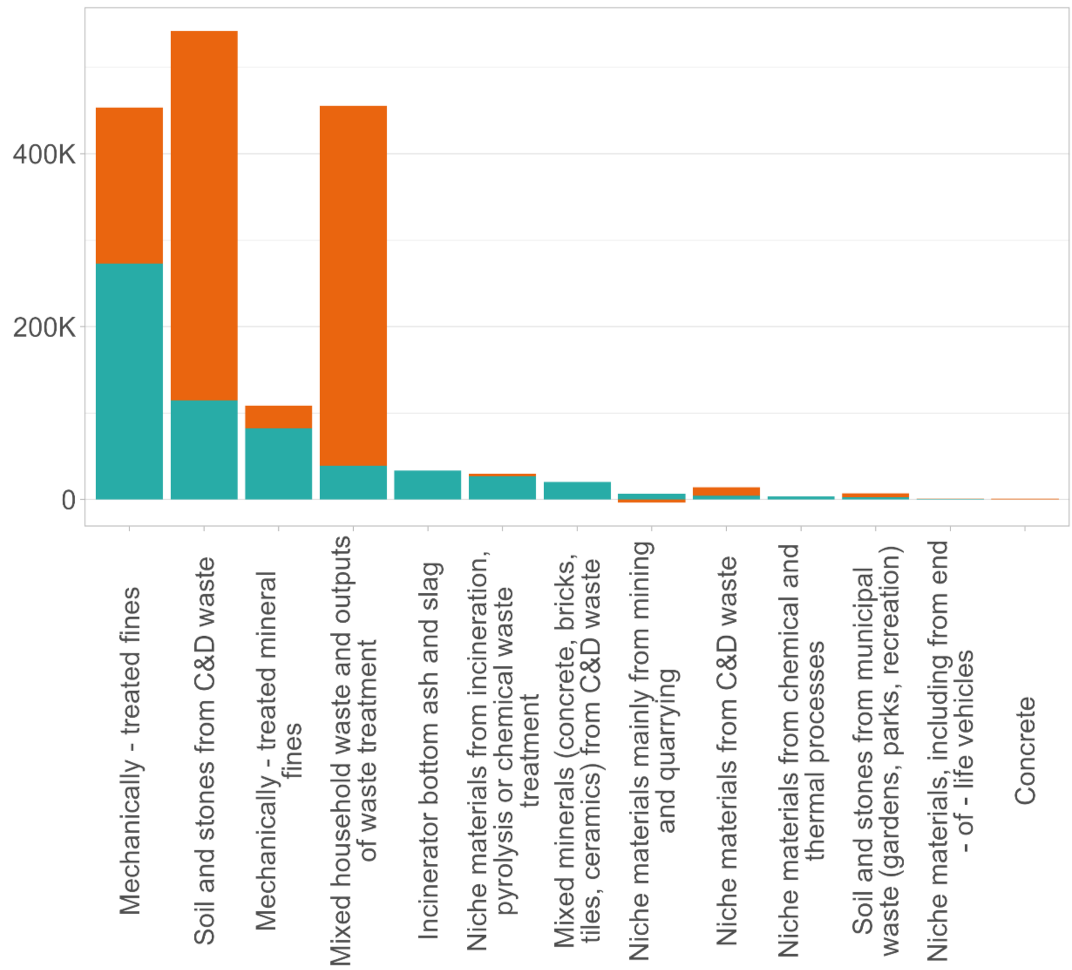

Figure 3: Tonnage of waste to landfill at standard and lower tax rates by EWC code, 2023-2024.

4.3 Analysis of waste quantities and composition data

We identified short-term trends for each material. We also reviewed operator descriptions in the SEPA data to better understand the materials and their origins. Summaries are presented for the three material groups landfilled in the greatest quantities at the lower rate of tax. These are presented in order with the highest tonnage first.

4.3.1 Mechanically-treated fines: EWC 19 12 12

This non-hazardous material group contains fine particle rejects from mechanical waste processing, including sorting, crushing, pelletising and compacting, as well as a minority share of anaerobic digestion residue. A more detailed description is provided in Section 5.1.

Approximately 60% of mechanically-treated fines were landfilled at the lower rate of tax in 2023-24. As shown through SEPA and Revenue Scotland data in Figure 4 below, the overall quantity landfilled has decreased over the most recent three-year period. However, the quantity landfilled at lower rate (in teal) has increased, while the quantity landfilled at standard rate (in orange) has decreased.

For context, the quantity landfilled under the lower rate was consistently under 200,000 tonnes before 2020. This increased sharply to a peak in 2022-23, before declining slightly again in 2023-24, but remaining well over pre-2020 levels.

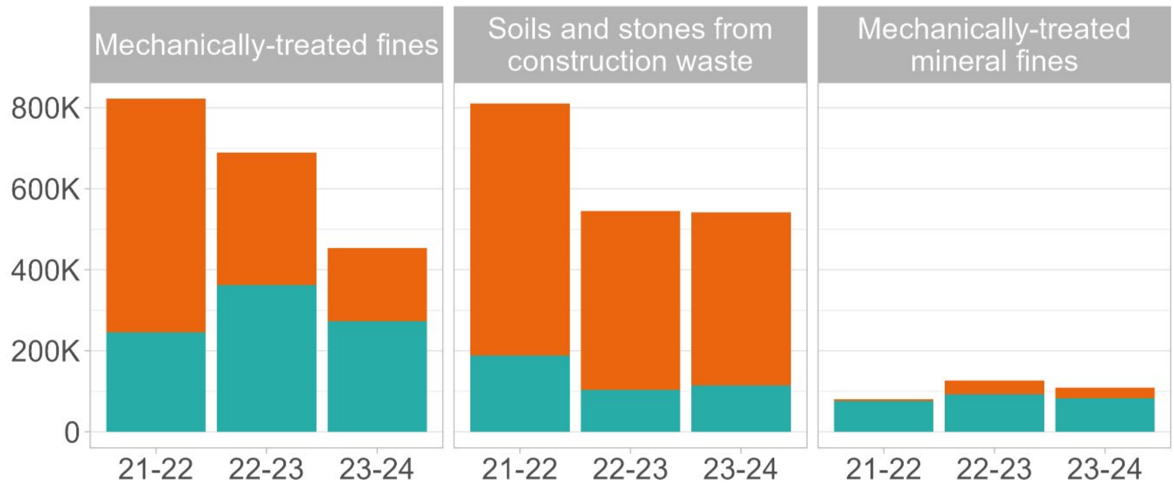

Figure 4: Tonnage of waste to landfill at standard and lower tax rates for the three priority materials from 2021 to 2024.

4.3.2 Soils and stones from construction waste: EWC 17 05 04

The soils and stones EWC code group is for non-hazardous materials and results from construction and demolition waste. It is restricted to topsoil, peat, subsoil and stones only. Therefore, soil waste classification testing must take place to determine if soils are non-hazardous or inert (qualifying for the lower rate), or hazardous (standard rate). More information is provided in Section 5.2.

Approximately 21% of soils and stones was landfilled at the lower rate in 2023-24. Figure 4 shows that both the total quantity landfilled (ie the combined teal and orange bars), and the quantity landfilled at lower rate (in teal), have decreased from a 2021-22 peak. As a result, the portion of this waste group landfilled at the lower rate has remained stable over the most recent three years.

Based on the operator descriptions submitted with the waste transfer notes, this EWC material group contained just over 12,000 tonnes (2.2%) of ‘contaminated’ soil in 2023-24. It should be noted that contaminated is not equivalent to ‘hazardous’. Descriptions of this EWC code attached to records of larger waste quantities simply state “contaminated soil” with no further specificity. Descriptions accompanying some of the smaller quantities of lower-rate waste have mention of contamination by Japanese knotweed.

In addition, around 10,000 tonnes (1.8%) was recorded as having traces of asbestos in 2023-24, almost entirely from one waste record. This was much higher than any records mentioning traces of asbestos for previous years.

These findings highlight uncertainty around the application of WAC testing to this code. Soil and stones containing hazardous substances may potentially have been misclassified under the non-hazardous code 17 05 04, instead of its hazardous counterpart, 17 05 03. From stakeholder interviews, it is understood that misclassification is likely to contribute to the large quantity of soil and stones being disposed of under this material group.

4.3.3 Mechanically-treated mineral fines: EWC 19 12 09

This material group is classified as fines from naturally occurring rocks and soils, silt, clay, sand and stones. It is non-hazardous. A more detailed description is available in Section 5.1.

76% of this material group was landfilled at the lower rate of tax in 2023-24, which was similar to the portion in 2022-23. Looking further back, the quantity landfilled at lower rate peaked at just over 120,000 tonnes in 2019-20, before a significant decline in the following two COVID years. Quantities landfilled at the lower rate have bounced back slightly but not to pre-COVID levels.

As shown in Figure 4 above, this material group is landfilled in proportionally greater quantities under the lower rate (in teal) than the standard rate (in orange).

4.4 Baseline environmental impact of materials

We used Zero Waste Scotland's SWEFT data to provide a high-level assessment of how the materials landfilled at lower rate may impact the environment. This enabled us to check whether any lower-tonnage material groups warranted further attention due to their disproportionately higher environmental impacts.

The tonnages for 2023-24 were multiplied by lifecycle-based SWEFT factors. Lifecycle-based SWEFT factors consider the entire environmental impact of a material, from extraction to disposal, which helps assess its true ecological footprint. This produced a weighted impact for each material group against each of SWEFT's six environmental indicators. Further information on methods and assumptions in application of SWEFT is provided in 58B.

Because SWEFT factors covers a range of environmental impacts, they cannot be aggregated into a single, comparable "score". To visualise and compare relative impacts, we used a spider diagram (see Figure 5), which presents the results for the top six material groups landfilled at lower rate in Scotland during 2023-4.

Figure 5 below shows that the top three material groups by tonnage also have the greatest environmental impacts. These materials – mechanically-treated fines, soil and stones, and mechanically-treated mineral fines – are shown in the colours teal, dark orange and black respectively .

Mechanically-treated fines are estimated to have the largest weighted impacts on air pollution, mineral resource scarcity, water consumption and land use. Soil and stones, and mechanically-treated mineral fines, have the next-highest impacts for the same indicators.

One mixed material group (shown in light orange) scores highest on GHG emissions and biodiversity. However, this group, was found to be almost entirely made up of drill cuttings in 2023/24 based on operator descriptions within the SEPA data. As a result, we chose to describe this as a niche material (see Table 2). This results in a high environmental impact but with high uncertainty.

No other material groups were flagged as priorities for further research based on this high-level analysis of environmental impacts. As such, the three lower-rate material groups landfilled in highest quantities were prioritised for further research.

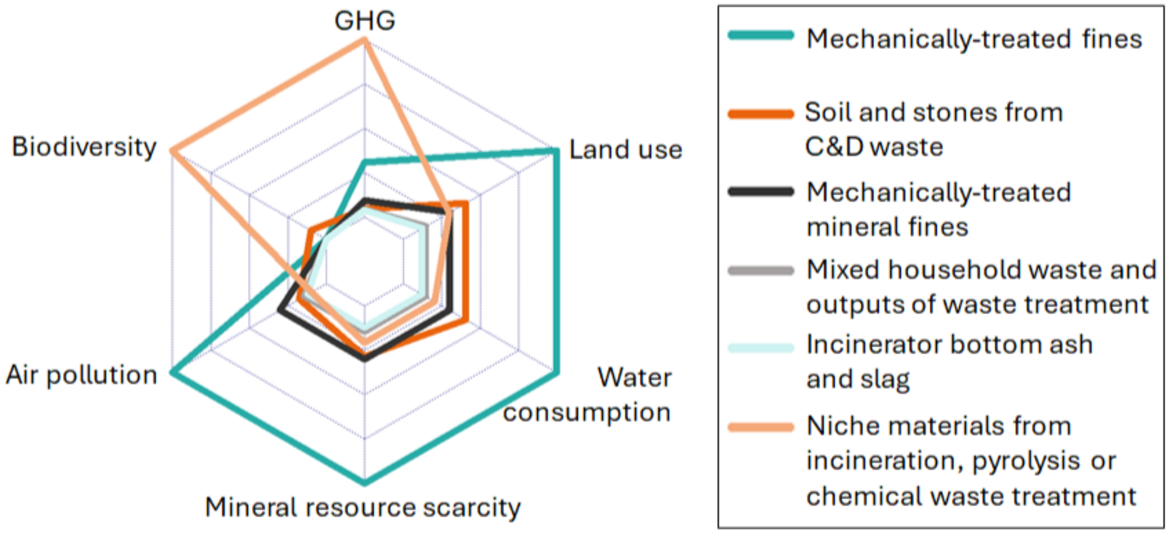

Figure 5: SWEFT tool results presented by material and relative environmental impact (only top six scoring material groups are shown)

4.5 Priority materials and supporting interview data

From the analysis of tonnage landfilled and environmental impact assessment, three material groups were prioritised: soils and stones, mechanically-treated fines, and mechanically-treated mineral fines. These materials accounted for 77% of lower-rate landfilled waste in 2023-24 and had some of the highest environmental impacts, particularly on air pollution, resource scarcity, and land use.

Grouped codes of niche materials were excluded due to data limitations: (i) they consist of multiple waste types with varying, and unknown, compositions and quantities, and (ii) the lack of specificity meant the assessment of environmental indicators relied more on generalised assumptions.

Focusing on the three dominant materials enabled targeted research into impactful interventions to reduce landfill and improve resource recovery. This selection was also verified through analysis of interviewee responses. For example:

- **Mechanically treated fines, mechanically-treated mineral fines and soils and stones were confirmed as the main materials:** “They are the majority of materials in the lower rate.” (Commercial remediation company interview); “A lot of the lower rate material will essentially be fines.” (C&D waste management processor)
- **Most high-quality materials are already reused in construction:** “The only reason construction companies take things off sites now is because they can’t use it.” (C&D skip operator)

- **Mechanically-treated fines come from transfer stations and skip waste:** "Mechanical fines come from transfer stations and sorting of skips waste. Skip operators generate the majority of the fines in the Scottish market." (Commercial remediation company)
- **Mechanical-treated fines create challenges for waste management:** "Mechanically-treated fines are the top waste we question whether the rate is right." (SEPA interview) and "we tend to stay away from mechanically-treated fines, because the administration and risk of misclassification sits with us." (Commercial landfill operator)

5 Complexities in the categorisation of priority materials

Determining when a material qualifies for the lower rate is not straightforward. This is due to the complex properties of the lower-rate materials, the sources of these materials and the different classification systems used in policy. To aid in understanding, this section outlines what the three priority material streams comprise, the sources of these materials and their link to categorisations in Scottish policy.

5.1 Mechanical fines: EWC 19 12 12 and 19 12 09

Two of the priority materials, mechanically-treated fines and mechanically-treated mineral fines, belong to the same EWC chapter 19 12. This chapter refers to waste from the mechanical treatment of waste, for example sorting, crushing, compacting or pelletising (Dsposal, n.d.). These are commonly referred to as trommel fines, or mechanical fines (typically 10-40mm).

Fines that qualify for the lower rate under both waste codes largely come from construction and demolition (C&D) waste and, therefore, share similar diversion options and barriers which are discussed in Section 6. The term 'mechanical fines' is used hereafter as shorthand when these two categories of fines are discussed together.

The key distinction between the codes is their composition:

- **Mechanically treated mineral fines (EWC 19 12 09):** Primarily from excavation and mechanical treatment of quarry waste, C&D waste, and aggregate recycling (WRAP and Environment Agency, 2013). Composition is relatively uniform.
- **Mechanically treated fines (EWC 19 12 12):** Includes fines from mixed C&D waste, municipal recyclate, and residual waste. Fines qualifying for the lower rate are primarily from mixed C&D waste due to higher inert content (Di Maria et al., 2013; Vincent et al., 2022). Composition is far more varied.

The interview findings and other data suggest that mechanical fines – whether classified under EWC 19 12 09 or 19 12 12 – are commonly produced at transfer stations and through the mechanical sorting of skip waste, particularly when handling C&D material. Composition is mostly crushed bricks, tiles, concrete, and ceramics – similar to mineral fines (the same as mechanically-treated mineral fines). However, the code can also include additional inert materials, including fines from the mechanical treatment to recycle furnace slags, bottom ash, and plasterboard to recover gypsum[3] (Environment Agency, 2023a; Environment Agency, 2023b).

To summarise, both types of mechanical fines may contain a small amount of contamination and non-qualifying material, but can still be eligible for the lower rate if they meet the conditions set out in Article 4 of the 2016 Order. To qualify, fines must either consist entirely of qualifying material or contain only a minimal amount of non-qualifying material, must not be artificially mixed or hazardous under WM3, and must pass the Loss on Ignition (LOI) test with a result of 10% or less (Revenue Scotland, n.d.). Otherwise, they are subject to the standard rate.

Some waste producers intentionally misclassify mechanical fines to avoid the higher rate of tax, using blending techniques to bring LOI values down (Ali, 2023; SEPA, C&D waste management processor interview, commercial landfill operator interview). Many small- to medium-sized skip operators handle this waste, making enforcement difficult (waste industry association and commercial remediation company interview).

5.2 Soils and stones from construction waste: EWC 17 05 04

The EWC code 17 05 04 refers to non-hazardous soils and stones from C&D waste (including excavated material from contaminated sites) (Dsposal, n.d.; Environmental Standards Scotland, 2024; Katsumi, 2015; Commercial remediation company interview; C&D waste management processor interview). In Scotland, this material becomes waste after removal from a site. It can be used for work on site without being classified as waste.

Soils and stones require multiple tests. They must be classified as hazardous or non-hazardous following the WM3 classification. When subjected to testing it is likely for other materials to be found, which could make the soil active (non-inert), such as grass. Unless the contaminating materials are in small amounts and pass the soil LOI test, the whole load will be charged the standard rate. Non-hazardous soil and stone can only be disposed of in inert landfill sites and charged the lower rate if a WAC test confirms this is appropriate. A WAC test will determine the leaching ability of any contaminants in the soil.

5.3 Misalignment in waste code and policy guidance

This section compares EWC code definitions (Dsposal, n.d.), Revenue Scotland guidance (Revenue Scotland, n.d.), and SEPA guidance (SEPA, 2015) for the three priority materials.

The Scottish Landfill Tax (Qualifying Material) Order 2016 determines which materials qualify for the lower tax rate. There are seven groups of materials which qualify for the

[3] Diversion options for gypsum have been reviewed, as the upcoming ban on landfilling biodegradable waste may unintentionally make it easier to landfill gypsum. Currently restricted from co-disposal with biowaste, gypsum may no longer face this barrier once all landfills exclude biodegradable waste.

lower rate. However, these seven qualifying material groups and EWC codes do not align. This allows material to be classed as standard or lower rate under a single EWC code, as seen in the analysis of waste quantities (Section 4.3). Such misalignment is common in other jurisdictions in the UK and beyond with the widespread use of EWC codes and varying landfill policies.

Table 3 below presents a systematic review of the EWC codes for the priority three materials against other categorisations in Scottish policy. This provides a more specific, detailed understanding of these material streams.

Soils and stones (EWC 17 05 04) are the most straightforward to categorise, aligning clearly with **Group 1** (Rocks and soils) and with no additional SEPA definitions or overlaps.

In contrast, mechanically treated fines (EWC 19 12 12) are the most complex to classify. As discussed in Section 5.1, this code can encompass materials across **all seven qualifying groups**, depending on source and composition, making consistent classification more challenging and reliant on testing and operator descriptions.

Table 3: Alignment of priority EWC codes with SLfT and SEPA definitions

Priority material	Mechanically treated mineral fines	Mechanically treated fines	Soil and stones
EWC code	EWC 19 12 09	EWC 19 12 12	EWC 17 05 04
EWC chapter	EWC 19 12: the mechanical treatment of waste, for example sorting, crushing, compacting or pelletising (Dsposal, n.d).	EWC 19 12: the mechanical treatment of waste, for example sorting, crushing, compacting or pelletising (Dsposal, n.d).	EWC 17 05: soil (including excavated soil from contaminated sites), stones and dredging spoil.
The Scottish Landfill Tax (Qualifying Material) Order 2016 groups	Group 1: Rocks and soils. Group 3: Minerals.	Group 1: Rocks and soils. Group 2: Ceramic and concrete materials. Group 3: Minerals. Group 4: Fines from the mechanical treatment to recycle furnace slags. Group 5: Fines from the mechanical treatment to recycle bottom ash. Group 6: Low activity inorganic compounds. Group 7: Fines from the mechanical treatment of plasterboard to recover gypsum.	Group 1: Rocks and soils.

SEPA definitions (SEPA, 2015)	Fines from processing naturally occurring rocks and soils (e.g. group 1). Fines from processing wholly inert bricks, tiles and concrete (e.g. group 3).	Fines from processing municipal recyclate or residual waste. Fines from the processing of mixed C&D waste.	No further definitions given.

6 Waste prevention and landfill diversion options

In this section, we outline findings on the end-of-pipe and upstream diversion options for the three priority materials described in Section 5: mechanically-treated fines, mechanically-treated mineral fines, and soils and stones. A preliminary feasibility assessment of these technologies is also presented.

'End-of-pipe' diversion options involve reprocessing materials that have already been classified as waste, to divert them from landfill. 'Upstream' diversion options entail keeping materials at their highest value and reducing waste generation. For mechanical fines, this means preventing C&D waste from being mechanically treated (for example, keeping bricks as bricks). For soil and stones, it involves direct reuse.

We use the term 'mechanical fines' where the diversion options relate to both mechanically-treated fines and mechanically-treated mineral fines.

6.1 Mechanical fines: End-of-pipe diversion

This section outlines the diversion options and associated barriers for mechanical fines. As some common challenges were identified, Section 6.1.1 first identifies overarching barriers relevant to all the diversion options. These barriers provide essential context for Sections 6.1.2 to 6.1.5.

6.1.1 Overarching barriers

Due to their complex and variable composition and technical processing requirements, mechanical fines are difficult, risky and costly to recover. According to a waste management company representative interviewed, currently only large- and medium-sized regional players are able to recover a proportion of mechanically-treated fines.

- **Material complexity (technical barrier):** Mechanical fines contain mixed materials, sometimes requiring washing to remove contaminants (Burdier *et al.,* 2022). Differing physical and chemical properties, including composition and size, affect the feasibility of end-of-pipe recovery (Hernandez Garcia *et al.,* 2024). This is further impacted by Scotland's wet climate, which reduces the effectiveness of dry screening technologies (as highlighted in research conducted by Ricardo for ClimateXChange, due to be published in summer 2025). Composition testing to match materials to diversion options is expensive. Virgin materials are often easier and cheaper to use.

- **Contamination (health and safety barrier):** Heavy metals in some mechanical fines pose health and safety risks, limiting recovery (Oujana & Sanchez, 2018). Washing removes some contaminants (Vincent *et al.,* 2022), but can create toxic wastewater and solid waste requiring further treatment (Cottrell, Ali and Etienne, 2024). The circularity benefits should be weighed against the resources and power needed to wash and process fines.
- **Processing infrastructure (operational barrier):** Washing plants remove silt and clay to produce clean aggregate. However, washing systems are expensive and often require bespoke designs so they do not clog processing systems, reducing efficiency (Vincent *et al.*, 2022; C&D waste management processor interview). Stakeholders cite uncertain policies and tax implications as barriers to investment (C&D waste management processor, C&D skip operator and SEPA interviews).
- **LOI testing (health and safety and regulatory barrier)**: LOI determines whether fines qualify for the lower rate tax or if they can be reused (interviews with C&D waste management processor and Commercial landfill operatorSUEZ). One interviewee reported that use of LOI tests to achieve end-of-waste status for mechanical fines was not permitted by SEPA due to its uncertain composition:

  "We tried for a couple of years to get end-of-waste status on this material because some of the material, it does look really good and it would serve a purpose in further aspects of construction. But they're very adamant that it's a big no, because of the testing and because this material doesn't come from a single source. You can't test it as a single source, so it's a bit of an unknown." (C&D waste management)

- **Liability (enforcement barrier)**: The current liability structure is a barrier to diversion, as it places the risk of misclassification on landfill operators rather than waste producers. This reduces producers' incentive to ensure accurate classification or pursue upstream diversion. With no direct repercussions, producers can intentionally or unintentionally misclassify mechanical fines as lower-rate material (see Section 5.3).

The following sections detail end-of-pipe diversion options for mechanical fines, noting more specific barriers to mechanically-treated mineral and mechanically-treated fines where relevant.

6.1.2 Landfill/quarry cover, engineering and restoration

Inert mechanical fines are used for engineering and landscaping, such as quarries and pavement base layers, or for daily landfill cover. There is demand in Scotland for such uses, particularly due to a shortage of soils and stones (commercial landfill operator interview). While this can support diversion from landfill, it can waste nutrient-rich fines that might be better suited for agricultural use (Renella, 2021).

6.1.3 Recycled aggregate

Mechanically-treated mineral fines can be stored on site for six months and reused as aggregate without a waste licence under the Waste Management Licensing (Scotland)

Regulations 2011 (schedule 1, paragraph 19). Mechanically-treated fines do not qualify for this exemption, however, and SEPA does not include them as waste suitable for the manufacture of recycled aggregate (SEPA, 2013).

Recycled aggregates (from crushed bricks, ceramics, and concrete) are used in roads, railways, and non-structural concrete production. Their carbon footprint can be lower than virgin aggregates when transport distances are short (ClimateXChange and Ricardo, 2025).

Reducing the environmental impact of concrete through recovery of inert fines has received a lot of research interest. For example, in 2023, 934 publications about reuse of clay waste (e.g. brick powder) in cement mixtures were published (Hernández García, Monteiro and Lopera, 2024). Studies suggest the material could replace 10-20% of virgin sand in non-structural concrete (Mansoor, Hama, Hamdullah, 2024; Ali, 2023; Zhao, *et al.*, 2020). Despite the diversion potential for fines, innovations have not been scaled up commercially as virgin aggregates are favoured (European Commission, 2023).

Barriers:

- Recycled aggregates have different properties to natural aggregates and suit only low to moderate strength concrete (European Commission, 2023; Ali, 2023; Transport Scotland *et al.,* 2020*;* commercial landfill operator interview; Ferriz-Papi and Thomas, 2020).
- Fine material can be inappropriate for some filling activities. For example, fines can be too smooth for use in layers for road-based applications (Burdier *et al.*, 2022). It could be beneficial to consider other diversion options that suit these physical properties, such as reuse in paint to improve grip, rather than invest in technologies to change them.
- Quality and supply of fines are inconsistent (European Commission, 2023).
- Despite a high concentration of wash plants in Scotland (C&D waste management processor interview), mechanical fines require further space and infrastructure investment to be diverted to precast or ready-mixed concrete plants (European Commission, 2023).
- Wet fines from wash plants require more cement in concrete mixtures, increasing resource use and cost (commercial remediation company interview). Raw material and energy savings from using recycled aggregate need to be balanced against these impacts.
- The lack of market uptake of recycled aggregates is likely due to a lack of know-how by concrete producers and trained personnel for recycled aggregates production (ClimateXChange and Ricardo, 2025; European Commission, 2023; Hernández García, Monteiro and Lopera, 2024).

6.1.4 Land treatment and agricultural soil improvement

Inert mechanical fines can improve land, for example, by stabilising soil through land remediation or as a fertiliser for agriculture (Manning and Vetterlein, 2004; Burlakov, *et al.,* 2021; Ali, 2023). This could be a positive diversion option for mechanically-treated mineral fines that are less useful for construction purposes (Renella, 2021).

Mechanically-treated fines can help replenish nutrients to the soil and reduce reliance on commercial fertilisers (Braga *et al.,* 2019; Szmidt and Ferguson, 2004; Campe, Kittrede and Klinger, 2012). By mixing these fines with organic materials, they can create a soil-like material for plants to grow in. Some fine particles, like clay, silt or ash, help keep the organic matter stable (Haynes, Zhou and Weng, 2021; Renella, 2021).

Mechanically-treated fines contain a mixture of these materials. However, the UK Government restricts the use of soil substitutes made from mechanically-treated fines as opposed to mechanically-treated mineral fines (Environment Agency, 2023b). This can only be done under specific permits, such as for landfill restoration schemes, and when ecological improvement is also demonstrable.

In Scotland, under the Waste Management Licensing (Scotland) Regulations 2011 (schedule 1, paragraph 9), exemptions allow the use of mechanically-treated mineral fines on land for agriculture and ecological improvement. Waste companies in Scotland sometimes use mineral fines from skips to create compost for local agriculture (C&D skip operator interview). SEPA, who registers such activities, has reported that this exemption often results in farmers being paid to accept such waste to reduce landfill disposal costs (SEPA interview). However, it is uncertain how much is used for genuine purposes, and how much is diverted to avoid paying tax (C&D waste management processor interview).

Barriers:

- Silt and clay fines, which are beneficial for soils, are generally landfilled and this is because of high contamination of heavy metals or presence of organic materials (Renella, 2021).
- Nutrient content varies, limiting predictability of composition and related cost savings for farmers. For example, recycled mechanical fines with high nutrient content can reduce costs by 25%, whereas those with low nutrient content may increase costs by 9% (Braga *et al.*, 2019).
- Potential conflicts with regulation on fertilisers. For example, UK government restricts the use of soil substitutes made from mechanically-treated fines (Environment Agency, 2023b) and new EU regulations may exclude some fines from fertiliser use (Renella, 2021).

6.1.5 Gypsum fines recycling

Gypsum fines (within EWC 19 12 12) can be recovered from plasterboard and used to make new plasterboards, cement, blocks and bricks (commercial landfill operator interview; Suárez, Roca and Gasso, 2016). Gypsum can also be used to improve soil in land remediation, particularly in areas with alkalinity or heavy metal contamination. SEPA advises that this is acceptable for treating land that has been flooded by seawater (SEPA, n.d).

Waste owners are encouraged to separate gypsum from other waste for recovery, as there are feasible diversion options and “because there’s a good recycling market for gypsum” (waste industry association interview). However, according to a commercial landfill operator, the composition of mechanically-treated fines “tends to be quite high in plasterboard and gypsum, which then means that we struggle to control the gas and the odours”. Gypsum can only be disposed of in landfills where no biodegradable waste is accepted as it has hazardous properties, releasing gas and odour, when mixed with biodegradable waste (commercial landfill operator interview).

When the ban on biodegradable waste to landfill is introduced at the end of 2025, it will potentially make the lower-rate landfill of mechanically-treated waste containing gypsum easier. Additional incentives for diversion to counter this could be necessary.

Barriers:

- Recycled gypsum has high market demand, but the lower rate categorisation encourages landfill over recycling (waste industry association interview, commercial remediation company interview, commercial landfill operator interview).
- Heavy contamination of mechanical fines restricts the potential to find and extract gypsum (Suárez, Roca and Gasso, 2016).
- Lack of incentives to enhance sorting of gypsum and plasterboard; and conversely incentives to process waste products containing gypsum into mechanical fines to qualify for the lower-rate tax (commercial landfill operator interview).

6.2 Mechanical fines: Upstream diversion

This section describes the upstream diversion options involving the reduction and reuse of concrete, bricks, tiles and ceramics. These options can prevent mechanical fines from being generated in the first place.

6.2.1 Reducing demolition through refurbishing and retrofitting

Refurbishing or repurposing buildings and assets extends their usable life, avoiding the generation of demolition waste. In doing so, it helps reduce both material use and embodied carbon, making it a key strategy for sustainable construction.

Lifecycle analysis (LCA) is a valuable tool for comparing the impacts of refurbishing and retrofitting with demolition and new build. While new builds may achieve lower operational carbon, they usually require more materials and result in more embodied carbon emissions. In many cases, this means retrofit has lower emissions overall.

Adopting a retrofit-first approach can reduce unnecessary demolition, prioritising reuse unless structures are severely derelict or face irreparable structural issues (Green Alliance, 2023; construction company interview). To support this, pre-demolition assessments could be introduced earlier in the planning process, ensuring that any proposed demolition is justified in terms of carbon and material impacts (Green Alliance, 2023).

Barriers:

- VAT policy favours new builds (0%) over renovations (20%) (Green Alliance, 2023).
- Current policies focus on reducing operational emissions, such the Heat in Buildings Strategy to increase energy efficiency (Scottish Government, 2021a), rather than embodied carbon emissions (Green Alliance, 2022).
- Circular principles are underused in construction and infrastructure, such as rail infrastructure projects (O'Leary, Osmani and Goodier, 2024).

6.2.2 Reduction and reuse of construction materials

Reducing demand for materials in the design stage has the greatest impact on reducing the environmental impact of construction (Green Alliance, 2023). This is particularly important for cement, which is challenging to remove from a building for reuse. Reduction and reuse can be increased through circular construction tools and approaches, sometimes described as ‘modern methods of construction’. These can improve companies’ understanding of GHG emissions throughout their supply chains. Examples include modular buildings, digital tools such as material passports, offsite manufacturing, and sustainable material substitution (Green Alliance, 2023).

Barriers:

- Current circular building standards are voluntary, such as the UK Net Zero Carbon Building Standard, and the Scottish Government’s Net Zero Public Sector Buildings Standard (Scottish Government, 2021b; UK Net Zero Carbon Building Standards, n.d.). Construction design is determined by the client. With voluntary initiatives, cost factors are more likely to win over environmental factors (Construction company interview).
- There are no mandatory requirements for construction companies in Scotland to conduct an LCA or report scope 3 emissions (those in its upstream and downstream value chains, which typically include the majority of material-related impacts) (construction company interview; Green Alliance, 2022).
- Skills shortages and inconsistent standards, for instance for LCAs and product passports, limit the sector’s ability to apply circular practices (Hurst and O’Donovan, 2024; construction company interview).
- Certain industry practices lead to unnecessary waste. For example, to ensure they have enough supply, contractors will often order 5-10% surplus, which can be hard to reuse (construction company interview).
- Sustainable construction materials often cost more (construction company interview).
- Environmental benefits of modern methods of construction are not fully accounted for in public procurement and other financial investment opportunities (Green Alliance, 2023).

6.2.3 Designing for deconstruction

Designing buildings with future disassembly in mind allows more materials, especially bricks and tiles, to be reused instead of downcycled. Such direct reuse has a greater impact in reducing raw material use than recycling (Green Alliance, 2023). However, deconstruction should only be pursued if the building is not fit for repurposing (construction company interview).

Early sorting of demolition materials also improves recovery outcomes. Many mechanical fines are produced from mixed, unsorted demolition waste, which results in variable and lower-quality outputs. Sorting materials earlier produces cleaner, inert fines that are more straightforward to reuse (C&D waste management processor interview, SEPA interview).

A major barrier to recovery and recycling of mechanically-treated fines is their complexity and variability (Section 6.1.1). To minimise the challenges associated with this, upstream measures should support sorting at source, before waste reaches skips or waste transfer sites (C&D waste management processor interview, SEPA interview). Greater source separation would generate more inert-only fines, which are also easier to find uses for due to waste management exemptions.

Barriers:

- Mainstream current and historical construction practices do not design for deconstruction (Arup and Ellen McArthur Foundation, 2020).
- Investors are not incentivised to incorporate circularity principles in design, considering material recovery (Arup and Ellen McArthur Foundation, 2020).
- Demand for low-quality recycled aggregate (Section 6.1.2) takes the focus away from higher-quality recycling and reuse.
- Integrated C&D tools and requirements for identifying, classifying and certifying salvaged materials are lacking (construction company interview).

6.3 Soil and stones: End-of-pipe diversion

This section explores the end-of-pipe diversion options for soils and stones from construction waste (EWC 17 05 04). End-of-pipe diversion options are concerned with when the material is classified as waste, and is then reprocessed into another material. As there are many exemptions for soil and stones reuse, the main diversion options are upstream, occurring before waste classification. The main end-of-pipe diversion option is to produce recycled aggregates.

6.3.1 Recycled aggregates

Soils can be washed to separate sand, gravel, and stone from contaminants, especially on brownfield sites, and reused as aggregate in construction (Magnusson *et al.,* 2015; Choi *et al.,* 2018; waste industry association interview).

Barriers:

- Recycled aggregate is more expensive than virgin materials (Magnusson *et al.,* 2015; commercial remediation company interview). Quarrying for natural aggregate is cheaper and more accessible (commercial remediation company and waste industry association interviews).
- Soil remediation technologies are not widely used in Scotland (C&D skip operator interview).
- Fluctuations in cost and quality lead to inconsistent demand, impacting the feasibility of supply. For example, a facility failed in 2016 due to lack of demand (commercial landfill operator interview). There is good supply in Scotland of recycled quarry materials, but demand is low (commercial remediation company interview).
- There is low industry understanding of how to use recycled aggregates. For example, road projects where the ground is damp tend to require natural aggregates; recycled aggregates are more applicable for farm tracks, because they meet requirements for tractors more easily than cars (C&D skip operator interview).

- There is a higher recycling and reuse rate for soils and aggregates on site; what is taken off site tends to be less usable (C&D skip operator interview).

6.4 Soil and stones: Upstream diversion options

This section covers how soils and stones can be kept on site or reused at another site under exemptions, avoiding classification as waste.

6.4.1 Landfill/quarry cover, engineering and restoration

Soils and stones are used for temporary or final landfill cover, haul roads within a site, and restoring quarry sites. In landfill restoration, layers of subsoil and topsoil must be added, to enable development of vegetation (SEPA, 2018).

In Scotland, exemptions from SLfT apply under the Waste Management Licensing (Scotland) Regulations 2011 (Schedule 1, paragraph 9). This relates to where soil and stones treat land for agricultural or ecological benefit. Soil and stones are not subject to the same per-hectare limits for infilling agricultural land as other waste types (Waste Management Licensing Regulations, Schedule 2, paragraph 2), making it easier to divert them in larger quantities.

Barriers:

- Fewer landfills are operational. The number has declined since 2005 (SEPA, 2023) and this is expected to reduce further after the ban on landfilling biodegradable municipal waste (interviews with commercial remediation company; waste industry association; large public body).

6.4.2 Landscaping and construction

On-site reuse of soils reduces transportation and storage issues, making it the most cost-effective option (commercial remediation company interview). Transfer to another work site requires a waste management licence or exemption. Exemptions apply where soils and stones are used to treat land, provided certain conditions are met (Waste Management Licensing (Scotland) Regulations 2011, Schedule 1, Paragraph 7).

SEPA has issued regulatory guidance to support the sustainable reuse of greenfield soils which are soils from undeveloped, uncontaminated land. The soil must be used for a specified purpose, identified before excavation begins, and transfer must be approved by SEPA. Purposes may include the operational land of railways or land which is woodland, park, garden, verge, landscaped area, sports or recreation ground, churchyard or cemetery.

Interviewees indicated that practices for coordinating soil reuse in Scotland vary between projects based on developers (commercial remediation company and engineering consultancy interview). Public sector contracts sometimes include reuse requirements, while private contracts typically show less incentive. Carbon considerations are an emerging driver for on-site reuse, where these materials are less ideal than virgin quarry materials but still meet requirements (engineering consultancy interview).

Barriers:

- The UK has over 700 soil types requiring thorough classification by type (topsoil/subsoil) and hazard level (hazardous/non-hazardous, active/inactive) prior to reuse (The Royal Society, 2020; Soil Association, 2021).
- Mismatches in soil type, availability, project timelines, and storage requirements often hinder reuse (Thompson, 2021; Choi *et al.,* 2018; Hale *et al.,* 2021; Marasini *et al.,* 2012; SEPA, commercial remediation company and engineering consultancy interviews).
- Geography and pressure to keep heavy vehicle movements off community roads incentivises finding reuse options close to sites of origin, but timing can prevent this (engineering consultancy interview).
- In some cases, the SLfT can have less negative financial impact on a project than costs of storage, transport, or project delays, making reuse impractical (engineering consultancy interview).
- Reuse of soil and stones may be deprioritised compared to the sustainability of manufactured materials like concrete (Berryman *et al*., 2023) especially where time and budget constraints apply (commercial remediation company and engineering consultancy interviews).
- Reuse options for contaminated soils are limited. Untreated soil is costly to landfill, while treated soil is typically restricted to low-grade uses such as embankments (engineering consultancy interview).
- Liability concerns discourage topsoil reuse as developers and landowners remain responsible for future environmental impacts (Hale *et al.,* 2021).
- Multiple compliance pathways such as exemptions, permits, and definition of waste protocols create confusion, increasing the risk of non-compliance, misclassification, and illegal disposal (commercial remediation company interview; Thompson, 2021).
- Despite Berryman's et al. (2023) guidance aimed at harmonising best practice, industry uptake remains inconsistent. The absence of a unified legislative framework results in varied approaches across agriculture, land development, engineering, and land management sectors (Thompson, 2021).

6.5 Preliminary feasibility assessment of diversion options

This section presents an indicative assessment of the viability of different waste diversion options for the three priority materials: mechanically-treated fines (19 12 12), mechanically-treated mineral fines (19 12 09), and soils and stones (17 05 04). The assessment considers how feasible the diversion options currently are. This includes information on current use, research and development activity, and the barriers mentioned above in section 6.

The feasibility score therefore indicates the extent that future interventions are needed to target barriers and enable diversion. The feasibility scoring is as follows:

- 1 = Not currently feasible, would require significant intervention to upscale.
- 2 = Feasible to some extent, some barriers would need to be addressed.
- 3 = Most feasible, already happening widely in Scotland.
- n/a = not applicable, didn't come up as a diversion option for the material in the research.

The methodology behind this assessment can be viewed in Appendix D.

Tables 4 and 5 below present the preliminary feasibility assessment of the end-of-pipe and upstream diversion options. For reference we also include a general impact rating of the technology based on the findings from desk-based research and stakeholder interviews. The impact rating reflects the overall environmental and circular economy benefits (e.g. quantities of materials diverted from landfill) that could be achieved if the option were implemented more widely, using a simple scale of ‘high’, ‘medium’ or ‘low’.

Key takeaways of the assessment are:

- **Mechanically-treated fines** have a limited number of feasible end-of-pipe solutions at present. Landfill cover and gypsum recycling are technically possible, but most other downstream options score low on feasibility and offer only low to medium impact. As a result, it is likely better to prioritise upstream interventions – such as deconstruction, modular construction, and refurbishment – for their higher impact potential, even though they are not yet widely adopted.
- **Mechanically-treated mineral fines** have more feasible end-of-pipe diversion options, including reuse in land restoration and aggregate recycling. These options are already in operation and could be scaled further considering the opportunity to provide ecological improvements so maximum value is retained.
- **Soils and stones** show the greatest feasibility overall, particularly for recycled aggregates and reuse in landscaping. While some remediation technologies are not yet fully developed, most of the downstream options are already in use.
- **Gypsum and plasterboard** recycling is moderately feasible and could play a larger role with better separation and recovery at source.
- **Upstream interventions** such as modular construction, deconstruction, and refurbishment, score high on impact across all materials where relevant, but face barriers related to investment, data, and planning. Technological readiness is improving – especially with AI-driven solutions for sorting and design – and deployment is likely to increase in the next 5–10 years with the right incentives and digital infrastructure.

Table 4: Preliminary feasibility assessment of end-of-pipe diversion options

Diversion options	**Potential impact (low, med, high)**	**Mechanically-treated fines**	**Mechanically-treated mineral fines**	**Soils and stones**
Landfill/quarry cover, engineering and restoration	Low	3	3	3
Recycled aggregates	Medium	1	2	3
Land treatment and agricultural soil improvement	Medium	1	3	n/a
Gypsum fines recycling	Medium	2	n/a	n/a

Table 5: Preliminary feasibility assessment of upstream diversion options

Diversion options	**Potential impact (low, med, high)**	**Mechanically-treated fines**	**Mechanically-treated mineral fines**	**Soils and stones**
Remediation technologies (e.g. soil washing)	Medium	1	1	2
Landscaping and construction soil reuse	High	n/a	n/a	2
Modular construction and material reuse	High	1	1	n/a
Deconstruction and material sorting	High	1	1	n/a
Refurbish or retrofit before demolition	High	1	1	n/a

Key (see the methodology above for more information)

Score	Colour
1: Not currently feasible	
2: Feasible to some extent	
3: Most feasible	
n/a: Not a diversion option	

7 Policy assessment

This section provides an overview of existing policies influencing the management and diversion of the three priority materials. It also identifies policy gaps and presents potential interventions discussed in previous sections to enhance waste diversion, aligning with Scotland's environmental objectives.

7.1 Overview of existing policies

Several key policies and fiscal mechanisms shape the management and disposal of the priority materials in Scotland. Some policies are devolved to the Scottish Government, while others are reserved, under UK Government control. These policies shape the incentives and barriers encountered by waste producers and processors in diverting materials from landfill.

7.1.1 Fiscal measures

Scottish Landfill Tax (SLfT), the focus of this study, is devolved legislation introduced in 2015 to reduce the environmental impacts of waste, encouraging waste reduction and adherence to the waste hierarchy in Scotland. While standard-rate SLfT has risen significantly to £126.15 per tonne in 2025-26, the lower rate (£4.05 per tonne in 2025-26) remains considerably lower, as is broadly the case in the rest of the UK. As discussed, this lower rate is applied to seven groups of qualifying materials (Section 5.3), typically inert or less polluting wastes such as some construction and demolition waste. The lower-rate aims to provide an economic incentive for their diversion from landfill while avoid imposing undue costs on sectors where alternative treatment options may be limited.

The **Aggregates Levy (AGL)** is a UK-wide tax applied to commercially exploited (virgin) crushed rock, sand, and gravel to encourage the use of recycled alternatives. A **Scottish Aggregates Tax (SAT)** is expected to replace the UK AGL from April 2026, offering an opportunity to explore ways to further incentivise the use of secondary aggregates (Scottish Government, 2024b).

The **Climate Change Levy (CCL)** and **Carbon Price Floor (CPF)** are UK-wide fiscal measures designed to reduce carbon emissions by taxing energy use and setting a minimum price for carbon from electricity generation (HM Revenue and Customs, 2024). While these policies primarily lead to emissions reductions (Döbbeling-Hildebrandt *et al.* 2024, p.2) they also indirectly affect waste management across the UK by incentivising energy efficiency and low-carbon industrial processes.

7.1.2 Other regulatory measures

The Waste (Scotland) Regulations 2012, which are devolved secondary legislation, require waste producers to prioritise prevention, reuse, and recycling over landfill disposal (Scottish Government, 2012b). Businesses must segregate recyclable materials to improve recycling rates (Zero Waste Scotland, 2023). While these regulations reinforce waste hierarchy principles, they do not specifically address lower-rate waste streams.

The upcoming **ban on biodegradable municipal waste (BMW) to landfill**, effective 31 December 2025, is a devolved Scottish Government policy aimed at reducing environmental impacts from organic waste. While this ban will primarily impact standard-rate waste (Scottish Government, 2022), it could have indirect consequences for certain lower-rate materials. Minerals, and soils and stones, traditionally used for landfill engineering purposes, may see temporarily higher demand for use in landfill closures, but a long-term decline in demand. Alternative diversion pathways would be needed for these to align with Scotland's circular economy objectives. In addition, gypsum, which currently can only be landfilled at sites without bio-waste, is likely to become easier to landfill. There may also be an increase bio-based mechanically-treated fines from municipal waste streams. Increased enforcement of fines' classification and incentives for recycling may therefore be required. However, the ban will not signal the complete end of bio-waste to landfill, as it includes certain exemptions.

Digital Waste Transfer Notes (WTNs), a UK-wide initiative, aims to improve traceability and enforcement by transitioning to an electronic system for recording waste movements (DEFRA, 2023). This system aims to reduce the misclassification of waste, including lower-rate materials like mechanically-treated fines, by providing greater transparency in the movement of waste. It is expected to "shine a light on transactions and actors" currently missing from the system, while enhancing compliance with landfill tax regulations (CIWM, 2023). The April 2025 roll-out has recently been postponed to April 2026.

These are the key fiscal and regulatory policies interacting with lower-rate materials. However, gaps remain in their effectiveness for supporting diversion options for the three categories of waste which make up the bulk of lower-rated waste in Scotland notably mechanically-treated fines, soils and stones, and mineral waste. Addressing these gaps could involve targeted interventions, as discussed in the following sections and Appendix A.

7.2 Policy gaps and potential interventions

Despite existing regulatory and fiscal policies, several policy gaps hinder the effective diversion of lower-rate materials from landfill, such as mechanically-treated fines, and soils and stones from construction. These gaps are categorised according to their relation to either end-of-pipe waste management or upstream prevention in the material life-cycle.

This section outlines potential interventions to address such gaps. These are not policy recommendations but options to consider. Further research, analysis and consultation would be required before deciding whether to take any, or all, forward.

7.2.1 End-of-pipe diversion

7.2.1.1 Compliance risks and landfill misclassification

A key enforcement challenge is misclassification of waste at landfill sites. The widening gap between standard- and lower-rate SLfT (now standing at above £100 per tonne in 2025-26) may have inadvertently created financial incentives for waste producers to classify waste as lower-rate whenever possible. Along with the complex classification criteria (see section 5.3), this may have led to both deliberate and unintentional misclassification, particularly for mechanically-treated fines.

Rather than being residual outputs of material recovery, large quantities of fines are purposefully produced to qualify for the lower rate (Section 6.1.1). This distorts waste tracking data and results in potentially recoverable material being landfilled.

Landfill operators hold tax liability for misclassification, even though they do not generate or pre-process the waste. This creates financial risks for operators, leading some to refuse lower-rate fines altogether.

Ambiguity in classification raises costs for both regulators and waste operators. Waste producers may unintentionally misclassify waste due to lack of clear, standardised guidance, leading to incorrect application of the lower tax rate (see Section 7.2.1.1). Although better guidance could reduce some misclassification, it is unlikely to fully resolve the issue. This is because the underlying rules that determine whether fines are subject to the lower or standard rate are themselves complex and difficult to apply consistently, particularly when mapped against EWC waste code classifications (see Section 5.3). Clearer guidance may help reduce ambiguity, though it may also be worth exploring whether simplification of the tax qualification rules could support more consistent classification.

A recent SEPA report on the BMW-to-landfill ban notes that sorting residues from processing municipal waste (including mechanically-treated fines) may be generated in greater volumes in order to bypass the ban (SEPA, 2024a). This risks undermining the intent of the bio-waste ban policy through reclassification rather than genuine diversion. This risk is supported by our findings about the production of mechanically-treated fines to qualify for the lower rate (Section 6.1.1).

Potential fiscal interventions:

- Explore the feasibility of a specific tax rate for mechanically-treated fines which is much closer to the standard rate, or reclassification under the standard rate. This could discourage excessive fines production while retaining the lower rate for less problematic inert materials. A careful balance would need to be struck to avoid unintended consequences, particularly for businesses reliant on landfill for inert waste management. Supportive measures, addressing upstream value chains, would likely be needed.

Potential non-fiscal interventions

- **Technical**: Review LOI testing requirements to ensure they do not deter investment in fines processing, while maintaining environmental safeguards (C&D waste management processor interview; waste industry association interview; C&D skip operator interview).

- **Enforcement**: Explore the potential for enhanced regulatory oversight through the upcoming digital waste transfer notes (WTNs) system to track and verify waste classification at source rather than at landfill. Through this, tax liability for misclassified mechanical fines could be shifted to the company which produced the fines, even if this is discovered after it has been accepted at landfill, along with penalties for misclassification.
- **Other**: Improve guidance on EWC code classification by providing clearer criteria to support consistent decisions on whether waste qualifies for the lower rate. This could include practical examples of lower-rate materials, decision trees, and alignment with the upcoming digital waste transfer note system. In the longer term, there may also be value in exploring whether simplifying the underlying rules on lower-rate material classification could further reduce classification ambiguity.

7.2.1.2 **Separation and recovery of mechanically-treated fines**

Inadequate pre-sorting of C&D waste leads to contamination and fines production. Once contaminated, fines are difficult to reprocess. Industry practices in Scotland and globally do not sufficiently prioritise separation at the source, meaning valuable materials are lost to landfill.

Potential fiscal interventions:

- Continue strengthening incentives to increase the demand for recycled fines. This is already starting with the planned introduction of the Scottish Aggregates Tax in April 2026 which will initially align with the UK Aggregates Levy. Over time, there may be scope for policy divergence in Scotland. Additional financial incentives – such as tax breaks or recycled content requirements – could drive up industry circularity, such as for reused material content, recycled material content and reusable materials (Green Alliance, 2023). However, interventions would have to avoid unintended consequences related to availability of recycled fines. This could be a particular issue in rural areas, which are further from recycling infrastructure (commercial remediation company interview).

Potential non-fiscal interventions:

- **Technological**: More support for technologies and infrastructure to reprocess fines and reduce contamination could help address issues with fines in washing facilities. Programmes like the Knowledge Transfer Partnership could play a role. Existing examples include phytoremediation, which uses plants and microorganisms to degrade pollutants and reduce heavy metals (Yadav *et al.,* 2022).
- **Technological**: Technologies exist to make the shape of fines coarser and more suitable for construction purposes, though the outputs are currently more costly than natural aggregates (C&D skip operator interview). Further reuse routes could be explored, for example how to promote fine aggregates being added to paints for flooring to increase traction.
- **Regulatory**: Encourage early-stage waste management planning by integrating material audits into construction permitting. This includes site investigations, sampling and testing to support effective use of recycled aggregates.

- **Other**: Improve industry understanding of recycled fines through guidance and awareness campaigns, including how and when they can be reused (C&D skip operator interview).

7.2.1.3 Cross-border waste movement risks

SLfT operates within a broader UK framework, presenting cross-border waste movement compliance challenges. For instance, if Scotland increased its lower-rate SLfT while England maintained the current lower rate, waste exports may increase, undermining the tax's effectiveness as well as Scottish tax revenues. Similarly, restricting mechanical fines' eligibility for the lower rate in Scotland could lead to this waste stream being diverted to England instead of being recovered.

These risks are particularly relevant in light of recent and proposed changes across the UK. As mentioned, the Welsh Government increased its lower rate of Landfill Disposals Tax in 2024, and the UK Government is currently consulting on significant reforms to Landfill Tax in England and Northern Ireland, with the consultation due to conclude in July 2025 (HM Treasury and HMRC, 2025).

Introducing financial or enforcement-based interventions is challenging in a cross-border context. The Scottish Government has limited or no authority over waste processed or disposed of in other UK jurisdictions.

Potential fiscal interventions:

- Considering penalties for cross-border misclassification, similar to Wales' Unauthorised Disposals Tax (150% of the standard rate) and the proposal in the UK government's consultation (200% of the standard rate) which creates an additional financial deterrent for people seeking to dispose of waste illegally.

Potential non-fiscal interventions:

- **Regulatory/enforcement**: Enhancing regulatory and enforcement coordination between Scotland, England, and Wales to ensure greater policy consistency and prevent waste tourism.

7.2.2 Upstream diversion

Reducing reliance on landfill also requires preventing lower-rate materials from being generated as waste. However, this is constrained by limited incentives for circular practices, inconsistent reuse standards, weak producer responsibility measures and insufficient integration of circularity in planning and procurement.

7.2.2.1 Lack of incentives for designing in circularity

Soils, stones, and minerals removed from C&D sites are often generated, and classified as waste, without efforts to improve their quality or assess their reuse potential. This results in unnecessary landfill disposal, despite available prevention and recovery pathways. Lack of guidance on soil and stone classification, combined with inconsistent reuse standards, means that secondary materials markets remain underdeveloped.

Mechanically-treated fines are often the result of poor material selection at the design and procurement stages. If more construction materials and products were designed for disassembly, reuse, or easier sorting, rather than demolition, the production of fines could be significantly reduced. Currently, there is no strong economic driver for waste producers to prioritise clean, separable materials over mixed waste streams that result in fines.

Current planning regulations and public procurement rules do not sufficiently integrate circular economy principles. Without upfront material assessments, valuable materials are classified as waste and disposed of unnecessarily.

The UK and the devolved nations are moving toward more comprehensive extended producer responsibility (EPR) schemes for other materials. If an effective system is adopted for construction, this could encourage producers to adopt circular practices and reduce waste generation at the design stage. There have also been sub-national developments in London, where large planning applications for approval by the mayor now require whole lifecycle carbon assessments, carbon reduction plans, and circular economy statements. Before a redevelopment or demolition plan can be approved, an audit must be carried out to determine the reuse potential of materials in the existing building (Mayor of London, 2022).

Circular economy policies such as these are needed to transition the construction sector as a whole, changing value chains so that much less of the priority materials in this study are generated. The lower rate of SLfT could be iteratively increased in tandem with these interventions, as a supporting measure; if it were to be raised too rapidly without supporting upstream interventions, negative impacts on the construction sector and on illegal disposal would likely occur.

Potential fiscal interventions:

- Consider raising the overall lower rate of SLfT to provide a greater incentive for circular practices on construction sites. Even a relatively modest increase could help to justify the costs of storing and transporting materials such as soils and stones for reuse (engineering consultancy interview). Wales' new lower rate (£6.30 per tonne) could serve as a benchmark. A rate of £6 per tonne was deemed viable by industry interviewees (commercial landfill operator and C&D waste management processor).
- Consider monitoring the development and impacts of the upcoming Scottish Aggregates Tax (SAT), which will replace the UK Aggregates Levy from April 2026. While the SAT will be limited to the commercial exploitation of aggregates as defined in the 2024 Act (Scottish Government, 2024b), its introduction provides a useful opportunity to review whether taxation influences the quantities of lower-rate aggregates sent to landfill. Insights from this review could help inform future considerations around the treatment of other virgin materials used in construction, within the context of devolved powers and existing legislative frameworks.
- Consider financial incentives for reuse in construction, such as tax relief for projects incorporating secondary materials (construction company interview).
- Ensure SLfT exemptions support the diversion of lower-rate materials from landfill. A review of existing and upcoming exemptions, for instance with the bio-waste to

landfill ban, may help assess their effectiveness in facilitating prevention, reuse and recovery while maintaining environmental protections.

- Consider engaging with HM Revenue and Customs over VAT reform, such as extending zero-rate VAT to refurbishment and retrofit to reduce incentives for demolition and new build construction.

Non-fiscal interventions

- **Policy**: Consider the expansion of EPR to cover construction materials, shifting financial responsibility for waste management onto producers to encourage modular design and reuse.
- **Policy**: Consider mandatory, rather than voluntary, circularity requirements targeting construction project clients (construction company interview). Investigate opportunities to strengthen public procurement rules to prioritise secondary materials, reuse, spoil management and design for deconstruction. These requirements could support more systematic waste prevention at the planning stage and drive investment in circular practices (SEDA, 2024; O'Leary, Osmani and Goodier, 2024).
- **Policy**: Consider reforms to embed circularity in planning policy, such as requirements for pre-demolition assessments, material recovery assessments before deconstruction and resource management plans to include deconstruction design (Construction company interview; Green Alliance, 2023).
- **Policy**: Explore adoption of carbon reporting tools that account for lifecycle emissions, including embodied carbon and Scope 3 (SEDA, 2024). Distinct reuse and recycling reporting for high-impact materials like concrete may also help reduce downcycling (Green Alliance, 2023).
- **Technological**: Consider supporting the development of product passports or material databases for construction materials to improve transparency and enable reuse (construction company interview).
- **Technological:** Consider the future use of AI and matching platforms to optimise design and reuse coordination (Huang et al., 2022; Choi et al., 2018; construction company interview).
- **Operational**: Consider investigating early-stage site audits, sampling and testing to support on-site recovery and reuse of recycled aggregates (C&D skip operator and engineering consultancy interviews).
- **Operational:** Consider the potential for construction material hubs to store and redistribute soils and other surplus materials. However, barriers remain around ownership, quality control, certification and fraud risk (commercial remediation company and construction company interviews).
- **Other**: Consider aligning government strategies on housing and urban development with circular economy targets to create long-term demand for reused materials (Green Alliance, 2023).
- **Other**: Consider investing in training and awareness to support greater uptake of recycled aggregates and reused soils. Cultural shifts may be needed to encourage viewing soil and stones as valuable resources, rather than 'dirt' (Thompson, 2021; Berryman *et al.,* 2023).

Addressing both end-of-pipe and upstream barriers will be essential for improving SLfT effectiveness and enhancing material recovery. As with other areas of circular economy policy, coordinated packages of measures working across material value chains, targeting incentives at multiple stakeholders, are likely to be needed. By considering these policy measures, Scotland could identify strategies to reduce landfill reliance, improve material efficiency, and accelerate its transition to a circular economy.

8 Conclusions

This section summarises the key findings of the research and assesses whether the lower-rate SLfT remains effective in supporting Scotland's environmental and waste management objectives. It also considers the broader policy implications, including potential enforcement challenges, unintended consequences, and cross-border impacts.

8.1 Summary of key findings

The lower rate of SLfT was introduced to enable the cost-effective disposal of low-risk, inert waste while ensuring compliance with Scotland's broader environmental policies. Overall landfill trends show a mild downward trend in landfilled lower-rate materials at least until early 2020 (Figure 1), suggesting the tax may have initially influenced disposal patterns. Tonnages of lower rate material to landfill have since fluctuated without a clear trend (Figure 1). This research identifies several factors that may influence the continued effectiveness of the lower rate:

- Lower-rate landfill disposal is dominated by three specific waste streams—mechanically-treated fines, soils and stones, and mechanically-treated mineral fines—which together accounted for 77% of all lower-rate waste landfilled in 2023-24.
- Mechanically-treated fines are landfilled in the greatest quantities out of all lower-rate materials, and have seen the greatest increase in quantities between 2021-2024 (with a slight dip in 2022-23). This is despite originally being intended as residual outputs from material recovery processes. This trend raises concerns over misclassification and evidence from our interviews of fines being produced on purpose.
- Environmental impact analysis highlights that mechanically-treated fines pose significant risks, contributing disproportionately to air pollution, resource depletion, and biodiversity loss compared to other lower-rate materials.
- Current SLfT structures, fiscal incentives, and policy measures are not effectively supporting higher-value diversion options for lower-rate materials. The relatively affordable lower tax rate continues to make landfill the most economically attractive option for many waste producers of the priority materials, as it does in some other parts of the UK.
- The upcoming ban on BMW (effective December 2025) will change landfill dynamics, reducing long-term demand for materials traditionally used in landfill engineering, and may lead to more lower-rate materials being sent to landfill.
- Misclassification of waste remains a major issue, exacerbated by complex EWC code classifications that do not always align with SLfT qualifying material criteria. The lack of easy-to-use guidance and strong oversight contributes to both deliberate and unintentional misclassification.

These findings suggest that while the lower-rate SLfT has played a role in reducing landfill disposal overall, there may be opportunities to better align it with Scotland's evolving circular economy and net zero ambitions.

8.2 Does the lower rate of Scottish Landfill Tax (SLfT) still support Scotland's environmental objectives?

The lower-rate SLfT was designed to provide a cost-effective landfill option for inert, low-risk materials while supporting Scotland's environmental policies, including waste reduction, emissions reduction, and adherence to the waste hierarchy. Since it was introduced, Scotland has introduced ambitious net zero targets and has increased its policy focus on achieving a circular economy. Compared to when the UK-wide Landfill Tax was first introduced in 1996, there is now more emphasis on reducing environmental impacts associated with upstream material use, rather than solely reducing emissions and hazards once materials are in landfill.

This research finds that the lower rate is no longer fully aligned with Scotland's environmental objectives. Evidence suggests that progress in diverting lower-rate materials may have stalled, with data indicating a levelling-off of lower-rate landfill tonnages since 2020–21 (Figure 1). In addition, there is insufficient incentive to divert materials upstream, including via the planning and design stages of the construction projects which generate much of these materials.

8.2.1 Misalignment with policy goals

While the SLfT was intended to discourage landfill disposal and promote alternative waste management options, the lower rate has, in some cases, created unintended incentives:

- Mechanically-treated fines have become a dominant lower-rate waste stream despite their potential for reduction and recovery, indicating that the tax structure may not sufficiently encourage more circular treatment of the mixed construction materials that make up this waste stream.
- The low cost of landfill disposal creates limited incentives for repurposing soils and stones, which could otherwise be reused in construction and landscaping.
- The lower rate of tax, at £4.05 per tonne (2025-26) appears to have had a limited impact in shifting waste up the hierarchy, with landfill remaining the most economically viable option for many waste producers.

8.2.2 Environmental and economic consequences

Mechanically-treated fines, which now make up a significant portion of lower-rate landfill disposal, have disproportionately high environmental impacts (on a whole life-cycle basis) compared to other lower-rate materials, including contributions to air pollution, resource depletion, and biodiversity loss.

The financial attractiveness of landfill compared to investment in secondary material recovery remains a major barrier. The cost of processing and diverting lower-rate materials often exceeds landfill costs, discouraging investment in alternative waste management solutions.

8.2.3 Compliance and enforcement challenges

The widening tax differential between standard- and lower-rate waste contributes to increased misclassification, particularly for mechanically-treated fines, where interviewees pointed to the ‘production’ of fines in order to qualify for the lower rate.

Landfill operators, who bear the primary tax liability for misclassified waste, face increased financial and compliance risks, leading some to refuse lower-rate fines due to the high burden of tax assessments and retrospective penalties.

Complexities in aligning SLfT qualifying criteria with EWC codes contribute to misclassification, due to a lack of clear guidance for waste producers and operators.

8.3 Conclusion and policy implications

The lower-rate SLfT remains partially effective but is increasingly misaligned with Scotland’s circular economy and wider environmental objectives. While it has supported landfill diversion in some cases, the increasing quantity of mechanically-treated fines being landfilled at lower rate undermines resource efficiency and waste hierarchy goals. Without adjustments, in conjunction with other supporting policies, there is a risk that the tax may continue to favour landfill disposal over resource recovery, limiting Scotland’s progress toward a low-carbon, circular economy.

To ensure Scotland meets its waste reduction, emissions reduction, and circular economy goals, reforms to the lower-rate SLfT are necessary. Key areas for further exploration could include:

- Raising the lower SLfT rate by a greater margin than in previous years (as Wales is doing and proposed in the UK’s 2025 consultation), to incentivise application of the waste hierarchy.
- Assigning a significantly higher SLfT rate to mechanically-treated fines specifically, to address misclassification and recognise its relatively high environmental impacts.
- Strengthening enforcement and guidance on material classification to reduce compliance risks.
- Build on existing cross-border regulatory and enforcement cooperation to address ongoing challenges such as waste tourism and the evolution of the landfill tax, recognising the complexities of working across different regimes.

By considering these targeted interventions, Scotland can help reduce reliance on landfill, improve material efficiency, and ensure that landfill tax policy aligns with long-term sustainability goals.

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10 Appendices

Appendix A Alignment of the Scottish Landfill Tax (SLfT) with broader policy frameworks

This appendix provides further context on how the SLfT aligns with key environmental policy frameworks, specifically the Circular Economy (Scotland) Act 2024 and Scotland's wider decarbonisation strategy. It highlights the role of SLfT in supporting waste hierarchy principles, promoting resource efficiency, and contributing to net-zero targets through practical examples – while also noting current limitations.

Circular Economy (Scotland) Act 2024

Example 1: Waste hierarchy alignment

The Circular Economy (Scotland) Act 2024 places strong emphasis on the waste hierarchy, which prioritises prevention, reuse, recycling, and recovery before landfill. SLfT reinforces this principle by applying a financial disincentive to landfill disposal. The lower rate of SLfT, applied to certain inert materials such as glass, ceramics and soil, encourages their diversion from landfill toward reuse or recycling. This supports the Act's objectives by reducing dependence on landfill and promoting material circulation within the economy. However, as outlined in Section 3.1 the lower rate appears to be an insufficient incentive to drive significant upstream changes, such as waste prevention or more ambitious reuse practices.

Example 2: Waste prevention and resource efficiency

The Act also aims to improve resource efficiency across sectors. By differentiating tax rates based on environmental impact, SLfT promotes the recovery of materials with low impacts and discourages disposal of more polluting waste. This financial incentive supports businesses in adopting sustainable waste practices. That said, the influence of SLfT on broader resource efficiency is limited, as its primary focus is end-of-pipe disposal rather than incentivising upstream design, reduction, or material substitution choices

Scotland's decarbonisation strategy

Example 3: Reducing emissions from waste management

Scotland's decarbonisation strategy includes a target of net-zero emissions by 2045. Landfilled waste—particularly biodegradable materials—generates GHGs such as methane. SLfT supports emissions reduction by applying a higher tax rate to waste streams which emit more GHGs in landfill, encouraging their diversion. The upcoming ban on landfilling biodegradable municipal waste in 2025 builds on this, aligning landfill policy with Scotland's climate commitments. However, SLfT's impact remains focused on reducing emissions from landfilled waste, and does not yet provide strong incentives to reduce embodied carbon or promote lower-carbon materials earlier in the lifecycle.

Example 4: Circular economy and carbon footprint reduction

The strategy also promotes circular economy practices as a means of reducing carbon emissions. SLfT complements this by encouraging alternatives to landfill, such as repurposing lower-rate materials like soil and stones for construction. This can reduce the need to extract virgin materials, contributing to lower carbon footprints. Nonetheless, SLfT's role in driving circular construction practices remains limited, as it does not directly incentivise material reuse, design for deconstruction, or low-carbon construction methods upstream.

Integration of policy goals

Example 5: Aligning SLfT with policy reviews and landfill ban

The Scottish Government has committed to reviewing waste management options by 2027, alongside the upcoming ban on landfilling biodegradable municipal waste. These developments present an opportunity to better integrate SLfT with other fiscal and regulatory tools. While SLfT plays a role in discouraging landfill and supporting environmental objectives, its effectiveness is partly constrained by limited coordination with wider policies on construction, procurement, and materials management. Stronger understanding of policy cross overs could enhance the overall impact of SLfT.

Appendix B Methodology for quantitative data gathering and analysis

Data requests

Both Revenue Scotland (as regulators of the SLfT) and SEPA (as the national environmental authority) hold and publish statistical data on waste to landfill in Scotland. However, the public-facing outputs are summarised and categorised from more disaggregated data. This is primarily to protect confidentiality within the tax returns (RS) and to make the outputs more accessible to the public (SEPA). As such, we made data requests to both organisations.

RS provided annual financial year (FY) data for five full years against 13 EWC codes / group codes as highlighted in Section 4.1. Multiple codes were grouped together in six of the 13 rows of data where RS needed to aggregate data to protect confidentiality. This is where only one company is responsible for an entire tax return for a single code and could therefore be directly identifiable.

SEPA provided 3 full years of data broken down by quarter, also at EWC code level. This annual data is publicly available but the latest year was released early to us by SEPA for the purposes of this report. The data is fully disaggregated and includes operator name & address, operator description and waste origin. There are 2,514 individual records in the data file.

We also made a request to Zero Waste Scotland for access to their Scottish Waste Environmental Footprint Tool (SWEFT). The tool provides lifecycle-based factors for certain waste categories across different treatment pathways (e.g. landfill, recycling, incineration...) for six different environmental criteria:

- Climate / greenhouse gases, as kg CO_2 eq. The contribution of emissions of greenhouse gases to climate change, measured as Global Warming Potential (GWP100)
- Biodiversity, as species loss. An aggregated measure of species at risk, based on the ReCiPe endpoint indicator for Ecosystem quality.
- Air pollution, as kg $PM_{2.5}$ eq., Air pollution's damage to human health, measured as the equivalent impact of $PM_{2.5}$.
- Mineral resource scarcity, as kg Cu eq. Mineral resource scarcity is a measure of the difficulty to mine a resource in the future given expected future production (measured in kg of copper equivalent).
- Water consumption, as m^3. Water consumption consists of the volume of water withdrawn and used.
- Land use, as m^2 annual crop eq. The species lost due to loss of habitat and soil disturbance, expressed as the equivalent species loss per sqm typical crop production.

Given the timeframe of this project and the desire to consider the role of SLfT against Scotland's wider environmental objectives – the use of such a tool was considered appropriate to provide quick assessment across a broad coverage of potential environmental impacts.

Data cleansing

We then cleansed the data:

I) Annual totals were created in the SEPA data by FY, assuming that a financial year is the sum of Q2, Q3, Q4 and the following Q1.

II) SEPA data was filtered to remove any EWC codes that do not appear in the RS data for lower rate materials.

III) Tonnages for EWC codes in the SEPA dataset were aggregated where relevant in order to match the EWC code grouping provided by RS.

IV) A SWEFT category was assigned to each material / material group in the RS/SEPA data. This was based on expert judgement of the project team, with the allocations presented in Table A 1 below. It is noted that SWEFT has to date only been compiled for *household* waste streams. Therefore, the nature of materials from a commercial / industrial source (more likely to qualify as lower rate materials) may differ in nature from household wastes of a similar material description. Given the timeline of this project and the aim to use SWEFT as an indicator of environmental impacts, this was deemed to be an acceptable weakness in the data review method.

We reviewed landfill tonnage data for potential discrepencies by comparing the national total to landfill (SEPA) which is assumed to represent the sum of both lower- and standard-rate materials against the RS data for the same period. For two of the grouped codes, the RS data for lower rate materials was found to be greater than the total to landfill represented by the SEPA data. In one case, this was resolved through communication with the data providers. For the remaining group, it was stated that “there can be slight differences in counting between the organisations due to water discounts applied, permanent removals, and movement from/to non-disposal areas”. For the most part, this verification exercise found good alignment between the two datasets. This is supported by the finding that the two datasets match in totals for some of the EWC codes that are only landfilled at lower rate. As such, the group with a remaining discrepency was identified to the project steering group for their information, without there being a significant impact on research outcomes.

Data analysis and prioritisation scores

We analysed the data with the view of identifying materials/ material groups to prioritise for further research.

- For each of the 13 material groups in the RS dataset, we calculated the percentage of lower rate material as a portion of the total material landfilled (SEPA totals) for that group. This allowed for the groups with the highest quantities landfilled at lower rate to be identified and prioritised for further research, whilst providing additional context on the relationship between lower and standard rate wastes within the material definitions.
- We reviewed a number of different reference material including the SEPA operator descriptions for each landfill record to give specificity to the materials included under each of the defined material groups. This also enabled us to screen out certain material groups as “niche materials” as described in Section 4.1.
- Environmnetal impacts were estimated for each of the 13 material groups across the six environmental indicators included in SWEFT. This was completed by multiplying the 2023/24 tonnage for each material group with the corresponding SWEFT factor.

- Based on step III, we ranked material groups in terms of their weighted impact against each environmental indicator. The output of this is provided in Table A 1 below.
- An alternative view of the results was defined by calculating the relative impact of each material group across each indicator proportionally from zero to one. This helps to show the significance of impact for each material group which is not automatically understood from the appraoch in step IV. For example, there may be a significant difference in the scale of environmental impact between the first and second ranked material group for a given indicator. The ouput of this analysis is the spider diagram presented in section 4.4.
- We assigned an overall priority score to each of the 13 material groups by considering both the overall tonnage disposed at lower rate; and the indicative environmental impacts. The ouput of this priority scoring is provided in Table A 1 below.

This method for prioritising materials was agreed with the project steering group as a basis for narrowing down the materials / material groups for further research and policy review.

Table A 1: Descriptor terms, SWEFT category, tonnage and weighted environmental impact rankings (SWEFT output)

EWC code/ group of codes	Descriptor	SWEFT category	Tonnage	GHG	Biodiversity	Air pollution	Mineral resource scarcity	Waster consumption	Land use	Overall priority rank
19 12 12	Mechanically-treated fines	Combustion wastes	1	2	NA	1	1	1	1	1
17 05 04	Soil and stones	Soils	2	4	2	3	3	2	2	2
19 12 09	Mechanical treated-mineral fines	Mineral waste from construction and demolition	3	3	NA	2	2	3	3	2
19 03 05, 19 05 99, 19 12 05, 19 13 06, 20 01 02, 20 01 99, 20 03 01, 20 03 03, 20 03 99[4]	Mixed household wastes / Niche materials	Mineral waste from construction and demolition	4	5	NA	4	5	5	5	4

[4] This group contains a code for mixed household wastes (20 03 01). An insignificant portion of this code is expected to be landfilled at lower rate. As such, it was assessed separately from the niche materials that make up the remainder of this group (which are more likely to be landfilled under the lower rate).

19 01 12	Bottom ash and slag	Combustion wastes	5	6	NA	5	6	6	6	5
19 01 02, 19 01 11, 19 01 14, 19 01 16, 19 02 09, 19 02 99	Niche materials	Mixed and undifferentiated materials (aggregated)	6	1	1	6	4	4	4	3
17 01 07	Mixed minerals (concrete, bricks, tiles, ceramics)	Mineral waste from construction and demolition	7	7	NA	7	7	7	7	No priority
01 04 08, 01 04 09, 01 04 10, 01 05 07, 02 01 03	Niche materials	Mineral waste from construction and demolition	8	8	NA	8	8	8	8	No priority
17 01 02, 17 01 03, 17 02 02, 17 05 06, 17 06 04, 17 09 04	Niche materials*	Mineral waste from construction and demolition	9	9	NA	9	9	9	9	No priority
06 01 99, 07 01 12, 07 07 12,	Niche materials*	Combustion wastes	10	10	NA	10	10	10	10	No priority

10 01 01, 10 01 17, 10 02 01, 10 03 05, 10 11 03										
20 02 02	Soil and stones (garden, park, recreation)	Soils	11	11	3	11	11	11	11	5
12 01 07, 12 01 17, 15 01 07, 16 01 20, 16 03 04, 16 11 02	Niche materials*	Mineral waste from construction and demolition	12	12	NA	12	12	12	12	No priority
17 01 01	Concrete	Mineral waste from construction and demolition	13	13	NA	13	13	13	13	No priority

NA: SWEFT factor = zero for biodiversity loss associated with landfill for those waste categories.

Appendix C Methodology for qualitative data gathering and analysis

The qualitative research consisted of a literature review and interviews to support an assessment of diversion and policy options.

Desk-based research

The desk-based research was initiated in two stages. The first stage was a preliminary review of diversion options for four top ranking materials, based on the quantitative data collection and analysis of SEPA and RS data (Appendix B). These were: mechanically treated fines, mechanically treated mineral fines, soils and stones, bottom ash, and slags. The second stage was a more detailed review following the quantitative assessment of environmental impacts and a narrowing of focus on three priority materials (Appendix B). After prioritisation was finalised, further research was not conducted for bottom ash and slags.

The priority materials were researched using academic search engines, such as Google Scholar, Scopus and Web of Science. Organisations concerned with inert waste were checked for relevant sources, such as WRAP, Zero Waste Scotland and Green Alliance. Sources were prioritised for review if they were based in Scotland or the UK, summarised a wide range of sources through a literature review, or were indicated to be widely referenced.

Often, sources were not published based on EWC codes. Instead, they refer to common industry names for the materials, for instance, ‘trommel fines’ or ‘mechanical fines’ rather than ‘EWC 19 12 12’. In addition, as research refers to the recycling and recovery of mechanical fines generally, we combined searches on diversion options for mechanically-treated fines and mechanically treated mineral fines.

A combination of search terms were used, including terms related to:

- Research questions, e.g. downstream, upstream, diversion, circular, barriers, enablers, limitations, risk, disposal and landfill.
- Priority materials, e.g. trommel fines, mechanical fines, minerals, bricks, tiles, ceramics, fines, skip fines, soils, stones and gypsum.
- Circularity or waste hierarchy stages, e.g. reuse, recovery, recycling, retrofit and refurbishment.
- Industries, e.g. construction, demolition, quarrying, excavation, engineering and recycling.
- Diversion options, e.g. aggregate, treatment, land, deconstruction, engineering, landscaping and cover materials.
- Geography, e.g. Scotland, UK, Europe and rural.

Stakeholder engagement

Eight one-hour, semi-structured interviews were conducted online and in-person between January and March 2025. In addition, questions were answered via email by some of these stakeholders, and a 3 further stakeholders. The full list can be viewed below in Table A 2 .

Table A 2: Stakeholder engagement list

Stakeholder category	Stakeholder reference	Form of data collection	Date of interview	Position held
Regulator	Revenue Scotland-A	Interview	21 Jan 2025	SEPA Specialist
	SEPA	Interview	21 Jan 2025	Waste Policy Lead
	Revenue Scotland-B	Email	N/A	Head of Scottish Landfill Tax
Waste management, including industry associations	Commercial landfill operator	Interview and email	10 Feb 2025	Regional Operations Manager
	C&D waste management processor	Interview and email	17 Jan 2025	Managing Director
				Chair
	Waste industry association	Interview	22 Jan 2025	Policy Advisor
	Large public body	Email	N/A	National Sustainability Manager
Upstream sources	Commercial remediation company	Interview	03 Feb 2025	Regional Remediation Manager, Scotland
	Engineering consultancy	Interview	21 Feb 2025	Technical Director
	C&D skip operator	Interview	06 Feb 2025	Operations Director
	Construction company	Interview	25 March 2025	Head of Supply Chain Development

A set of standard interview/email questions were developed based on the overarching research questions asked in the project. Before each contact with a stakeholder, these standard questions were tailored to the stakeholder's knowledge and background and developed into an interview proforma. The standard questions investigated the following key points:

- verifying quantitative findings on priority materials and sources of lower-rate materials;
- identifying existing or future end-of-pipe diversion options for each priority material;

- identifying existing or future upstream diversion options for each priority material;
- understanding the barriers hindering the advancement of each diversion option, including technical, operational, policy, financial or wider barriers;
- understanding potential policy options to address barriers associated with accelerating the diversion options; and
- understanding the unintended consequences of any policy options.

All meeting invites were issued by the Scottish Government via email and were accompanied by a participant information and consent form for interviewees to review and sign. This included full details of data use and protection, in line with UK Government guidance.[5]

Interview requests were sent out in two stages to support research aims. The first stage targeted regulators, waste management organisations, local governments and tax-implementing organisations. They were selected to provide insights on data availability and granularity, triangulate/verify the assessment prioritising certain materials, and identify further stakeholders to contact. The second stage targeted 'the source' of lower-rate materials sent to landfill. Namely, stakeholders from sectors using large amounts of priority materials. Their insights were used to understand the on-the-ground situation, and triangulate quantitative findings on priority materials and desk-based findings on diversion options.

Qualitative analysis

Findings from desk-based research and stakeholder engagement were added to a spreadsheet, using the template shown below in Table 6. This spreadsheet enabled assessment of the diversion options, barriers and enablers. In addition, it informed the analysis of policy options and unintended consequences of these options, and was used to conduct the feasibility assessment described below in Appendix D.

Table 6: Template of structural headings used to analyse qualitative data

Priority material	Description of diversion option	Limitations	Upstream or downstream	Current barriers	Potential enablers	Risks

[5] UK Government: Getting informed consent for user research

Appendix D Methodology for the preliminary feasibility assessment

This initial feasibility assessment evaluates the viability of different waste diversion options for mechanically-treated fines (19 12 12), mechanically-treated mineral fines (19 12 09), and soils and stones (17 05 04) by considering their existing use in Scotland, research and development efforts, and regulatory and financial barriers. The Table A 2 below details the logic behind our assessment given in Section 6.5.

Note that this assessment serves more as a summary of Section 6 and a high-level guide for policy-makers, than an in-depth feasibility assessment.

Table A 2: Feasibility assessment methodology

Diversion option	Lifecycle stage of diversion	Key barriers	Feasibility score (3 max)	Feasibility score justification
Mechanically-treated fines (19 12 12)				
Landfill cover/quarry cover, engineering and restoration	End-of-pipe	Demand exists, minimal barriers	3	Common practice in Scotland, demand for landfill cover
Recycled aggregates	End-of-pipe	Low substitution rate, contamination risks, infrastructure investment lacking	1	Variability of fines makes reuse challenging and current incentives make virgin aggregate use easier.
Land treatment and agricultural soil improvement	End-of-pipe	Contamination concerns, nutrient content inconsistency	1	Regulatory restrictions in the UK – more limited land where mechanically-treated fines can be used
Gypsum fines recycling	End-of-pipe	Contamination risks, landfill tax incentives encourage disposal	2	Existing recovery infrastructure, but purity issues and low cost to landfill remain
Remediation	Upstream	Need bespoke technologies, barriers to investment in infrastructure	1	Some promising research, but not scaled commercially
Mechanically-treated mineral fines (19 12 09)				
Landfill cover/quarry cover, engineering and restoration	End-of-pipe	Demand exists, minimal barriers	3	Common practice in Scotland, but might waste nutrient rich fines that could be used in agriculture, providing a higher value
Recycled aggregates	End-of-pipe	Lack of steady supply, market uptake issues	2	Exemptions exist, and some use is ongoing but low demand.
Land treatment and agricultural soil improvement	End-of-pipe	Requires permits, some contamination concerns	3	Permitted in agriculture with waste management licensing exemptions

Diversion option	Lifecycle stage of diversion	Key barriers	Feasibility score (3 max)	Feasibility score justification
Remediation	Upstream	Need bespoke technologies, barriers to investment in infrastructure	1	Some promising research, but not scaled commercially
Soils and stones (17 05 04)				
Landfill cover/quarry cover, engineering and restoration	End-of-pipe	Long-term decline in landfill sites	3	Common practice in Scotland
Recycled aggregates	End-of-pipe	Cost competitiveness with virgin aggregates	3	Commercially used, but virgin materials remain cheaper
Remediation (e.g., soil washing)	Upstream	Limited adoption, investment barriers and high processing costs	2	Underutilised in Scotland as it is costly but growing
Landscaping and construction	Upstream	Coordination challenges between projects	2	Varies across projects
Fines upstream diversion (19 12 09 and 19 12 12)				
Modular construction and material reuse	Upstream	Expensive upfront investment, scalability challenges	1	Expanding in modern construction but cost barriers remain Future advances in AI will help
Deconstruction and material sorting (including sorting plasterboard)	Upstream	Lack of incentives, infrastructure and industry skill/common practice limitations	1	Circular economy support exists, but still underdeveloped
Retrofit before demolition	Upstream	Predominantly policy/fiscal barriers	1	Wide understanding that retrofit often has a better carbon impact, but fiscal policy and cost are a barrier

How to cite this publication:
Ross, V., Owens, H., Evans, S., Claxton, R., Kaczmarski, J., Chalmers-Arnold, I. (2025) 'Scottish Landfill Tax: lower rate review', ClimateXChange.
DOI: http://dx.doi.org/10.7488/era/6063

This work was supported by the Rural and Environment Science and Analytical Services Division of the Scottish Government (CoE – CXC).

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