18 Materials

This chapter considers the potential impacts associated with the use and consumption of material resources and the production and management of waste during construction of the proposed scheme. Material requirements during operation of the proposed scheme were not assessed as they were not considered to be significant and would be minimal in the context of those arising during construction.

The use and consumption of material resources during construction was estimated based on the likely requirements of the DMRB Stage 3 design of the proposed scheme. The range of materials likely to be required and wastes likely to be generated are described in the chapter. By applying key material and waste management principles, such as the waste management hierarchy, the impacts on natural resources and need for permanent disposal of wastes will be reduced. In particular, this will be achieved by re-using existing soils and infrastructure where possible, taking into consideration the environmental impacts of products during their procurement.

Proposed mitigation measures will minimise materials use, maximise re-use and recycling of wastes and ensure all materials and waste are handled according to the regulatory requirements. These will be implemented through several plans addressing different aspects of construction site management, including a Site Waste Management Plan (SWMP) and a Construction Environmental Management Plan (CEMP).

Transport Scotland's Carbon Management System (CMS) was used to estimate the total embodied carbon emissions, measured as carbon dioxide equivalent (CO_2e), associated with material resources used for construction of the proposed scheme. The CMS indicated carbon emissions for the proposed scheme of between 21,800 tonnes and 25,000 tonnes of CO_2e (including 15% contingency).

The overall residual impact magnitude on material resources is anticipated to be moderate based on the assessment of embodied carbon.

The assessment of generation and management of waste predicted that the residual impact would be of minor magnitude and Neutral/Slight significance, which was not considered to be significant.

18.1 Introduction

18.1.1 This chapter presents DMRB Stage 3 assessment of the proposed scheme in terms of the use and consumption of material resources and the production and management of waste. It identifies measures for mitigating potential impacts and describes the significance of the residual impacts that remain post mitigation.

18.1.2 This assessment addresses 'materials' in accordance with the aims and objectives of DMRB, Volume 11, Part 1: HA 200/08 which identifies 'materials' as an Environmental Impact Assessment (EIA) topic to be assessed. Reference has been made to draft guidance DMRB Volume 11, Section 3, Part 6 HD212/11 Materials (The Highways Agency et al, unpublished 2012). The guidance is hereafter referred to as draft HD 212/11, which considers the environmental impacts associated with:

- the use and consumption of material resources from primary and recycled/secondary sources, and manufactured construction products required for the construction of roads represented as total embodied carbon emissions; and
- the production and management of wastes resulting from the construction, improvement and maintenance of roads in terms of the application of the waste hierarchy and the availability of waste management facilities.

18.1.3 The focus of the assessment was on the construction phase, as this phase of the project is likely to have potential significant impacts. Significant impacts were not considered likely during operation and maintenance therefore these were scoped out of the assessment. It was anticipated that impacts associated with the operation and maintenance of the proposed scheme would be minimal and mitigated by the continued application of the waste hierarchy principles, and by adequate upkeep of the proposed scheme by the appointed maintenance contractor.

18.1.4 The consumption of materials is assessed using published data to assign embodied carbon dioxide equivalent (CO_2e) per unit of material used (i.e. tonnes of carbon dioxide (CO_2) per tonne, or per cubic metre (or similar) of material). This assessment did not consider environmental impacts associated with the off-site extraction of raw materials or the off-site manufacture of materials/products. Embodied

tonnes of CO_2e were taken as a proxy for the energy and other inputs required to bring these materials 'to the factory gate' (i.e. the stage at which materials could be purchased by the Contractor for use in construction of the proposed scheme).

18.1.5 Detailed aspects of the proposed scheme design, such as the source of materials, depend on the construction proposals of the appointed Contractor(s), details of which are not currently available at DMRB Stage 3. In accordance with draft HD 212/11 guidance, embodied carbon associated with the transportation of materials to site has therefore not been included within this assessment.

Legislative and Policy Background

Material Resources

18.1.6 Material resources encompass the materials and construction products required for the construction of the road network and include: primary raw materials (such as aggregates and minerals), secondary or recycled sources, and manufactured products (such as bitumen, precast concrete, barriers and fences), as identified in draft HD 212/11.

18.1.7 The Scottish Government's Sustainable Development Strategy (Scottish Government, 2005) aims to achieve 'more with less' by using resources more efficiently and delivering new products and services with lower environmental impacts. This aligns with the targets set in Climate Change (Scotland) Act 2009 (Scottish Government, 2009) to lower carbon emissions and the priority of the Scottish Government Circular Economy 'Making Things Last' strategy (Scottish Government, 2016) where products and materials are kept in high value use for as long as possible.

18.1.8 Material resources may be imported to the construction site or obtained from the re-use of site won materials. Site-won materials are materials removed from one area of the proposed scheme during construction and re-used in another for applications such as landscaping. Potential impacts (including carbon emissions) can be reduced through the implementation of material resource efficiency, which requires an assessment of both material selection and waste management; for example, specifying materials with a low environmental impact and effective ordering of materials to meet exact needs, reduce wastage and facilitate re-use of materials that are generated on site.

Generation and Management of Waste

18.1.9 In considering the use of material resource and waste management, it is important to define when, under current legislation and understanding, a material is considered to be a waste. The Waste Framework Directive (European Directive 2006/12/EC, as amended by Directive 2008/98/EC), transposed into Scottish legislation through the Waste (Scotland) Regulations 2012, defines waste as: *'any substance or object that the holder discards or is required to discard.'* Waste that is subject to legislative control is termed controlled waste.

18.1.10 Some types of waste are harmful to human health, or to the environment, either immediately or over an extended period of time. From a regulatory perspective these wastes are called special wastes in Scotland according to the Special Waste Regulations 1996 and the Special Waste Amendment (Scotland) Regulations 2004 (The Scottish Government, 1996, and amendments 2004); elsewhere in the UK and the EC, special waste is referred to as hazardous waste. For consistency, special waste is referred to as hazardous waste for the remainder of the chapter.

18.1.11 Other types of waste that may be generated during construction projects include; non-hazardous waste and inert waste. Non-hazardous waste is defined by Article 7 (3) in the revised Waste Framework Directive as waste that does not display hazardous properties. Inert waste is a sub-classification of non-hazardous waste and is defined in the Landfill Directive (article 2(e)) as: *'waste that does not undergo any significant physical, chemical or biological transformations'.*

18.1.12 Once a material has become waste, it remains waste until it has been fully recovered and no longer poses a potential threat to the environment or to human health, at which point it is no longer subject to the controls and other measures required by the Waste Framework Directive.

18.1.13 A waste management licence is required to authorise the deposit, disposal and treatment of controlled waste according to the Waste Management Licensing (Scotland) Regulations SSI 228 (Scottish Government, 2011). Exemptions from licensing are set out in Schedule 1 of the Waste Management Licensing (Scotland) Regulations 2011 and the Waste Management Licencing (Scotland) Amendment Regulations 2016. Some activities involving waste materials are exempt from licensing if they meet the requirements detailed in Regulation 17. Activities under exemptions, includes the re-use of inert soils and stones and brick, concrete, tiles and ceramics for construction or land reclamation and at landfills for engineering, capping and restoration.

18.1.14 Relevant exemptions for Construction, Demolition and Excavation (CD&E) waste as per SEPA information (SEPA, 2016), are as follows:

- Paragraph 7 - The treatment of land for agricultural benefit or ecological improvement;
- Paragraph 9 - The reclamation or improvement of land;
- Paragraph 13 - Manufacture of specified goods from specified wastes; and
- Paragraph 19 - Waste for construction and other "relevant work".
- Paragraph 24 – Size reduction of bricks, tiles or concrete.

18.1.15 The Scottish Government's 'Code of Practice – Duty of Care' (Scottish Government, 2012b) applies to anyone handling waste, and includes a requirement to properly store waste and only transfer it to someone authorised to handle it.

18.1.16 Construction waste accounts for approximately three times as much waste as all UK households combined and accounts for about 50% of all waste in Scotland (Scottish Government, 2016). The construction sector is the biggest user of materials and responsible for over half of Scotland's carbon emissions when the operation of buildings is included. Scotland's Zero Waste Plan (Scottish Government 2010) sets out the Scottish Government's vision for a zero waste society. This describes a Scotland where all waste is viewed as a resource; waste is minimised; valuable resources are not disposed to landfill; and the majority of waste is sorted, leaving a minimal volume of waste requiring treatment. The Zero Waste Plan sets a target of 70% recycling of construction and demolition (C&D) waste by 2020.

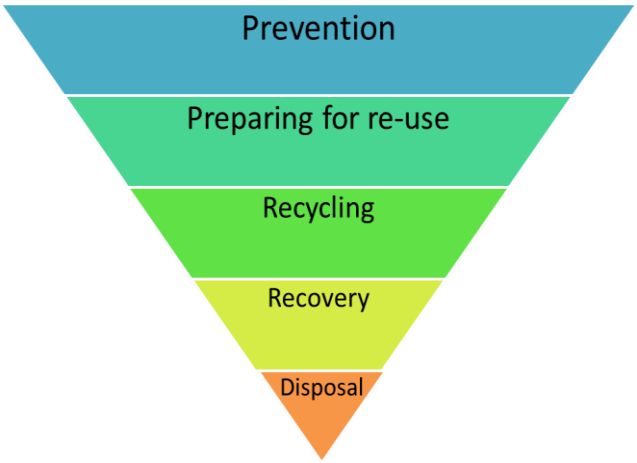
18.1.17 The Scottish Government's Waste Prevention Programme, 'Safeguarding Scotland's Resources – Blueprint for a More Resource Efficient and Circular Economy' (Scottish Government, 2013), forms part of the Government Zero Waste agenda and aims to cut 7% of all waste in Scotland by 2017 and 15% by 2025 (from 2011 levels).

18.1.18 Scotland's first circular economy strategy 'Making things Last: A Circular Economy Strategy for Scotland' (Scottish Government, 2016), has been developed by the Scottish Government, and builds on the targets and ambitions set out in the Zero Waste Plan and in Safeguarding Scotland's Resources. A key priority stated within the strategy, and relevant to the proposed scheme, is:

> *'We will work to avoid depletion of primary aggregates and timber resources through* ***enhanced recycling of demolition materials****'.*

18.1.19 Waste management is primarily based on the waste hierarchy (Illustration 18.1) as defined in Article 4 of the Waste Framework Directive. The revised Waste Framework Directive encourages the application of the waste hierarchy to reduce the impact on the environment and / or human health.

Illustration 18.1: The waste hierarchy



18.1.20 Application of the waste hierarchy provides a method to reduce waste generation at source and reduce the volume of waste to be sent to landfill through re-use, recycling and recovery.

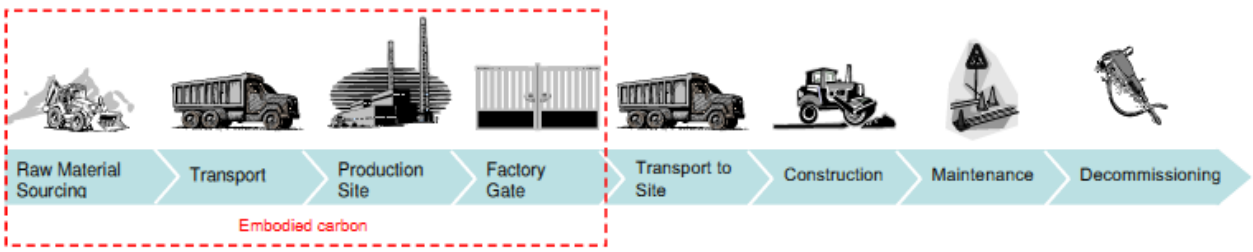
Carbon emissions

18.1.21 The Scottish Government has committed to mitigating Scotland's carbon emissions and adapting to climate change by setting a target to reduce emissions by 80% (from 1990 baseline levels) by 2050, as set out in the Climate Change (Scotland) Act 2009 (Scottish Government, 2009). Scotland's Zero Waste Plan (Scottish Government, 2010) acknowledges that waste management has climate impacts, particularly the emission of the greenhouse gas methane from landfill sites or the emissions avoided from re-use and recycling replacing the need for virgin materials. A zero waste Scotland will play an important role in helping to achieve the targets set in the Climate Change (Scotland) Act 2009 to reduce Scotland's greenhouse gas emissions (Scottish Government 2010).

18.1.22 In June 2013, the Scottish Government published 'Low Carbon Scotland: Meeting our Emissions Reduction Targets 2013 – 2027', reiterating the targets provided in the Waste Prevention Programme and stating the aim of recycling all waste with no landfill by 2050.

18.1.23 Draft HD 212/11 uses embodied CO_2 emissions associated with the use of material resources to assess the impacts, and uses 'carbon' as a short hand to refer to the basket of six greenhouse gases (GHGs) recognised by the Kyoto Protocol. GHGs are converted to CO_2e based on their global warming potential per unit as compared to one unit of CO_2. Draft HD 212/11 defines the embodied CO_2 emissions of a material as the total CO_2e emissions released prior to the material leaving the factory gate; this boundary is known as 'cradle-to-gate'. According to draft HD 212/11 the 'cradle-to-gate' boundary normally includes CO_2 emissions from extraction (or harvesting), the manufacturing process and any pre-distribution transportation (refer to Illustration 18.2).

Illustration 18.2: Diagrammatic representation of the measure of embodied carbon in relation to material life cycle (Highways Agency et al., unpublished 2012)



18.1.24 As can be seen from Illustration 18.2, the embodied carbon in the materials assessment does not include the CO_2 emissions associated with transport from the factory gate to site, construction activities (i.e. plant fuel use emissions), maintenance or decommissioning of the proposed scheme.

18.1.25 A number of tools have been developed which facilitate the quantification of carbon impacts of different materials and waste management methods, including Transport Scotland's carbon calculator tool, known as the Carbon Management System project carbon tool (CMS).

18.1.26 Transport Scotland has developed and implemented the CMS to measure the carbon emissions associated with their construction activities across their road and rail schemes. The CMS is intended to provide a robust and reliable means of measuring, monitoring and reporting a project's carbon footprint across its life cycle (Transport Scotland, 2009). The CMS uses an 'activity' based system to categorise emissions based on the activity that is the source of the emissions, and includes: material use, transport of materials and wastes, plant fuel combustion and electricity consumption, waste treatment, construction site utilities and operational electricity consumption.

Legislation, Plans, Policies and Guidance

18.1.27 The proposed scheme is required to comply with legislation/policy. An assessment of compliance with 'key' legislation/policy relevant to the proposed scheme is provided in Chapter 19 (Policies and Plans).

18.1.28 The Strategic Environmental Design Principles, developed as part of the A9 Dualling Programme SEA (Transport Scotland, 2014), that are most relevant in regard to influencing material resource use and waste management are, as follows:

- minimise use of raw materials, through use of appropriate recycled materials that meet safety and durability performance requirements (Strategic Environmental Design Principle M3);
- use long-life performance materials to improve durability and reduce whole life carbon (Strategic Environmental Design Principle M5);
- use locally sourced materials and suppliers, to reduce material transport emissions and to support local businesses, where feasible (Strategic Environmental Design Principle M6); and
- assess the effect of recycled material specifications to determine the associated carbon impact and maintain flexibility to select the option that provides the optimal balance between embodied and transportation carbon effects (Strategic Environmental Design Principle M7).

18.1.29 The A9 Dualling Programme Sustainability Strategy includes a sustainability objective in relation to materials and waste of '*optimising resource efficiency across the life of the A9 dualling programme, with particular regard to geographical scale and project alignment'* (Transport Scotland, 2016).

18.1.30 Other legislation, regulations, guidelines or policy that have influenced this assessment.

- Sustainability strategy:
  - A9 Dualling Programme Sustainability Strategy, 2016;
  - EU Sustainable Development Strategy – Renewed Strategy, 2006;
  - Securing the Future – The UK Government Sustainable Development Strategy, 2005; and
  - Choosing our Future - Scotland's Sustainable Development Strategy, 2005.
- Waste legislation:
  - Environmental Protection (Duty of Care) (Scotland) Regulations 2014;
  - Waste (Scotland) Regulations 2012;
  - Waste Management Licensing (Scotland) Regulations 2011;
  - Waste Framework Directive 2008, as amended;
  - Landfill (Scotland) Regulations 2003 and their amendments in 2003 and 2013;
  - Special Waste Amendment (Scotland) Regulations 2004;

- Landfill Directive 1999; and
- Special Waste Regulations 1996.

- Scottish waste policy:
  - Scottish Government, Making Things Last: A Circular Economy Strategy for Scotland 2016;
  - Scotland's Zero Waste Plan 2010; and
  - Scottish Government, Safeguarding Scotland's Resources – Blueprint for a More Resource Efficient and Circular Economy 2013.
- Carbon emissions:
  - Scottish Government, Low Carbon Scotland: Meeting our Emissions Reduction Targets 2013 – 2027, 2013; and
  - UK Government Carbon Budgets.
- Economic, planning and local development:
  - Scottish Government, Scotland's Economic Strategy 2015;
  - Scottish Government, Planning and Waste Management Advice 2015;
  - Cairngorms National Park Local Development Plan 2015;
  - Scottish Planning Policy 2014;
  - Perth & Kinross Council Local Development Plan 2014; and
  - TAYplan: Strategic Development Plan (2016-2036), 2017.
- Waste guidance:
  - SEPA Guidance: Recycled Aggregates from Inert Waste, 2013;
  - SEPA Guidance: Management of Forestry Waste, 2013;
  - Scottish Government, Code of Practice – Duty of Care, 2012;
  - SEPA Regulatory Guidance: Promoting the Sustainable Re-use of Greenfield Soils in Construction, 2010;
  - Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, 2009;
  - SEPA Guidance on the Production of Fully Recovered Asphalt Road Planings, undated;
  - SEPA Land Remediation and Waste Management Guidelines, undated; and
  - SEPA Technical Guidance Note Paragraph 19 Exemption Waste for Construction and Other "Relevant Work", undated.
- Other legislation:
  - Climate Change (Scotland) Act 2009;
  - The Contaminated Land (Scotland) Regulations 2000 and 2005;
  - Pollution Prevention and Control (Scotland) Regulations 2000;
  - Environment Act 1995; and
  - Environmental Protection Act 1990.

18.2 Approach and Methods

Scope

18.2.1 Paragraph 4.40 of draft HD 212/11 states that:

'[a] detailed assessment should be applied where there is the potential for the use and consumption of materials and the production and management of waste to cause significant environmental effects and where the extent of these can be quantified after the simple assessment'.

18.2.2 A simple assessment was undertaken at DMRB Stage 2. The assessment at DMRB Stage 2 focused on the potential environmental impacts resulting from the production of materials, the generation and management of waste on site during construction and potential impacts of the proposed scheme on waste policies and available waste management facilities.

18.2.3 A detailed assessment (draft HD 212/11) has been undertaken for the proposed scheme at DMRB Stage 3, given:

- the DMRB simple assessment identified the potential for significant environmental effects; and
- the level of detail available for the proposed scheme.

18.2.4 The assessment included the calculation of tonnes CO_2e in relation to use of material resource, derived via design stage estimates for principal material quantities associated with construction of the proposed scheme. The calculations have been undertaken utilising Transport Scotland's CMS (Revision 2016 1.01).

18.2.5 Transport of materials to the site and the removal of surplus materials and waste from the site are excluded from the design stage assessment in accordance with the methodology set out in draft HD 212/11. However, it is anticipated that the CMS will be further utilised and the carbon footprint further developed during the construction stage as more information becomes available. Plant emissions were also excluded at this stage due to lack of data and the complexity of modelling this fuel/ electricity consumption. Waste emissions were excluded at this stage as the impacts associated with management of waste were assessed based on the capacity for any waste arising from the proposed scheme.

18.2.6 Operational impacts associated with resource use and waste generation were not assessed in the DMRB Stage 2 assessment as they were considered not to be significant in the context of the proposed scheme. The materials and waste associated with the operational phase are not expected to be significant in the context of construction of the proposed scheme and were considered to be similar to the operational and maintenance regime of the existing A9. Based on the same reasoning this DMRB Stage 3 detailed assessment does not consider operational (maintenance) impacts associated with resource use and waste generation of the proposed scheme.

Study Area

18.2.7 The study area for material use and waste generation is informed by the Compulsory Purchase Order (CPO) boundary and the indicative Land Made Available (LMA).

18.2.8 In addition, a wider study area for the management of waste included the relevant materials and waste facilities within The Highland Council and TAYplan Strategic Development Plan (SDP) area. TAYplan covers the administrative areas of Dundee, Angus, Perth & Kinross and the North part of Fife Council. This is based on all available 100km routes along the Scottish Trunk Road Network (to avoid local roads and villages) from the extents of the proposed scheme. This distance was selected based on professional judgement and is considered an appropriate distance for the purpose of this assessment.

Baseline Conditions

18.2.9 This materials assessment, in contrast to other environmental chapters in this DMRB Stage 3 assessment, has not considered impacts in terms of changes to baseline conditions. It instead focused primarily on material imported/exported and wastes rather than changes to an existing situation. Section 18.3 (Baseline Conditions) of this chapter therefore provides background on materials required and waste generated by construction of the proposed scheme. Reference is also made to Chapter 10 (Geology, Soils, Contaminated Land and Groundwater), which includes consideration of the proposed scheme in the context of anticipated ground conditions and any potentially contaminated sites where hazardous waste could be generated.

18.2.10 The assessment was informed by details of the waste management infrastructure that is likely to be available to treat and dispose of waste generated by the project. The most up to date information available on landfill capacity and waste sites was obtained from SEPA's Landfill Sites and Capacity Report for Scotland 2015 (SEPA, 2017). These data provide a baseline for disposal capacity within The Highland Council and TAYplan SDP area.

Impact Assessment

18.2.11 In accordance with the draft HD 212/11, the detailed assessment methodology has been used to assess both materials and waste associated with the proposed scheme and aims to identify and quantify the following:

- the types and quantities of materials required for the project;
- details of the source/origin of materials, including site-won materials to replace virgin materials;
- the cut and fill balance;
- the types and quantities of forecast waste arisings, including any hazardous waste;
- surplus materials and waste falling under regulatory controls;
- waste that requires storage on-site prior to re-use, recycling or disposal;
- waste to be pre-treated and/or disposed of off-site;
- the impacts that would arise in relation materials and waste;
- a discussion of the sensitivity of receptors, and the magnitude, nature and significance of those impacts; and
- identification of measures to mitigate impacts.

18.2.12 Quantities of material resources required, and wastes arising for the proposed scheme, have been forecast using design information and professional judgement.

Material Resources

18.2.13 An assessment of the potential embodied carbon impacts associated with the material resource demands of the proposed scheme was undertaken using Transport Scotland's CMS, in line with the requirements of draft HD 212/11 detailed assessment. Total embodied carbon was estimated based on the indicative consumption of materials associated with design quantities for the proposed scheme.

18.2.14 The material quantities required for construction of the proposed scheme were entered into the CMS, which calculates the CO_2e of each of the materials. The tool can also be used to quantitatively estimate which principal components of the proposed scheme are likely to have a greater carbon footprint in terms of materials required.

18.2.15 The material import data are based on the following assumptions:

- Civil engineering structures (principal structures and retaining walls): includes precast concrete, in situ concrete and steel.
- Drainage: includes filter materials, pipes and chambers.
- Road pavement: includes sub-base, base, surface and binder layers, capping, tack coat and kerbs.
- Safety barrier: includes steel safety barriers.
- Earthworks: includes soil, rock and topsoil.
- Fencing: includes mammal fencing. Noise barriers and accommodation works fencing have been excluded due to lack of specification data.
- Cabling and signage: includes ducting, cabling and chambers.
- Lighting: not included as lighting for the proposed scheme is anticipated to be limited to the A9 Southern Tie-In Interim Roundabout only.

18.2.16 In terms of earthworks quantification, the following general assumptions were used in the constructability assessment and hence the quantities used in the assessment:

- Earthworks acceptability across the whole of the proposed scheme: 90% (with treatment).
- The depth of topsoil to be stripped: 300mm.
- The topsoil depth for placed material: 300mm.
- Any localised areas with poor characteristics making the soil unsuitable for reuse have not been accounted for across the site;
- The road depth varies along the proposed scheme depending on the pavement requirements for each section.

18.2.17 Given that the estimated materials required may change between this assessment and eventual construction, a 15% uplift has been applied to the principal material demands. This uplift aimed to account for additional materials not accounted for in this assessment (e.g. accommodation works fencing, lighting etc. as noted above) and for potential changes during the construction phase. The scale of the uplift applied reflects the 'Optimism Bias Adjustment' used in the proposed scheme cost estimates from which much of the source data have been obtained.

18.2.18 The embodied carbon emissions are considered a proxy measure of the environmental impacts of materials according the scale of impact magnitude summarised in Table 18.1, as per draft HD 212/11. The magnitude identified in draft HD 212/11 is based on benchmark data from previous road projects where the magnitude of change as a result of material use has been quantified.

Table 18.1: Impact magnitude – material resources

Impact Magnitude	CO_2 Represented as Tonnes of Carbon
No change	<1,000
Negligible	1,000 – 5,000
Minor	5,000 – 20,000
Moderate	20,000 – 40,000
Major	>40,000

18.2.19 Draft HD 212/11 does not define sensitivity or significance for material consumption and use and states that in the absence of a true measure of significance, impact magnitude provides an indication of the severity or otherwise of the identified impacts.

Generation and Management of Waste

18.2.20 The assessment aimed to identify and estimate the likely wastes arising as a result of construction of the proposed scheme and the potential impact on waste receptors. The available waste management infrastructure (including treatment facilities) is the primary receptor for waste and the impacts on the capacity of the waste management infrastructure were therefore assessed.

18.2.21 The quantities of waste generated during the construction of the proposed scheme were estimated based on application of good practice wastage rates. The wastage rates were taken from the Net Waste Tool (WRAP, 2008). Wastage rates account for the proportion of a component that ends up as waste during the construction process.

18.2.22 The available waste management infrastructure is identified by undertaking a review of the waste infrastructure facilities within the local authority areas within the wider study area, and their remaining available capacities.

18.2.23 Draft HD 212/11 determines the value/sensitivity of the identified waste receptor on the basis of capacity as shown in Table 18.2.

Table 18.2: Waste receptor sensitivity criteria

Sensitivity	Criteria
Very High	There is no available waste management capacity for any waste arising from the proposed scheme.
High	There is limited waste management capacity in relation to the waste arising from the proposed scheme.
Medium	There is adequate waste management capacity for the majority of wastes arising from the proposed scheme.
Low	There is adequate available waste management capacity for all wastes arising from the proposed scheme.

18.2.24 Draft HD 212/11 recommends the nature and characteristic of the impact should be established and described to enable the magnitude of impacts to be determined, and that the impact should be quantified where possible and the wastes categorised using the Waste Hierarchy (refer to Illustration 18.1). The magnitude of the impact is assessed against the capacity of the waste infrastructure to treat or dispose of those wastes, according to the scale summarised in Table 18.3.

Table 18.3: Impact magnitude - waste

Magnitude	Criteria
Major	Waste is predominantly disposed of to landfill or to incineration without energy recovering with little or no prior segregation.
Moderate	Wastes are predominantly disposed of to incineration with energy recovery.
Minor	Wastes are predominantly segregated and sent for composting, recycling or further segregation and sorting at a materials recovery facility.
Negligible	Wastes are predominantly re-used on-site or at appropriately licensed or registered exempt sites elsewhere.

18.2.25 Significance of waste impact was determined by combining sensitivity and magnitude as set out in Table 18.4. Impacts were considered adverse unless otherwise stated.

Table 18.4: Waste assessment significance criteria

Sensitivity / Magnitude	Low	Medium	High	Very High
Negligible	Neutral	Neutral/Slight	Slight	Slight
Minor	Neutral/Slight	Slight	Moderate/Slight	Moderate/Large
Moderate	Slight	Moderate	Moderate/Large	**Large/Very Large**
Major	Slight/Moderate	Moderate/Large	**Large/Very Large**	**Very Large**

18.2.26 Impacts of Large/Very Large and above are considered to be significant in the context of the EIA Regulations. Mitigation measures to avoid or reduce impacts have been considered and are reported in Section 18.5 of this chapter.

Limitations to Assessment

18.2.27 Baseline information, potential impacts and mitigation were described based on the design information available at the time of the assessment to estimate material use and waste management requirements. These amounts are approximate and indicative only and are subject to change. A 15% uplift has been applied to the principal material requirements to account for potential changes (refer to paragraph 18.2.17).

18.2.28 The best available data were used in determining baseline conditions but data may have changed since publication.

18.2.29 The Waste Site Capacity data and Landfill Capacity data were extracted from SEPA's public register of licensed/permitted sites and from information supplied by site operators. Although checks were made by SEPA for anomalies or errors in the dataset prior to publications, SEPA cannot guarantee that the data are error free, or identify any commercial decisions taken by operators that may affect the data.

18.2.30 The availability of capacity for CD&E waste may be impacted by other major infrastructure projects taking place at the time of construction of the proposed scheme (refer to Chapter 20: Cumulative Impacts). Furthermore, changes to the permitted capacity of waste facilities during the construction of the proposed scheme cannot be identified at this stage.

18.2.31 The locations of temporary construction compounds and material storage areas will depend on the Contractor, taking into account constraints identified by this ES and/or other constraints or permissions applicable to any separate consent.

18.2.32 As noted in paragraph 18.1.24, some environmental impacts associated with the extraction and transport of primary raw materials and manufactured products would occur off-site. The source and processing/manufacturing cannot be determined at this stage and the production of these materials is likely to have been subject to separate consent procedures (such as applications for planning permission and permits), which may have included environmental assessment. Therefore, it is outside the scope of this assessment to consider the environmental impacts associated with the extraction of raw materials and manufacturing of products. However, in accordance with the draft HD 212/11, it is within the scope of the assessment to consider the embodied carbon impacts associated with the extraction and manufacture of products (termed 'cradle to gate') as a proxy for the 'overall' scale of impacts associated with raw material extraction and use.

18.2.33 The embodied carbon emissions of site-won materials are zero rated within the CMS for the purposes of determining design stage carbon emissions. Emissions for site-won materials were captured within the CMS during the construction phase using the Contractor's plant fuel consumption activity, which is considered to be a more accurate method of measurement. As a result, specifying the materials as site-won risks underestimating the embodied carbon of the material resources for the proposed scheme. Therefore, based on the scale of earthworks associated with the proposed scheme, a bespoke emission factor has been used for site-won soil, rock and topsoil.

18.2.34 The emission factor of 0.023tCO_2e/t, as published in the University of Bath's Inventory of Carbon and Energy (ICE) v2.0 (January 2011) database, and utilised in the CMS for imported soil, rock and topsoil, is likely to significantly overestimate the fuel use associated with earthworks activities as it includes all the necessary processing. Research by Hughes (2012) gives emission factors for site-won earthworks materials in the range of 0.0007–0.003tCO_2e/t depending on haul distances and excavator and articulated dump truck combinations. Based on this research the CMS emissions factor used for site-won soil, rock and topsoil was 0.003tCO_2e/t (this emission factor is based on a 35 tonne excavator, 30 tonne articulated dump truck and 4km haul). Use of this emission factor is considered to provide a more realistic assessment of the embodied carbon emissions associated with sourcing site-won engineering and landscaping fill.

18.3 Baseline Conditions

18.3.1 Receptor types potentially at risk of impacts under this topic include:

- resource depletion from quarries, other sources of minerals and other finite raw material resources; and
- the capacity of waste management infrastructure, such as landfills, material recovery facilities, metal recyclers and waste transfer facilities.

Material Resources

18.3.2 Material resources can include:

- raw materials such as aggregates and minerals from primary, secondary or recycled sources; and
- manufactured construction products.

18.3.3 Primary aggregates refer to materials extracted directly from the ground, and can either be sand, gravel or hard rock. Secondary aggregates are materials produced as a by-product of other mining or quarrying activities or obtained as a by-product of other industrial processes; they include colliery

spoil, incinerator bottom ash aggregate and reclaimed railway ballast. Recycled aggregates refer to CD&E wastes that have been treated and/or recycled to use as an alternative to primary aggregates.

18.3.4 Manufactured construction products are materials which have been converted from a raw material into a finished product such as concrete or steel.

18.3.5 The Scottish Aggregates Survey Report (Scottish Government, 2015) outlines that the most important sources for primary aggregates in Scotland are crushed rock (from igneous rock, sandstone and limestone) and sand and gravel. The report provides an estimate of the aggregate production recorded by region for 2012. The report concludes that the reserves for crushed rock, sand and gravel in 2012 were generally sufficient to meet local development demand.

18.3.6 There are a number of active quarries and sand and gravel pits within the wider study area which would be suitable for the sourcing of high quality aggregates, typically used for road pavement construction, and it is the expectation that as much of the materials as possible will be sourced locally. It is up to the Contractor appointed to construct the proposed Scheme to source materials for the project and typically they will look to use local suppliers and to re-use materials on site to reduce costs. The use of such reclaimed waste material will be controlled in accordance with specifications within the Manual of Contract Documents for Highway Works (Highways Agency et. al. 2014).

18.3.7 Table 18.5 shows the production of aggregate (by type) for The Highland Council and Moray Council together and the TAYplan SDP area. The table provides the latest available data (end of 2012) for the landbank for hard rock and sand and gravel. These data suggest there is supply within the study area of primary aggregates for 20 years and sand and gravel for 13 years. These data indicate that the study area has good supplies of mineral resources.

Table 18.5: Primary aggregate production in The Highland Council, Moray Council and the TAYplan SDP areas (Scottish Aggregates Survey Report, Scottish Government, 2015)

Regions	Hard Rock		Sand & Gravel	
	Primary Aggregate Production (thousand tonnes)	Maximum Supply from Active Sites at 2012 Production Levels (years)	Primary Aggregate Production (thousand tonnes)	Maximum Supply from Active Sites at 2012 Production Levels (years)
The Highland Council & Moray Council	6,040	4	521	10
TAYplan	848	20	827	13

18.3.8 There is evidence of sand and gravel extraction within the study area for Chapter 10 (Geology, Soils, Contaminated Land and Groundwater). Based on historical evidence of sand and gravel extraction and the superficial and bedrock descriptions, there is also potential for further sand and gravel resources to be available within the study area. Further details are provided on Figure 10.1, Figure 10.2 and Chapter 10 (Geology, Soils, Contaminated Land and Groundwater).

18.3.9 Zero Waste Scotland has previously produced a directory of suppliers of recycled aggregates who have successfully demonstrated their compliance with the WRAP Quality Protocol for the production of aggregates from inert waste (Zero Waste Scotland, undated). Table 18.6 provides details on the locations of suppliers, identified from the directory, that are within The Highland Council area or TAYplan SDP area and could be utilised for the proposed scheme (i.e. within 100km of the proposed scheme). These suppliers could be utilised to provide recycled aggregates or potentially to process waste from the proposed scheme. Other potential sources of alternative aggregates would be investigated as the detailed design is progressed, including opportunities to re-use site-won materials and materials from major development sites in the area.

Table 18.6: Recycled aggregate suppliers in The Highland Council and the TAYplan SDP areas (www.zwsaggsuppliers.org.uk)

Regions	Address of Recycled Aggregate Supplier	Products
The Highland Council	Highland Lime - Leiths Scotland Ltd, Dornie Quarry, PH33 6SW	Sub-base (Type 1) Capping (6F3) Asphalt planings
TAYplan	Collace Quarry - Tayside Contracts, PH2 6JB	General fill Sub-base (Type 1) Sub-base (Type 4) Drainage and filter bedding
TAYplan	Ardownie - Geddes Group, Ardownie Quarry, DD5 4HW	Sub-base (Type 1) Capping (6F5)
TAYplan	Waukmill - Geddes Group, Waulkmill Quarry, DD11 4UT	Sub-base (Type 1) Capping (6F5)

18.3.10 An estimate of the quantities of materials required for the proposed scheme was derived from the design of the proposed scheme assessed within this ES and interpretative ground investigation (GI) reports. Details of the GI reports can be found in Chapter 10 (Geology, Soils, Contaminated Land and Groundwater).

18.3.11 A summary of the potential materials required for construction of the proposed scheme along with estimated quantities, is provided in Section 18.4 (Potential Impacts; Table 18.10). Specific sources of raw materials to be used for the construction of the proposed scheme have not yet been identified as this decision will remain with the appointed Contractor.

Generation and Management of Waste

18.3.12 The main CD&E wastes arising due to construction of the proposed scheme are shown in Section 18.4 (Potential Impacts; Table 18.12).

18.3.13 For the purpose of this assessment, waste management facilities have been separated into two categories:

- operational landfills; and
- licenced treatment facilities (all other licenced operational sites e.g. metal recycler, transfer station, multiple activity sites, composting and incineration).

18.3.14 The SEPA Waste Site and Capacity Report for Scotland 2015 (SEPA, 2017) was used to identify the location of suitable operational landfills and licenced treatment facilities in The Highland Council and TAYplan SDP areas that accept commercial and/or inert waste.

18.3.15 Sites identified as being suitable for taking waste from the proposed scheme were screened based on the following criteria:

- operational sites only;
- excluded sites where only activities were: local authority civic amenity, local authority recycling centres (or combination of these activities); and
- excluded sites that only accept household waste.

18.3.16 A total of five operational landfills and 44 licenced treatment facilities were identified as being suitable for the proposed scheme wastes within 100km.

<u>Operational Landfills</u>

18.3.17 Table 18.7 shows the annual permit capacity for landfills accepting inert waste and non-hazardous waste in 2015, along with the remaining annual permit capacity (% surplus) as of 31 December 2015 for each area.

18.3.18 Table 18.7 also shows the total remaining landfill capacity for operational landfills (inert and non-hazardous), as at 31 December 2015 (tonnes). For the purposes of this assessment, figures have been presented for Perth & Kinross separate to the other local planning authorities that make up the TAYplan area (Angus, Dundee and Fife Councils).

Table 18.7: Operational landfills (inert and non-hazardous) within the study area as at 31 December 2015 (SEPA, 2017)

2015 Capacity	The Highland Council	TAYplan - Perth & Kinross Council	TAYplan - Angus, Dundee and Fife Councils	Total
Inert landfills				
Annual permit capacity (tonnes)	0	0	75,000	**75,000**
Annual permit capacity 2014 (% surplus)	n/a	n/a	71%	**71%**
Total remaining capacity as at 31 December 2015 (tonnes)	0	0	1,134,206	**1,134,206**
Non-Hazardous landfills				
Annual permit capacity (tonnes)	0	0	427,500	**427,500**
Annual permit capacity 2015 (% surplus)	n/a	n/a	65%	**65%**
Total remaining capacity as at 31 December 2015 (tonnes)	0	0	543,756	**543,756**

18.3.19 Table 18.8 provides more details of these sites, including their remaining capacity (% surplus) in 2015. Locations for the sites are shown on Figure 18.1 (SEPA, 2017). Based on data (SEPA, 2017) and consultation with SEPA it is understood that both Granish Landfill in Aviemore and Binn Farm Landfill in Glenfarg are no longer accepting waste other than that which can be used for engineering and capping; the capacity available for use by the proposed scheme will therefore be dependent on the activity taking place at these sites at the time of the proposed scheme's construction. Ardownie Landfill is anticipated to cease infill in 2035. The year in which the other landfills will cease infill is not known (SEPA, 2017).

Table 18.8: Annual and remaining capacity of operational landfills (inert and non-hazardous) within the study area (SEPA, 2017)

Operational landfills, 2015	Annual Capacity on Permit (tonnes)	Remaining Capacity 2015 (% surplus)
Inert landfills		
D Geddes Ltd, Ardownie Landfill, Monifieth	75,000	71%
Total	**75,000**	**71%**
Non-Hazardous landfills		
Granish Landfill Site Cell 3, By Aviemore*	0	n/a
Binn Farm Landfill, Sita, Binn Farm, Glenfarg, Perth*	0	n/a
Fife Council, Lower Melville Wood L/F, Cupar	282,500	56%
Restenneth Landfill Site, Montrose Rd, Forfar	145,000	84%
Total	**427,500**	**65%**

*Sites only accepting waste which can be used for engineering and capping. The volume of materials that could potentially be used in this manner cannot be quantified, hence remaining capacity has been set at zero.

18.3.20 The only active hazardous landfill in Scotland in 2015 was Avondale in Falkirk, located approximately 110km south of the proposed scheme. A total of 33,116 tonnes was landfilled at this site in 2015, leaving a surplus of 83% of the annual permit capacity (200,000 tonnes) as of 31 December 2015 and a total remaining lifetime capacity of the landfill of 164,264 tonnes.

18.3.21 The location of operational landfills identified as being suitable for the proposed scheme are shown on Figure 18.1 (as informed by SEPA's Waste Site and Capacity Tool, 2017).

Licenced Treatment Facilities

18.3.22 Table 18.9 shows the capacity of licenced treatment facilities, considered as being suitable for the proposed scheme within the wider study area of The Highland Council and TAYplan. The table provides the annual waste capacity and annual waste accepted in 2015 for licenced treatment facilities in each of these areas (tonnes/annum), along with the remaining capacity (%) of the annual permit capacity as of 31 December 2015.

Table 18.9: Licenced treatment facilities in within the study area as of 31 December 2015 (SEPA, 2017)

Area	Annual Capacity (tonnes/annum)	Waste Accepted 2015 (tonnes)	Surplus Capacity 2015 (%)
The Highland Council	302,999	14,869	95%
TAYplan – Perth & Kinross	690,451	421,387	39%
TAYplan – Angus	519,575	97,727	81%
TAYplan – Dundee	497,596	217,213	56%
TAYplan – Fife	383,973	269,239	30%
Total	**2,394,594**	**1,020,435**	**57%**

18.3.23 The locations of licenced treatment facilities identified as being suitable for the proposed scheme are shown on Figure 18.1 (as informed by SEPA's Waste Site and Capacity Tool, 2017).

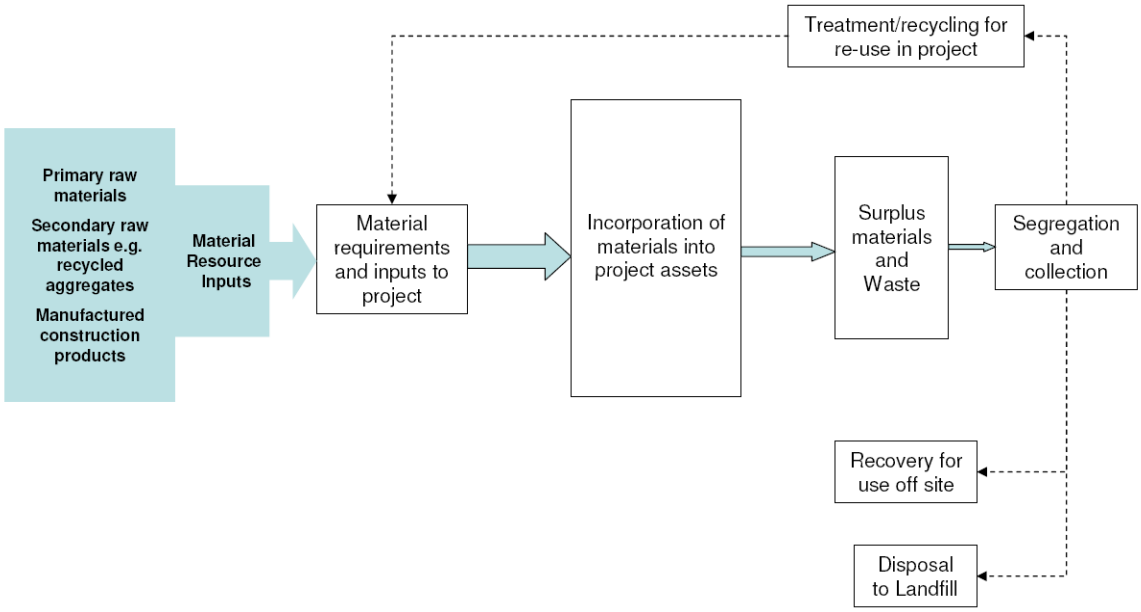
18.3.24 As per paragraph 18.1.14, certain activities may fall under an exemption and as such, the figures shown in Tables 18.7-18.9, only provide a partial picture of the overall capacity for CD&E waste within the study area; for instance, the recycled aggregate suppliers shown in Table 18.6 have potential to process waste from the proposed scheme.

18.3.25 Sites storing waste require to be licenced or have a relevant exemption in place. The storage limit under a Paragraph 13 Exemption is 20,000 tonnes, 50,000 tonnes under a Paragraph 19 Exemption and 20,000 tonnes under a Paragraph 24 Exemption.

18.4 Potential Impacts

18.4.1 Environmental impacts associated with material resources and wastes occur at each stage of the proposed scheme's material flow cycle. A simplified diagrammatic representation of materials resource flows is shown on Illustration 18.3, identifying material resource use and the management of waste.

Illustration 18.3: A Project's Material Flow Cycle (Highways Agency et al., 2011)



Material Resources

18.4.2 The types of materials likely to be required for construction are common to all road schemes and many of these would originate on-site and would be re-used on-site. Other materials and products such as those required for fencing and signage would be purchased and imported to site for use during construction. Indicative quantities of the major materials required for the construction of the proposed scheme have been estimated and are shown in Table 18.10.

Table 18.10: Summary of material volume and embodied carbon emissions

Project Element	Material Resource	Unit	Approximate Estimated Material Quantity*	Embodied Carbon Emissions (tCO_2e) – Primary Material Use	Embodied Carbon Emissions (tCO_2e) –Worst Case Scenario (15% Contingency)
Bulk Earthworks	Top soil (site-won)	m^3	110,600	1,941	2,232
	Top soil (imported)	m^3	0		
	Soil and rock (site-won)	m^3	332,500		
	Aggregates (imported)	m^3	0		
Road Pavement	Sub-base	m^3	56,400	11,243	12,930
	Base	m^2	181,000		
	Capping	m^3	0		
	Binder	m^2	187,400		
	Surface	m^2	187,400		
	Kerbs	m	200		
	Tack coat	m^2	368,300		
Safety barrier	Steel	m	23,200	992	1,040
Drainage	Filter material	m	23,900	921	1,059
	Filter drain pipe	m	23,900		
	Carrier drain (HDPE)	m	3,400		
	Concrete chambers	m^3	600		
Civil	In-situ concrete	m^3	8,900	6,104	7,019

Project Element	Material Resource	Unit	Approximate Estimated Material Quantity*	Embodied Carbon Emissions (tCO_2e) – Primary Material Use	Embodied Carbon Emissions (tCO_2e) –Worst Case Scenario (15% Contingency)
engineering structures	Precast concrete	m^3	900		
	Structural steel	t	600		
	Steel reinforcement	t	2,600		
Fencing	Mammal fence	m	11,000	111	127
Cables and electronic equipment	Cable ducting	m	66,500	481	553
	Fibre optic cable	m	16,600		
	Power cable	m	16,600		
	Concrete chamber	m^3	100		
Total	**-**	**-**	**-**	**21,793**	**24,961**

*To nearest 100 for each unit. Amounts are approximate and indicative and are subject to change. Uncertainties in relation to the data are outlined in the limitations to assessment section.

18.4.3 Based on the assumptions in paragraphs 18.2.15-16, the Transport Scotland CMS tool estimated the whole life carbon emissions of the proposed scheme to be 21,800 tCO_2e (to the nearest 100 unit) and the worst case scenario figure (with a 15% contingency) to be 25,000 tCO_2e (Table 18.10). The magnitude of impact of the proposed scheme is therefore considered to be moderate based on draft HD 212/11 (Table 18.1). The draft guidance uses benchmark data from previous road projects to define the scale of magnitude and considers emissions between 20,000 and 40,000 tCO_2e to be moderate (Table 18.1). The materials data used to generate the carbon emissions (Table 18.10) are approximate and indicative only and are subject to change (refer to paragraph 18.2.27).

18.4.4 Based on the DMRB Stage 3 design it is anticipated that the majority of the excavated material (estimated as 433,100m^3) is suitable for re-use on-site as engineering fill and will be modified/processed as required to meet specification requirements. As such, the total earthworks import has been estimated as 0m^3 (Table 18.11). There is potential for greater re-use on-site but will be dependent on the refinement of the geotechnical information.

Table 18.11: Earthworks volumes estimates

Earthworks	Topsoil (m^3)	Soil and Rock (m^3)	Total (m^3)
Site-won used	110,600	332,500	443,100
Import to site	0	0	0
Export from site	37,500	293,500	331,000

Note: values are to nearest 100 for each unit. Amounts are approximate and indicative and are subject to change. Uncertainties in relation to the data are outlined in the limitations to assessment section.

18.4.5 Imported aggregates are likely to be required for structures, drainage and road pavement construction. There is a potential for depletion of finite natural resources through extraction of primary aggregates from local or other quarries. The choice of whether to use primary, secondary or recycled aggregates (or a combination) would be made considering a combination of factors such as materials availability, specification, production and transport. Secondary and recycled aggregates may not always have the lowest impact on the environment and materials would be selected based on a consideration of all relevant impacts.

18.4.6 Based on the information available (refer to paragraph 18.3.7 and 18.3.8), within The Highland Council and TAYplan areas there is capacity to supply high quality aggregate material for the proposed scheme. However, due to European Union competition regulations, it is not possible to prescribe materials sources and this decision will remain with the appointed Contractor. It should also be noted, that due to a number of other projects along the A9 that are currently being progressed and also likely to require locally sourced aggregate material, it cannot currently be confirmed whether there is sufficient capacity at these locations to accommodate the proposed scheme.

18.4.7 Poor planning of materials re-use can lead to excessive use of plant and vehicles to move and handle bulk materials, resulting in inefficient use of energy (contributing to climate change) and increased risk

of spillages of fuel, lubricants etc., and potentially causing localised contamination of soils or watercourses.

Generation and Management of Waste

18.4.8 For wastes and surplus or defective materials, the potential impacts would be primarily associated with the production and processing (including recycling/recovery) of wastes, and, if required, their disposal at licensed off-site facilities.

18.4.9 It is assumed that the majority of the waste generated from the construction of the proposed scheme will be CD&E waste. CD&E waste includes, but is not limited to, inert materials such as soils and rubble, excavated road planings, off-cuts and waste timber, plastics (such as uPVC & HDPE), packaging (for example card, wood and plastic film) and aggregate materials (such as masonry, brick and block, paving, tiles and ceramics).

18.4.10 The potential wastes arising due to construction of the proposed scheme can be found in Table 18.12. Based on the DMRB Stage 3 design, estimated quantities have been calculated for pavement, topsoil and earthworks materials that will potentially require export off-site. Table 18.12 includes an estimate of the quantities of material that will be produced from the demolition of structures and from the use of construction materials.

Table 18.12: Summary of potential CD&E waste arising

Construction phase	Potential CD&E waste stream	Approximate Quantity (m^3)	Approximate Quantity (tonnes)
Groundworks	Bulk Earthworks (soils and/or rock)	293,500	428,500
	Topsoil	37,500	54,800
	Pavement	34,000	75,200
	Demolition of structures	600	700
Construction	Pavement		69,600
	Structures		600
	Other*		0
TOTAL		-	**629,400***

Note: values are to nearest 100 for each unit. Amounts are approximate and indicative and are subject to change. Uncertainties in relation to the data are outlined in the limitations to assessment section.
*Includes 'Drainage', 'Safety Barriers', 'Fencing and Signs', 'Signals & Comms'; before rounding to nearest 100 total is 41 tonnes.

18.4.11 The proposed scheme aims to achieve an earthworks balance in order to reduce the need for earthworks materials to be imported (earthworks deficit) or off-site (earthworks surplus). Currently it is assumed that 10% of all excavated materials will be unacceptable for re-use on-site on the basis of information from Advanced and Preliminary GI and materials acceptability assessments based on laboratory test data. The proportion of excavated material acceptable for re-use may be increased as further ground investigation takes place and there is potential for the surplus material to be used for landscaping on-site; however, the extent is not known and it is acknowledged that there would be some surplus fill material which will require to be exported from site. This surplus material calculated based on current assumptions (refer to Table 18.11), and other materials arising during the groundworks and construction phases, was classified as potential waste, as it could potentially need to be discarded and not utilised in the proposed scheme.

18.4.12 Materials are considered to be a waste if there is no possibility of recovering the material on-site or through processing that would enable materials to be used elsewhere. If material is processed in line with SEPA's guidance on recycled aggregates from inert waste (SEPA, 2013) or guidance on the production of fully recovered asphalt road planings (SEPA, undated) it ceases to be waste. Soils compliant with SEPA's guidance on the re-use of greenfield soils in construction, or used according to a remediation plan as set out in the Land Remediation and Waste Management Guidelines, are also not classed as waste (SEPA, 2010, undated).

18.4.13 Waste management can become a concern if there was a risk of filling local facilities up to capacity, thereby forcing locally produced wastes to be transported greater distances for disposal elsewhere.

18.4.14 The proposed scheme was predicted to generate approximately 504,400 tonnes of inert waste (bulk earthworks, pavement and demolition) with the potential to become waste (refer to Table 18.12); of which 428,400 tonnes is bulk earthworks. The annual capacity for inert landfills in the wider study area in relation to the proposed scheme is equivalent to 75,000 tonnes per annum (refer to Table 18.7). With an estimated construction programme of approximately 2.5-3.0 years it is considered that there is inadequate inert landfill capacity within the study area in relation to the estimated production of inert waste for the proposed scheme unless the Contractor can treat a high proportion of waste for re-use or recycling to divert this waste from the inert landfills (refer to paragraph 18.4.16).

18.4.15 The proposed scheme was predicted to generate approximately 37,500 tonnes of topsoil and 70,200 tonnes of construction materials with the potential to become a waste (refer to Table 18.12). There is potential for greater re-use of topsoil on-site but will be dependent on the refinement of the geotechnical information. Excess topsoil also has the potential to be re-used on other sites and will not be classified as waste if managed in accordance with SEPA's regulatory guidance on the re-use of greenfield soils (SEPA, 2010). The annual capacity for non-hazardous landfills in relation to the proposed scheme is equivalent to 427,500 tonnes (refer to Table 18.7). With an estimated construction programme of approximately 2-3 years it is considered that there is adequate capacity within the study area in relation to the estimated production of non-hazardous waste for the proposed scheme.

18.4.16 Table 18.9 identifies an annual capacity at licenced treatment facilities in the study area of approximately 2.3 million tonnes of which 57% (approximately 1.4 million tonnes) of capacity was unused in 2015. SEPA reports that in 2015 over 80% of construction and demolition waste was recycled or re-used in Scotland (excluding soil and stone) (SEPA, 2015a). In addition, in 2015 approximately 2.3 million tonnes of soil were recycled and 0.75 million tonnes of waste were recycled into aggregates in Scotland (including 0.51 million tonnes under simple exemption) (SEPA, 2015b). There is scope for recycling and re-use of construction waste from the proposed scheme but the quantity achievable will be dependent on the Contractor, and therefore cannot be determined at this stage. However, as illustrated, the construction sector seeks to recycle and re-use construction waste in response to legislative, fiscal and policy drivers, as well as cost minimisation, which would result in a likely reduction in the quantity of material that would leave site and require disposal to landfill.

18.4.17 Other wastes that may be generated from the proposed scheme, but that have not been quantified, include:

- surplus organic materials including vegetation from shrub or tree clearance;
- peat;
- hazardous wastes including bituminous mixtures containing coal tar and asbestos; and
- municipal solid waste (MSW) from construction workers.

18.4.18 Chapter 10 (Geology, Soils, Contaminated Land and Groundwater) identifies a total of 23 potentially contaminated land sources within the study area, and predicts direct disturbance of a number of these; contaminated soil could potentially be classified as hazardous waste. All soil tonnage is captured under bulk earthworks and topsoil; any contaminated soil would be reclassified from inert or non-hazardous to hazardous and be managed appropriately. Chapter 10 also confirms that only localised areas of peat are expected to be encountered.

18.4.19 There is potential for the impact in relation to waste management capacity to be larger if other sections of the A9 Dualling Programme currently being progressed have a large requirement for waste disposal (refer to Chapter 20: Cumulative Impacts).

Summary of Impacts Prior to Mitigation

18.4.20 The potential impacts identified for both materials and waste above, and their magnitude / significance are summarised, as appropriate, in Table 18.13.

Table 18.13: Potential impacts reporting matrix prior to mitigation

Activity	Potential Impacts	Description of the Potential Impacts
Site remediation/ Preparation/ Demolition	Site preparation resulting in production of inert CD&E waste: soils and rock.	• A large volume of soil and rock will be generated from the earthworks. • A proportion of soils and rock can be re-used for the construction works. • After re-use on-site for engineering purposes there will be a surplus of 428,500 tonnes; the material would potentially need to be discarded and would thus be classified as waste. • Scope for further re-use on–site for landscaping, temporary haul roads, sub-base for construction compounds. • Scope for re-use off-site at development projects, licenced and exempt sites. • Adequate waste management capacity is available: 2.3 million tonnes of treatment capacity and 75,000 tonnes of annual capacity at inert landfill. Sensitivity: medium Potential impact: minor magnitude, adverse, short term, temporary and direct Potential significance: Slight
Site remediation/ Preparation/ Demolition	Site works resulting in waste top soil and organic materials from vegetation.	• After re-use of topsoil on-site for engineering purposes there will be a surplus of 54,800 tonnes. Accurate tonnage of green waste cannot be quantified at this stage of the proposed scheme. • Where re-use on-site of any material is not possible, the material would potentially need to be discarded and would thus be classified as waste. • Scope for further re-use on–site for landscaping. • Scope for re-use off-site at development projects, licenced and exempt sites. • Adequate waste management capacity is available: 2.02 million tonnes of treatment capacity and 427,500 tonnes of annual capacity at non-hazardous landfill. Sensitivity: low Potential impact: minor magnitude, adverse, short term, temporary and direct Potential Significance: Neutral/Slight
Site remediation/ Preparation/ Demolition	Demolition of existing structures and road pavement resulting in production of CD&E wastes.	• Production of 75,900 tonnes of waste. • Where re-use on-site of any material is not possible, the material would potentially need to be discarded and would thus be classified as waste. • Scope for further re-use on–site for pavement construction, temporary haul roads, construction compounds. • Scope for re-use off-site at development projects, licenced and exempt sites. • Adequate waste management capacity is available: 2.02 million tonnes of treatment capacity and 75,000 tonnes of annual capacity at inert landfill. Sensitivity: medium Potential impact: minor magnitude, adverse, short term, temporary and direct. Potential significance: Slight
Site remediation/ Preparation/ Demolition	Site works resulting in production of hazardous waste.	• The tonnage of hazardous waste cannot be quantified as this stage of the proposed scheme but low volumes expected. Chapter 10 (Geology, Soils, Contaminated Land and Groundwater) identifies direct disturbance of a number of potential contaminated land sources. • Given anticipated low volumes adequate waste management capacity available. There is a hazardous waste facility located in Falkirk with an annual permit capacity of 200,000 tonnes, with 83% of the annual capacity unused in 2015. Sensitivity: low Potential impact: major magnitude, adverse, short, temporary and direct Potential significance: Slight/Moderate
Construction	Use of site-won and imported material resources.	• Use of construction materials and products. Materials are predominantly available from site-won materials or locally but the material demand is relatively large. The depletion of finite natural resources could occur through extraction of resources such as: primary aggregates (e.g. sands and gravels) from local or other quarries. • Waste and materials being stored on-site potentially resulting in issues such as silty run-off and dust (refer to Chapter 10 (Geology, Soils, Contaminated Land and Groundwater) and Chapter 11 (Road Drainage and the Water Environment)) and double handling. • Based on the CMS tool the overall embodied carbon impacts (tCO2e) of construction materials is between 21,800 tCO2e and 25,000 tCO2e (including 15% contingency)

Activity	Potential Impacts	Description of the Potential Impacts
		Potential impact: moderate magnitude, adverse, long, permanent and indirect* *In line with HD212/11 significance nor sensitivity are assessed for material consumption and use (refer to paragraph 18.2.19)*
Construction	Disposal of wastes from imported construction materials use and municipal solid waste production.	• Municipal solid waste production is expected to be minimal. • The quantity of waste generated as a result of material use in construction is estimated to be 70,200 tonnes. • Adequate waste management capacity is available: 2.02 million tonnes of treatment capacity and 427,500 tonnes of annual capacity at non-hazardous landfill. Sensitivity: low Potential impact: minor magnitude, adverse, short term, temporary and direct Potential significance: Neutral/Slight

18.5 Mitigation

18.5.1 Measures will be implemented to minimise both the use of materials and the generation of waste in relation to the proposed scheme. There is significant synergy between materials re-use and the avoidance of the generation of waste. There is therefore a substantial overlap between the mitigation measures for materials and waste, which will in turn reduce the embodied carbon impacts.

18.5.2 The importance of careful management of materials to promote re-use and reduce waste has been widely recognised by the construction industry. There are legislative, fiscal and policy drivers to incentivise maximising re-use on site, re-use and recycling off-site and diversion from landfill. Both transport and disposal of waste is an important cost to be taken into consideration by the Contractor. Both legislation and voluntary best practice mechanisms have been developed and implemented. These provide measurable and accountable processes that form the basis for mitigating adverse environmental impacts associated with materials and waste.

18.5.3 Mitigation measures listed in this chapter will be specified as environmental commitments in the contract documents to ensure implementation by the appointed Contractor.

Embedded Mitigation

18.5.4 The DMRB Stage 3 design aims to achieve an earthworks balance to reduce the need for earthworks materials to be disposed off-site and the requirement for the import of raw materials.

Standard Mitigation

18.5.5 Standard measures to mitigate potential impacts relating to the use and consumption of materials and the production and management of waste during construction are set out in the Standard Mitigation Commitments (**Mitigation Items SMC-M1** to **SMC-M7**), presented in Table 18.14.

Table 18.14 Standard A9 mitigation

Mitigation Item	Description
SMC-M1	Prior to construction a Site Waste Management Plan (SWMP) will be developed as part of the CEMP (see **Mitigation Item SMC-S1**) to set out how all construction phase materials will be managed and it will be updated regularly during the construction of the proposed scheme. The SWMP will identify, prior to the start of construction works, the types and likely quantities of wastes that may be generated and it will set out, in an auditable manner, how waste will be reduced, re-used, managed and disposed of in accordance with relevant Zero Waste Scotland Guidance. The SWMP will include specific materials management and soil management plans developed under voluntary and industry regulated Codes of Practice including: • Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (Defra, 2009); • Land Remediation and Waste Management Guidelines (SEPA, 2009); and • Promoting the Sustainable Reuse of Greenfield Soils in Construction (SEPA, 2010). Appropriate waste minimisation and associated KPI targets will also be included.

Mitigation Item	Description
SMC-M2	The Contractor will comply with all relevant waste legislation in relation to waste handling, storage, transport and disposal (e.g. The Waste Framework Directive) and consultation with SEPA for advice on waste practices, licences and exemptions where appropriate.
SMC-M3	The Contractor will apply the principles of the 'Waste Hierarchy' (Prevention, Prepare for Reuse, Recycling, Other Recovery, Disposal) to minimise waste generation, maximise re-use of site-won materials on-site and minimise the need for disposal of waste. Where re-use is not possible within the proposed scheme, alternative re-use and recycling options will be sought off-site with disposal the final option, with clear justification of options provided.
SMC-M4	The Contractor will implement Zero Waste Scotland's Design for Resource Efficient Construction Principles.
SMC-M5	Where practicable, the key material elements (i.e. aggregates, asphalt, cement, precast concrete products, ready-mixed concrete and steel) used within the proposed scheme shall be specified to be responsibly sourced from suppliers who have a minimum ISO 14001 certification and, if available, BES 6001 (Framework Standard for the Responsible Sourcing of Construction Products) certification for the material.
SMC-M6	All timber and timber products shall be sourced from independently verifiable legal and sustainable sources as defined in Scottish Procurement Policy Note(s) SPPN 09/2004 and SPPN (09) 2005.
SMC-M7	Alternatives to primary aggregates shall be investigated, including opportunities to use recycled or secondary aggregates in the construction of the proposed scheme; either sourced from construction, demolition and excavation waste obtained on-site or off-site; or secondary aggregates obtained from a non-construction or post-consumer or industrial by-product source.

18.5.6 In addition to the materials mitigation measures stated in this chapter, environmental mitigation included in other chapters of this ES will also influence appropriate management and handling of materials, particularly those in relation to Community and Private Assets (Chapter 8); Geology, Soils, Contaminated Land and Groundwater (Chapter 10); Road Drainage and the Water Environment (Chapter 11); and Air Quality (Chapter 16). Those measures of particular relevance are **Mitigation** Items **SMC-CP8, SMC-G3, SMC-G8, SMC-G9, SMC-G10, SMC-G14, SMC-W2, SMC-W6** to **SMC-W10, SMC-AQ1 and SMC-AQ2**, which are listed in Chapter 21 (Schedule of Environmental Commitments).

18.5.7 In terms of potential waste arisings from forestry and tree felling, mitigation is stated separately in Chapter 8 (People and Communities - Community and Private Assets), whereby commercially viable timber that could not be retained would be felled and provided to the landowner. Any remaining forest residues in these commercial woodland areas would be dealt with in accordance with existing forest development plans.

18.5.8 Where suitable, green waste from vegetation clearance will be re-used or recycled where practicable, such as through on-site landscaping or ecological improvement works; for example, for habitat creation, or spread as chippings or mulch, with appropriate consideration and control of any watercourse pollution risk. Off-site disposal through a green waste disposal contractor will also offer recycling through composting. Details of any specific proposed ecological improvement works are outlined in Chapter 12 (Ecology and Nature Conservation).

18.5.9 The availability of responsibly sourced local, secondary and recycled materials will be considered. For instance, Table 18.6 identifies secondary and recycled aggregate suppliers that may be considered suitable for the proposed scheme. There will also be potential to reduce impact by consideration of the recycled content of materials used within the proposed scheme; for instance, both reinforced concrete and steel structures include a measurable recycled content in their manufacture.

18.5.10 A principal mitigation measure relating to material resources and waste management would be the development and implementation of a CEMP (**Mitigation Item SMC-S1)** which will include the following:

- Procurement and waste management protocols/Key Performance Indicators (KPIs) and targets designed to minimise impacts on the environment and maximise local procurement of materials and waste management options. Materials with a higher recycled content and/or the use of re-usable or recyclable materials should be favoured and clear justification for materials selection to demonstrate optimisation of resource efficiency will be provided. Structures, drainage, road restraint systems, traffic signals and signage products will be procured for the proposed scheme with consideration of the environmental impacts associated with their manufacture including carbon

footprint, as well as other considerations such as structural design, energy consumption, long-life performance, visual impacts, durability and cost.

- Good materials management methods, such as co-location of temporary haul routes on permanent capping and recovery and re-use of temporary works materials from haul routes, plant and piling mattresses and use of 'just-in-time' delivery to minimise double handling.
- Risk/impact-specific method statements and strategic details of how relevant environmental impacts would be addressed throughout the proposed scheme, embodying the requirements of the relevant SEPA Guidance for Pollution Prevention (GPPs) (SEPA et al, various).
- Development and Implementation of an Earthworks Management Plan as part of the SWMP. The Earthworks Management Plan developed by the appointed Contractor would include opportunities to re-use soil, topsoil and rock.

18.5.11 Current regulations do not afford trunk road construction schemes the opportunity for carbon offsetting. National infrastructure project-related carbon impacts will be encapsulated in national level reporting and, by default, associated measures to achieve climate change targets.

18.5.12 Table 18.15 in Section 18.6 (Residual Impacts) provides a summary of the mitigation measures proposed to minimise the potential impacts of the proposed scheme in accordance with Annex 4 of draft HD 212/11 and residual impacts.

Specific Mitigation

18.5.13 No project-specific mitigation measures have been identified for the proposed scheme. Environmental mitigation included in Community and Private Assets (Chapter 8) will also influence appropriate management and handling of materials; a Soil Resource Plan will be prepared under **Mitigation Item P03-CP22**.

18.6 Residual Impacts

18.6.1 A high proportion of the residual impacts associated with materials and waste cannot be absolutely predicted as they will be dependent on the procurement and construction details implemented by the Contractor. It is therefore not possible at this stage to define how the waste generated will be treated; however, professional judgement, based on knowledge of the performance of the construction industry in Scotland and Transport Scotland's demonstrated approach to major infrastructure development, has been used to assess the likely residual impacts.

18.6.2 The final embodied carbon footprint will not be known until the Contractor has completed the construction of the proposed scheme, using the CMS tool estimated total embodied carbon emission to be between 21,800 and 25,000 tonnes of CO2e (including a 15% contingency). Due to the proposed scheme length, and civil engineering structures required, any reductions realised as a result of implementation of mitigation commitments are unlikely to bring the total embodied carbon footprint for the proposed scheme to below 20,000 tCO_2e. A reduction to be below 20,000 tCO_2e would be necessary to demonstrate a reduced magnitude of impact for the purposes of the assessment.

18.6.3 The UK's 3rd carbon budget (2018 to 2022) (the period in which construction is likely to be undertaken) is 2,544 million tonnes CO_2e (Committee on Climate Change, undated). The proposed scheme's total embodied carbon emissions represent a very small proportion (<0.001%) of this carbon budget.

18.6.4 The authorisation of national road network projects in Scotland is devolved to the Scottish Government; however, in the absence of an equivalent Scottish policy statement, reference has been made to the Department for Transport (2014) 'National Policy Statement for National Networks' (used as the primary basis for making decisions on development consent applications for national networks nationally significant infrastructure projects in England) which provides the following pertinent statements with regard to carbon emissions from road developments:

- *"The impact of road development on aggregate levels of emissions is likely to be very small"*

- *"It is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets"*
- *"The Government has an overarching national carbon reduction strategy (as set out in the Carbon Plan 2011) which is a credible plan for meeting carbon budgets:*

- *It includes a range of non-planning policies which will, subject to the occurrence of the very unlikely event described above, ensure that any carbon increases from road development do not compromise its overall carbon reduction commitments*
- *The Government is legally required to meet this plan. Therefore, any increase in carbon emissions is not a reason to refuse development consent, unless the increase in carbon emissions resulting from the proposed scheme are so significant that it would have a material impact on the ability of Government to meet its carbon reduction targets"*

18.6.5 The proposed scheme cannot influence all of the elements that underpin its embodied carbon emissions. Some of the elements are only likely to be influenced by the UK/Scottish Government, whilst others are related to the commercial decisions of private manufacturing companies which are outside the direct control of both Transport Scotland and Government.

18.6.6 Current regulations do not afford trunk road construction schemes the opportunity for carbon offsetting. National infrastructure project-related carbon impacts will be encapsulated in national level reporting and, by default, associated measures to achieve climate change targets.

18.6.7 The residual impacts may be impacted by other major infrastructure projects taking place at the time of construction of the proposed scheme (refer to Chapter 20: Cumulative Impacts).

18.6.8 It should be noted that at all stages of the construction of the proposed scheme, the Contractor will seek to minimise waste, re-use as much material as possible on-site, recycle/recover as much waste that cannot be used on site as possible and minimise carbon emissions. Thus the proposals accord with relevant legislation, policy and guidance as set out in this chapter.

18.6.9 An assessment of the magnitude and/or significance of residual impacts is presented in Table 18.15. Timing of measures is considered in Chapter 21 (Schedule of Environmental Commitments).

Table 18.15: Residual impacts and mitigation measures reporting matrix*

Activity	Potential Impacts	Proposed Mitigation and Residual Impacts	Implementation and Monitoring of Measures
Site remediation/ Preparation/ Demolition	Site works resulting in production of inert CD&E waste: soils and rock.	**Mitigation Items SMC-M1, SMC-M2, SMC-M3, SMC-M4, SMC-M5, SMC-M7, SMC-S1** and **P03-CP22** • Application of well-planned and well-controlled construction site management through procedures included in the CEMP and SWMP. • It may be possible that a higher tonnage could be re-used on-site with further treatment or for landscaping but it is not possible to ascertain at this stage of the design of the scheme. Re-use and recycling off-site will be maximised. Waste hierarchy will be applied so that alternative re-use and recycling options will be sought off-site with disposal the final option. • Waste not used on-site will be transferred to development sites according to regulatory guidance, or by licenced waste carriers to licenced or registered exempt waste management facilities for preparation for re-use, recycling and disposal. • It is not possible at this stage to define how the waste generated will be treated. Impact significance based on the proportion of material likely to be suitable for re-use. Residual impact: negligible magnitude, adverse, short term, temporary and direct Residual significance: Neutral/Slight if predominantly re-used or recycled	CEMP SWMP

Activity	Potential Impacts	Proposed Mitigation and Residual Impacts	Implementation and Monitoring of Measures
Site remediation/ Preparation/ Demolition	Site works resulting in waste top soil and organic materials from vegetation.	**Mitigation Items SMC-M1, SMC-M2, SMC-M3, SMC-M4, SMC-M5, SMC-M7, SMC-S1** and **P03-CP22** • Application of well-planned and well-controlled construction site management through procedures included in the CEMP and SWMP. • Green waste composted/chipped on-site to act as a soil improver for landscaping purposes or composted/chipped off-site. • Waste hierarchy will be applied so that alternative re-use and recycling options will be sought off-site with disposal the final option. • Waste will be transferred to development sites according to regulatory guidance, or by licenced waste carriers to licenced or registered exempt waste management facilities. • It is not possible at this stage to define how the waste generated will be treated. Impact significance based on the proportion of material likely to be suitable for re-use. Residual impact: negligible magnitude, adverse, short term, temporary, direct Residual significance: Neutral if wastes are predominantly re-used or recycled	CEMP SWMP
Site remediation/ Preparation/ Demolition	Demolition of existing structures and road pavement resulting in production of CD&E wastes.	**Mitigation Items SMC-M1, SMC-M2, SMC-M3** and **SMC-S1** • Application of well-planned and well-controlled construction site management through procedures included in the CEMP and SWMP. • Screening and crushing on-site for re-use where possible. • Waste hierarchy will be applied so that alternative re-use and recycling options will be sought off-site with disposal the final option. • Waste not used on-site will be transferred to development sites according to regulatory guidance, or by licenced waste carriers to licenced or registered exempt waste management facilities for preparation for re-use, recycling and disposal. • It is not possible at this stage to define how the waste generated will be treated. Impact significance based on the proportion of material likely to be suitable for re-use. Residual impact: negligible magnitude, adverse, short term, temporary, direct Residual significance: Neutral/Slight if wastes are predominantly re-used or recycled	CEMP SWMP
Site remediation/ Preparation/ Demolition	Site preparation resulting in production of hazardous waste.	**Mitigation Items SMC-M1, SMC-M2, SMC-M3** and **SMC-S1** • Application of well-planned and well-controlled construction site management through procedures included in the CEMP and SWMP. • Risk assessment and mitigation, if required, would be specified. The risk assessment will determine whether the soils could stay on-site, require treatment to make them suitable to remain on-site or will need to be disposed of off-site. Transport for disposal if necessary to hazardous waste landfill in Falkirk. Residual impact: major magnitude, adverse, short term, temporary, direct Residual significance: Slight/Moderate	CEMP SWMP

Activity	Potential Impacts	Proposed Mitigation and Residual Impacts	Implementation and Monitoring of Measures
Construction	Use of site-won and imported material resources.	**Mitigation Items SMC-M1, SMC-M2, SMC-M3, SMC-M4, SMC-M5, SMC-M6, SMC-M7** and **SMC-S1** • Application of well-planned and well-controlled construction site management through procedures included in the CEMP and SWMP. • Re-use as much of on-site materials as possible to reduce overall demand from external sources. Use of procurement policies, targets and KPIs to maximise local sourcing of materials and the inclusion of as much recycled content as practicable in accordance with the required specifications of the construction material. • Ensure materials/suppliers are sourced as close to the site as possible. • Application of good materials management practices can minimise the amount of materials wasted during the construction process. • Mitigation may reduce the overall impact but the magnitude is expected to remain moderate. Draft HD 212/11 uses benchmark data from previous road projects to define the scale of magnitude and considers emissions between 20,000 and 40,000 tCO_2e to be moderate. Residual impact: moderate magnitude, adverse, long, permanent, indirect. Residual significance: not applicable	CEMP SWMP
Construction	Disposal of wastes from imported materials use and municipal solid waste production.	**Mitigation Items SMC-M1, SMC-M7** and **SMC-S1** • Municipal solid waste production is expected to be minimal. • Application of well-planned and well-controlled construction site management through procedures included in the CEMP and SWMP including the Earthworks Management Plan. • Application of good materials management practices can minimise the amount of materials wasted during the construction process. • Waste hierarchy will be applied so that segregation on-site is managed and alternative re-use and recycling options are sought off-site with disposal the final option. • Waste will be transferred by licenced waste carriers to licenced or registered exempt waste management facilities. Residual impact: negligible magnitude, adverse, short term, temporary, direct Residual significance: Neutral if wastes are predominantly re-used or recycled	CEMP SWMP

18.7 Statement of Significance

Material Resources

18.7.1 With the proposed scheme in place, and taking into account mitigation measures as described in Section 18.5 (Mitigation), the impact magnitude on material resources is anticipated to be moderate based on the assessment of embodied carbon.

Generation and Management of Wastes

18.7.2 With the proposed scheme in place, and taking into account mitigation measures as described in Section 18.5 (Mitigation), the overall residual impacts in terms of waste are anticipated to be Neutral/Slight, which is not considered significant in the context of the EIA Regulations. The waste impacts may be affected by other major infrastructure projects taking place at the time of construction of the proposed scheme (refer to Chapter 20: Cumulative Impacts).

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