UK Strategy for the Management of Solid Low Level Waste from the Nuclear Industry

Strategic Environmental Assessment

Environment and Sustainability Report

Consultation draft

Volume 1 – Main report

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Contents

1. Introduction

The Strategy and the Strategic Environmental Assessment

1.1. In 2010, the UK Strategy for the management of solid low level radioactive waste from the nuclear industry was published on behalf of the UK Government and the devolved administrations of Scotland, Wales and Northern Ireland. The Strategy is now being revised and updated and a draft of the updated Strategy is to be published for public consultation in January 2015.

1.2. The original Strategy was subject to a Strategic Environmental Assessment (SEA). The SEA informed the development of the Strategy and identified the potential environmental effects of implementing the Strategy.

1.3. The outcome of the SEA was expressed in an Environmental and Sustainability Report (which was used to inform public consultation) and a Post-Adoption Statement (which reported on the outcome of the public consultation and how it had informed finalisation of the strategy).

1.4. This document is a new Environment and Sustainability Report that has been prepared ahead of public consultation in early 2015. Following completion of the consultation, this document will be updated to reflect the outcome of consultation and a new Post-Adoption Statement will be prepared.

What is solid low level radioactive waste?

Solid radioactive wastes fall into three main categories: low, intermediate and high level wastes. Unlike intermediate and high level waste (ILW and HLW), low level waste (LLW) does not normally require special shielding during handling or transport.

However, low level waste still covers a wide range of radioactivity. In addition, some forms of radioactivity will be quite short-lived and others may last much longer before it decays naturally.

Most low level waste can be divided into waste produced during the operations of nuclear industry sites and waste produced during the decommissioning of nuclear industry sites.

Operational waste includes such materials as plastic, paper, tissue, clothing, wood and metallic items. Decommissioning waste is mainly building rubble, soil and various metal plant and equipment. All wastes have acquired some radioactivity, or have incorporated some radioactive material, during their use on a nuclear industry site.

The nuclear industry includes former nuclear power stations that are undergoing decommissioning, other nuclear sites licenced to store waste or reprocess fuel (such as Sellafield), existing nuclear power stations, some Ministry of Defence sites and research facilities.

The purpose of this report

1.5. This Environment and Sustainability Report expresses the outcome of an SEA that has been carried out during development of the updated Strategy, and will be used to inform public consultation on the Strategy.

1.6. The report describes the environmental objectives and considerations that have influenced the development of the Strategy, and the ways that implementation of the Strategy could affect the environment.

1.7. The report is published at this stage to inform public consultation on the draft Strategy. It therefore has the following detailed aims:

- To provide the environmental context behind the Strategy;
- To show how implementing the Strategy could affect the environment;
- To show how adverse effects on the environment could be mitigated or where environmental improvements could be achieved; and
- To enable the public and other stakeholders to respond to consultation on the Strategy in an informed manner, in the light of the environmental context and potential environmental effects of the Strategy.

1.8. This report will be updated after the public consultation, to reflect any changes in the Strategy that result from the consultation and to take into account any comments on the SEA itself. It is intended that the updated report will assist future decision-making on implementation of the Strategy and on the scope and direction of future, more detailed assessments required to inform decision-making.

What is Strategic Environmental Assessment?

SEA is a systematic process to ensure that environmental and sustainability considerations are properly and effectively taken into account in the development of strategies, plans and programmes.

SEA is required under the European SEA Directive (*Directive 2001/42/EC 'on the assessment of the effects of certain plans and programmes on the environment'*). The Directive is implemented in the UK through the '*Environmental Assessment of Plans and Programmes Regulations 2004*'.

Scope and content of this report

1.9. This report has three main components, each bound as a separate volume:

- The non-technical summary;
- The main text (this document, Volume 1 of the report); and
- The appendices (Volume 2 of the report).

1.10. Although a separate non-technical summary has been provided, every effort has been made to use non-technical language in Volume 1 and to present it in a manner that is as accessible as possible to a general audience.

1.11. Volume 2 contains a body of supporting material and technical information.

Additional assessments

1.12. In addition to SEA, under some circumstances a plan or programme may be subject to a requirement for other forms of environmental assessment.

1.13. At this stage, the additional assessment most likely to be relevant is Habitats Regulations Assessment (HRA). HRA is required[1] where a plan, programme or project is likely to have a significant effect on one of several qualifying categories of sites protected at International or European level.

1.14. However, at this stage, there is too much uncertainty about the details of implementation of the Strategy to enable a meaningful HRA to be carried out, and there is no material risk that any specific works will take place that could adversely affect the integrity of a protected habitat without the opportunity for appropriate assessment to be undertaken in advance.

1.15. In consequence, it is considered premature and impracticable to undertake an HRA at this stage. More specific information is likely to be available at later stages in the implementation of the Strategy, in connection with specific proposals relating to the Strategy or site specific programmes of work. At such stages, one or more HRAs may be carried out, potentially in parallel with project-level Environmental Impact Assessments (EIA).

[1] Under Regulation 48 of the Habitat Regulations 1994, amended by the Habitat Regulations 2010 (Regulations 60 to 67), implementing Article 6(3) of the Habitats Directive (92/43/EEC)

2. Overview of the Strategy

Introduction – the Strategy review process

2.1. The UK Strategy for the Management of Low Level Waste from the Nuclear Industry ('the Strategy') was published in August 2010. It was prepared in response to the UK Government's *'Policy for the Long-Term Management of Solid Low level Radioactive Waste in the United Kingdom'* (March 2007).

2.2. The aim of the Strategy is to ensure that there are appropriate treatment and disposal routes available for the long-term management of solid LLW from the nuclear industry, building on objectives described within the UK Government's policy mentioned above.

2.3. The Strategy is subject to periodic review. This first review of the Strategy commenced in April 2014 with the intent of publishing a final updated Strategy in Autumn 2015.

2.4. Since publication of the Strategy, significant changes have been made in the way that low level waste is managed, including:

- The establishment of a waste services framework by LLW Repository Ltd, allowing waste generators access to a range of alternative treatment and disposal facilities;
- The application of the waste hierarchy across the industry, resulting in the diversion of significant quantities of waste away from disposal; and
- The establishment of the LLW National Programme, enabling:
    - implementation of the UK Solid LLW Strategy through the coordination of the implementing activities of nuclear industry waste generators;
    - communication and sharing of best practice;
    - identification of opportunities for improvement; and
    - engagement of a wider stakeholder group within the process.

2.5. The aim of the current review of the Strategy is to ensure that it still describes the correct direction of travel for the nuclear industry to manage its solid LLW waste. Thus, the objectives of the review are to ensure that the Strategy still:

- Fulfills the intent of Government Policy;
- Reflects the current maturity of the industry;
- Identifies where there are opportunities to develop the strategy to improve practice in the management of low level waste; and
- Aligns with other relevant strategies[2].

2.6. The scope of the review is not to rewrite the Strategy. Rather, it is to ensure that it reflects the progress made by the industry since its original publication and to provide a strategic level view of the forward direction for the industry.

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[2] i.e. strategies dealing with radioactive waste from the non-nuclear industry, naturally occurring radioactive materials and higher activity radioactive waste.

Outline of the updated Strategy for the management of solid LLW

2.7. This UK-wide Strategy has been prepared by NDA on behalf of the UK Government's Department for Energy and Climate Change (DECC), the Scottish and Welsh Governments and the Department of the Environment for Northern Ireland. It forms part of a wider integrated approach also incorporating:

- The UK Strategy for the management of solid LLW from the non-nuclear industry; and
- The Strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom.

2.8. The integrated approach to waste management recognises that management of solid LLW cannot be separated from management of other wastes (i.e. liquid and gaseous LLW, wastes with higher levels of radioactivity, and non-radioactive controlled wastes).

2.9. Some potential initiatives to reduce the amount of LLW could increase other types of waste. For instance, decontamination of LLW creates a small volume of decontamination products and a larger volume of non-radioactive or less radioactive materials that may be open to a variety of other waste management routes. Similar initiatives to decontaminate Intermediate Level Waste (ILW) could result in the creation of additional LLW.

2.10. There are only two engineered facilities in the UK for the disposal of LLW; the LLW Repository in West Cumbria, which can receive waste from any part of the UK and one recently built at Dounreay on the north coast of Scotland, which will receive waste only from the decommissioning of the adjacent Dounreay site and Vulcan MOD site. In addition to these engineered facilities, in recent years three landfill facilities (at Lillyhall, Kings Cliffe and Clifton Marsh) have received permits for the acceptance of lower activity LLW which can co-dispose some LLW along with conventional wastes.

2.11. Disposal capacity for LLW is a precious resource that must be carefully managed and used only as a last resort. It requires careful and integrated planning for waste management across all aspects of the nuclear life-cycle from design, construction and commissioning to operations and decommissioning. This requires long-term planning over a period of decades, taking account of changing waste types and volumes over that period.

2.12. Successful management of radioactive waste is dependent on good quality (i.e. up to date and accurate) information about waste. Obtaining such information involves the characterisation of waste. This means obtaining information on the physical, chemical and radiological properties of the waste. Such information can be used to plan for sorting and segregation, an essential prelude to effective management of waste.

Strategic themes

2.13. The Strategy is structured under three main strategic themes:

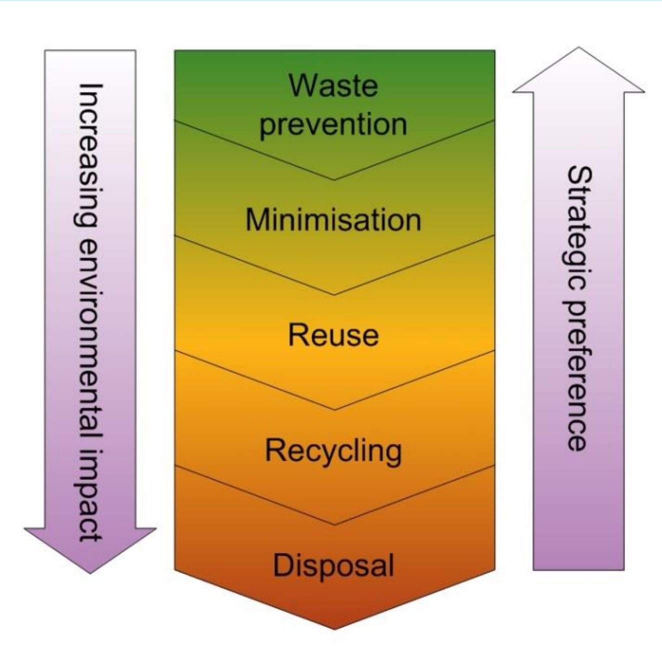
- Application of the waste management hierarchy;
- Make best use of existing facilities; and
- Development and use of new fit-for-purpose management and disposal routes.

2.14. These three strategic themes can be expanded as shown in paragraphs 2.15 to 2.17 overleaf.

Application of the waste management hierarchy

2.15. This contains the following opportunities:

- Waste prevention – this is the highest level in the hierarchy and yields the highest benefit. Good design, management and planning for decommissioning throughout the lifetime of a facility create significant opportunities for waste prevention and therefore minimise the need for waste management. These best practice approaches should be applied throughout the nuclear industry, including within nuclear new build;
- Minimisation of waste – if it is not possible to avoid creating waste at all, then the next preference is to minimise the amount of waste created, or the amount of waste that has to be managed as radioactive waste. There are a range of methods that can be applied to achieve this, including by ensuring that the level of radioactivity in the materials is so low that it is not classified as radioactive waste at all;
- There are opportunities to reuse materials, equipment and buildings before they become waste, for instance if they have reached the end of their original intended purpose but still have potential value for another purpose. Waste producers should exploit these opportunities. In other cases, there are still opportunities to reuse materials even once they have been designated as waste, for instance soil and rubble reused in void filling and landscaping on decommissioned sites;
- Recycling – materials not open to direct reuse may still be open to recycling after treatment. The main opportunity is in relation to metal treatment and recycling, but there are opportunities to treat some other materials as well; and
- Volume reduction – although not formally a step in the waste management hierarchy, volume reduction has a role to play in the provision of optimised disposal.



The waste management hierarchy is a classification of waste management options in declining order of environmental impact.

Waste should be managed at the highest practicable level of the hierarchy.

If the occurrence of waste cannot be prevented, the amount should be minimised, and then reuse or recycling are much preferable to disposal.

Figure 2.1 The waste management hierarchy as applied to this Strategy

Making best use of existing facilities

2.16. Opportunities under this heading include:

- Existing waste disposal facilities – the UK LLW Repository in West Cumbria is critical to ensuring that a multi-barrier engineered disposal facility for LLW is retained that can receive waste from anywhere in the UK. This facility can continue to be used as at present or its use can be optimised.

  A second LLW disposal facility has been built in Scotland, but will only receive waste from the immediately adjacent Dounreay and Vulcan sites. This facility will enable LLW from these sites to be disposed of in conditions similar to those at the LLW Repository.

- Packaging – there is the opportunity to achieve significant efficiency through alternative packaging methods for disposal;

- Transport – transport is a significant issue for stakeholders, and can conflict with environmental objectives. There may be opportunities to avoid or reduce the impact of transport of waste through the implementation of the Strategy;

- Alternative disposal routes – LLW is a very broad category. Towards the lower end of the radioactivity spectrum included in LLW some of the wastes do not need disposal under the levels of engineered containment required at the LLW Repository. With improved characterisation and segregation of radioactive waste there is an opportunity to consider the use of alternative disposal facilities, and since 2010 landfill sites at Lillyhall, Kings Cliffe and Clifton Marsh have been authorised for disposal of LLW;

- Reuse – since 2010, there has been increased reuse of plant, materials and equipment, particularly within NDA, who operate a register of redundant plant and equipment to enable it to find a new use rather than being consigned as waste; and

- Treatment – since 2010, there has been increased use of waste treatment techniques either to divert waste from disposal or to increase the efficiency of disposal, including decontamination, recycling, melting, compaction and incineration. Some of these techniques used existing facilities and some use facilities which now have become available to facilitate treatment, including three commercial incinerators that have been licenced to treat lower activity LLW. There may be opportunities to expand the use of these techniques by making increased use of these facilities.

Develop and use new fit-for-purpose management and disposal routes

2.17. This could give rise to the following opportunities:

- Alternative disposal routes – there are opportunities to consider both an expansion of the use of commercial landfill sites and the use of other alternative disposal methods, such as disposal in-situ or the use of dedicated landfill-style facilities on existing nuclear industry sites or elsewhere;

- Reuse – there are opportunities to expand reuse, for instance by expanding NDA’s best-practice examples of transferring redundant equipment to new uses to other operators and by finding new uses for other types of LLW. Soils and rubble, for instance can be considered for reuse in landscaping on existing nuclear industry sites as part of the decommissioning process, while some buildings can find alternative uses during decommissioning, deferring their demolition and consignment of the materials as waste;

- Treatment – there are opportunities to expand the use of any of the treatment methods described above through the development of new facilities or licencing of additional commercial facilities; and
- Decay storage – there is an opportunity to consider storage of LLW until the radioactivity levels within the waste naturally decay to levels that allow it to be managed as non-radioactive waste, or as lower-activity LLW.

Key environmental issues for the Strategy to address

2.18. The SEA Directive requires the identification of "*the existing environmental problems which are relevant to the plan or programme".* In this case, the following environmental problems have been identified as those which are most relevant in the context of this Strategy:

- The total quantity of low level radioactive waste existing in the UK, or forecast to be created in the UK, is greater than the total amount of existing disposal capacity and other management routes are therefore required;
- The UK Government is committed to a programme of constructing new nuclear power stations, which means that in addition to the existing legacy wastes and waste from the operation and decommissioning of existing nuclear industry facilities, further radioactive waste will continue to be created through the operational and decommissioning life-cycle of the new power stations;
- Very long-term environmental change, including coastal erosion and the effects of climate change, potentially pose a risk to the very long term integrity of disposal facilities, in particular the LLW Repository in West Cumbria. Other sites in low-lying locations, such as the landfill site at Clifton Marsh, may in the very long term be at risk of damage by flooding;
- Groundwater – groundwater is vulnerable to contamination during waste storage and management. The groundwater body under Sellafield is contaminated, and there is groundwater contamination at several other nuclear industry sites; and
- Transport – it is a key driver of UK waste policy that waste should be managed as close as possible to its source ('the proximity principle'). However, in the case of radioactive waste, the nearest appropriate facility may be at a significant distance from the source, entailing substantial transport requirements.

2.19. Since publication of the 2010 Strategy, there has been a significant increase in the volume of LLW diverted from disposal at the LLW Repository, which has extended its lifetime. Successful implementation of the Strategy should defer the need to develop an alternative/replacement LLW Repository indefinitely.

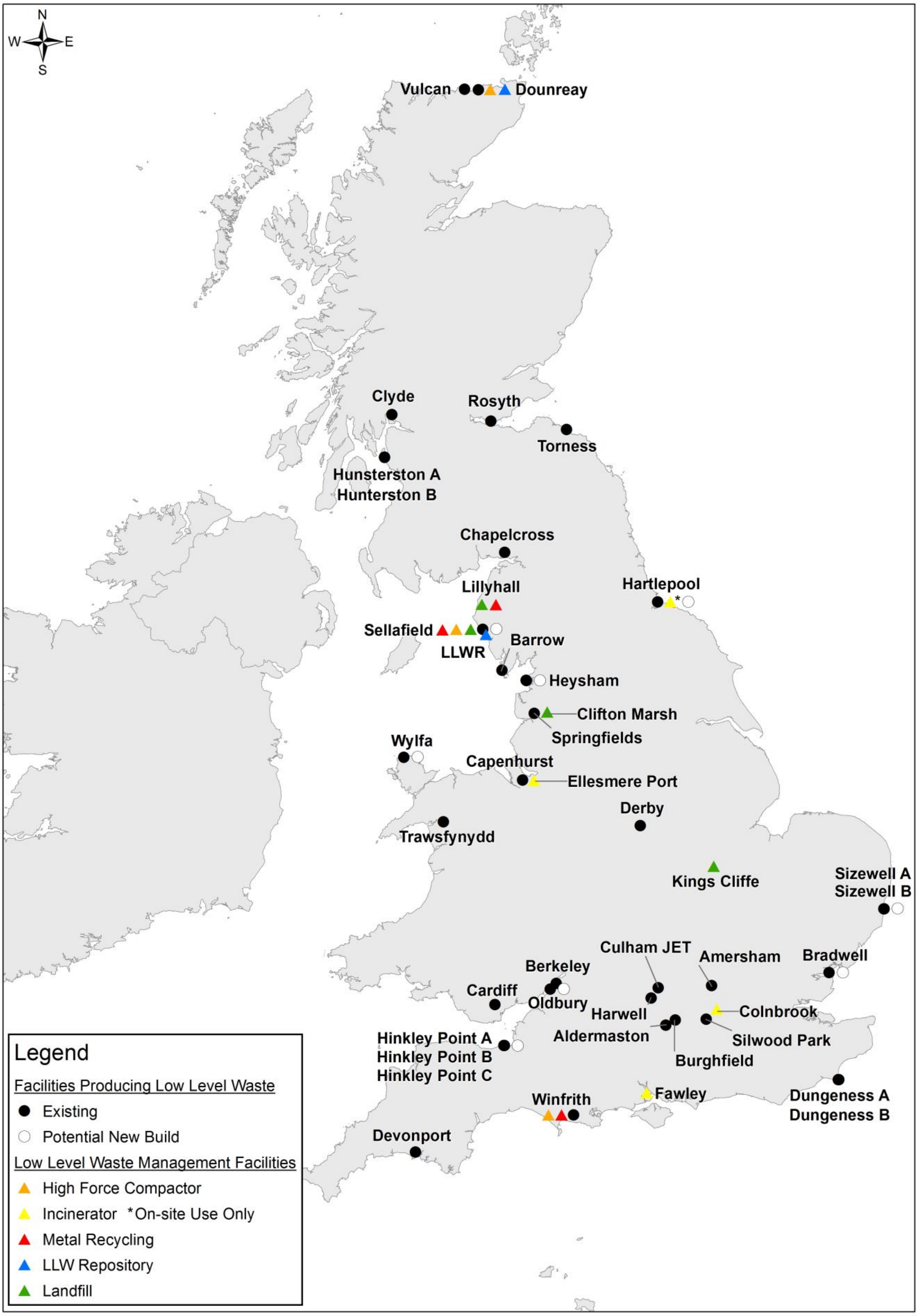


Figure 2.1 The UK nuclear industry and LLW management facilities in the UK

Strategic considerations and options

2.20. The identification of strategic options within the overall strategy and any future implementation depend on the complex interactions of four key considerations:

- Who will manage the waste?
- Where will the waste be managed?
- How will the waste be managed?; and
- When will any new waste management routes be available?

Who will manage the waste?

2.21. NDA is the key overseeing/coordinating body for the management of LLW in the UK, and the owner of much of the waste that is to be managed. The LLW Repository in West Cumbria is owned by NDA and managed by LLW Repository Ltd, and is the only multi-barrier engineered disposal site that can receive LLW from throughout the UK.

2.22. It is a principle of the Strategy that new waste management routes will emerge through the wider supply chain, principally the UK waste management industry. This has been achieved in the first four years of implementation through the establishment of a waste services framework by LLW Repository Ltd.

Where will the waste be managed?

2.23. The degree of flexibility open in respect of where the waste could be managed is closely related to the way in which the waste is to be managed, and to some extent influenced by the time at which it is required to be managed. Locational options include:

- A single national facility near Sellafield – such as the existing LLW Repository in West Cumbria, or a new similar facility built in the same general area;
- A single national facility elsewhere – e.g. the construction of a new facility to supplement or replace the existing LLW Repository, outside the general area surrounding Sellafield;
- A small number of regional facilities receiving waste from several sites – e.g. replace or supplement the LLW Repository with several smaller sites on a regional basis, thereby reducing transport requirements, rather than a single national facility;
- Multiple local facilities on, or close to nuclear industry sites – e.g. replace or supplement the LLW Repository with a larger number of local sites designed to receive waste from one or more nuclear industry sites in close proximity to them, thereby eliminating transport of LLW except over short distances. This option is currently being implemented in one location, at Dounreay/Vulcan, on the north coast of Scotland; and
- International facilities – transport LLW overseas for treatment and potentially disposal, although the latter is currently constrained by Government policy.

How will the waste be managed?

2.24. Options for the method of waste management focus around the waste hierarchy – i.e. can LLW be treated such that a higher proportion of it can be managed at higher levels of the waste hierarchy and a lower proportion sent for disposal?

2.25. It is important to be aware that the intention behind the strategy is to develop a range of options for assessment and keep all suitable options open for implementation in parallel, rather than to compare a number of options and select a single preferred option.

2.26. Options that emerge from the Strategy include:

- **Decay storage** of LLW prior to further treatment or disposal – i.e. safe storage of radioactive wastes that contain radioactive materials with relatively short half-lives, until the radioactive materials have naturally decayed to a lower level and the waste can be managed as VLLW or as waste exempt from controls applied to radioactive materials.

  Effectively this is a form of preliminary treatment to enable the diversion of waste from disposal at the LLW Repository, followed by further decision-making on management of the waste via other means. It can be seen as both a form of waste minimisation and a precursor to recycling. Its practical applicability depends on the amount of time required for sufficient decay to take place for any particular type of waste.

  Decay storage is most likely to be applied at multiple local facilities, because this is where the waste is currently located, but could be applied at a few regional sites;

- **Decontamination** of facilities, materials and equipment at the end of their useful life prior to consignment as waste – appropriate characterisation, segregation and decontamination may in some cases avoid the need to consign some materials as waste at all. In other cases it would minimise the amount of waste requiring management as LLW, and open up a wider range of other options for subsequent waste management at various levels on the waste hierarchy.

  In the first four years of implementation of the Strategy, decontamination has focused mainly on metallic waste, although there has been some decontamination of concrete. In future, there may be further opportunities for decontamination of non-metallic LLW.

  Decontamination is likely to be applied both locally and regionally;

- **Reuse LLW** to avoid consigning as radioactive waste – some materials that remain radioactive could nevertheless be reused in construction, landscaping, shielding etc., where suitable opportunities arise, to avoid the need to consign it as waste. This is most likely to occur within the estate of nuclear industry facilities;

- **Recycling of LLW** – some LLW materials are open to recycling inside or outside the UK nuclear industry. In the first four years of implementation this has focused mainly on metallic wastes such as items of plant, storage/transport drums, other containers and reinforcing bars, often after decontamination and/or melting. There may be scope in future to expand recycling to include other materials such as soils and rubble.

  Recycling is likely to be both a local and regional activity;

- **Incineration** – incineration can achieve two things: a significant reduction in the volume of combustible wastes and the recovery of energy. However, it is unlikely that the quantity of combustible LLW would be sufficient to achieve significant energy recovery unless it was burned together with a large volume of non-radioactive municipal waste.

With one exception (an incinerator continuing in use on an individual site at Hartlepool), current incineration services are on a regional basis and this is likely to be the model for any future development;

- **Treatment or volume reduction of metallic LLW by melting** – melting can be used to decontaminate metallic waste or to reduce its volume before disposal.

  Melting is currently only available using international facilities; in principle, if facilities were to be developed in the UK, they could take the form of a single national site near Sellafield or elsewhere or of more than one site on a regional basis;

- **Volume reduction** – other than incineration and melting, volume reduction can be achieved by compaction, at low pressure in drums or through high force into pucks.

  At present, low force compaction is carried out at some local sites and high force compaction at two regional facilities;

- **Continued disposal at the LLW Repository** – applying either existing packaging and disposal practices or alternative, optimised packaging and disposal practices to maximise packaging efficiency, minimise resource use and optimise the efficiency of use of the existing engineered facilities at the repository. By definition, this is an activity that can only take place at a single national site near Sellafield;

- **Disposal of LLW at landfill sites** – subject to regulatory approval, lower activity LLW and VLLW can be disposed of at landfill sites, together with non-radioactive waste. Three such sites have received approval in the first four years of implementation.

  While there are such a small number of sites available, this is best seen as a regional activity. If there is a significant expansion in the number of landfill sites licenced to receive LLW, it may change its character such that it becomes more of a local service;

- **Disposal of LLW in non-engineered surface facilities** – the use of dedicated new non-engineered facilities, using landfill-style or novel methods for the disposal or management of LLW or VLLW to avoid the need for engineered disposal vaults such as those at the LLW Repository. This option could include the in-situ containment of contaminated land without removing it from its original location.

  This is primarily a local option for disposal or management of waste on or close to individual nuclear industry sites; and

- **Deep disposal of long-lived LLW in a Geological Disposal Facility (GDF)** – where LLW contains particularly problematic radioisotopes, such as those with very long half-lives, it may be most appropriate to dispose of them together with Intermediate Level Waste (ILW) several hundred metres below ground in a GDF, when this becomes available. This is considered here as a single national facility either near Sellafield or elsewhere. This option is only available for LLW from England and Wales, as the Scottish devolved government has a different policy for the management of higher activity radioactive wastes (HAW) - near-site near-surface disposal.

When will any new waste treatment routes be available?

2.27. Each option for how or where waste could be treated has different implications for when that option may be available. Some options are available now, either in full or in part, and these include:

- Continued disposal of LLW at the LLW Repository and the repository at Dounreay, once it is open, using existing packaging and disposal practices (if it were desired to adopt optimised packaging and disposal practices, these could be phased in over a period of time);
- Decontamination facilities are available now at some UK sites, although in general only for treating metals, and internationally in the USA, Germany and Sweden;
- Some facilities exist for waste recycling on existing nuclear industry sites;
- Incineration facilities formerly available at several UK nuclear industry sites have closed due to changes in air quality emissions law. However, incineration capability for some LLW is now available through the supply chain at three UK facilities;
- Compaction and/or high-force compaction is available at a limited number of existing sites, including Sellafield which can provide this service for waste from other sites prior to despatch to the LLW Repository;
- The potential for reuse of some LLW, particularly after decontamination, exists now, and this could be expanded subject to future expansion of decontamination capabilities;
- Disposal at landfill sites – there are many landfill sites already in existence. Three have regulatory approval for disposal of lower activity LLW and two are in active use; and
- Disposal in non-engineered surface facilities – some aspects of this option (e.g. in-situ containment) could be implemented now, with regulatory approval. Other aspects would need the development of new sites and facilities, and would be a future option.

2.28. Some options are dependent on the development of new facilities and/or capabilities at the LLW Repository, other nuclear industry sites or through the wider supply chain. These options are not available immediately. The timescales required to achieve their availability will vary and are dependent on a number of factors, including when they are needed; technical hurdles; whether or not a new site is required; and the nature and extent of the planning and regulatory hurdles to be crossed. These options would include:

- Construct a new LLW Repository, near Sellafield or in another region – not likely to be required under current strategic plans. If required in the future, it would require a number of years of preparatory work in advance;
- Wider availability of decontamination facilities in the UK, and broader decontamination capabilities. After decontamination it may be possible to use recycling facilities at conventional waste management sites for the recycling of some waste, subject to regulatory approval;

- There are no appropriate metal melting facilities in the UK and if this method of recycling or treatment is to be used it will be dependent on continued use of overseas facilities or on the development of new plant in the UK;
- The availability of decay storage facilities would be subject to the provision of suitable storage capability;
- Energy recovery – incineration capacity exists now, typically at hazardous or clinical waste disposal facilities, which do not have the scale/capacity for cost-effective energy recovery. It is considered unlikely that this option will be considered practicable in the long term; and
- Deep disposal of long-lived LLW in a Geological Disposal Facility – creation of a GDF is mandated by government policy for the management of higher activity wastes (except in Scotland, as the Scottish Government has a different policy for management of HAW), but is a very long-term project that is in its early stages.

Reasonable alternatives and a preferred option

2.29. The Strategy, as described in the preceding sections of this chapter, encompasses a very broad range of alternative options, all of which are potentially open to implementation. This means two things:

- All of the reasonable alternatives that have been identified are incorporated within the strategy; and
- It is a principle of the strategy that there is no preferred option. Waste facility operators are primarily in the private sector and it is intended that the Strategy will encourage them to bring forward new and additional facilities enabling the management of LLW through multiple routes. Waste producers are required to demonstrate that their chosen waste routes represent the 'Best Available Technique' (BAT); or, in Scotland, Best Practicable Means (BPM). NDA and LLW Repository Ltd. will continue to act as the coordinating organisations on behalf of UK Government and devolved administrations to develop more integrated and effective management of LLW higher up the waste hierarchy.

2.30. Consideration has been given to whether there are reasonable alternatives under the heading of 'who will manage the waste?'.

2.31. Both the original Strategy of 2010 and the updated Strategy under consideration here are reliant on a wider supply chain, predominantly in the private sector, to implement the options put forward in the Strategy. If the supply chain were not to come forward to do so this would represent a failure of the Strategy. This risk could be avoided if the nuclear industry was to manage its waste itself, and this therefore represents a reasonable alternative. However, this alternative has not been pursued for the following reasons:

- Experience of the first four years of implementation shows that, in fact, the supply chain is willing and able to come forward to implement multiple options for LLW management and there is no reason to expect this to change; and

- The focus of the majority of the nuclear industry is the safe, cost-effective decommissioning of nuclear liabilities. Supply chain waste management options therefore represent a best value approach to managing some LLW.

3. Approach to Strategic Environmental Assessment

Outline of the SEA process

3.1. SEA is defined in Chapter 1, together with the legislative background to the requirement for SEA.

3.2. The approach to SEA adopted here has been developed from that adopted in the original SEA of 2009. Some changes have been made; these are described, with the reasons for them, in Appendix F.

3.3. Figure 3.1 below provides an overview of the five stages of the SEA process, and the key SEA outputs, in relation to the ongoing development of the Strategy for the management of LLW from the nuclear industry.

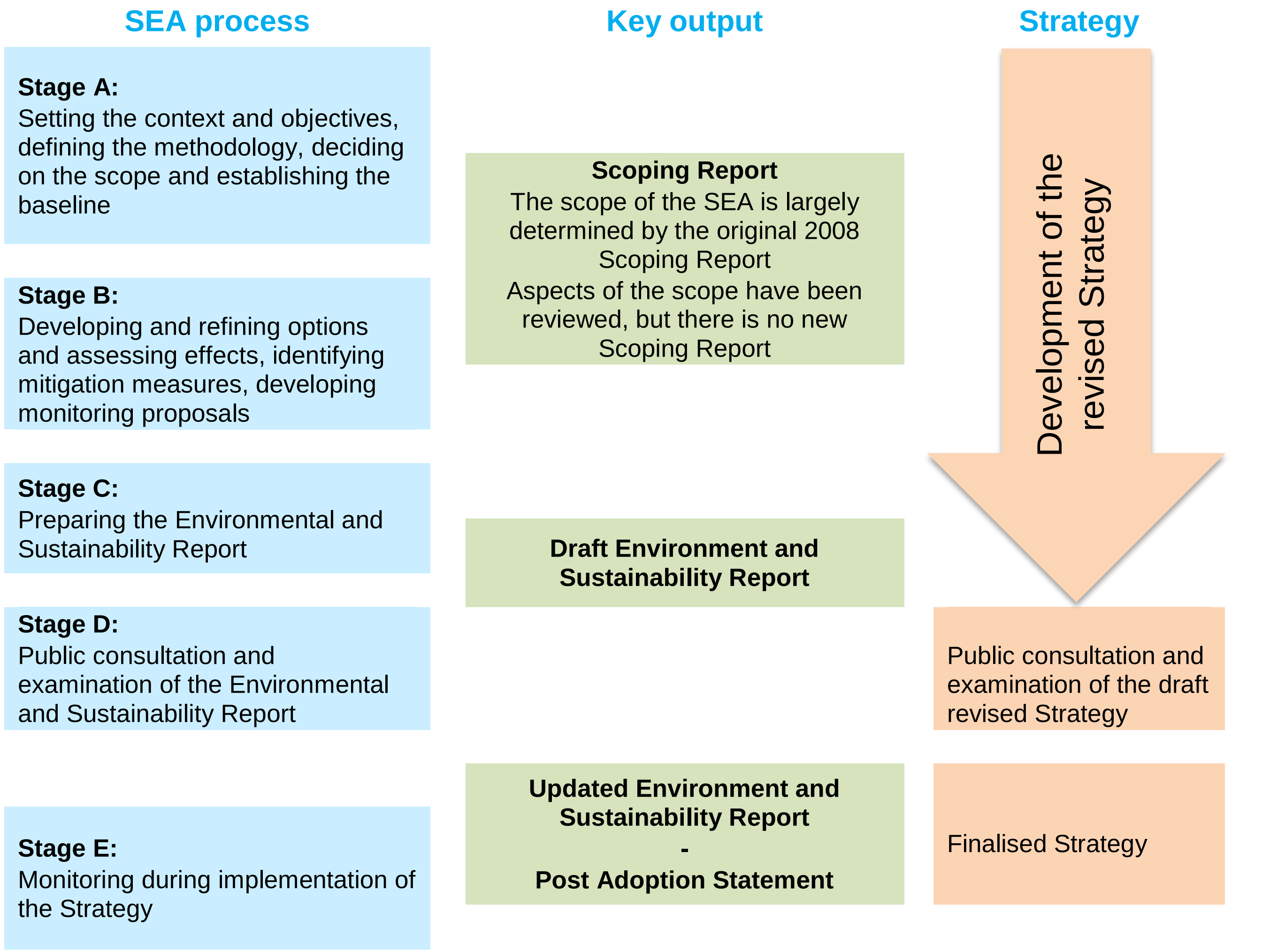


Figure 3.1 Outline of the SEA process relative to development of the revised Strategy

Consultation

3.4. During preparation of the draft Strategy, meetings were held with a stakeholder consultation group, comprising representatives from the UK government and devolved administrations, statutory environmental bodies, the nuclear industry and the waste management industry.

3.5. Prior to preparation of this report, a smaller stakeholder group, with a particular focus on statutory environmental bodies, met to discuss the approach to the SEA.

3.6. This draft Environment and Sustainability Report will be published for consultation and, in addition, will be issued to statutory consultees for their comment. Feedback from both members of the public and the statutory consultees will be taken into account in finalising the report after the consultation period is over.

Scope of the SEA

Thematic scope and setting the objectives

3.7. The SEA Directive defines 12 themes that are to be considered in scoping any SEA:

- Biodiversity;
- Population;
- Human health;
- Fauna;
- Flora;
- Soil;
- Air;
- Climatic factors;
- Material assets;
- Cultural heritage (including architectural and archaeological heritage); and
- Landscape.

3.8. In principle, these issues can be considered individually to determine whether they should be scoped ‘in’ or ‘out’ of consideration for a specific SEA. For current purposes, all of the issues are considered to be scoped ‘in’, because in principle the implementation of the Strategy could have effects relevant to any of these themes.

3.9. For the purposes of carrying out the assessment, it is necessary to define more detailed ‘environmental and sustainability objectives’ which draw on the 12 themes identified in the Directive. Table 3.1 on the next page identifies the environmental and sustainability objectives that have been defined for the purposes of this SEA update, together with the SEA Directive themes relevant to each objective.

3.10. The objectives used here have been developed from those used in the original 2009 SEA. The expansion of scope to cover socio-economic issues made in 2009 has been retained. Some objectives considered to be outside the environment/ sustainability brief are no longer included. The titles and definitions of other objectives have been altered to better reflect their intention and avoid duplication.

3.11. Within Table 3.1, the SEA Directive themes may each occur more than once, against two or more environment and sustainability objectives. This is because these themes form unifying threads running throughout the SEA.

Sustainability objective	Definition of objective	Relevant SEA Directive themes
Air quality	Minimise emissions of pollutant gases and particulates to the air and enhance air quality.	Air; Biodiversity; Human health; Flora; Fauna; Soil; Water
Global climate change and energy	Minimise detrimental effects on the climate from greenhouse gases and increase resilience and adaptability to climate change.	Climatic factors; Material assets
Biodiversity, flora and fauna	Protect and enhance habitats and species and promote opportunities to conserve and enhance wildlife (includes terrestrial, freshwater and marine habitats and wildlife).	Biodiversity; Flora; Fauna
Landscape and visual	Protect and enhance landscape character, landscape quality and visual amenity. Includes specific consideration of seascapes.	Landscape; Cultural heritage
Cultural heritage	Protect and, where appropriate, enhance the historic environment including historic buildings, archaeological remains and historic landscapes.	Cultural heritage; Landscape
Geology, ground and groundwater quality	Minimise or remove the detrimental impact and maintain, restore and enhance to establish or increase the positive impact on groundwater, soil function and quality and geological features.	Soils; Human health; Biodiversity; Flora; Fauna; Water
Surface water resources and quality	Minimise the consumption of water resources and detrimental impact on surface water quality, enhancing it where appropriate. Protect the quality of near-shore coastal waters.	Water; Biodiversity; Human health
Economy, society and skills	Contribute to sustainable local economies and social well-being by enhancing the population's skill base and contributing to employment opportunities, recognising workforce needs, thus supporting vibrant local communities.	Population
Traffic and transport	Minimise the detrimental impacts of travel and transport on communities and the environment.	Climatic factors; Material assets; Human health
Land use	Contribute to the sustainable use of land within environmental limits.	Material Assets; Soil
Noise and vibration	Minimise disturbance to people and wildlife from noise and vibration.	Human health; Fauna

Table 3.1 Environment and sustainability objectives

3.12. Although there is no 'Waste' objective, as in 2009, the central theme running throughout this SEA is the management of radioactive waste. The reasons for removal of this objective and three others ('Health and safety', Hazard reduction' and 'Value for money and affordability') are given in Appendix F.

Geographic scope

3.13. UK nuclear industry sites, and therefore the sources of low level waste, are distributed throughout Great Britain (i.e. England, Scotland and Wales, but not Northern Ireland).

3.14. Environmental impacts associated with each environment and sustainability objective can occur at a range of different scales that need to be taken into account in assessing potential effects, as illustrated in Table 3.2 below.

Environment and sustainability objective	Local/regional	National	International
Air quality	✓	✓	✓
Global climate change and energy	✓	✓	✓
Biodiversity, flora and fauna	✓		
Landscape and visual	✓		
Cultural heritage	✓		
Geology, ground and groundwater quality	✓		
Surface water resources and quality	✓	✓	✓
Economy, society and skills	✓		
Traffic and transport	✓	✓	✓
Land use	✓		
Noise and vibration	✓		

Table 3.2 Geographic scales of potential impacts

Assessment methodology

3.15. Each strategic option described in Chapter 2 of this report has been assessed against each of the environment and sustainability objectives to determine whether it contributes positively or negatively towards the achievement of the objective.

3.16. The assessment is carried out using professional judgement and experience, and recorded using a qualitative scoring system, as shown in Table 3.3 below.

Description	Symbol
The proposed option contributes significantly to the achievement of the objective	++
The proposed option contributes to the achievement of the objective but not significantly	+
Any positive or negative effect on the achievement of the objective is negligible	0
The proposed option detracts from the achievement of the objective but not significantly	-
The proposed option detracts significantly from the achievement of the objective	- -
There is no clear relationship between the proposed option and the achievement of the objective, or the relationship is negligible	~
There is too much uncertainty, or too little information, to enable an assessment	?

Table 3.3 Qualitative scoring system

3.17. To assist in making the professional judgements required for the assessments, a number of ‘guide questions’ have been associated with each of the environment and sustainability objectives, as shown in Table 3.4 over the following two pages.

Sustainability Objective	Guide Questions
Air Quality	• Will the Strategy cause a change in the radioactive discharges to air? Will the Strategy cause a change in the non-radioactive discharges? • Will the Strategy result in a change in the effects on people or wildlife from pollutant emissions including dust and odour? • Will the Strategy change effects on air of radioactive, non-radioactive, dust or odour discharges? Will the Strategy promote the effective mitigation of any detrimental air quality effects and maximise any positive effects?
Global Climate Change and Energy	• Will the Strategy cause a change in the direct emissions of carbon dioxide and other greenhouse gases or ozone depleting substances? • Will the Strategy cause a change in the indirect emissions of carbon dioxide or other greenhouse gases due to energy use? • Will the Strategy promote the effective adaptation to any detrimental climatic risks to nuclear industry sites or sites at which LLW is managed or disposed? • Will the Strategy promote resilience to, and effective management of, adverse effects of climate change such as increased risk of flooding, coastal erosion/inundation etc. to nuclear industry sites or sites at which LLW is managed or disposed? • Will the Strategy have wider implications for the mitigation of climate risks?
Biodiversity, Flora and Fauna	• Will the Strategy have any effects on fauna or flora, including protected species? • Will the Strategy have any effect on important non-designated and designated sites? • Will the Strategy affect access to areas of biodiversity interest? • Will the Strategy promote effective mitigation of any detrimental effects on biodiversity and maximise positive effects? • Will the Strategy have any effect on designated or non-designated marine flora or fauna?
Landscape and Visual	• Will the Strategy have any effects on designated landscapes/seascapes? • Will the Strategy affect landscape/seascape character or structure or valued landscape/ seascape features? • Will the Strategy affect visual amenity either during the day or at night? • Will the Strategy affect access to open spaces? • Will the Strategy affect the quality or quantity of publicly accessible green space? • Will the Strategy promote effective and sensitive mitigation of any relevant adverse effects?
Cultural Heritage	• Will the Strategy have an effect on (or encourage the conservation of) historic buildings, places or spaces that contribute to local distinctiveness, character and appearances? • Will the Strategy have an effect on surface or sub-surface archaeology? • Will the Strategy promote effective mitigation of any detrimental effects on cultural heritage or promote positive effects?
Geology, Ground and Groundwater Quality	• Will the Strategy contribute to the remediation of historic groundwater and/or soil contamination? • Will the Strategy change the risk of future contamination of groundwater and/or soil? • Will the Strategy affect the density of soils (e.g. will it cause a compaction of soils)? • Will the Strategy have any potential effects on geological designated sites? • Will the Strategy change the potential for sensitive human or wildlife receptors to be exposed to contaminated soil? • Will the Strategy promote effective mitigation of any detrimental effects on groundwater, geology or soils whilst maximising positive effects? • Will the Strategy limit the potential for future economic exploitation of mineral resources?
Surface Water	• Will the Strategy result in changes in radioactive or non-radioactive discharges?

Sustainability Objective	Guide Questions
Resources and Quality	• Will the Strategy contribute to the remediation of historic surface water contamination? • Will the Strategy cause there to be any change in non-radioactive or radioactive contamination of surface water and sediments (freshwater or marine)? • Will the Strategy result in a change in the demand for water? • Will the Strategy promote effective mitigation of any detrimental effects on surface water quality whilst maximising positive effects? • Will the Strategy result in a significant change in the likelihood of eutrophication?
Economy, Society and Skills	• Will the Strategy affect the range and level of skills required for the management of LLW from the nuclear industry? • Will the Strategy affect the number of jobs required for the management of LLW from the nuclear industry? • Will the Strategy have a significant effect on investment in local economies? • Will the Strategy significantly affect numbers or types of jobs provided by local economies? • Will the Strategy contribute to the diversification of local economies? • Will the Strategy have an effect on educational and skills development opportunities? • Will the Strategy have an effect on the sense of positive self-image and attractiveness of areas near nuclear industry sites as places to live, work and invest in? • Will the Strategy have an effect on the economic and social infrastructure of local economies? • Will the Strategy affect the continuity of employment? • Will the Strategy have an effect on addressing the inequalities of health?
10. Traffic and Transport	• Will the Strategy result in changes in traffic movements to and from nuclear industry and LLW management sites? • Will the Strategy result in changes to the distances travelled? • Will the Strategy result in changes in the types of transport to/from nuclear industry and LLW management sites? • Will any changes in transport patterns affect areas where there is potential for disturbance to local communities? • Will the Strategy promote effective mitigation of any adverse effects of traffic or transport?
Land Use	• Will the Strategy change economic conditions for agricultural or other land uses in the land surrounding nuclear industry and LLW management sites? • Will the Strategy increase or reduce the amount of land required to support industrial operations at nuclear industry and LLW management sites? • Will the Strategy promote the mitigation of any adverse land use effects or constraints on the use of natural assets? • Will the Strategy cause a release of land for beneficial reuse (taking into account stakeholder preferences for end-states and the timescales for the release of land)? • Will the reuse of land be within agreed environmental limits?
Noise and Vibration	• Will the Strategy result in significant changes in noise and vibration sources or levels? • Will the Strategy result in any significant effects on sensitive human or wildlife receptors? • Will the Strategy promote the effective mitigation of any relevant detrimental effects?

Table 3.4 Environment and sustainability objectives and guide questions

4. The assessment of effects

Introduction

4.1. This chapter summarises the overall assessment of the potential environmental effects of the strategic options described in Chapter 2. The full detailed assessment is described in the assessment matrices set out in Appendix E.

4.2. The detailed assessment has been made using the methodology set out in Chapter 3, including the application of the qualitative scoring system (see Table 3.3). The scores awarded to each option against each environmental topic have been brought together in the assessment summary tables on the following pages (Tables 4.1 to 4.3), which are subdivided geographically as follows:

- Table 4.1 summarises the assessment of those strategic options available at a single national facility near Sellafield or a single national facility not near Sellafield;
- Table 4.2 summarises the assessment of those strategic options available at a small number of regional facilities or through use of international facilities; and
- Table 4.3 summarises the assessment of those strategic options available at multiple local sites.

4.3. Some strategic options appear in more than one of these tables, but the assessment is not always the same, depending on the geographic context.

4.4. The tables are followed by a summary of key issues arising on an environmental topic-by-topic basis, and a summary on a strategic option-by-option basis.

	Single national facility near Sellafield Only available options are shown								
	Treatment or volume reduction of metallic LLW by melting			Disposal at LLW Repository			Deep disposal at a GDF		
Timescale (short/medium/long)	S	M	L	S	M	L	S	M	L
Air quality	**?**	**?**	**?**	**0**	**0**	**?**	**0**	**0**	**0**
Global climate change and energy	**- -**	**- -**	**- -**	**?**	**?**	**?**	**0**	**0**	**+**
Biodiversity, flora and fauna	**?**	**?**	**?**	**0**	**0**	**- -**	**~**	**+**	**+**
Landscape and visual	**- -**	**- -**	**- -**	**0**	**0**	**0**	**~**	**~**	**~**
Cultural heritage	**?**	**?**	**?**	**~**	**~**	**~**	**~**	**~**	**~**
Geology, ground and groundwater	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**
Surface water quality and resources	**?**	**?**	**?**	**0**	**0**	**?**	**~**	**~**	**~**
Economy, society and skills	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**
Traffic and transport	**-**	**0**	**0**	**?**	**?**	**0**	**~**	**0**	**0**
Land use	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**
Noise and vibration	**?**	**?**	**?**	**0**	**0**	**0**	**~**	**0**	**0**

	Single national facility not near Sellafield Only available options are shown					
	Treatment or volume reduction of metallic LLW by melting			Deep disposal at a GDF		
Timescale (short/medium/long)	S	M	L	S	M	L
Air quality	**?**	**?**	**?**	**0**	**0**	**0**
Global climate change and energy	**- -**	**- -**	**- -**	**0**	**0**	**+**
Biodiversity, flora and fauna	**?**	**?**	**?**	**~**	**+**	**+**
Landscape and visual	**- -**	**- -**	**- -**	**~**	**~**	**~**
Cultural heritage	**?**	**?**	**?**	**~**	**~**	**~**
Geology, ground and groundwater	**?**	**?**	**?**	**0**	**0**	**0**
Surface water quality and resources	**?**	**?**	**?**	**~**	**~**	**~**
Economy, society and skills	**?**	**?**	**?**	**0**	**0**	**0**
Traffic and transport	**-**	**0**	**0**	**~**	**0**	**0**
Land use	**?**	**?**	**?**	**0**	**0**	**0**
Noise and vibration	**?**	**?**	**?**	**~**	**0**	**0**

Table 4.1 Assessment summary table – single national facility near Sellafield or not near Sellafield

	Small number of regional facilities Only available options are shown																					**International facilities**		
	Decay storage			Recycle			De-contamination			Incineration to recover energy or reduce volume			Treatment or volume reduction of metallic LLW by melting			Volume reduction by compaction			Disposal at landfill sites			Treatment or volume reduction of metallic LLW by melting		
Timescale (short/medium/long)	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L
Air quality	**0**	**0**	**+**	**?**	**?**	**?**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**-**	**?**	**?**	**?**
Global climate change and energy	**0**	**0**	**+**	**+**	**++**	**++**	**-**	**-**	**0**	**0**	**0**	**0**	**- -**	**- -**	**- -**	**-**	**-**	**-**	**+**	**+**	**+**	**- -**	**- -**	**- -**
Biodiversity, flora and fauna	**0**	**0**	**~**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**
Landscape and visual	**0**	**0**	**~**	**~**	**~**	**~**	**?**	**?**	**?**	**- -**	**- -**	**- -**	**- -**	**- -**	**- -**	**-**	**-**	**-**	**0**	**0**	**0**	**- -**	**- -**	**- -**
Cultural heritage	**0**	**0**	**~**	**~**	**~**	**~**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**
Geology, ground and groundwater	**0**	**0**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**-**	**-**	**-**	**0**	**0**	**0**	**?**	**?**	**?**
Surface water quality and resources	**0**	**0**	**+**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**
Economy, society and skills	**~**	**~**	**~**	**+**	**+**	**+**	**+**	**+**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**+**	**+**	**+**	**?**	**?**	**?**
Traffic and transport	**~**	**~**	**~**	**0**	**0**	**0**	**0**	**0**	**0**	**-**	**0**	**0**	**-**	**0**	**0**	**+**	**+**	**+**	**0**	**0**	**0**	**0**	**0**	**0**
Land use	**0**	**0**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**
Noise and vibration	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**

Table 4.2 Assessment summary – small number of regional facilities and international facilities

	Multiple local facilities Only available options are shown																				
	Decay storage			De-contamination			Reuse			Recycle			Volume reduction by compaction			Disposal at landfill sites			Disposal at non-engineered facilities		
Timescale (short/medium/long)	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L	S	M	L
Air quality	**0**	**0**	**+**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**-**	**0**	**0**	**-**
Global climate change and energy	**0**	**0**	**+**	**-**	**-**	**0**	**+**	++	++	**+**	**++**	**++**	**-**	**-**	**-**	**+**	**+**	**+**	**+**	**+**	**+**
Biodiversity, flora and fauna	**0**	**0**	**~**	**?**	**?**	**?**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**
Landscape and visual	**0**	**0**	**~**	**?**	**?**	**?**	**~**	**~**	**~**	**~**	**~**	**~**	**0**	**0**	**0**	**0**	**0**	**0**	**-**	**-**	**-**
Cultural heritage	**0**	**0**	**~**	**?**	**?**	**?**	**~**	**~**	**~**	**~**	**~**	**~**	**0**	**0**	**0**	**0**	**0**	**0**	**-**	**-**	**-**
Geology, ground and groundwater	**0**	**0**	**?**	**0**	**0**	**0**	**?**	**?**	**?**	**0**	**0**	**0**	**-**	**-**	**-**	**0**	**0**	**0**	**?**	**?**	**?**
Surface water quality and resources	**0**	**0**	**+**	**0**	**0**	**0**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**	**?**
Economy, society and skills	**~**	**~**	**~**	**+**	**+**	**0**	**+**	**+**	**+**	**+**	**+**	**+**	**0**	**0**	**0**	**+**	**+**	**+**	**?**	**?**	**?**
Traffic and transport	**~**	**~**	**~**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**+**	**+**	**+**	**0**	**0**	**0**	**0**	**0**	**0**
Land use	**0**	**0**	**?**	**0**	**0**	**0**	**?**	**?**	**?**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**?**	**?**	**?**
Noise and vibration	**0**	**0**	**0**	**?**	**?**	**?**	**0**	**0**	**0**	**?**	**?**	**?**	**0**	**0**	**0**	**?**	**?**	**?**	**?**	**?**	**?**

Table 4.3 Assessment summary – multiple local facilities

Summary of assessment by environment and sustainability objective

Air quality

"*Minimise emissions of pollutant gases and particulates to the air and enhance air quality*"

4.5. This objective addresses the quality of the air we breathe. Air quality is determined on a local or regional level by the concentrations of chemical or particulate pollutants in the air. Above certain concentrations, some pollutants can harm human health and/or damage biodiversity, flora and fauna, and some can settle out into the soil or water.

4.6. 'Good' air quality is defined in generic terms as conditions in which all pollutants are below specified concentrations that have been set in relation to human health and the health of ecosystems. Where the pollutants are radioactive, this is defined in relation to radiation dose limits for public exposure. For other pollutants, it is related to standards defined in the relevant European Directive and UK Regulations. A significant adverse impact is any change that would threaten to breach one of these defined limits, in an area where there are people living or other relevant receptors likely to be affected.

4.7. A number of options (deep disposal in a GDF, decay storage) would have no significant emissions, while emissions from other options depend on the detailed method (decontamination, re-use). It is noted that emissions of radioactive gases from LLW are limited. Decay storage has a positive effect in the long term because when the LLW is retrieved from storage for further management, it will pose less of a risk of emission of radioactive gases or particulates.

4.8. Some other options similarly show no significant emissions (disposal at the LLW Repository, at landfill sites or at non-engineered facilities) in the short or medium term, but do raise the potential risk that very long-term environmental change (on a scale of hundreds of years or more) could lead to the re-exposure of buried LLW which could give rise to emissions to air.

4.9. However, there are a number of options for which a significant level of uncertainty remains. These options present small risks to the achievement of the air quality objective because they have the potential to lead to the emission of pollutants, but require more detailed assessment at site-selection or project-specific level to determine whether a significant impact would occur.

4.10. Processes that pose a particular risk to air quality are industrial-scale thermal processes such as melting and incineration. These risks are normally mitigated through the application of strict regulatory controls. Chemical processes and activities that create dust are of lesser significance.

4.11. However, while there may be a risk that some of these options could lead to increases in the concentrations of some pollutants, even if this were to occur it does not necessarily mean that there would be knock-on effects for human health, biodiversity etc. These would only occur if the concentrations were raised above the relevant limits, and this is only likely to be the case if either the existing background levels in the local area were already elevated due to other sources of pollution such as road traffic, or there were proposals for development in the vicinity which would emit any of the same pollutants (i.e. cumulative effects). In addition, it is only likely to lead to significant effects if the source(s) of the emissions are in proximity to human populations or other sensitive receptors.

4.12. Traffic and transport (addressed separately below) is often seen as a key contributor to air pollution, and overall it is the main source of air pollution in the UK. However, the quantities of freight traffic associated with the management of LLW, particularly given the wide dispersal of the sources and destinations of the traffic, are not seen as a significant issue in this context.

Global climate change and energy

"*Minimise detrimental effects on the climate from greenhouse gases and increase resilience and adaptability to climate change*"

4.13. This objective addresses the long-term issues arising from climate change, both in terms of root causes (such as greenhouse gas emissions) and long-term effects (such as raised sea levels, coastal erosion, extreme weather events, and the need for LLW management planning to anticipate these effects).

4.14. A positive contribution to the objective is anything that tends to reduce long-term emissions of greenhouse gases, or else tends to promote resilience or adaptation to the effects of climate change. A negative effect is anything that increases emissions or weakens resilience/ adaptation.

4.15. Melting of metallic LLW, and to a lesser extent some decontamination techniques, have been picked out as potentially working significantly against this objective, due to the amount of energy used and the potential greenhouse gas emissions associated with these techniques.

4.16. Some uncertainty arises over continued use of the LLW Repository, depending on the methods applied for packaging. The potential for beneficial or adverse effects is outlined in Appendix E.

4.17. Potentially significant savings in greenhouse gas emissions would arise from the adoption of more recycling of LLW and from disposal of LLW at landfill sites or non-engineered facilities (due to the savings in energy use and embodied carbon in materials compared to the alternative disposal methods).

4.18. There are significant differences between options in relation to adaptation and resilience to long-term environmental change and the effects of climate change. Disposal of waste in the LLW Repository, in landfill or in non-engineered facilities (including in-situ disposal) raises the potential in the very long term (hundreds of years or longer) that natural forces, such as coastal erosion, could lead to the exposure of LLW that had been thought buried forever. Some sites will be more vulnerable than others (sites on the coast, adjacent to rivers, on easily eroded or very low lying ground, etc.). This places a great onus on the site selection process and on the design of the sites to maximise their resilience.

4.19. Management of LLW further up the waste hierarchy (e.g. through recycling or reuse), so as to avoid disposal, removes this long-term risk.

Biodiversity, flora and fauna

"*Protect and enhance habitats and species and promote opportunities to conserve and enhance wildlife (includes terrestrial, freshwater and marine habitats and wildlife)*".

4.20. This objective addresses the wildlife, flora and habitats around us, on land, in the air, in freshwater and in the sea, and the maintenance of its integrity and biological diversity.

4.21. Options contribute positively to this objective if they help to remove existing threats to habitats and wildlife or promote improved conditions for habitats and wildlife. A significant adverse impact is anything that threatens the survival or integrity of a wildlife or plant species at a local population level or greater, or that threatens the survival or integrity of a valued habitat, or that threatens to reduce or limit biodiversity in an area.

4.22. All habitats have value, but those of greatest priority have been prioritised through the UK Biodiversity Action Plan. The most important habitats and other areas of natural importance have been given protection under one of several European or UK statutory designations or local government policy. Some aspects of this objective have a close relationship with the landscape, surface water, geology/groundwater and land use objectives.

4.23. Deep disposal in a GDF is deemed to remove LLW from any realistic prospect of interaction in any way with wildlife or habitats, removing a potential threat to their health in the medium to very long term.

4.24. Decay storage, recycling and volume reduction by compaction are deemed to have no significant effect on the achievement of the biodiversity, flora and fauna objective.

4.25. Potential risks of adverse impacts in the very long term associated with disposal at the LLW Repository, landfill sites or non-engineered facilities derive from the potential for long-term environmental change to result in the erosion of the disposal site. Any uncertainty associated with this form of risk relates to the need for site-specific assessment.

4.26. Options involving active processing of LLW in preparation for other forms of management (e.g. melting of metallic LLW, incineration, decontamination) tend to give rise to risks of impacts on habitats and wildlife, mainly through the emission of pollutants. However, in general these cannot be confirmed or assessed without more specific knowledge of the processes and the locations involved, so they have been marked as ‘uncertain’.

4.27. Reuse of LLW (soils or rubble) in landscaping or disposal of LLW in non-engineered surface facilities, and in particular disposal in-situ, gives rise to a potential concern about rainwater or groundwater percolating through the LLW and carrying radionuclides or other contaminants beyond the extent of the site into adjacent habitats. The potential for this to occur will depend very much on local ground and groundwater conditions, and the potential for significant impacts as a result will depend very much on local ecological conditions. This will therefore be a key issue for assessment at the early stages of considering any such option.

Landscape and visual

“*Protect and enhance landscape character, landscape quality and visual amenity. Includes specific consideration of seascapes*”.

4.28. This objective addresses potential effects on the landscape (including seascapes and townscapes) and visual impacts. Landscape impacts and visual impacts are separate, but related. Landscape impacts are changes in the fabric, quality and character of the landscape itself. Visual impacts are changes in available views of the landscape, and the effects that these changes in views may have on peoples’ enjoyment. Landscape and visual impacts do not necessarily coincide.

4.29. Positive contributions to this objective would be any option that, in the first place, avoids the removal of key landscape features or the fragmentation of landscape patterns and the creation of visually intrusive features; and in the second place facilitates the removal of intrusive features and restoration of former landscape features or patterns that had been lost. Some aspects of this objective have close inter-relationships with the Cultural heritage, biodiversity and land use objectives.

4.30. Potentially significant impacts on landscapes, townscapes or seascapes, including potential visual impacts, have been identified in association with incineration and melting of metallic LLW. This is because any expansion of existing capacity in the UK for either of these LLW management methods (all melting is currently done overseas) would require construction of large, industrial-scale plant for high-temperature thermal processes. The new buildings and their supporting infrastructure could significantly affect landscape/townscape/seascape character and quality and could be significantly visually intrusive, particularly given the probable need for tall stacks.

4.31. Lesser potential impacts have been identified in association with disposal of LLW at non-engineered surface facilities, as a result of the potential need to create new voids or land-raising sites for disposal of LLW.

4.32. There is some potential for adverse effects if any new facilities are required to carry out decontamination of LLW, particularly if they are provided at waste management sites rather than at existing nuclear industry sites. However, any potential impact remains very uncertain and subject to site-specific assessment.

4.33. Other options remain low-risk or are not relevant in relation to the landscape.

Cultural heritage

"*Protect and, where appropriate, enhance the historic environment, including historic buildings, archaeological remains and historic landscapes*".

4.34. Cultural heritage in its widest sense includes the whole of the historic environment, literature and the arts and the broader cultural context of society. However, for the purposes of assessment, it is usually understood to be represented by the physical manifestations of the historic environment. This is because these are the elements of cultural heritage most vulnerable to being affected by changes in the physical environment.

4.35. 'Protection' of the historic environment, especially where buried archaeological remains are concerned, can imply simply the prevention or avoidance of physical damage or destruction, whether by development/demolition works or by long-term damaging forms of land management. It can also include more subtle considerations such as the maintenance of the integrity of linked features over wide areas – particularly applicable to historic landscapes – and of the 'setting' of historic buildings or ancient monuments that enables them to be properly understood or appreciated in their historic context. Enhancement goes beyond this, for instance by changing existing land management practices to avoid damage, restore lost link by removing features that cause severance, or remove features that intrude onto the historic setting. Some aspects of this objective have a close inter-relationship with the landscape objective.

4.36. Disposal at the LLW Repository, at a GDF or at landfill sites were considered to have no significant effect on or no relationship with this objective. This is either because these sites already exist or because disposal of LLW there would be a secondary use of a facility created for other reasons, and would not add to impacts already in place.

4.37. Decay storage and volume reduction by compaction were also considered to be very low risk for cultural heritage. However, other options (melting, decontamination, incineration and particularly disposal at non-engineered facilities) all pose the potential risk of adverse impacts associated with the provision and operation of new facilities, both because of the potential for physical damage/severance during construction and longer term effects on setting. There remains a very broad range of magnitude and significance within which any impact could occur, which could only be determined though site-specific assessment.

Geology, ground and groundwater

"*Minimise or remove the detrimental impact and maintain, restore and enhance to establish or increase the positive impact on groundwater, soil function and quality of geological features*".

4.38. Geology and soils are important factors in determining the environmental character and quality of an area. Underlying rocks are key determinants of landform, while the physical and chemical properties of the rocks and overlying soils influence the type and variety of vegetation that will grow, agricultural quality, flood risk and water storage capacity.

4.39. Groundwater is water that is held within either the matrix of the bedrock or fissures within it, or in the body of overlying younger deposits. It is a vital element of our environment, in that it provides the base flow for most rivers and streams which keeps them going when it isn't raining; and it is heavily exploited for drinking water, industrial use and for agricultural irrigation.

4.40. In some cases, historic land uses have changed the geology, soils and groundwater, either by introducing chemical or other contaminants or by removing valuable minerals (mining/quarrying) and, sometimes, replacing them with waste (landfill). Groundwater is particularly vulnerable to chemical contamination, as it is very difficult to clean up once contaminated. Other impacts can include compaction, removal or covering up of deposits, thereby denying access to valuable mineral resources, or depletion of groundwater resources, with knock-on effects on surface waters, habitats and the availability of water for human use.

4.41. Decay storage would have no significant impact on this objective in the short or medium term, but in the long term there is the potential for beneficial effects, subject to site-specific assessment, as a result of the diversion of LLW away from disposal.

4.42. There are risks to soils and particularly groundwater arising from reuse of LLW, particularly through reuse of rubble and soils in void filling and landscaping, as water percolating through these reused wastes could enter groundwater. Similar risks arise in relation to disposal in-situ (part of the 'non-engineered facilities' option). These risks relate closely to site-specific ground and groundwater conditions, so they cannot be determined except on a site-specific basis.

4.43. Again, any risks of impacts associated with any expansion of existing capacity for incineration or melting of metallic LLW are primarily site-specific, and associated with the need for development of new industrial-scale plant.

4.44. Other options are not considered to have significant impacts in relation to geology, ground and groundwater.

Surface water quality and resources

"*Minimise the consumption of water resources and detrimental impact on surface water quality, enhancing it where appropriate. Protect the quality of near-shore coastal waters*".

4.45. This objective addresses the quality and continued availability of fresh water on the surface – that is, streams, rivers, ponds and lakes and coastal waters. These are core elements of our environment in many ways – as key elements in the landscape; as vital habitats or components of habitats for much of our wildlife and plant life; as sources of water for drinking, industry and irrigation; and not least as a means of carrying away some of our liquid wastes. The availability of water and its quality are essential for human health and for biodiversity.

4.46. Impacts on surface water can include anything that affects its quality (i.e. introduces pollutants or excess nutrients into the water) and anything that affects the availability of water resources (i.e. reduces the replenishment of water bodies, or extracts excessive quantities of water from them).

4.47. In the long term, decay storage has the potential for benefits to the quality of surface water bodies, as it contains LLW preventing leaching, and off-site management is deferred until a point where risks to groundwater are greatly reduced, thereby reducing any risk to surface waters fed by groundwater.

4.48. Industrial-scale processes to reduce volume (principally incineration or melting) do raise the potential for risks to the quality of surface waters, mainly associated with the need to develop and operate new industrial plant. The likelihood of any impact can only be determined at a site-selection or site-specific stage.

4.49. There are risks to surface water quality arising from reuse of LLW, particularly through reuse of rubble and soils in void filling and landscaping, as water percolating through these reused wastes could enter neighbouring water bodies. Similar risks arise in relation to disposal in-situ (part of the ‘non-engineered facilities’ option). These risks relate closely to site-specific environmental conditions, so they cannot be determined except on a site-specific basis.

4.50. Other options are generally considered to pose little risk of impact to surface water quality or resources.

Economy, society and skills

“*Contribute to sustainable local economies and social well-being by enhancing the population’s skill-base and contributing to employment opportunities, recognising workforce needs, thus supporting vibrant local communities*”.

4.51. This objective addresses the principal socio-economic effects of the Strategy, taking account of its potential effects on employment opportunities and skill levels in local communities and how these might have wider effects in the community.

4.52. The Strategy will contribute positively to the objective where it provides additional employment opportunities. It is particularly beneficial these are across a range of skill levels, and include opportunities for existing residents within their existing skill levels but also opportunities for local residents that enable them to increase their skills. New jobs that simply pull in people from outside the area have mixed effects – they will increase spending in the local economy, but could increase house prices to the detriment of existing local people.

4.53. Positive effects have been identified for a number of options (recycling, decontamination, reuse and disposal at landfill sites), all because these options have the potential to create new jobs. However, in general the number of jobs likely to be created is small and is not likely to have a significant impact on any but the smallest communities.

4.54. No significant effect in relation to this objective has been identified for disposal at the LLW Repository or at a GDF or for volume reduction by compaction, as it is unlikely that any significant number of new jobs will be created by these options.

4.55. Melting of metallic LLW and incineration leave a significant degree of uncertainty as to their overall effects. This is in part due to uncertainty over the likely character of their locations, should they be pursued, and the potential effects of the creation of a relatively small number of jobs, and in part due to consideration of the generally negative image and potential impact that large combustion plant, in particular incinerators, tends to have within communities, which could off-set any benefit from new employment.

4.56. The assessment of the effects of disposal at non-engineered facilities is also very uncertain, due to uncertainty over the form(s) that these facilities may take, the small number of jobs likely to be involved during operation, and the likely involvement of contractors (potentially from outside the local area) during construction.

Traffic and transport

"*Minimise the detrimental effects of travel and transport on communities and the environment*".

4.57. This objective addresses the potential effects that traffic and transport associated with the management of LLW might have on the environment, including travel for staff to and from nuclear industry sites and waste management facilities and freight transport for LLW between its points of origin and the waste management sites (where it is not being managed on site).

4.58. Traffic and transport can have impacts in a number of ways. It can contribute to pollution of the air and of surface or (more rarely) groundwater; it creates noise; and it can affect communities through increased congestion and community severance and reduced road safety.

4.59. In general, however, staff numbers involved in the management of LLW are small, and the proportion of freight traffic entering and leaving nuclear industry sites and most waste management sites that relates directly to the management of LLW are also small. Any changes at most existing sites are therefore likely to be insignificant in their effect.

4.60. The exception might be if, in a reversal of policy, greater priority was given to disposal of LLW at the LLW Repository in West Cumbria. This is one of the few sites that cannot be accessed from the strategic road network without passing through the local community of Drigg. Any increase in road freight could cause disruption to the community. However, the great majority of deliveries of LLW to the LLW Repository are by rail from Sellafield, and therefore do not pass through the community, so any effect on the local community is unlikely to be significant.

4.61. In addition, where new industrial plant is required, particularly large-scale plant as for melting or incineration, then there is the potential for short-term significant increases in flows of traffic associated with the development of the site. Volumes of LLW-related freight traffic during operation are not likely to be sufficient to cause significant disruption to communities.

4.62. Other than very short-term effects potentially associated with the development of new facilities, it is not anticipated that the flows of traffic associated with the management of LLW in any one location are likely to be sufficient to significantly affect local air quality (i.e. the concentrations of traffic-related air pollutants around residential properties, nature conservation sites and other sensitive receptors). Any contribution to greenhouse gas emissions is also likely to be minimal.

Land use

"*Contribute to the sustainable use of land within environmental limits*".

4.63. This objective addresses the potential effects of the Strategy on the use of land – that is, land currently occupied by existing nuclear industry sites or LLW waste management facilities, other land that could be occupied for the management of LLW, or knock-on effects on land adjacent to either of the above. Aspects of this objective have a close relationship with the landscape and biodiversity objectives.

4.64. A positive contribution to this objective is anything that allows land currently in the nuclear industry estate to be returned to an alternative beneficial use after decommissioning, or that limits the amount of land required to support nuclear industry or waste management operations. The greater the restrictions placed on the use of land at or around nuclear industry or waste management sites, the less beneficial is the effect.

4.65. Recycling, decontamination, volume reduction by compaction and disposal at landfill sites or a GDF have all been identified as having little or no impact on this objective, as they are unlikely to require any new land-take specifically for management of LLW, but nor would they enable release of land for alternative uses.

4.66. The LLW Repository is designed to be permeable in the long term. However, there are very substantial engineering and packaging controls in place to contain any radioactive or other contaminants, and these controls are subject to stringent regulatory oversight through the Environmental Safety Case and licencing process. It is therefore considered that there is little or no risk of contamination of adjacent land or groundwater.

4.67. There is some uncertainty over the effects of melting of metallic LLW or of incineration, as it is not clear whether new facilities would be required or where they would be located and the effects of any such new facility would be very location specific. The effects of reuse of LLW, particularly reuse of soils and rubble in landscaping, could place significant constraints on the subsequent use of the affected land, but this again is dependent on case-specific assessment, taking into account the specific nature of the contamination involved and the nature of the site and circumstances under which it has been reused.

4.68. Disposal at non-engineered facilities includes leaving bulk LLW in place, which again may place restrictions on the future use of that land and potentially could affect adjacent land through leaching, subject to site-specific assessment. Creation of new non-engineered disposal facilities could also have similar significant land-use implications, varying according to the circumstances and the nature of the land used, and would again be subject to site-specific assessment.

Noise and vibration

"*Minimise disturbance to people and wildlife from noise and vibration*".

4.69. This objective addresses the effects that noise and vibration related to the management of LLW could have on the people and wildlife near nuclear industry sites or waste management facilities. Noise in its widest sense can be defined as 'unwanted sound', and can come from industrial, agricultural, domestic, transportation or natural sources. Vibration is made up of oscillatory waves that pass through either the air or the ground to nearby buildings, and can be caused by some industrial, construction or transportation activities. Information on noise levels is given in Appendix D.

4.70. A positive contribution to this objective is anything that promotes the management of waste in a manner that produces no noise or vibration, or very little, at the location of any sensitive receptor; or that results in a reduction in pre-existing levels of noise and vibration for sensitive receptors. Reductions at source are also beneficial, as this would protect the workforce from the ill effects of noise and vibration.

4.71. Disposal at a GDF or at the LLW Repository are considered to have no significant effect on this objective essentially because they would not add to noise already taking place at those facilities. Decay storage, once the waste has been packaged, is essentially a passive and silent process. Volume reduction by compaction again is not expected to add to existing noise levels. High-force compaction could generate low-frequency vibration, but is unlikely to take place close to any sensitive receptor.

4.72. Several other options (reuse, recycling, decontamination, melting) all include processes that could entail the generation of significant amounts of noise during operation, and if construction of new facilities is required could generate both noise and vibration in the short-term during construction. However, the actual effects depend very much on the specific process involved (which could vary for some of these options), the design of the facility and the specific environmental conditions of the location, including the number, nature and proximity of environmental receptors.

Summary of assessment by strategic option

Decay storage prior to further treatment or disposal

4.73. Decay storage is likely to be applied to relatively small quantities of waste, and is most likely to be carried out at the nuclear industry site where the waste originates, although it could in principle be transported for storage at a smaller number of sites on a regional basis.

4.74. Decay storage is a passive process. Once the waste has been appropriately packaged and placed in storage, there is very little risk of significant emissions to air, land or water and storage is silent. In the short to medium term, therefore, no adverse impacts and no benefits have been identified in relation to any environmental and sustainability objective.

4.75. The aim of decay storage is to allow the radionuclides in the LLW to decay naturally past one or more half-lives until the waste can either be managed as non-radioactive waste or achieves a lower radioactive waste classification and is open to a wider range of management options. This means that, when it is ultimately released from decay storage for further treatment or disposal, there is a greater potential for more of the LLW to be managed at higher levels on the waste hierarchy and less to go for disposal. Whatever the management route, the radioactive components of the LLW will pose a lower risk to air quality and surface water bodies, and there are potential benefits for geology, ground and groundwater and for land use. There may also be benefits for climate change through avoiding the need for high-energy decontamination techniques or through opening up opportunities for greater use of recycling.

Decontamination of facilities, materials and equipment before consignment as waste

4.76. Decontamination covers a variety of physical and chemical processes for removing radioactive material from LLW. A high proportion of these processes are most likely to be carried out at the nuclear industry facility where the waste originates, although some may be concentrated at a few regional facilities. Melting of metallic LLW, although characterised here principally as a volume reduction technique, can also be used for decontamination, and is currently applied overseas.

4.77. Some decontamination processes are energy-intensive, which implies a high rate of carbon emissions and therefore negative effects on climate change. Other emissions to air from decontamination processes are assumed to be insignificant, due to stringent regulatory controls.

4.78. Potential adverse effects on biodiversity, landscape and heritage are primarily associated with any potential expansion of decontamination involving provision of new facilities, and could only be confirmed after site-specific assessments.

4.79. None of the management options are highly labour-intensive, but relative to most other options decontamination is likely to require a larger workforce with a broad range of skill levels. In the short to medium term, therefore, it is likely to make a positive contribution to the economy of local communities.

4.80. Relative to most of the other options, some decontamination activities have the potential to create the greatest levels of noise. However, the actual effect of this is very dependent on site-specific factors such as screening and the presence or absence and proximity of sensitive receptors. The effects can only be assessed, therefore, on a site-specific basis.

Reuse LLW to avoid consigning it as waste

4.81. Once waste has been generated, reuse is the highest available level on the waste hierarchy for managing it (i.e. the next preferred option after ‘prevention’ and ‘minimisation’). The term is generally used where the material can be reused without significant prior processing.

4.82. Reuse of manufactured items in particular offers potentially significant savings in carbon emissions compared to disposal of the material as waste and replacing it with items newly manufactured from virgin materials. Wider savings can also be recognised, taking into account the avoidance of depletion of non-renewable resources.

4.83. Minor additional benefits are likely to arise in relation to employment, but not sufficient to significantly affect communities.

4.84. However, reuse of bulk materials such as soils and rubble in void filling and landscaping poses potential risks to achievement of a number of other environmental and sustainability objectives, including biodiversity, geology ground and groundwater, surface water quality and land use. In all cases, this is because of the potential for contaminants in the reused material to leach out. Such effects would be very dependent on site-specific conditions and could only be confirmed by site-specific assessment, which would determine whether a given site was suitable for this form of reuse.

Recycle LLW after consignment as waste

4.85. Recycling is essentially a catch-all term for the reuse of materials after they have been processed to make reuse possible; it would therefore include reuse after decontamination or decay storage, or after a range of other conventional processes for sorting or processing of waste for recycling that are applicable irrespective of their radioactive status. It may be carried out at local or regional facilities.

4.86. Some recycling processes are energy intensive and could result in the release of pollutants to air and the generation of noise. The confirmation of any impact would be subject to site-specific assessment, depending on the specific process involved and a range of site-specific factors. These potential adverse impacts would have to be set against the potential impacts of manufacturing virgin materials.

4.87. There are significant benefits to global climate change through recycling, particularly due to the potentially substantial savings in energy consumption from recycling materials compared to manufacturing virgin materials. For instance, recycling steel can save up to 75% of the energy used to make virgin steel.

4.88. Increased use of recycling would create a relatively small number of new job opportunities, mainly in trade skills with a small number of managers and specialists. While beneficial, the numbers involved are unlikely to make a significant difference to communities, especially given that they would be widely distributed.

Incineration of LLW to recover energy or reduce volume

4.89. Some nuclear industry sites formerly had their own incinerators at a local level. All of these are now closed barring one at Hartlepool, and incineration services for other sites are provided via three sites on a commercial basis (at Ellesmere Port, Colnbrook and Fawley). Current projections are that these three sites provide sufficient capacity for management of combustible LLW for the medium term. Any future expansion of the use of incineration would entail either increased use of these existing sites or licensing of additional commercial incinerators, whether existing or newly built.

4.90. Incineration is a high-temperature combustion process, with the potential to release a range of gaseous, particulate and radioactive pollutants to air. It reduces volume by destruction of the combustible component of the waste, leaving only a non-combustible residue for disposal at the LLW Repository or elsewhere.

4.91. LLW is currently co-incinerated with hazardous or clinical waste in dedicated facilities designed for these purposes. In order to achieve sufficient bulk to enable cost-effective recovery of energy co-combustion with bulk municipal waste would be required. This is likely to significantly increase the quantity and range of non-radioactive pollutants included in the emissions. However, none of the existing licenced incinerators have the capability for energy production and it is considered unlikely that this option will be pursued.

4.92. All incinerator operations are subject to very strict regulatory oversight and licencing conditions that include monitoring and the provision of filters and scrubbers in their stacks to clean up the emissions before they reach the atmosphere.

4.93. Nevertheless, the precise effects on air quality remain uncertain and would be subject to specific assessment prior to implementation. Any significant emission of pollutants to air has potential knock-on effects for other objectives, including biodiversity, geology (because of effects on soils), surface waters, land use and noise.

4.94. There are wider potential effects if the use of incineration is to be expanded through the provision of new facilities, with the potential for significant site-specific effects on biodiversity, landscape, heritage, geology, surface water, land-use and noise, with short-term effects on traffic and transport. The majority of these effects remain very uncertain and subject to confirmation during site selection and site-specific Environmental Impact Assessment.

4.95. Finally, in general, incineration is a high-temperature combustion process which uses a large amount of energy and therefore contributes to emissions of greenhouse gases.

However, total incineration makes up a very small proportion of the total UK greenhouse gas emissions. In addition, relative to total waste generation in the UK, the quantities of relevance to LLW would be small. As such, the effects would not be significant.

Treatment or volume reduction of metallic LLW by melting

4.96. Melting of metallic wastes is a high-temperature thermal process, currently carried out using international facilities, and can be used as a form of treatment/decontamination prior to recycling of metallic LLW or to reduce the volume of metallic wastes prior to disposal. Any expansion of the practice could entail building new facilities in the UK, although there are no such plans at present, it is assumed this would be on a national or regional basis.

4.97. Although the range of pollutants potentially generated would be narrower, in other respects the environmental risks associated with melting, and particularly with the provision of any capacity for melting in the UK, would be very similar to those described above for incineration. Potential impacts relevant to a wide range of environment and sustainability objectives remain very uncertain and would require site-specific assessment. Where used for volume reduction, there would be adverse effects in relation to climate change due to the high energy usage involved in melting, though not assessed as being of a significant level relative to other sources of emissions nationally. Where used for treatment of metals, these effects would be offset by the savings in energy use during manufacture of ‘virgin’ metals from ores.

Volume reduction by compaction

4.98. Compaction includes two processes both designed to reduce the volume of LLW to maximise the efficiency of use of the available volume for disposal at the LLW Repository, or other disposal facility. Low-force compaction is a relatively low-technology process carried out at some nuclear industry facilities, while high-force compaction is carried out at three regional centres (Sellafield, Winfrith and Dounreay).

4.99. High-force compaction, which is currently used to a greater extent than low-force compaction, is a relatively energy intensive process (although much less so than melting) due to the operation of high-force hydraulic systems and ventilation systems etc., so there would be minor effects on climate change due to emissions of greenhouse gases. In addition, there is the potential for construction of any new high-force compaction plant to have visual impacts, although this is likely to be limited by its probable location within an existing nuclear industry site. The process would also increase the efficiency of use of transport, potentially reducing the total number of vehicle movements involved in the management of LLW.

Disposal of LLW at the LLW repository

4.100. In recent years, disposal of LLW at the existing Repository in West Cumbria has greatly reduced compared to the situation before first implementation of the Strategy. This reduction is due to the diversion of LLW to other management or disposal routes.

4.101. In the very long term (on a timescale of many hundreds of years or potentially longer), coastal erosion could compromise the integrity of the LLW Repository, leading to the re-exposure of waste that had been intended to be buried in perpetuity. It is likely that radioactive decay would have significantly reduced the activity levels in the waste by this stage, but some radionuclides would remain, and other, non-radioactive contaminants may also be present. There is therefore an unquantifiable risk that such radionuclides and other contaminants could be released into the environment at an unknown date in the distant future, with potential knock-on effects for air quality, biodiversity, soils, surface water and land use, and in particular for coastal waters and marine habitats.

4.102. Disposal at the LLW Repository could be carried out using existing packaging and disposal techniques, or novel packaging. New methods may have differing implications – positive or negative – both for emissions of greenhouse gases in the packaging and placement of waste process, and for very long-term resilience of the packaging in the face of environmental change. These factors mean that the implications of this aspect of disposal remain uncertain.

4.103. The LLW Repository is designed to be permeable in the long term, and overlies a groundwater body classified as a principal aquifer. However, there are very substantial engineering and packaging containment measures in place to ensure that no radioactive or other contaminants escape. These precautions are subject to very stringent regulatory oversight through the Environmental Safety Case and licencing processes, as part of which it is a requirement that it is demonstrated that no adverse effect would occur. It is therefore considered unlikely that any significant effect on land use or groundwater would occur.

Disposal of lower activity LLW at landfill sites

4.104. In respect of most environment and sustainability objectives, the use of landfill sites for disposal of lower activity LLW is a low-risk option, with little potential for significant environmental impact. This is, in some cases, because the impacts associated with establishment and operation of the landfill itself would already be in place and not directly attributable to LLW. Disposal in landfill is subject to the same Environmental Safety Case process and the same regulatory standards and oversight as disposal at the LLW Repository.

4.105. There are potential benefits in relation to emissions of greenhouse gases, in that disposal at landfill sites requires a much lower level of engineering and therefore energy expenditure, and much less materials and therefore embodied carbon emissions, than disposal at the LLW Repository or any equivalent facility. To set against that, in the very long term landfill sites may be more vulnerable to erosive forces and therefore the effects of long-term environmental change, increasing the risk that buried LLW may be re-exposed and released into the environment in the distant future. This risk is very much subject to site specific factors (e.g. geological conditions, proximity to the coast or rivers, susceptibility to flooding).

4.106. Increased use of landfill would create a relatively small number of new job opportunities. While beneficial, the numbers involved are unlikely to make a significant difference to communities, especially given that they would be widely distributed.

Disposal of LLW at non-engineered surface facilities

4.107. This option includes two main variants – disposal in dedicated landfill-style facilities, and disposal in situ.

4.108. Disposal of LLW in dedicated landfill-style facilities could use existing voids, newly excavated voids or land-raising techniques, and could be located within nuclear industry sites, adjacent to them or elsewhere.

4.109. Disposal in-situ does not require the LLW to be moved or disturbed from its present position. Instead, minor works are carried out to secure and contain the waste in place. Disposal at non-engineered surface facilities would be subject to the same Environmental Safety Case and regulatory oversight requirements as other disposal options. The outcome of this may determine the practicability of implementing any variant of this option in any given location.

4.110. The potential environmental effects differ between the two variants. The use of dedicated landfill-style facilities has potential negative effects, or uncertain effects subject to site-specific assessment, associated with the creation of new facilities, particularly if they are outside the boundaries of existing nuclear industry sites. This could, depending on the location, include effects on biodiversity, landscape, heritage, geology, ground and groundwater, surface water, land use and noise.

4.111. Disposal in situ is in many respects a low-impact option, but depending on the nature of the waste, the local ground and groundwater conditions and the surrounding environment, it has the potential to cause leaching of contaminants into groundwater or surface water, with knock-on effects on biodiversity and land use. These effects remain uncertain, due to their dependence on site-specific factors.

4.112. Both types of disposal are relatively low-risk in relation to air quality, although there is, in the very long term, the potential for pollutants to become airborne if the sites are affected by erosion as a result of long-term environmental change. This places a great onus on appropriate site selection and preparation.

4.113. Finally, there are potential benefits for climate change, as a result of the relatively low level of engineering works involved in this option (particularly for in-situ disposal). This means that there would be much less energy expended and embodied carbon in materials than would be the case if the waste were disposed of in the LLW Repository or an equivalent facility.

Deep disposal of LLW in a Geological Disposal Facility

4.114. This assessment is made on the assumption that a GDF is used only for disposing of that fraction of LLW that contains very long-lived or otherwise problematic radionuclides that are not suitable for disposal or other management at near-surface facilities.

4.115. Disposal of such LLW in a GDF is a very low-risk option for all environmental objectives. This is not to say that there would not be environmental impacts associated with the construction and operation of a GDF. However, the principal purpose of a GDF would be to dispose of higher activity wastes (ILW and HLW and other higher activity radioactive materials). Disposing of some LLW at a GDF would be a secondary use that would not add significantly to its impacts.

4.116. There are potential benefits arising from the very high resilience of a GDF in the face of long-term environmental change, in that the LLW would be placed as far as is practicably possible outside the reach of erosive forces, flooding, extreme weather events, etc. In addition, it would be placed beyond any reasonable possibility of interaction with the biosphere, maximising the protection of biodiversity from the effects of radioactive or other contamination.

4.117. If a larger fraction of the total LLW inventory were to be sent to a GDF, then the overall capacity of the underground vaults etc. would need to be significantly increased, adding to the amount of excavated rock produced, backfill required and transport requirements for a GDF and any environmental effects associated with those factors.

Cumulative effects

Introduction – definition and approach to cumulative effects

4.118. It is a principle of the Strategy that there is no preferred option, and that multiple options are likely to be implemented simultaneously. This section therefore considers whether the simultaneous implementation of more than one option could result in cumulative or combined effects.

4.119. Cumulative or combined effects could occur in one of four main sets of circumstances:

- Where more than one option is implemented at a single location, and both options have effects relevant to the same objective or objectives that act in a cumulative manner to increase the significance of the combined effect;
- Where a single option is implemented at more than one location, and the combined impact in multiple locations acts in a cumulative manner to increase the significance of the overall effect;
- Where more than one option, implemented in separate locations, have effects relevant to the same objective or objectives that act in a cumulative manner to increase the significance of the combined effect; and
- In addition to the above, the implementation of any option or options could have effects that act cumulatively with the effects of other developments unrelated to the management of LLW but taking place in the same area.

4.120. It is important to note that the simple occurrence of several impacts of a similar kind, especially if they are at separate locations, does not necessarily represent a cumulative impact, particularly if the individual impacts are felt solely or primarily at a local level. So, for instance, noise effects at several different locations might occur, but would not act together because they would each be felt only at the local level. However, if several different noise sources are created on one site, they might have a combined effect on an individual receptor. Similarly, greenhouse gas emissions from several different sites would act together to have a combined effect on the global climate.

Cumulative effects relating to air quality

4.121. Air quality impacts are felt principally at a local level, and to a lesser extent at a regional level. Cumulative effects, therefore, are only likely to be felt where options with the potential for significant emissions to air are implemented at the same site or otherwise in close proximity.

4.122. Options with potential air quality effects during their operation are incineration, melting of metallic LLW, recycling and compaction. There is a significant potential for the latter two to be implemented together (possibly at the same site as other options that are not associated with air quality impacts); however, they are substantially lower in their potential effects than incineration and melting.

4.123. There is the potential for incineration to be combined with other options at Hartlepool, although the incinerator there handles only waste from that site and is likely to incinerate less waste than other, regionally-based incinerators. Other existing incinerators are provided through the supply chain and stand at separate locations from nuclear industry facilities; they are therefore unlikely to create cumulative impacts at a local level, and given their relatively small scale they are unlikely to do so at a regional or greater scale.

4.124. Incineration and melting are industrial processes; any new plant is likely to be provided through the supply chain and to be located in urban/industrial areas (albeit melting is currently carried out solely overseas). There is some potential for any emissions to air from such plant to act cumulatively with emissions from other industrial plant and/or road traffic in surrounding urban/industrial areas. However, it is assumed that such effects would be considered in the initial EIA and consenting process for the plant, and either shown to be insignificant or eliminated through design measures before consent is granted for the plant.

4.125. All of these potential effects are subject to site-specific assessment and may therefore not occur, even if the options are implemented.

4.126. Some disposal options have the potential to cause air quality effects in the very long term, as a result of the re-exposure of LLW by erosion. It is very unclear whether such effects could act together, as if they do occur, it would be at widely separated locations and probably at widely separated times – possibly separated by centuries.

Cumulative effects on global climate change and energy

4.127. Incineration and melting of metallic LLW are both high-temperature thermal processes with potentially adverse contributions to greenhouse gas emissions. While not significant in isolation, the emissions from these options may be significant in combination with each other and/or other LLW Strategy options. Irrespective of where the plant is located, the simultaneous implementation of these options or of either one of these options at more than one location would act cumulatively to adversely affect the global climate.

4.128. Other options with a relatively high energy usage such as decontamination would also contribute to greenhouse gas emissions and act together with incineration and melting of metallic LLW.

4.129. Although options such as recycling and reuse do consume energy, and therefore result in greenhouse gas emissions, they enable much larger savings in greenhouse gas emissions through the avoidance of the manufacture of new items or virgin materials. If implemented in parallel, these options would act together to benefit the global climate and, in addition, to reduce the depletion of finite resources.

4.130. Disposal at landfill sites and at non-engineered facilities, if applied in parallel and/or together with recycling and reuse, would make smaller cumulative beneficial contributions to greenhouse gas savings, through the avoidance of using energy and embodied carbon in materials required for the more heavily-engineered disposal methods used at the LLW Repository.

Cumulative effects relating to biodiversity, flora and fauna

4.131. Habitats and populations of wildlife or plant species are often interconnected over long distances. Where local habitats or populations have lost these interconnections and become isolated, this is often the result of human development and it makes them particularly vulnerable. ‘Priority habitats’ (as defined in the UK Biodiversity Action Plan) are often those that have either become particularly rare and fragmented, or those that are depended on by protected species, or species that are in decline or are otherwise especially vulnerable.

4.132. Many nuclear industry sites in the UK are in coastal locations. Although the nature of the ecosystems around these sites is quite varied, there is some potential for impacts on similar habitat types, wildlife populations and ecosystems, both on land and in the sea.

4.133. Wherever any option has the potential to affect habitats or wildlife, it has the potential to act cumulatively with other such options if implemented at a single site, or implemented at a number of sites in similar locations. If designated sites, priority habitats or protected or otherwise vulnerable species are present, then such effects have the potential to become significant.

4.134. The identification of any such impact at any individual site is subject to site-specific assessment, and no cumulative effect would occur until similar impacts affecting the same habitat or species has been confirmed at more than one site.

Cumulative effects relating to landscape and visual impacts

4.135. Landscape and visual impacts (including seascape and townscape impacts) are primarily experienced at a local level. Any option that involves building new facilities or significantly extending or altering existing facilities has the potential to affect the landscape, and it could act cumulatively with existing facilities (e.g. by removing residual parts of a landscape feature already damaged by previous development, or further disrupting a landscape pattern, or adding to the zone of visual influence of the existing development). Where more than one option is implemented on the same site or otherwise in close proximity, they could act cumulatively in similar ways.

4.136. The identification of such impacts, both on an individual and on a cumulative basis, is very much a site-specific issue, and can only be identified on the basis of site-specific assessment.

Cumulative effects in relation to cultural heritage

4.137. In a similar way to landscape effects, effects on cultural heritage are primarily experienced at a local level. Any option that involves building new facilities or significantly extending or altering existing facilities has the potential to affect archaeological remains, historic buildings or historic landscapes if they are present, and development of the option could act cumulatively with existing facilities (e.g. by removing residual parts of archaeological remains already damaged by previous development, or adding to existing effects on the historic setting of a Listed Building). Where more than one option is implemented on the same site or otherwise in close proximity, they could act cumulatively in similar ways.

4.138. In principle, there is the potential for heritage impacts to act cumulatively on a wider geographic scale, for instance if several related archaeological sites or archaeological sites of the same type were to be affected by implementation of options in different locations. However, this would only occur by chance and is relatively unlikely.

4.139. As for landscape, the identification of such impacts, both on an individual and on a cumulative basis, is very much a site-specific issue, and can only be identified on the basis of site-specific assessment.

Cumulative effects in relation to geology, ground and groundwater

4.140. This topic covers a wide and fairly disparate range of receptors – geology, including geological sites/features protected by law or policy for their scientific interests; geological resources of economic value; soils; and groundwater, which is of fundamental importance as the basis for continuous flow in rivers, for keeping lakes and ponds full, and as a source of water for agriculture, industry and for drinking.

4.141. Impacts are largely felt at a local level, but ‘local’ can be very widely defined when dealing with the sometimes very large areas covered by an individual aquifer or with impacts on soil from the settling out of pollutants from the air.

4.142. Any option involving new construction can, in principle, prevent exploitation of underlying mineral deposits. This would only occur where mineral deposits of economic value are present, and where they are open for exploitation (e.g. not in an existing urban/industrial area). Disposal in non-engineered facilities is probably the most likely option to create such effects. Cumulative effects would only occur where options are implemented on the same site in such a way as to sterilise different parts of the same deposit, or in different locations but preventing access to deposits of the same kind (this would only happen by chance and is not a likely outcome).

4.143. Soils may be vulnerable to cumulative effects if multiple options are implemented at the same site, particularly if that involves extending the site boundary, as increased quantities of soils (especially topsoil) would be displaced and/or disturbed by construction activities and some areas may be disturbed more than once. Soils are vulnerable to contamination by spillages, by deposition of pollutants from the air, to compaction and to changes in their drainage.

4.144. Groundwater may be vulnerable to cumulative effects as a result of accidental spillages during construction or operation of some options, or as a result of leaching of contaminants from other options (particularly disposal options). Cumulative effects may occur where more than one potential source of contamination is present within the area of a single groundwater body such as an aquifer.

Cumulative effects in relation to surface water quality and resources

4.145. The potential for impacts directly on surface water quality and resources in the short to medium term have been identified from four options – incineration, melting, reuse and disposal in non-engineered facilities. All of these impacts are uncertain and subject to site-specific assessment. The nature of the options and the impacts is such that there is little potential for them to act cumulatively.

4.146. It should be noted, however, that the potential cumulative effects on groundwater described above could have knock-on effects on surface water bodies, many of which gain their base flows/supplies from groundwater.

4.147. In the very long term, some disposal options (at the LLW Repository, in landfill, in non-engineered facilities) have the potential to result in the release of contaminants into water bodies as a result of long-term environmental change and erosive forces. In principle these effects could act cumulatively, particularly if the contaminants enter the same river system or the same coastal waters (e.g. the Irish Sea). However, this potential may be limited by the low probability of such releases, if they occur at all, being close together in time – they could be separated by centuries.

Cumulative effects in relation to economy, society and skills

4.148. A number of options have the potential to create employment, with varying ranges of skill levels, but in all cases the numbers are relatively small and are unlikely to make a significant difference to communities.

4.149. However, where there is the opportunity to implement a number of employment-creating options in the same location or in close proximity, then the combined number of new jobs and the overall skill mix could be more beneficial to local communities, especially if relatively small rural communities are involved.

4.150. To the extent that any of these options involve adverse effects such as the generation of noise, air quality impacts, disruption from traffic etc., these effects could also act cumulatively if the options are implemented in close proximity, with consequent effects on the community.

Cumulative effects in relation to traffic and transport

4.151. In general, this assessment has suggested that traffic and transport is not a significant environmental and sustainability problem associated with the Strategy, because of the relatively low level of transport associated with the management of LLW and its wide geographic dispersal.

4.152. However, there is in principle the potential for a number of individually insignificant traffic effects to combine to become significant, particularly in the short term, for instance if several options were to be implemented simultaneously in the same area and all required construction work. This is, however, a relatively unlikely outcome, particularly given the intention that the Strategy will be delivered through the supply chain.

Cumulative effects in relation to land use

4.153. A number of options have been identified as having the potential to affect land-use, either as a result of land-take for the construction of new facilities or as a knock-on effect of ground or water contamination that would place restrictions on future uses of the land.

4.154. In most cases, these effects are essentially individual to the site affected and would not act cumulatively. However, where the effect comprises contamination of land adjacent to a nuclear industry site or waste management facility, there is the potential, in principle, for cumulative effects to occur if more than one option is implemented in close proximity, resulting either in contamination of large areas of land or increased contamination of the same land. In addition, where new facilities are built resulting in an impact through land-take, there is the potential for an impact on the same land through contamination during operation of the facility, placing further restrictions on the use of the land (or increased remediation requirements) when the facility is decommissioned.

4.155. However, all of these contamination-related impacts should be viewed as risks rather than impacts, and are preventable.

Cumulative effects in relation to noise and vibration

4.156. A number of options (recycling, decontamination, incineration, melting, compaction, disposal at landfill sites) have, to varying degrees, some potential to generate noise and/or vibration. In some cases, there may be a single principal source of noise, or there may be more than one source of noise associated with a given option.

4.157. Incineration and melting are probably the options with the greatest potential to generate significant noise. However, they are also the options least likely to be implemented in combination with others at the same site. They may, nevertheless, be implemented in urban/industrial areas where their noise may act cumulatively with that of other, unrelated developments to affect nearby residential areas or other sensitive receptors. However, they would, as part of their consenting process, be subject to an assessment of noise emissions and a requirement to limit any effects on nearby receptors through design measures or noise barriers, taking existing noise levels into account. This would eliminate the potential for a cumulative noise effect.

4.158. Other options could, potentially, be implemented on a single nuclear industry site or otherwise in close proximity, so that their combined noise emissions could affect nearby receptors (if present). However, similar assessment and consenting procedures to those described above would apply, taking into account the cumulative effect, so that the overall effect on the receptor is kept within agreed/permitted limits through the application of design measures or noise barriers.

5. Conclusions

Introduction

5.1. The final version of this report, once it has been updated to reflect the results of public consultation, will be used to assist future decision-making in relation to the implementation of the Strategy. These conclusions are therefore structured around the three strategic themes that form the core of the Strategy itself (see Chapter 2):

- Application of the waste management hierarchy;
- Make best use of existing facilities; and
- Development and use of new fit-for-purpose management and disposal routes, so waste producers have more choice in determining waste management routes.

5.2. Several waste management routes have the potential to generate greenhouse gas emissions, with consequent adverse effects on the global climate. In the cases of incineration and melting of metallic LLW, which are high-temperature thermal processes, the total effect could lead to significant emissions.

Application of the waste management hierarchy

5.3. The principal methods examined in this SEA for managing LLW on the higher levels of the waste hierarchy are reuse and recycling, facilitated where needed by decontamination. Decay storage could also be considered, to some extent, as a method for facilitating the management of waste further up the hierarchy.

Decontamination

5.4. Decontamination could help to divert significant quantities of LLW from disposal to recycling, although it would also generate a smaller quantity of secondary waste, including more concentrated radioactive waste, which would require separate management. Decontamination also carries the potential for adverse effects in relation to several aspects of the environment, particularly if new facilities are required, although in most cases these effects are uncertain and subject to the need for site-specific assessment.

5.5. Application of decontamination to any particular waste-stream therefore requires a thorough prior assessment and site selection process. The scope would be determined on a case-by-case basis, but key issues to be considered would always include the potential for effects on:

- Biodiversity, flora and fauna;
- Landscape and visual (including seascape and townscape, where relevant);
- Cultural heritage; and
- Noise and vibration.

Reuse

5.6. Once waste has been generated, reuse is the highest/most desirable available level on the waste hierarchy still available (i.e. the next level after avoidance or minimisation). It has significant potential benefits, including:

- It defers the need to dispose of the material as waste for a substantial period, possibly indefinitely, during which time its radioactivity is likely to reduce due to decay; and
- It avoids the need for the use of new materials, which could themselves become contaminated and then need to be managed as radioactive waste.

5.7. However, reuse of materials that remain radioactive – albeit at a low level – can be problematic. The circumstances under which the materials can be reused are limited, in order to avoid the risk of human or environmental exposure. In particular, the reuse of soils or rubble in void-filling or landscaping as part of the decommissioning process for nuclear industry sites could be very beneficial in diverting large bulk materials from disposal. However, this practice would carry a risk of contaminants leaching out of the material and affecting surrounding environmental receptors as a result of rainwater or groundwater percolating through the body of the waste.

5.8. Any consideration of the potential for reuse therefore needs to be subject to rigorous assessment and site-selection processes. As above, the scope would be determined on a case-by-case basis, but key issues to be considered would include:

- The nature of the LLW concerned and the circumstances of reuse;
- The prevailing ground and groundwater conditions; and
- Surrounding environmental conditions, including biodiversity, surface water and land use.

Recycling

5.9. Recycling of LLW, often after decontamination or other treatment such as melting, has the potential to significantly reduce the quantity of LLW being consigned for disposal. There are some potential, but uncertain, adverse effects, relating to air quality and noise in particular, but in general recycling is a relatively low-risk option for the environment. Potential effects associated with any prior treatment are considered under the relevant headings (decontamination and melting of metallic LLW).

5.10. The assessment has been based on the effects of recycling itself and has assumed that no new facilities would be required.

Decay storage

5.11. Like decontamination, decay storage can be considered a form of treatment of LLW to prepare it for other forms of management and widen the range of management options available by reducing its level of radioactivity.

5.12. The benefit of decay storage is that material that would have required disposal at the LLW Repository or GDF could, after storage, either require less onerous disposal conditions or could be open to management further up the waste hierarchy. The disadvantage is that it is only likely to be applicable to limited types and relatively small quantities of LLW.

5.13. The assessment has identified no significant potential for adverse effects in relation to any of the environmental and sustainability options in the short to medium term. In the long term, there may be knock-on benefits to air, climate change and surface water, with the possibility of benefits for ground and groundwater and for land use.

5.14. In circumstances where it is applicable, therefore, decay storage is a low-risk option with potentially significant benefits.

Make best use of existing facilities

The LLW Repository

5.15. Prior to first implementation of the Strategy, the LLW Repository was forecast to require replacement in or around 2037, as it was expected to have reached its maximum capacity by that time. However, successful implementation of the Strategy to date is resulting in extension of the expected life of the LLW Repository and it is envisaged that as long as sufficient diversion of wastes can be achieved, the LLW Repository will have enough capacity for the foreseeable future. As a result, this SEA has not considered options relating to the replacement of the Repository.

5.16. Increased use of the LLW Repository in preference to other routes would reverse that trend and would mean that a new site would be required in future; it is not considered a realistic option. However, continued use of the repository as at present, to dispose of LLW that cannot be managed elsewhere, is a necessity. Any differences between packaging options are not significant in environmental terms, although they may have cost implications.

5.17. Continued minimisation of the waste sent to the LLW Repository is given extra value by the very long term risk that coastal erosion could lead to the re-exposure of LLW that had been thought permanently buried, resulting in its release into the environment.

Volume reduction

5.18. Compaction of LLW to reduce its volume before disposal is a well-established practice, intended to maximise the efficiency of use of the available space in the LLW Repository. Low-force compaction on nuclear industry sites, usually inside drums, is carried out at some sites to maximise transport efficiency, before transport to Sellafield or Winfrith for high-force compaction into pucks before disposal. High-force compaction is also carried out at Dounreay. Both forms of compaction are low-risk activities in environmental terms (with appropriate containment), and achieve significant benefits in terms of efficient use of disposal space.

5.19. Melting of metallic wastes is a technique presently carried out using overseas facilities. It is used both to reduce the volume of wastes before disposal, and as a form of treatment before recycling. Incineration is also used to reduce volume, by burning the majority of the waste leaving just an incombustible residue to be disposed of. Commercial incinerators licenced to receive LLW are now available at Ellesmere Port, Colnbrook and Fawley. Both techniques require industrial-scale plant carrying out thermal processes, and there are potentially significant environmental impacts associated with their construction and operation, although they are subject to very strict environmental regulation.

5.20. While these options have a potentially valuable role to play, the assessment also indicates that they carry the greatest potential environmental risks of all the options considered. Any decision to apply these options would be subject to a demonstration that the long-term environmental and sustainability benefits outweigh the potential risks.

5.21. The potential range of effects associated with these methods is such that any proposal to expand their use requires careful assessment through its site selection and EIA process.

Develop and use new fit-for-purpose management and disposal routes

5.22. The development of the Strategy has taken into account the broad range of levels of radioactivity within the overall LLW category. Not all LLW requires the degree of containment conferred by a highly engineered facility like the LLW Repository. At the lower end of the range, some LLW is at such low levels of radioactivity that it would require prolonged direct contact or actual ingestion to cause significant health effects. In addition, while some radionuclides have long half-lives and take a very long time to decay, others are short-lived and will decay very fast.

5.23. For such lower activity LLW and LLW containing short-lived radionuclides, alternative forms of disposal are appropriate, subject to a demonstration that disposal will meet all required regulatory risk targets and any other regulatory requirements. The methods considered here include disposal at landfill sites and disposal at non-engineered facilities. A third route, disposal at a GDF, is appropriate for LLW at the opposite end of the spectrum – waste that contains such long-lived or otherwise problematic radionuclides that it cannot be accepted at the LLW Repository.

5.24. All of these routes except disposal at a GDF carry a risk that, in the very long term, they could be affected by erosion that could re-expose waste that has been disposed of there. This means that the selection of suitable sites needs to include careful consideration of factors potentially affecting very long-term stability and resilience, such as proximity to a river or the coast, geological conditions, vulnerability to flooding, etc.

Disposal at landfill sites

5.25. It is assumed in this SEA that this option implies co-disposal of some lower activity LLW with other waste at landfill sites that primarily serve a wider market than just the nuclear industry, and that the landfill sites are not therefore established principally for the purposes of LLW disposal. Any environmental impacts associated with the establishment and management of the landfill site as such are therefore separately accounted for as part of the original consenting and licencing process for the landfill site itself. Any variations to allow it to take lower activity LLW would be addressed in a specific licencing process for that purpose.

5.26. Use of landfill void is not, in principle, a sustainable option compared to non-disposal methods; however, if the alternative is disposal at the LLW Repository, then landfill is preferable. This is because there are only two LLW Repositories able to take waste, including only one which can accept waste from anywhere in the UK; space there is much more limited than the available landfill space in the UK, and disposal at the LLW Repository uses much more resources than disposal in landfill. It is unlikely that disposal of LLW will ever significantly deplete available landfill void – the total of all LLW expected to arise over more than 100 years is well under 1% of the total volume of landfill space available, but only a proportion (probably a small proportion) of the total LLW is likely to be sent to landfill.

Disposal at non-engineered facilities

5.27. There are two principal routes under this heading – the use of dedicated landfill-style facilities for LLW alone, and in-situ disposal.

5.28. The use of dedicated landfill-style facilities would, in environmental terms, be broadly similar to the use of landfill sites, with the addition of any environmental effects associated with the initial establishment and overall management of the site. This significantly increases the potential range of environmental factors that would need to be considered in site selection and assessment before a decision was made to implement this option.

5.29. In-situ disposal has advantages in that the waste does not need to be disturbed from its existing position or removed from the site. However, it may be difficult to ensure adequate containment and prevent impacts on ground and groundwater, which could impact on environmental receptors on adjacent land. Available mitigation options could entail substantial engineering works. The key factor influencing decisions on implementation of the option would generally be local ground and groundwater conditions

Disposal at a GDF

5.30. Disposal of LLW at a GDF is seen as a low-impact, low-risk option. However, it is only ever likely to be applicable to a small proportion of LLW, including problematic categories of LLW that are not suitable for other management routes. It is not likely to be available in the short term.

Monitoring

5.31. This section sets out the strategy for monitoring the potential significant effects of the Strategy. Monitoring can help to address such questions as:

- Were the assessment's predictions of effects accurate?
- Is the Strategy contributing in practice to the achievement of the environment and sustainability objectives as set out for the SEA?
- Are there any adverse effects (i.e. is the Strategy acting against achievement of the objectives)? If so, are they within acceptable limits or is remedial action required?

5.32. Monitoring action should therefore be focused on:

- Significant sustainability effects that may give rise to irreversible damage, with a view to identifying trends before such damage is caused; and
- Aspects where the assessment has identified the potential for significant adverse effects, but where there is uncertainty, and where monitoring would help to resolve that uncertainty and to enable preventative or mitigation/remedial measures to be taken.

5.33. Monitoring need not in all cases continue in perpetuity. In some cases, monitoring can cease once a trend has been confidently established and uncertainty removed, if it has shown that the previously identified risk of harm is in fact absent or insignificant. In other cases, monitoring may need to continue as environmental performance may vary from year to year. Detailed site-specific requirements will normally emerge from site-specific, and technology-specific, assessments, consenting and permitting processes.

5.34. Table 5.1 below sets out a series of potential indicators that could be used for monitoring the effects of the Strategy. To be effective, it would be necessary to require consistent reporting of these factors from all nuclear industry sites and from all waste management facilities handling LLW. This is not in place at present, and it may only be possible to put in in place progressively through the application of contractual conditions. Not all indicators may be relevant to all sites.

Objective	Monitoring indicator	Potential source of information
Air quality	Authorised radioactive gaseous and particulate discharges to air Discharges of other pollutants to air	RIFE annual reports; NDA annual site specific baseline reporting; Site Licenced Companies (SLCs)/facility operators; Waste management site operators; Environment Agency Scottish Environmental Protection Agency Natural Resources Wales
Global climate change and energy	Energy consumption Emissions of greenhouse gases Vulnerabilities to climate change/flooding/extreme weather and any local incidents	NDA annual site specific baseline reporting; Site Licenced Companies (SLCs)/facility operators; Waste management site operators; Defra; Environment Agency (inc. Nuclear Sector Plan) Scottish Environmental Protection Agency Natural Resources Wales
Biodiversity, flora and fauna	Condition and any changes in condition of designated sites within 2km (local, national, European, international) If there are any wildlife monitoring programmes, updated status If there is a site BAP, updated status of relevant habitats	NDA annual site specific baseline reporting; Site Licenced Companies (SLCs)/facility operators; Waste management site operators; Natural England; Scottish Natural Heritage; Natural Resources Wales.
Landscape and visual	Changes in the visual appearance of the facilities or the condition of the surrounding landscape/ seascape/ townscape	NDA; Site Licenced Companies (SLCs)/facility operators; Waste management site operators; Any site-related development proposals and environmental assessments, including Environmental Statements.
Cultural heritage	Changes in the condition or integrity of historic buildings, archaeological remains or historic landscapes within or adjacent to a site or the setting of an of the above within 2km	English Heritage, Historic Scotland or Cadw; Local Historic Environment Records or equivalent; Any site-related development proposals and environmental assessments, including Environmental Statements.
Geology, ground and groundwater	Changes in status of any existing contaminated land on or adjacent to the site, or any new contamination Changes in status of any groundwater bodies underlying the site or adjacent land Changes in condition of any agricultural or other topsoils on or adjacent to the site	NDA annual site specific baseline reporting; Site Licenced Companies (SLCs)/facility operators; Waste management site operators; Environment Agency; Natural England; Scottish Natural Heritage; Natural Resources Wales; Any site-related development proposals and environmental assessments, including Environmental Statements.
Surface water quality and	Ecological and chemical status of surface water near to site	Environment Agency;

Objective	Monitoring indicator	Potential source of information
resources	Water quality monitoring	Scottish Environmental Protection Agency; Natural Resources Wales; NDA annual site specific baseline reporting; Site Licenced Companies (SLCs)/facility operators; Waste management site operators;
Economy, society and skills	Unemployment levels, levels of qualifications etc. in local communities Changes in employment at the site	National statistics; NDA; Site Licenced Companies (SLCs)/facility operators; Waste management site operators.
Traffic and transport	Traffic activity levels around each relevant site	Site operator for traffic entering/leaving; Department for Transport for overall traffic in surrounding area.
Land use	Changes in land use within or adjacent to the site	NDA; Site Licenced Companies (SLCs)/facility operators; Waste management site operators.
Noise and vibration	Noise levels at site boundary and at key receptors Any new sources of noise or existing sources removed Noise complaints	NDA annual site specific baseline reporting; Site Licenced Companies (SLCs)/facility operators; Waste management site operators;

Table 5.1 Potential monitoring indicators

Next steps

5.35. This Environment and Sustainability Report will be presented for consultation alongside the Strategy in January 2015 for a period of 12 weeks. Feedback from members of the public and from statutory consultees will be taken into account in finalising the Strategy, and this report will then be finalised taking into account both the feedback received and any changes to the Strategy. The finalised report will be published alongside the final Strategy and a Post-Adoption Statement.

5.36. Once the updated Strategy begins to be implemented, it is intended that the final version of this report will be used to inform decision-making on the choice of options and site selection. As this is a strategic document and those are tactical decisions, it is likely that the report, alongside the Strategy document, will set a framework providing guidance for the scope of more detailed assessments focused on the specific decisions to be made on each occasion, but this report will form the starting point on each occasion.

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