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BEST PRACTICABLE ENVIRONMENTAL OPTION FOR CARE AND MAINTENANCE PREPARATION WASTES AT CHAPELCROSS

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EXECUTIVE SUMMARY

A BPEO study was carried out to support the identification of appropriate management options for wastes arising during the 'care and maintenance' phase of decommissioning activities at Chapelcross Power Station.

Two main waste categories were considered

- Intermediate level radioactive waste (ILW);
- Low level radioactive waste (LLW);

The study applied a Best Practicable Environmental Option (BPEO) methodology to evaluate management options. The approach was designed to make use of currently readily available information, including the technical expertise and site knowledge of BNG staff, within the relatively limited time available for this work. This report presents the results of the study. The approach taken is consistent with the environment agencies guidance on the application of BPEO to radioactive waste management issues.

A number of treatment options were identified for specific types of waste in each waste category.

The treatment options were screened for compliance with UK law and international conventions where clearly defined and consistency with UK policy where clearly defined. The remaining options were then scored against a series of attributes in the following groups:

- **Health and safety**: attributes in this group reflect the confidence that an option could protect human health from both radiological and non-radiological impacts.
- **Environmental impacts**: attributes in this group reflect the assessment of the impact on air quality, water quality, land, visual impact, nuisances, energy usage, flora and fauna.
- **Environmental objectives:** attributes such as compliance with the waste hierarchy, the move towards 'concentrate and contain', minimisation of waste volumes and the rate of hazard reduction.
- **Technical performance**: attributes in this group address an option's ability to perform its planned function in terms of viability, nuclear safety, flexibility and programme.
- **Socio-economic**: attributes in this group are concerned with possible impacts to the local community (the immediate area surrounding Chapelcross) in terms of economy, and culture and heritage.
- **Financial cost**: attributes in this group include the undiscounted cost of implementing each option within the constraints and scope of this study and the reduction of the NDA's nuclear liabilities expressed in terms of the completeness of the solution.

Scoring of the options against the attributes was undertaken by a two stage process that involved individual scoring by BNG staff and collation and consolidation of individual scores to provide overall group scores, followed by collective discussion at an internal 'round-table' forum, drawing on the

specialist knowledge and practice experience of BNG staff, and facilitated by independent consultants.

The unweighted scores were then weighted in four different schemes to test the robustness of the outcomes. The four different weighting schemes were devised to test the outcome if an emphasis was put on such factors as costs and the environment. The highest scoring options for each waste group are as provided in the following table.

Waste category	Waste group	Highest scoring option
ILW	Metals	Conditioning and interim storage
	Ceramics	Conditioning and interim storage or Disposal at Sellafield
	Sludges	Conditioning and interim storage
	Resins	Conditioning and interim storage
	Aggregate	Conditioning and interim storage
	Magnox and graphite	Conditioning and interim storage or Disposal at Sellafield
	Desiccants	Conditioning and interim storage
	Oils and oily wastes	Conditioning and interim storage
LLW	Metal	Decontaminate to SoLA levels
	Asbestos	Disposal at the National LLW repository near Drigg
	Aggregate	On-site disposal in a purpose-built facility
	Cellulosic	On-site disposal in a purpose built facility
	Plastic and rubber	Decontaminate to SoLA levels
	Contaminated waste water	Discharge without treatment
	Organic liquids	Off-site disposal by incineration (from previous specific BPEO study).

It is important to consider this summary information in context; in some cases a relatively small number of options was considered and the differences between the scores may not be significant.

1. INTRODUCTION

1.1 Background

Chapelcross is the site of a four-reactor Magnox type power station, which was built on the site of a former RAF station. It is located 3 km north-east of the town of Annan in the Dumfries and Galloway region of south-west Scotland. It is situated 6 km from the coast of the Solway Firth and 13 km from the land border with England. Chapelcross was built and commissioned between 1955 and 1959. The cessation of electricity generation was formally announced on 29th June 2004.

Chapelcross is slightly different from most of the other Magnox power station sites: there are no active effluent treatment plants, the effluent discharge pipeline is 6 km long, there are no reactor vaults and the heat exchangers are external to the reactor buildings. In addition to these features of the power station, other unique features exist on the site e.g. the North Site, including the UO_3 store (B141) and the Production Plant (CXPP, which is a Ministry of Defence plant that processes neutron absorption cartridges that are removed from the reactors).

Initial decommissioning of the site is being undertaken in parallel with defuelling. Redundant plant and buildings are being removed or made safe, and waste materials are disposed of or will be placed in a safe condition and location for interim storage. This initial work will prepare the site for 'care and maintenance' where the reactor block and remaining wastes will be left in a safe state pending final site clearance. This work is planned to be completed in 2021.

1.2 Objectives and Scope

The purpose of the study was to support the identification of appropriate management options for the 'care and maintenance' preparations wastes. The study undertaken used a Best Practicable Environmental Option (BPEO) methodology.

The waste groups considered within the study were those arising from Care and Maintenance preparations:

- Intermediate Level Waste (ILW)[1] but also including that generated during the operational lifetime of the reactors
- Low Level Waste (LLW)[2]

Consideration of non-radioactive waste streams was outside the scope of this project.

1.3 Strategic Considerations

The study was performed in order to:

[1] Waste with radioactivity levels which exceed the upper boundary for low-level waste, but which does not generate significant amounts of heat.
[2] Waste which contains radioactive materials which do not exceed 4 GBq/tonne alpha or 12 GBq/tonne beta/gamma activity.

1. Support a future submission by the site for a revised multi-media RSA application once the focus of operations changes from power generation to decommissioning; and

2. Inform the development of the Chapelcross's site's Integrated Waste Strategy.

The study applied a BPEO methodology to evaluate management options. The approach was designed to make the use of currently readily available information, including the technical expertise and site knowledge of BNG staff, within the relatively limited time available for this work. This report presents the results of the study. The approach taken is consistent with the environment agencies guidance on the application of BPEO to radioactive waste management issues.

2. THE BPEO METHODOLOGY

2.1 General approach

The BPEO methodology is a formalised system for evaluating issues and their environmental implications and for determining appropriate options to address these issues. The system was first proposed by the Royal Commission on Environmental Pollution (RCEP) in the mid-1970's [RCEP, 1976] as a way to help control air pollution with the aim of diverting releases to the environmental medium where there is the least environmental impact.

The RCEP went on to define BPEO as follows in its Twelfth Report [RCEP, 1988]:

"… the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term."

Various definitions and suggested implementations of BPEO have since been published by Government bodies and advisory bodies [e.g. Department of Environment, 1986]. Most recently the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA) have published guidance on the application of BPEO to radioactive waste management [EA & SEPA, 2004]. The environment agencies and other regulators frequently require BPEO studies or appropriate option studies before approving projects.

The methodology applied in this study involves the following seven steps:

- Step 1: Definition of the objectives and scope of the study to provide a focus for the assessment and to help establish a basis for subsequent decision-making by setting out the primary boundary conditions.
- Step 2: Generation of a comprehensive list of management options to ensure that all reasonably practical or technical feasible options are included and the outcome is not pre-judged.
- Step 3: Initial screening of options to remove from consideration those options that are clearly non-viable (e.g. would contravene either UK law or international obligations).
- Step 4: Definition of a series of 'attributes' that are viewed to be important for determining the best option and which are relevant at the level of detail being considered.
- Step 5: Evaluation ('scoring') of the options against the attributes to allow them to be compared quantitatively.
- Step 6: Identification of the 'best' option(s) on the basis of the scoring results and using appropriate weighting schemes.
- Step 7: Analysis of the robustness of the 'best' options(s) to the weighting scheme employed in the scoring exercises, and other possible alternatives, through a sensitivity analysis.

The identification of the BPEO is an important input to strategic decision making. In practice, however, few decisions are made solely on the basis of such a study. The selection and approval of a preferred option may be modified by other factors that are not taken directly into account in the BPEO study. These other factors may include political considerations or the results of more detailed safety, economic and technical optimisation studies.

The objectives of the study were agreed at a meeting with British Nuclear Group to be to undertake a study that:

- results in a BPEO assessment that can be presented to SEPA;
- could be used to inform the site's integrated waste strategy (IWS);
- provides consistent links, as required, to the site's programme of best practicable means (BPM) studies; and
- enables the site to make best use of existing and future waste management routes, including those based on reuse and recycling, and clearance and exemption in line with the application of the waste hierarchy and the expectation of the regulators.

Enviros was commissioned by British Nuclear Group to support them by providing:

- facilitation at workshops;
- a multi-attribute decision analysis evaluation process; and,
- documentation of the study.

2.2 The approach at Chapelcross

The approach to the BPEO process at Chapelcross was to hold two workshops:

- The optioneering workshop
- The scoring workshop

Both workshops were attended by technical and expert staff from British Nuclear Group.

2.2.1 The optioneering workshop

The aim of optioneering workshop was to:

- confirm the materials assigned to each waste group
- draw-up a long-list of management options for each wastestream;
- draw-up a list of screening criteria;
- undertake a screening exercise to draw-up a short-list of options for more detailed assessment in the second round of assessments;

- draw-up an initial list of assessment criteria (attributes); and
- identify the information needs to enable the detailed assessment to be undertaken.

2.2.2 The scoring workshop

The aim of this workshop was to review the scoring that had been carried out independently by site staff and to resolve any areas of discrepancy that were highlighted from an analysis of the scoring.

The independent scoring exercise was facilitated by the production of a briefing pack and instructions to individuals on how to undertake the scoring.

2.2.3 Data and information

The BPEO requires input in terms of data and information. Due to the high level and wide ranging nature of the study, generic data were derived and used on the basis of expert input from BNG site staff.

3. BPEO ISSUES GENERIC TO ALL WASTE CATEGORIES

3.1 Identification of options

The study identified a range of waste management options for the waste categories and these are set out in detail for ILW in section 4 and for LLW in section 5.

The identification of potential options was undertaken collectively by internal staff in a 'round-table' forum made up of British Nuclear Group staff with a wide-range of specialist knowledge and practical experience with support from an independent environmental consultancy. The panel members are detailed in Appendix A.

3.2 Screening Priorities

The priorities used in this option study to define screening criteria relate to the following issues.

- Compliance with UK law and international conventions where clearly defined.

- Consistency with UK policy where clearly defined.

These issues are discussed in more detail below. Screening criteria are based on these main issues where a specific and definable requirement could be identified. It should be noted that criteria requiring a degree of interpretation, though considered to be important, such as the requirement for 'concentrate and contain' or a 'passively safe wasteform' were considered to be an integral part of the attribute identification and scoring process described in sections 3.4 and 3.5.

The most relevant screening criteria in this context are identified in the following section.

3.2.1 Compliance with UK law and international conventions

With regard to national law and international conventions, the most relevant relate to:

- **London Convention**: the marine environment has been specially protected with international treaties and conventions since the 1950s. Disposal to sea of solid radioactive waste was indefinitely suspended in the UK in 1985 after an extension to the 'London Convention' treaty.

- **OSPAR Convention on the Protection of the Marine Environment:** the UK is a signatory of the 'OSPAR Convention' of 1992 which covers the protection of the North-East Atlantic. The strategy on radioactive substances, created under this convention, includes the objective to reduce discharges, emissions and releases of radioactive substances by 2020, with the ultimate aim of reducing the additional concentrations of naturally occurring radionuclides in the marine environment to near background levels, and to close to zero of artificial radionuclides [OSPAR, 1998].

- **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal:** provides a framework for a global system of environmental controls on transfrontier movements of waste. The convention seeks to reduce transboundary movements of hazardous wastes to a minimum, dispose of these wastes as close as possible to where they were generated and minimise their generation.

- **Groundwater Regulations:** the disposal of liquid wastes containing List I substances into groundwater is forbidden by the Water Environment and Water Services (Scotland) Act 2003 and the relevant regulations – the Water Environment (Controlled Activities) (Scotland) (Amendment) Regulations 2007.

- **Protection from Radiation**: general principles for the protection of humans from the harmful effects of ionising radiation are established by the ICRP. The ICRP's system of radiological protection was affirmed in 1991 [ICRP, 1991] to consist of just three basic principles (i) 'justification' which requires that a practice must do more good than harm; (ii) 'optimisation' which requires that the benefit of the practice must be maximised; and (iii) 'limitation' which requires an adequate standard of protection. These principles are further interpreted in a practical manner in European (e.g. EURATOM Basic Safety Standards) and UK legislation (e.g. Ionising Radiation Regulations, see below).

- **Ionising Radiations Regulations**: the Ionising Radiations Regulations 1999 [The Ionising Radiation Regulations, 1999] require employers to keep exposure to ionising radiations as low are reasonably practicable (ALARP) and they are enforced by the HSE. Exposures must not exceed specified dose limits. Restriction of exposure should be achieved first by means of engineering control and design features. Where this are no reasonably practicable alternatives employers should introduce safe systems of work and only rely on the provision of personal protective equipment as a last resort.

3.2.2 Consistency with UK policy and guidance

With regard to UK policy, the most relevant relate to:

- **Policy on Radioactive Waste Management:** The primary statements of UK policy on radioactive waste management are contained in Cmnd 2919 [Secretary of State for the Environment, 1993] and the recently published 'Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom [Defra et al, 2007]. Cmnd 2919 provides specific policies for a range of waste categories and management processes. Cmnd 2919 takes account of guidance from international bodies such as the ICRP and IAEA [IAEA, 1993], as well as the views of official UK advisory bodies such as NRPB [NRPB, 1992].Some aspects of this document, related to the management of low level radioactive waste, have been amended or superseded by the LLW policy document. For example, Cmnd 2919 places restrictions on the export and import of radioactive waste may to or from other countries to small quantities and under special conditions. The new policy for LLW amends the policy with regard to LLW; export and import of LLW may be permitted for the recovery of re-useable materials or for treatment that will make its subsequent storage and disposal more manageable. Additionally Cmnd 2919 sets out the policy aim to store waste in a passively safe condition. With regard to LLW, the new policy includes a presumption towards management solutions which can be implemented 'early rather than late'. The LLW policy also supersedes previous policy on disposal of LLW at landfill sites by stating that there 'is no reason to preclude controlled burial[3] from nuclear sites from the list of options to be considered in any options assessment' [Defra, 2007]. The categorisation of very low level waste (VLLW) is also modified to allow for 'dustbin disposal' of low volume VLLW to an unspecified landfill and disposal of high volume VLLW to specified landfill sites.

- **Policy statement on the Decommissioning of the UK Nuclear Industry's Facilities:** this policy statement [UK Government, 2004] replaces paragraphs 120 -131 of Cm 2919. It sets out the requirement for operators to produce and maintain a decommissioning strategy which includes a comprehensive decommissioning plan for safely carrying out the decommissioning process with due regard to security and protection of the environment. It also sets out policy with respect to the review of decommissioning strategies, the funding of decommissioning operations the dissemination of best practice and the requirement to consider decommissioning at the design stage for new facilities.

- **Regulations and Guidance on Radioactive Waste Management**: detailed guidance on requirements for the authorisation of LLW and ILW disposal has been published [EA *et al.*, 1997] by the EA and SEPA. The guidance interprets policy described in Cmnd 2919 in more detail in practical terms. The policy aims to require that waste is stored in a passively safe condition is set out in the guidance.

3.3 Chosen Screening Criteria

The general screening criteria identified for the purposes of this project are outlined in Tables 1 and 2 below.

Table 1 Criteria from Conventions, Legislation and Regulations Relevant to Radioactive Waste Management Options

Criterion	Name	Description
1	London Convention	Disposal of solid radioactive waste at sea is suspended indefinitely.
2	OSPAR Convention	Reduction of discharges by 2020 with the aim of reducing additional concentrations of natural radionuclides in the north eastern Atlantic to close to background, and close to zero for artificial radionuclides.
3	Controlled Activities Regulations	The disposal of liquid wastes containing certain listed substances into groundwater is forbidden by the Controlled Activities Regulations.
4	Dose limits	The annual individual dose to members of the public must not exceed 1 mSv/yr. Doses to workers are limited to 20 mSv/yr averaged over five years (other limits also apply).

[3] Also known as 'special precautions burial' – the burial of LLW that could be disposed of as VLLW at landfill sites.

Table 2 Criteria from Government Policies and Guidance Relevant to Radioactive Waste Management Options

Criterion	Name	Description
5	Waste import and export	Radioactive waste may only be exported to (or imported from) elsewhere in small quantities and under special conditions.
6	Guidance on the conditioning of ILW	EA guidance on ILW conditioning requiring it to be made passively safe.

3.4 Attribute Lists

When selecting attributes for use in this study, a list of suggested attributes was developed in discussion with British Nuclear Group staff, based on previous experience.

Environmental objectives were included as attributes to capture the consideration of how the study takes into account certain policy aims such as the philosophy of the Government's waste hierarchy, the policy shift from 'dilute and disperse' towards 'concentrate and contain' and the policy aim to ensure hazard reduction by implementing passively safe systems for managing materials. The attribute relating to waste volumes also results from the policy aim to ensure waste minimisation but also allowed consideration of the potential impact of certain options on disposal routes which have limited capacity, such as the National LLW repository near Drigg. These attributes were different in nature to the attributes relating to environmental impact which are concerned with considerations about impact on specific environmental media and amenity.

The list of attributes was organised into a number of separate groups that cover a range of all relevant topics, so as not to overly place an emphasis on one particular issue. This is consistent with the approach suggested in the EA-SEPA guidance on BPEO studies for radioactive waste management [EA & SEPA, 2004]. The attribute groups considered in this study were:

- **Health and safety**: attributes in this group reflect the confidence that an option could protect human health from both radiological and non-radiological impacts. Three separate attributes were identified in this group:
  - public health and safety (for individuals),
  - public health and safety (societal),
  - worker health and safety (for individuals).
- **Environmental impacts**: two sub-groups of attributes are recognised in this group:
  - physical environment which is further subdivided into air quality, water quality, land, visual impact, nuisances (i.e. noise and vibration, dust, light and odour) and energy usage and transport emissions.
  - flora and fauna to reflect the fact that there is a clear distinction in UK environmental and planning laws between the consequences of industrial and construction activities on these two elements.

- **Environmental objectives:** these attributes reflect the Government policy objectives in such matters as:
  - waste minimisation, waste reuse and recycling,
  - the rate of hazard reduction,
  - the move towards concentrate and contain,
  - the generation of secondary wastes,
  - greenhouse gas emissions, and
  - the proximity principle.
- **Technical performance**: attributes in this group address an option's ability to perform its planned function. Four separate attributes were identified in this group:
  - viability is the ease with which it can be demonstrated that an option is technically feasible within time constraints imposed by the Chapelcross LTP, considering the existing maturity of technology, the continued availability of the option and the throughput or capacity of the option,
  - nuclear safety relates to the requirement for the waste to meet the Conditions for Acceptance at the receiving site (e.g. the National LLW repository near Drigg) or to gain a Letter of Compliance for an ILW wasteform from Nirex,
  - flexibility is the scope for the strategy option to be varied, if required to meet requirements for different end-points; and
  - programme relates to the likelihood that an option could be carried out within the timescales of the Chapelcross LTP, will reduce the project risk to the NDA; will result in a reduction of the NDA's liabilities at Chapelcross and the consistency of the option with the preferred site end state.
- **Socio-economic**: attributes in this group are concerned with possible economic impacts to the local community (the immediate area surrounding Chapelcross) in terms of economy, and culture and heritage.
- **Regulatory issues**:
  - regulatory acceptance (HSE, NII, EA, planning etc.) was also assessed using a separate attribute.
- **Financial cost**: this group contains three attributes:
  - the undiscounted cost of implementing each option within the constraints and scope of this study. This includes the capital costs of new plant (including development costs), plus operational and decommissioning costs, as well as the cost of interim storage on site of the volumes of wastes generated or the cost of disposal. Undiscounted costs were used as opposed to discounted cost

because they give a time independent assessment of costs which can be meaningfully compared,

- the rate of spend compared to the current estimates contained within the LTP is used as a proxy to assess the relative affordability of options, and

- an attribute to assess the stability of cost estimates is used to identify particular areas subject to high uncertainty or volatility.

The attribute groups, attributes and sub-attributes derived for use in the study are listed in Appendix B. The listing in Appendix B is considered to master list for the project, not all attributes were considered to be relevant to all the waste categories.

3.5 Scoring Schemes for Attributes

To help make the option scoring process consistent and to relate the numerical scores to meaningful measures of performance, scoring (calibration) schemes were devised for each sub-attribute. The approach adopted was that if the performance of a strategy option as judged against a sub-attribute was considered to be “unacceptable” then a score of 0 was awarded. If the performance of a strategy option as judged against a sub-attribute is considered to be “ideal” then a score of 5 was awarded. Intermediate integer scores of 1 to 4 are possible and would generally equate to a range of “acceptable” performance.

Some calibrated scoring schemes were defined quantitatively (e.g. for risks to human health) and other were defined qualitatively (e.g. air quality). Qualitative scoring schemes were adopted when no numerical data on performance were possible or available, for example when an evaluation is entirely subjective. The requirements used in the study for each sub-attribute are given in Appendix B.

3.6 Scoring of options

Scoring of the options for the Chapelcross site against the attributes was undertaken by a two stage process:

1. British Nuclear Group staff, who attended the optioneering workshop, were provided with scoring spreadsheet templates and supporting briefing material on attributes and scoring criteria. A small number of staff completed spreadsheets. It was agreed that the mean of the individual scores should be used as a consensus measure due to the small sample size. The standard deviation between individual scores was also calculated to identify the attributes where there was significant spread in individual results.

2. A scoring workshop was held at which the consolidated scoring spreadsheets for each waste group were discussed in a ‘round-table’ forum made up of British Nuclear Group staff with a wide-range of specialist knowledge and practical experience with support from an independent environmental consultancy. Due to time constraints, discussions were focused on those attributes where there was a significant spread in individual scores (standard deviation > 2). The panel members are detailed in Appendix C.

3.7 Weighting schemes

A number of different weighting schemes were applied to the scores to test the sensitivity of the results and the conclusions given above. If the application of different weighting schemes does not change the conclusions, then those conclusions can be deemed to be robust.

Different weighting schemes were applied and these are shown in Table 3. These weightings were applied to the normalised (average) scores for each attribute group, so as to avoid biasing the results in favour of groups with a large number of sub-attributes. For example, if the unweighted score for an option in the 'Human health and safety' attribute group is 31, the chosen weighting factor is 10, and there are 7 sub-attributes in the group, then the normalised weighted score for the group is (31x10)/7 = 44.

Table 3 Adopted weighting schemes

Attribute group	'Preferred' Team Weighting	Technology position	Environmental position	Financial position
Human health and safety	10	10	10	1
Environmental impact	10	1	10	1
Environmental objectives	5	1	10	1
Technical	8	10	1	1
Socio-economic	1	1	1	1
Stakeholder	5	1	1	1
Financial cost	8	10	1	10

The 'Preferred Team Weighting' scheme was agreed in consultation with the British Nuclear Group project manager, and based on previous group weightings established for another Magnox Electric site.

The other weighting schemes reflect a number of possible 'positions' that could be held by interested parties. For example, the 'Environmental position' weighting scheme reflects a viewpoint that supports the minimisation of all environmental impacts with less concern for costs and technical restrictions.

4. INTERMEDIATE LEVEL RADIOACTIVE WASTE

4.1 The Waste

A range of intermediate level wastes are expected to arise from routine operations and care and maintenance preparations. These were identified by BNG staff and discussed at the optioneering workshop.

Some ILW streams are dispatched for storage in the Miscellaneous Beta Gamma Waste Store (MBGWS) at Sellafield as per the MBGWS Conditions for Acceptance (CfA) and the Chapelcross site discharge authorisation. Other ILW waste streams are stored on site and decommissioning of the reactor buildings is pending the establishment of a UK disposal route for ILW. These are summarised below in Table 4.

Table 4 Intermediate Level Waste Materials at Chapelcross

Waste material name	Current location	Total amount	Description
Operational Waste			
Miscellaneous Activated Components	Reactors and Ponds	1.5 m^3	Activated components including: stainless steel compacted liners, dry stored in stainless steel containers, shield plugs and coupling.
Miscellaneous Reactor Components	Reactors (90%) and Cooling ponds (10%)	38.6 m^3	Activated components include: reactor furniture (2-3 m^3); holding down weights, support struts, and thermocouples. Mainly steel but some magnox and Al cladding and graphite materials. Stored in skips (wet and dry storage).
Ion exchange resins	Fuel storage ponds	48.8 m^3	Spent AW500 zeolite ion exchange resins. 48 spent resin components in storage and up to another 12 in use.
Sludges	Cooling pond building	8 m^3	Sludges containing corrosion products from the ponds. Corrosion products from ponds. Around 2 m^3 is stored in skips; the remainder is in detention tanks.
CXPP ceramic pellets		9.7 m^3	Dry stored in 2020 bottles and stainless steel cans in temporary storage vessels.
Contaminated plant components	CXPP	3.6 m^3	Includes tritium contaminated steel plant (pipes, valves, etc) and graphite. Stored in disposable flask liners.
Rotary Pump Oil	CXPP	Max 0.5 m^3	Tritium contaminated oil. Stored in stainless steel cans

Waste material name	Current location	Total amount	Description
Operational Waste			
Fuel skips in ponds 1 & 2	Ponds 1 & 2	200 m^3	190 skips of mild steel with Cs surface contamination present in the paint.
Dessicant	Reactor building	0.4 m^3	800 kg Al in the form of pellets, heavily loaded with tritium in humidriers; activity to be verified.
Spent furnaces	CXPP	6 units (0.25 m^3)	Tritium and depleted uranium contamination. Composed of a steel outer case and uranium inner lining.
Care and Maintenance preparations waste			
CXPP Dismantling ILW		237.0 m^3	Post-operational clean out and plant cleanout wastes e.g. vacuum furnace, pipework. Materials include stainless steel, alloys, plastic, o-rings and stack pumps with tritium and activation product contamination. Rotary and diffusion pumps and motors may also fall into this category.

4.2 ILW waste grouping

Due to the number of types of ILW to be included in the study a scheme was developed to rationalise the waste types. The objective was to simplify the study by grouping types of wastes that are amenable to similar treatment techniques. The components of the complex location-specific waste streams above were identified from information provided by BNG staff and through discussion at the Optioneering workshop and with reference to the 2004 UK Radioactive Waste Inventory [Nirex and Defra, 2005].

Table 5 ILW Waste Groups

	Metal	Ceramics	Sludges	Resins	Aggregate	Magnox & Graphite	Dessicant	Oils & Oily wastes
Operational waste								
Miscellaneous Activated Components	✓							
Miscellaneous Reactor Components	✓					✓		
Ion exchange resins				✓				
Sludges			✓					
CXPP ceramic pellets		✓						
Contaminated plant components	✓							
Rotary Pump Oil								✓
Miscellaneous beta/gamma waste	✓							
Fuel skips in ponds 1 & 2	✓							
Pond skip decontamination sludges			✓					
Dessicant							✓	
Spent furnaces	✓							
Spent sources								
C&M Preps								
CXPP Dismantling ILW	✓				✓			
Pond Structures					✓			

4.3 The management options for ILW

A number of management options for ILW were identified during the initial optioneering workshop. These were:

- Deferred retrieval and treatment;
- Blend ILW with LLW to reclassify the ILW;

- Decontamination;
- Condition ILW and interim store (on site) pending long-term UK solution;
- Overseas disposal;
- Deep sea disposal;
- Treatment and discharge to borehole;
- Thermal treatment;
- Transfer to another site for treatment prior to disposal;
- Transfer to another site for disposal.

4.4 Screening the ILW Options

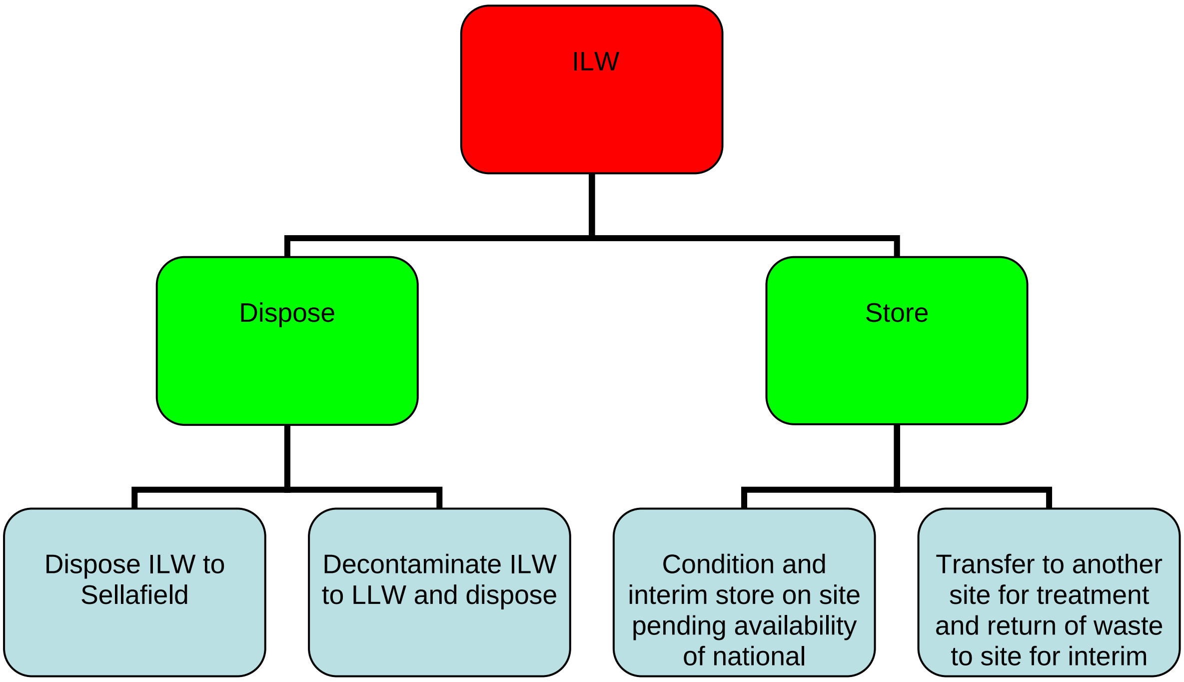
Using the screening criteria in Section 3.3, waste management options were examined and screened. Table 6 and the flowchart in Figure 1 shows the options and screening process and indicates the reasons for screening certain options out.

Table 6 Management Options identified for ILW

Option	Screened?
Deferred retrieval and treatment	Yes – perceived to be against NDA contract conditions by BNG staff.
Blend ILW with LLW to reclassify the ILW	Yes – against policy
Decontamination	No
Condition ILW and interim store pending long-term UK solution	No
Overseas disposal	Yes – against policy/Basel Convention (only possible when processes not available here)
Deep sea disposal	Yes – London Convention[4]
Treatment and discharge to borehole	Yes – likely to be against policy (e.g. Water Environment (Controlled Activities) (Scotland) (Amendment) Regulations 2007.
Thermal treatment	No
Transfer to another site for treatment prior to disposal	No
Transfer to another site (Sellafield) for disposal	No

[4] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 and 1996 Protocol thereto.

Figure 1 Options for dealing with ILW



4.5 The short-listed ILW management options

4.5.1 Disposal Options

- **Dispose ILW to Sellafield**

  Waste would be conditioned and packaged suitability then disposed of by transfer to Sellafield. This is a current practice, authorised under RSA 93 for certain wastes.

- **Decontaminate ILW to LLW and dispose to LLWR near Drigg**

  Decontamination of ILW using wet or dry techniques to remove contamination resulting in waste complying with LLW limits set out in the LLW Policy document [Defra et al, 2007] and meeting the Conditions for Acceptance (CfA) for the LLWR near Drigg.

4.5.2 Storage Options

- **Condition and interim store on site**

  Waste would be conditioned to passive safety and stored in an interim store on site pending availability of national repository. This would require the granting of a Letter of Compliance (LoC) and the building of an engineered interim store.

- **Transfer to another site for treatment and return of waste to site for interim storage**

  This option would involve transfer to another UK Nuclear Licensed Site where it would be conditioned to passive safety. The conditioned waste product would be returned to Chapelcross for interim storage. This would require the granting of a LoC and the building of an engineered interim store. This may be subject to authorisation under RSA 93 and regulations related to the transportation of radioactive waste.

4.6 Matching the Management Options to the ILW Waste Groups

The short-listed options and ILW types were examined and the matrix in Table 7 was developed to show the options which could be applied to each type of ILW.

Table 7 Possible Management Options for each type of ILW

	Decontaminate ILW to LLW	Condition and interim store on site pending availability of national repository	Transfer to another site	Dispose of ILW to Sellafield	No. of Options
Metal	✓	✓	✓	✓	4
Ceramics		✓	✓	✓	3
Sludges		✓		✓	2
Aggregate	✓	✓			2
Resins		✓	✓		2
Magnox and Graphite		✓	✓	✓	3
Dessicant		✓	✓	✓	3
Oily waste		✓	✓	✓	3

4.7 The Attributes and Scoring Scheme

The attributes and scoring scheme in Appendix B were used to score the options for each waste type. The results are outlined in the sections below.

4.8 The ILW scores

A summary of the unweighted and weighted scores for each waste group are presented below. The option giving rise to the highest unweighted score is identified for each group together with any key determining factors. The number of ideal (5) and unacceptable (0) scores are also identified as appropriate. The robustness of the choice of the highest scoring option is considered by identifying any differences that arise from the application of the various weighting schemes.

The detailed consolidated scores are included in Appendix D. Where there was discussion of scores during the scoring workshop, a note of the discussion is also included in the tables in this appendix.

4.8.1 Metal

Four management options were identified for metals. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 8 below.

Table 8 Scoring for ILW Metal Waste Treatment Options

	Decontaminate to LLW	Condition and interim store on site pending availability of national repository	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
Overall unweighted total	115	**122**	100	112
No. of 5s	0	1	0	0
No. of 0s	0	0	0	0
Overall team weighted total	148	**162**	133	150
Overall technology weighted total	105	**117**	95	107
Overall environmental weighted total	**113**	**112**	97	105
Overall financial weighted total	46	**54**	44	49

The option involving conditioning and interim storage receives the highest overall unweighted score, primarily due to its higher scoring under attributes within the technical and financial headings. Under the technical grouping, this option received a maximum score (5) for throughput. It also received the highest scores for attributes related to: scheduling variance to LTP; consistency with the end state and minimisation of project risk to the NDA. The high scores arise from the fact that this option is already included in current plans.

The option involving conditioning and interim storage continue to be the highest scoring option under all of the weighting schemes, although decontamination to LLW receives similarly high scores under the environmental weighting. This is the result of the greater relative weight given to environmental objectives under this weighting scheme – and the correspondingly greater weight applied to the higher scores for decontamination option for the following attributes: waste volume; hazard reduction and generation of greenhouse gases.

4.8.2 Ceramics

Three management options were identified for ceramics. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 9 below.

Table 9 Scoring for ILW Ceramics Waste Treatment Options

	Condition and interim store on site pending availability of national repository	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
Overall unweighted total	**114**	104	**114**
No. of 5s	0	0	0
No. of 0s	0	0	0
Overall team weighted total	**152**	134	**153**
Overall technology weighted total	**108**	101	**110**
Overall environmental weighted total	**110**	98	**106**
Overall financial weighted total	**46**	**47**	**50**

The following two options receive similar unweighted scores for this waste stream: conditioning and interim storage and disposal at Sellafield. There is little to distinguish the options from one another within the different attribute headings and both options score similarly under each of the various weighting schemes.

4.8.3 Sludges

This waste group includes Magnox contaminated sludge amd materials from pond skip decontamination. Two management options were identified. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 10 below.

The option involving conditioning and interim storage receives the highest overall unweighted score, although this is very similar to the overall scoring for the alternative option – disposal of ILW at Sellafield. The higher scores for the conditioning and interim storage option derive from attributes under the following headings: environmental objectives and technical. The particular attributes under the environmental objectives heading concerned are: hazard reduction, concentrate and contain and the proximity principle. This reflects the assumed effectiveness of the conditioning requirements to render the waste in a contained passive state and the fact that wastes are not moved off-site. The main distinguishing technical issues are the continued availability of the option and the likelihood of meeting conditions for acceptance for disposal at Sellafield.

Table 10 Scoring for ILW Sludge Waste Treatment Options

	Condition and interim store on site pending availability of national repository	Dispose of ILW at Sellafield
Overall unweighted total	**118**	114
No. of 5s	0	0
No. of 0s	0	0
Overall team weighted total	**155**	149
Overall technology weighted total	**112**	108
Overall environmental weighted total	**108**	**109**
Overall financial weighted total	**51**	**49**

The option involving conditioning and interim storage is the highest scoring option under all weighting schemes, although the alternative option – disposal at Sellafield – scores similarly under environmental and financial weighting schemes. The environmental weighting result is due to the fact that disposal at Sellafield receives higher scores for environmental impact (for air, water and land quality and for visual impact) and these attributes are given a relatively greater weight under the environmental weighting scheme. The financial scoring result is a consequence of the fact that the options score similarly under the financial heading and that under this weighting scheme, these attributes are given significantly greater weight than other attributes for which the options score differently.

4.8.4 Resins

Two management options were identified for resins. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 11 below.

The option involving conditioning and interim storage received the higher overall unweighted total score. The main distinguishing groups of attributes were the human health and safety and technical issues. The alternative option – which involves transfer of waste off-site for treatment and return of conditioned waste – receives lower scores under the human health and safety heading due to the potential for public doses and non-radiation risks associated with moving waste materials on and off-site. The lower scores for the off-site transfer option under the technical heading arise from the attributes related to: continued availability and throughput of the option, and minimisation of risk to NDA. This is a reflection of this option's dependence on a third party.

Table 11 Scoring for ILW Resin Waste Treatment Options

	Condition and interim store on site pending availability of national repository	Transfer to another site for processing and return to Chapelcross
Overall unweighted total	**123**	107
No. of 5s	0	0
No. of 0s	0	0
Overall team weighted total	**166**	141
Overall technology weighted total	**122**	101
Overall environmental weighted total	**115**	102
Overall financial weighted total	**57**	48

The option involving conditioning and storage remains the highest scoring option under each of the weighting schemes

4.8.5 Aggregate

Two management options were identified for aggregate. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 12 below.

Table 12 Scoring for ILW Aggregate Waste Options

	Decontaminate to LLW	Condition and interim store on site pending availability of national repository
Overall unweighted total	109	**116**
No. of 5s	0	0
No. of 0s	0	0
Overall team weighted total	141	**155**
Overall technology weighted total	101	**111**
Overall environmental weighted total	103	**110**
Overall financial weighted total	45	**50**

The option involving conditioning and interim storage received the higher unweighted score. This is primarily the result of the higher scores under the human health and safety heading, and the attributes related to public doses and risks in particular due to the higher radiation doses expected to arise from the alternative option of decontamination. The option involving conditioning and interim storage continues to receive the higher scores under each of the various weighting schemes.

4.8.6 Magnox and Graphite

Magnox and graphite were considered as a combined waste group because these materials were considered to be amenable to similar treatment methods. Three management options were identified for Magnox and graphite. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 13 below.

Table 13 Scoring for ILW Magnox and Graphite Waste Treatment Options

	Condition and interim store on site pending availability of national repository	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
Overall unweighted total	**115**	102	**114**
No. of 5s	0	0	1
No. of 0s	0	0	0
Overall team weighted total	**153**	133	**154**
Overall technology weighted total	109	94	**114**
Overall environmental weighted total	**110**	97	101
Overall financial weighted total	**50**	39	**50**

The options involving conditioning and interim storage and the option involving disposal of ILW at Sellafield received similarly high overall unweighted scores. Conditioning and interim storage received higher scores under the environmental objectives heading, due to its relative scores for attributes related to hazard reduction, greenhouse gas emissions and the proximity principle. The disposal at Sellafield option received higher scores under the technical heading, for a range of attributes. This included a maximum score (5) – for the maturity of technology attribute – due to the fact that this disposal route is already in existence.

These options also score similarly under the team and financial weighting schemes. Disposal at Sellafield is the highest scoring option under the technology weighting, while the option involving conditioning and interim storage is higher scoring under the environmental weighting scheme. This variation is the result of the higher weighting applied to environmental objectives under the environmental weighting – and consequently higher weighted scores for conditioning and interim storage, and the higher weighing given to the technology heading under the technology weighting – and the correspondingly higher weighted score assigned the existing disposal route to Sellafield.

4.8.7 Dessicant

Three management options were identified for Dessicant. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 14 below.

Table 14 Scoring for ILW Dessicant Waste Treatment Options

	Condition and interim store on site pending availability of national repository	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
Overall unweighted total	**121**	103	107
No. of 5s	0	0	0
No. of 0s	0	0	0
Overall team weighted total	**163**	131	143
Overall technology weighted total	**123**	99	109
Overall environmental weighted total	**111**	97	98
Overall financial weighted total	**57**	43	51

The option involving conditioning and interim storage received the highest overall unweighted score. This option is also the highest scoring option for each of the attribute headings. It is also the highest scoring option under each of the weighting schemes.

4.8.8 Oils and Oily Wastes

Three management options were identified for Oils and Oily wastes. Detailed raw and weighted scores are contained in Appendix D. A summary of the scores is given in Table 15 below. The option involving conditioning and interim storage received the highest overall unweighted score. This option is the highest scoring option under each of the attribute headings, but the greatest differences arise from the human health and safety and environmental impact headings. Under the health and safety heading, this option was considered likely to give rise to lower radiation doses and non-radioactive risks to members of the public than other options, while under the environmental impact heading, it was considered likely to have lower off-site environmental impacts due to the lower levels of off-site transport (reflected in scores for air and water quality, nuisance and transport). This option also scores a single maximum score – for proximity principle – due to the on-site nature of the processes.

Table 15 Scoring for ILW Oily Waste Treatment Options

	Condition and interim store on site pending availability of national repository	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
Overall unweighted total	**119**	101	94
No. of 5s	1	0	0
No. of 0s	0	0	1
Overall team weighted total	**158**	130	125
Overall technology weighted total	**111**	91	88
Overall environmental weighted total	**115**	97	91
Overall financial weighted total	**50**	41	43

Disposal at Sellafield was initially considered to be an option but, during scoring, it was considered to be unacceptable (and a zero score was assigned for attribute related to the likelihood of meeting CfA) because liquid wastes are excluded under the CfA for Sellafield.

The option involving conditioning and interim storage is also the highest scoring option under each of the weighting schemes.

4.9 The highest unweighted scoring options for ILW

A summary of the highest unweighted scores for ILW is shown in Table 16.

Table 16 The highest unweighted scoring options for ILW

ILW group	Highest scoring option
Metals	Conditioning and interim storage
Ceramics	Conditioning and interim storage or Disposal at Sellafield
Sludges	Conditioning and interim storage
Resins	Conditioning and interim storage
Aggregate	Conditioning and interim storage
Magnox and graphite	Conditioning and interim storage or Disposal at Sellafield
Desiccants	Conditioning and interim storage
Oils and oily wastes	Conditioning and interim storage

It is important to consider this summary information in context; in some cases a relatively small number of options was considered and the differences between the scores may not be significant.

5. LOW LEVEL RADIOACTIVE WASTE

5.1 The Waste

LLW arises as primary and secondary wastes from ongoing operations. Significantly increased volumes of LLW will be generated during care and maintenance preparations, principally due to building materials, but this waste stream will also include a range of other materials.

LLW is sorted, assayed and size reduced as appropriate prior to being packaged in drums or placed directly into ISO containers, for disposal to the National LLW repository near Drigg. The National LLW repository near Drigg stipulates precise acceptance criteria, and certain wastes require pre-treatment or conditioning to meet these.

The following types of LLW were identified at Chapelcross from information provided by BNG staff and from discussions at the optioneering workshop.

Table 17 Summary of LLW types

Waste material name	Current location	Total amount	Description
Operational waste			
CXPP tritiated waste	CXPP	4 m^3 per year. Around 20 m^3 in total	Mainly soft waste (clothes, gloves, tissues etc). Stored in alkathene containers in 205 l drums (waste and containers combustible). Not suitable for super compaction (due to potential for H-3 release).
Reactor and associated areas LLW	In reactors and CXPP	Current arisings 74 m^3 per year during normal operations. Expected to increase to 120 m^3 per year and to peak at 300 m^3/y during defuelling.	Soft waste (PPE and fabric) Stored in 205 l drums (as above).
Cooling ponds LLW		Current average 6.4 m^3 per year. Peak during decommissioning.	Soft waste arising from flask cleaning (wipes etc.) primary contaminant Cs. The peak expected during repackaging of waste from ponds. Stored in 205 litre drums.
Large Items from Reactor Areas		892.0 m^3 (Total)	Comprises steel plant and equipment (primarily various grades of steel and some lead) including: contaminated charge baskets; redundant flasks (PRDO); grabs, BCGDs (cast steel). Not expected to be activated or contaminated with PCBs. Wrapped and stored in

Waste material name	Current location	Total amount	Description
			HHISO.
Large items from Cooling Ponds		15.6 m^3 per year (current operational arisings – increase during C&M preps)	Comprises grabs, pumps, lights, scaffold boards. Wrapped and loose stored in HHISO.
UO_3 contaminated LLW	Building 141	16.0 m^3 (total value)	Soft waste and plywood boards Stored in 205 l drums
Oils	Hanger 39 (following dismantling of Tank Farm)	100,000 litres	Comprises a mix of liquid organic waste stored in plastic double lined tanks. Approx. 50,000 l of this amount exempt under SoLA. Remainder (approaching 40,000 l) will be stored on site pending authorisation. Trace beta contamination (H-3 and C-14 activities below 0.4 Bq/g). An additional 50,000 l oily waste in blowers, which may be categorised as LLW.
Other liquid organic wastes		400 MBq H-3 200 kBq C-14 and S-35	Scintillant
Hydraulic fluids	B151 (CXPP)	560 litres	Stored in 55 plastic bottles mixed with vermiculite within stainless steel drums. Unsuitable for further treatment.
Liquid effluent discharges from Ponds		Total volume of around 5.5 million litres from ponds	Liquid effluent arising from from ponds (and additional quantities from groundwater).
Liquid effluent discharges from CXPP		Around 3,800 litres discharged 2-3 times per year	Liquid effluent arising from from CXPP.
Groundwater ingress into reactor basements		Around 1,300,000 gallons annual average (subject to seasonal variations).	Groundwater tritiated to around 0.2-0.4 Bq/ml. Removed by pump and discharged through existing discharge pipeline.
Aerial effluents	Processing plant (little from reactors)	200 TBq per year (Current authorised limit 5000 TBq/y)	Aerial discharge primarily H-3 from CXPP. Some C-14 also discharged from reactors and expected to continue during C & M Preps.
<u>C&M preps waste</u>			
Reactor LLW		4370 m^3	Comprises large plant components, including: defuelling machines; turbo

Waste material name	Current location	Total amount	Description
			generators; heat exchanger pipework; blowers; building fabric; iron ductwork; transformers; generators; large lead acid batteries; MMMF; switch gear scaffolding poles. Materials include cast steel (not much stainless steel); cement-bound asbestos; brickwork and reinforced concrete with surface contamination. Metals may be decontaminated but decontamination of other materials would be difficult. Not suitable for super compaction
Ponds LLW		2330.0 m^3	Comprises full pond structure including the walls (assuming to be contaminated to depth); redundant flasks; furniture and concrete. Not suitable for super compaction
Redundant Active effluent pipeline concrete LLW		1335.0 m^3	Cast concrete. Not suitable for super compaction. Management options for this pipeline are still under discussion – removal not certain.
Replacement active effluent pipeline steel LLW		1,658 tonnes	Spun Steel; Surface contaminated with Cs and Sr. Not suitable for super compaction
North site LLW	Currently in temporary storage building – expected to be removed before C&M Preps	270.0 m^3	Not suitable for super compaction. This amount does not include cooling towers (due for demolition in April 2007 and considered to be uncontaminated).
CXPP dismantling LLW (of the process line)		325.0 m^3	This category relates to the containment of the process line (not including building structure). It comprises tritiated equipment (pumps, valves etc) of largely metal construction. Not suitable for super compaction

5.2 LLW waste grouping

Due to the number of types of LLW to be included in the study, a scheme was developed to rationalise the waste types. The objective was to simplify the study by grouping types of wastes that are amenable to similar treatment techniques.

Table 18 LLW Waste Groups

	Metal	Asbestos	Aggregate & Soil	Cellulosic	Plastic & Rubber	Water	Organic Liquids[5]
CXPP tritiated waste				✓	✓		
Reactor and associated areas LLW		✓		✓	✓		
Cooling ponds LLW			✓	✓	✓		
Large Items from Reactor Areas	✓			✓	✓		
Large items from Cooling Ponds	✓			✓	✓		
UO3 contaminated LLW				✓	✓		
Oils (lubricating and hydraulic)							✓
Other liquid organic wastes							
Hydraulic fluids							
Liquid effluent discharges (Pond)						✓	
Liquid effluent discharges (CXPP)						✓	
Groundwater ingress into reactor basements						✓	
Reactor LLW	✓						
Ponds LLW	✓		✓				
Active effluent pipeline concrete LLW			✓				
Active effluent pipeline steel LLW	✓						
North Site LLW	✓		✓				
CXPP dismantling LLW	✓		✓				
General reactor LLW					✓		

5 Subject to a separate BPEO Study (as indicated in the following section)

5.3 The management options for LLW

A number of management options for LLW were identified:

- Deferred retrieval and treatment
- Decontamination to achieve SoLA exemption
- Incineration
- Disposal to hazardous landfill
- On-site landscaping
- On-site disposal
- Disposal to national VLLW repository
- Disposal to national LLW facility
- Overseas disposal
- Deep sea disposal
- Treatment and discharge to sea
- Treatment and discharge to borehole
- Melting and high temperature treatment
- Decay storage
- Conditional recycling
- Transfer to another site for treatment prior to disposal.

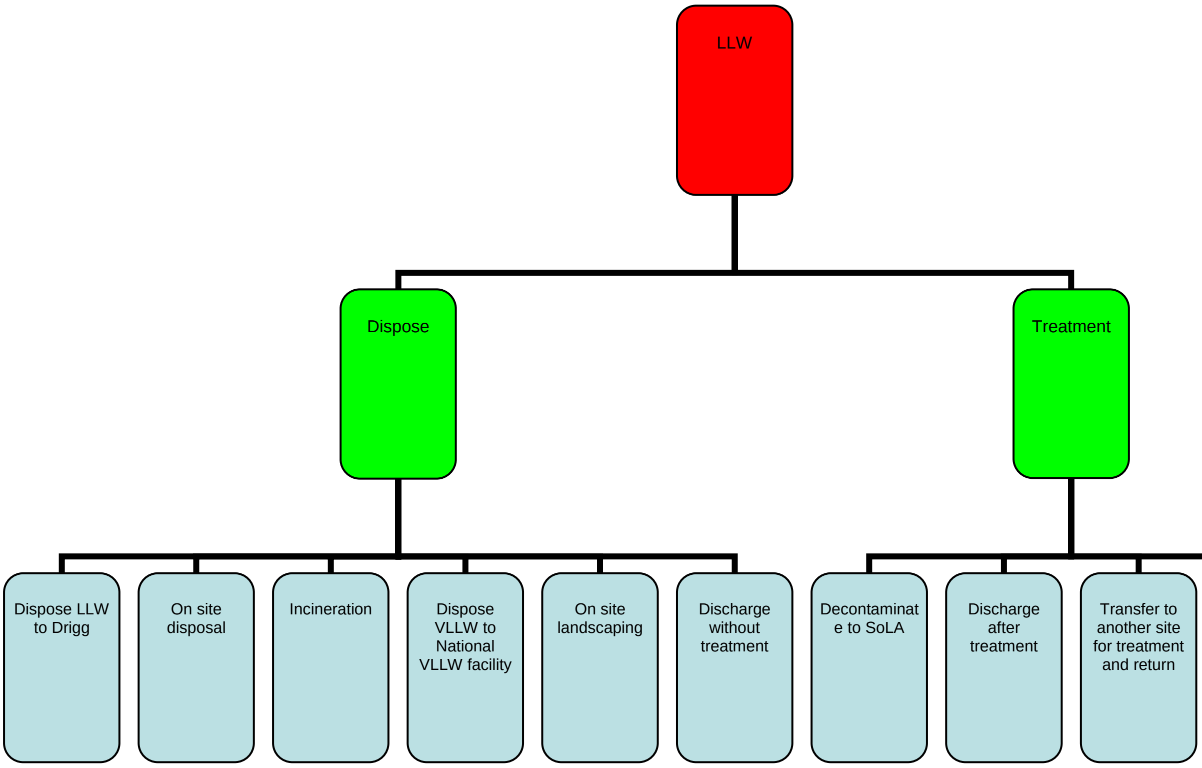
5.4 Screening the LLW options

Using the screening criteria in Section 3.3, waste management options were examined and screened. Table 19 and the flowchart in Figure 2 show the options and screening process.

Table 19 Identified Management Options for Low Level Radioactive Waste

Option	Screened?
Deferred retrieval and treatment	Yes – perceived to be against NDA contract conditions by BNG staff.
Decontaminate to SoLA	No
Incineration	No
Dispose to hazardous landfill (special precautions burial)	No
On-site landscaping	No
On-site disposal in purpose built facility	No
Dispose of vLLW separately	No
Dispose of LLW to national LLWR near Drigg	No
Overseas disposal	Yes – against policy/Basel Convention (only possible when processes not available here)
Deep sea disposal	Yes – London Convention
Treatment and discharge to sea	No
Treatment and discharge to borehole	Yes – likely to be against policy (e.g. Water Environment (Controlled Activities) (Scotland) (Amendment) Regulations 2007.
Thermal treatment	No
Decay storage to SoLA	Yes
Recycle	Yes - recycling of LLW limited to particular waste forms, although there may be opportunities for industry-wide initiatives to increase re-use and recycling of some forms of LLW.
Transfer to another site for treatment prior to disposal	No

Figure 2 Categories of LLW Treatment Options



5.5 The short-listed LLW options

5.5.1 Disposal

- **Disposal to the national LLWR**

  Disposal at Drigg is an established route for LLW which falls within the specification set out in the Conditions for Acceptance. Wastes which fall outside the specification set out in the conditions for acceptance may under certain circumstances be disposed under special arrangements. Drigg has limits on the radionuclides and activity it is able to accept set out in the authorisation granted under RSA93. Generally, waste of a conventional hazardous nature such as putrescible, pyrophoric and explosive are not accepted and in general waste has to be immobilised to prevent migration of radionuclides from the containers into the facility and beyond.

- **Dispose on site**

  This would require the building of a new disposal facility. Waste may need further conditioning or treatment to passive safety whilst the facility becomes available. It is foreseen that this option would require the construction of a new store on the site because existing buildings on the Chapelcross site are not suitable or are planned to be demolished as part of the planned site restoration programme.

- **Incineration**

  Solid radioactive waste that is combustible or is not suitable for disposal to landfill because of its hazardous properties may be authorised for disposal by incineration at an authorised incinerator. Incineration often results in a large volume reduction and the release of volatile radionuclides from the waste. It is normal for the resultant ash to be disposed of as a solid waste. In this study, the incinerator is assumed to be off-site at a location more distant than the national LLWR.

- **Dispose VLLW to a National VLLW facility**

- There is a significant amount of waste from decommissioning that contains low levels of radionuclides at the bottom end of the levels currently considered to be LLW and often referred to as VLLW. An updated waste management policy for the long-term management of LLW within the UK has recently been published [Defra *et al*., 2007] which does not preclude controlled burial of VLLW from nuclear sites and which identifies two categories of VLLW: Low Volume VLLW, for which 'dustbin disposal' to an unspecified landfill may be appropriate; and high volume VLLW which may be disposed of to specified landfill sites.

- **On-site landscaping**

  This is envisaged to be the use of inert construction and demolition material predominately for the infill of turbine hall basements or other landscaping applications.

- **Discharge without treatment**

  This is only considered to be an option for aqueous liquid wastes such as cooling pond water and water arising from groundwater control practices.

5.5.2 Treatment

- **Decontaminate to SoLA**

  The removal of contamination could allow material to be exempted from RSA93 by meeting the conditions of SoLA. Such decontamination may be possible using simple techniques such as wiping or washing or more aggressive techniques such as high-pressure jet washing.

- **Discharge after treatment**

  This is envisaged to include the discharge of liquid waste following treatment. This would require the construction of a purpose-built facility on-site.

- **Transfer to another site for treatment and return**

  This is an interim option which would result in the waste product returning to Chapelcross for inclusion in another final disposal option.

- **Thermal treatment**

This option in envisaged for waste contaminated only with tritium. The waste would be heated to volatilise the tritium which would be disposed as an aerial discharge. The aim would be that the heated waste would be below SoLA levels.

5.6 Matching the management options to the LLW waste groups

The short-listed options and LLW types were examined and the matrix in Table 20 was developed to show the options which could be applied to each type of LLW.

Table 20 Summary of Management Options Relevant to Decommissioning LLW

	Decontaminate to SoLA	Incineration	On-site landscaping	On-site disposal (facility)	Dispose of vLLW separately	LLW to national LLWR near Drigg	Treatment and discharge	Discharge	Thermal treatment	Transfer to another site	No. of Options
Metal	✓			✓	✓	✓			✓	✓	6
Asbestos						✓			✓		2
Aggregate	✓		✓	✓	✓	✓					5
Cellulosic		✓		✓	✓	✓					4
Plastic & Rubber	✓	✓		✓	✓	✓					5
Soil			✓	✓	✓	✓					4
Water							✓	✓			2
Organic Liquids	Subject of a previous separate BPEO study, as discussed in Section 5.8.7										
Air	Aerial effluents would be the result of the other waste treatment processes and their consideration in isolation would involve double counting.										

5.7 The attributes and scoring scheme

The attributes and scoring schemes applied are outlined in Appendix B in Tables B1 and B2 respectively.

5.8 The LLW scores

5.8.1 Metal

Six management options were identified for Metal. Detailed raw and weighted scores are contained in Appendix E. A summary of the scores is given in Table 21 below.

Table 21 Scoring for LLW Metal Waste Treatment options

	Decontaminate to SoLA	On-site disposal in a purpose built facility	Dispose of vLLW separately in a national facility	Dispose to national LLWR near Drigg	Thermal treatment	Transfer to another site for processing and return to Chapelcross
Overall unweighted total	**138**	123	111	129	114	118
No. of 5s	4	5	0	1	0	0
No. of 0s	0	0	0	0	0	0
Overall team weighted total	**181**	155	148	171	148	154
Overall technology weighted total	**128**	113	108	121	108	111
Overall environmental weighted total	**134**	122	107	120	111	114
Overall financial weighted total	**56**	46	48	50	49	49

Decontamination to SoLA received the highest unweighted score. This option received the highest overall score for each of the attribute headings, although it received one fewer maximum scores than the on-site disposal option. The attributes for which SoLA decontamination option scored the maximum were: public and worker non-radiation accident risks, the proximity principle; and consistency with site end state. This option scored most favourably under the environmental objectives and technical attributes. This is a result of the fact that decontamination acts to reduce the volume of waste for disposal and the level of off-site transport. In addition, it is based on proven processes with sufficient capacity to deal with waste arisings, due to its direct dependence on workforce availability.

The decontamination option was also the highest scoring option under each of the weighting schemes.

5.8.2 Asbestos

Two management options were identified for asbestos. Detailed raw and weighted scores are contained in Appendix E. A summary of the scores is given in Table 22 below.

Table 22 Scoring for LLW Asbestos Waste Treatment Options

	Dispose to National LLWR near Drigg	Thermal treatment followed bys disposal to non-hazardous landfill
Overall unweighted total	**114**	**111**
No. of 5s	0	0
No. of 0s	0	0
Overall team weighted total	**156**	139
Overall technology weighted total	**116**	104
Overall environmental weighted total	**106**	**108**
Overall financial weighted total	**53**	41

Both options – disposal at the national LLWR and thermal treatment and disposal of the product at a hazardous landfill – received very similar unweighted scores. The thermal treatment option received higher relative scores for attributes related to environmental objectives but lower scores for the financial attributes. The environmental objectives of particular note are waste volume, hazard reduction and the proximity principle. The financial scoring is a reflection of the fact that thermal treatment would be significantly more expensive than disposal at the LLWR, and would also require accelerated expenditure compared to the LTP.

Disposal at the LLWR was the higher scoring option under the team, technology and financial weighting schemes. The team weighted scores are a combined result of the greater weight given to technical, regulatory and financial issues, as compared to the unweighted scores. The relatively unproven nature of the high temperature process results in relatively low scores under the technical heading (for attributes for maturity of technology and scheduling variance to LTP). The possibility of such uncertainties influencing regulatory acceptance is also reflected in the regulatory issues attribute. The greater weighting applied to financial endpoints places a greater weight on the higher cost of the thermal treatment – giving it a lower overall score.

5.8.3 Aggregate

Five management options were identified for aggregate. Detailed raw and weighted scores are contained in Appendix E. A summary of the scores is given in Table 23 below.

Table 23 Scoring for LLW Aggregate Waste Treatment Options

	Decontaminate to SoLA	On-site landscaping	On-site disposal in a purpose built facility	Dispose of vLLW separately to a national facility	Dispose to National LLWR near Drigg
Overall unweighted total	116	119	**126**	112	110
No. of 5s	0	3	4	1	1
No. of 0s	0	1	0	0	0
Overall team weighted total	157	148	**161**	153	150
Overall technology weighted total	115	109	**117**	114	110
Overall environmental weighted total	112	121	**124**	102	104
Overall financial weighted total	**53**	51	**52**	49	46

The option that received the highest overall unweighted score was on-site disposal in a purpose-built facility. This option also received the the highest number of maximum scores (5s). These scores relate to the following attributes: routine doses to members of the public; concentrate and contain; the proximity principle and the continued availability of the option. These scores reflect the fact that: the containment assumed to be a design feature of an on-site facility would lead to low public doses; the on-site location would not require transportation of waste off-site: and the location would also allow the site relatively complete control over this disposal route.

The use of LLW aggregate as an on-site landscaping material received the second highest score. However, this option was considered to be unacceptable on the basis that it would be inconsistent with the currently assumed Greenfield site endstate –receiving a zero score for the attribute relating to consistency with end state.

Oon-site disposal in a purpose-built facility was also the highest scoring option under the various weighting schemes, although under the financial weighting scheme the decontamination to SoLA levels received a similar scoring – reflecting the financial outlay required for construction of an on-site facility.

5.8.4 Cellulosic

Four management options were identified for cellulosic wastes. Detailed raw and weighted scores are contained in Appendix E. A summary of the scores is given in Table 24 below.

Table 24 Scoring for LLW Cellulosic Waste Treatment Options

	Incineration	On-site disposal in a purpose built facility	Dispose of vLLW separately to a national facility	Dispose to National LLWR near Drigg
Overall unweighted total	109	**118**	103	112
No. of 5s	0	2	0	2
No. of 0s	0	0	0	0
Overall team weighted total	145	**150**	136	**152**
Overall technology weighted total	**106**	**107**	101	**106**
Overall environmental weighted total	100	**118**	94	105
Overall financial weighted total	**49**	45	**47**	**47**

The option receiving the highest overall unweighted score was on-site disposal in a purpose built facility. This scoring was the primarily the result of high scores under the headings related to human health and safety and environmental impacts. The maximum scores received (for transport and proximity principle) for on-site disposal both relate to the on-site location of the site and consequent reduction in transportation of waste materials.

The on-site disposal option also received one of the highest scores under the various weighting schemes with the exception of the overall financial weighting schemes where all other options scored better – this is a reflection of the significant financial outlay required to build an on-site facility. Under the team weighting scheme, the disposal to the national LLWR received a similar overall score to the on-site disposal option. This is primarily due to the relatively greater weighting given to regulatory issues in the team weighting. Disposal at the LLWR is an established authorised process while the on-site facility would require mew regulatory consents for construction and operation to be established. The option related to disposal at the LLWR also receives one of the highest scores under the technology weighting; the relative scores under this category reflect the fact that the on-site facility is not currently available and that it would imply a continuing on-site liability to the NDA.

5.8.5 Plastic and Rubber

Five management options were identified for plastic and rubber. Detailed raw and weighted scores are contained in Appendix E. A summary of the scores is given in Table 25 below.

Table 25 Scoring for LLW Plastic and Rubber Waste Treatment Options

	Decontaminate to SoLA	Incineration	On-site disposal in a purpose built facility	Dispose of vLLW to a national facility	Dispose to national LLWR near Drigg
Overall unweighted total	**122**	107	110	102	108
No. of 5s	3	1	3	0	0
No. of 0s	0	0	0	0	0
Overall team weighted total	**158**	135	139	137	144
Overall technology weighted total	**113**	103	101	97	107
Overall environmental weighted total	**118**	98	108	100	97
Overall financial weighted total	**53**	47	44	47	46

The option receiving the highest overall unweighted score was decontamination to SoLA. This option received the highest scores under each of the following headings: human health and safety, environmental impact and objectives and financial costs. This option received 3 maximum scores for: nuisance, waste hierarchy and hazard reduction – this scoring reflects the fact that the decontamination option does not involve significant noise or dust or off-site transport and that it acts to remove the hazard into another waste stream, thus allowing materials to be reused.

The decontamination to SoLA option remains the highest scoring option under each of the weighting schemes.

5.8.6 Water

Two management options were identified for water or liquid aqueous wastes. Detailed raw and weighted scores are contained in Appendix E. A summary of the scores is given in Table 26 below.

The option receiving the highest overall unweighted score is discharge without additional treatment. This option also received the greater number of maximum scores.

The greatest difference in scores between the two options arises under the technical heading, as a result of the higher scores assigned to discharge without treatment for the following technical attributes: availability of the option; scheduling variance and discharge of NDA liabilities. This is a result of the time-element implicit in the scoring criteria for these attributes and the fact that the option to discharge following treatment would necessitate the construction and operation of a new liquid effluent treatment plant and consequently scores relatively poorly.

Table 26 Scoring for Contaminated Water Waste Options

	Treatment and discharge	Discharge without treatment
Overall unweighted total	124	**132**
No. of 5s	6	9
No. of 0s	0	0
Overall team weighted total	172	**187**
Overall technology weighted total	122	**141**
Overall environmental weighted total	**124**	**124**
Overall financial weighted total	46	**53**

The option without treatment receives higher scores for all groups of attributes except those under the environmental objectives heading, where the option that includes treatment receives higher scores for attributes related to hazard reduction and the concentrate and contain principles. The scores for environmental impacts are similar for the two options.

Discharge without treatment remains the higher option under each of the weighting schemes, although under environmental weighting the two options are receive similar scores.

5.8.7 Organic Liquids

This was the subject of a separate BPEO study, undertaken by NNC in 2005 [NNC, 2005]. The best performing options identified were as follows:

- Off-site incineration;
- On-site incineration.

5.9 The highest unweighted scoring options for LLW

A summary of the highest unweighted scores for LLW is shown in Table 27.

Table 27 The highest unweighted scoring options for LLW

LLW group	Highest scoring option
Metal	Decontaminate to SoLA levels
Asbestos	Disposal at the national LLWR near Drigg
Aggregate	On-site disposal in a purpose-built facility
Cellulosic	On-site disposal in a purpose built facility
Plastic and rubber	Decontaminate to SoLA levels
Contaminated waste water	Discharge without treatment
Organic liquids	Off-site disposal by incineration (from previous specific BPEO study).

It is important to consider this summary information in context; in some cases a relatively small number of options was considered and the differences between the scores may not be significant.

6. SUMMARY

This report records the methodology and results of a study carried out to support the identification of appropriate management options for wastes arising during the 'care and maintenance' phase of decommissioning activities at Chapelcross Power Station.

Two main waste categories were considered

- Intermediate level radioactive waste.
- Low level radioactive waste;

The study applied a Best Practicable Environmental Option (BPEO) methodology to evaluate management options. The approach was designed to make use of currently readily available information, including the technical expertise and site knowledge of BNG staff, within the relatively limited time available for this work. This report presents the results of the study. The approach taken is consistent with the environment agencies guidance on the application of BPEO to radioactive waste management issues.

A number of treatment options were identified for specific types of waste in each waste category.

The treatment options were screened for compliance with UK law and international conventions where clearly defined and consistency with UK policy where clearly defined. The remaining options were then scored against a series of attributes in the following groups:

- Health and safety
- Environmental impacts
- Environmental objectives
- Technical performance
- Socio-economic
- Financial cost

Scoring of the options against the attributes was undertaken by a two stage process that involved: (1) individual scoring by British Nuclear Group staff and collation and consolidation of individual scores to produce group scores, followed by (2) collective discussion at an internal 'round-table' forum of staff, with relevant technical expertise and site knowledge. These processes were facilitated by independent consultants.

The unweighted scores were then weighted on the basis of four different schemes to test the robustness of the outcomes. The four different weighting schemes were devised to test the outcome if an emphasis was put on such factors as costs and the environment. The highest scoring options for each waste group are as provided in the following table.

Table 28 Highest Scoring Options

Waste category	Waste group	Highest scoring option
ILW	Metals	Conditioning and interim storage
	Ceramics	Conditioning and interim storage or Disposal at Sellafield
	Sludges	Conditioning and interim storage
	Resins	Conditioning and interim storage
	Aggregate	Conditioning and interim storage
	Magnox and graphite	Conditioning and interim storage or Disposal at Sellafield
	Desiccants	Conditioning and interim storage
	Oils and oily wastes	Conditioning and interim storage
LLW	Metal	Decontaminate to SoLA levels
	Asbestos	Disposal at the national LLWR near Drigg
	Aggregate	On-site disposal in a purpose-built facility
	Cellulosic	On-site disposal in a purpose built facility
	Plastic and rubber	Decontaminate to SoLA levels
	Contaminated waste water	Discharge without treatment
	Organic liquids	Off-site disposal by incineration (from previous specific BPEO study).

It is important to consider this summary information in context; in some cases a relatively small number of options was considered and the differences between the scores may not be significant.

7. REFERENCES

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APPENDICES

APPENDIX A. OPTIONEERING WORKSHOPS ATTENDEES

Name	Organisation
Walter Kennedy	British Nuclear Group Chapelcross
Philip Jones	British Nuclear Group Chapelcross
Bob Millard	British Nuclear Group Chapelcross
John MacInnes	British Nuclear Group Chapelcross
Anne Marie Gemmell	British Nuclear Group Chapelcross

The workshop was facilitated by Enviros Consulting Ltd.

APPENDIX B. MASTER LIST OF ATTRIBUTES AND SCORING SCHEME

Table B1. Master list of Attributes

Attribute group and attribute	Sub-attribute
Human health and safety:	
1. Public health and safety (individuals)	1.1 Routine radiation doses 1.2 Radiological accident risks 1.3 Non-radioactive hazards and risks
2. Public health and safety (societal collective dose)	2.1 Routine radiation doses
3. Worker health and safety (individuals)	3.1 Routine radiation doses 3.2 Radiological accident risks 3.3 Non-radioactive hazards and risks
Environmental impact:	
4. Physical environment	4.1 Air quality 4.2 Water quality of receiving body 4.3 Land quality 4.4 Visual impact 4.5 Nuisances (noise, light, dust, etc) 4.6 Use of natural resources 4.7 Transport
5. Flora and fauna	5.1 Preservation of ecosystems
Environmental objectives:	
6. Environmental objectives	6.1 Waste volumes 6.2 Waste hierarchy 6.3 Hazard reduction 6.4 Concentrate and contain 6.5 Generation of secondary wastes 6.6 Greenhouse gas emissions 6.7 Proximity principle
Technical:	
7. Viability	7.1 Maturity of technology 7.2 Continued availability of option 7.3 Throughput/capacity of option
8. Nuclear safety	8.1 Likelihood of meeting CfA
9. Flexibility	9.1 Foreclosing of options
10. Programme	10.1 Scheduling variance compared to LTP 10.2 Minimising project risk to NDA 10.3 Discharge of NDA liabilities 10.4 Consistency with site end state
Socio-economic:	

Attribute group and attribute	Sub-attribute
11. Local community	11.1 Economic impacts 11.2 Culture and heritage
Regulatory issues:	
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance
Financial cost:	
13. Overall cost	13.1 Total undiscounted cost 13.2 Rate of spend compared to LTP 13.3 Stability of cost estimates

Table B2. Scoring Scheme

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
Human health and safety		
1. Public health and safety (individuals)		
1.1 Routine radiation doses	Difficult to demonstrate doses <1 mSv y^{-1} (Basic Safety Limit – BSL)	Easy to demonstrate doses <10 μSvyr^{-1} ('below regulatory concern')
1.2 Radiological accident consequences	Unacceptably high consequence	Low consequence
1.3 Non-radioactive hazards and risks	Difficult to demonstrate risk <10^{-4} yr^{-1}	Easy to demonstrate risk <10^{-6} yr^{-1} ('below regulatory concern')
2. Public health and safety (societal collective dose)		
2.1 Routine radiation doses	Difficult to demonstrate doses <100 person Sv	Easy to demonstrate doses <1 person Sv
3. Worker health and safety (individuals)		
3.1 Routine radiation doses	Difficult to demonstrate doses <20 mSv y^{-1} (Basic Safety Limit – BSL)	Easy to demonstrate doses <2 mSv y^{-1} (Basic Safety Objective – BSO)
3.2 Radiological accident consequences	Unacceptably high consequence	Low consequence
3.3 Non-radioactive hazards and risks	Difficult to demonstrate risk <10^{-3} yr^{-1} (largest tolerated risk where activity is crucial for society and economy)	Easy to demonstrate risk <10^{-5} yr^{-} (consistent with typical 'safe' practice in non nuclear industry)
Environmental Impact		
4. Physical environment		
4.1 Air quality	Persistent objectionable substances in air in buildings off site	No discernible reduction in air quality
4.2 Water quality	Sterilisation of water resource off site or affects ability to reach site end-point	No discernible reduction in water quality
4.3 Land quality	Sterilisation of substantial area of land off site or affects ability to reach site end-point	No discernible reduction in land quality
4.4 Visual impact	Construction completely out of keeping with existing landscape	No discernible visual impact
4.5 Nuisances (noise, light, dust etc)	Long-term disturbance/disruption of local life	No outward signs of the material management scheme
4.6 Use of natural resources	Unacceptably high use of resources and practice not sustainable	Limited use of resources and managed in a sustainable way
4.7 Transport	Unacceptably high increase in off	No increase in off site

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
	site transport operations	transport operations
5. Flora and fauna		
5.1 Preservation of ecosystems	Complete loss of natural ecosystem	No discernible reduction in quality of the natural ecosystem
Environmental objectives		
6. Environmental objectives		
6.1 Waste volume	Unacceptably high volumes of waste generated	Lowest volumes of waste generated
6.2 Waste hierarchy	Inconsistent with waste hierarchy and no material is reused or recycled, and there is no possibility that it ever can be	Consistent with waste hierarchy and all material is reused or recycled, and none disposed
6.3 Hazard reduction rate	No reduction in hazard or hazard is increased over the long term	Hazards associated with the materials are reduced to a minimum, as rapidly as feasible
6.4 Concentrate and contain	Activity is dispersed to the wider environment and no long remains under engineering or management control	Activity is contained by passive engineered systems, and remains under management controls
6.5 Generation of secondary wastes	Large amounts of secondary waste produced far in excess of original waste volume	Limited secondary waste produced
Technical		
7. Viability		
7.1 Maturity of technology	Unproven and not achievable with existing technology in timescale of LCBL	Established approach, with good track record and applied under similar circumstances.
7.2 Continued availability of option	Not existing on site and could not be procured in timescale of LCBL	Existing on site and is available
7.3 Throughput/capacity of option	Throughput or capacity is very low sufficient to affect LTP	Throughput or capacity meets or exceeds demand and results in no impact on LTP
8. Nuclear safety		
8.1 Likelihood of meeting CfA	Significant dialogue required to gain approval	Demonstrable precedent exists
9. Flexibility		
9.1 Foreclosing of options	Once implemented, no possibility for reversible steps or retrieval of material	Flexible option that allows for reversibility and easy retrieval of material
10. Programme		
10.1 Scheduling variance compared to LTP	Would cause substantial delays to activities on site that lie on critical path, causing failure to meet final LTP objectives and timescales	Can be achieved independently of other activities on site and without impacting on the timing and ordering of other activities

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
10.2 Minimising project risk to NDA	Significant project risk to NDA	No additional project risk to NDA
10.3 Discharge of NDA liabilities	NDA liabilities increase in scale or in time	NDA liabilities significantly reduced in scale or period of liabilities significantly shortened
10.4 Consistency with site end state	Completely consistent with defined site end state	Consistent with defined site end state
Socio-economic		
11. Local community		
11.1 Economic impacts	Collapse of local economy	Major enhancement to the local economy [NB Score of 3 = no change]
11.2 Culture and heritage	Collapse of local community through depopulation	Major enhancement of local community [NB Score of 3 = no change]
Regulatory Issues		
12 Regulatory issues		
12.1 Likelihood of gaining regulatory acceptance	Significant dialogue required to gain approval	Demonstrable precedent exists
Financial Cost		
13. Overall cost		
13.1 Total undiscounted cost	Significant undiscounted cost above LTP cost estimates	Significant undiscounted cost below LTP cost estimates [NB Score of 3 = no change for current LTP cost estimates]
13.2 Rate of spend compared to LTP	Significantly increased cash flow forecast compared to current LTP estimates	Significantly decreased cash flow forecast compared to current LTP estimates [NB Score of 3 = no change]
13.3 Stability of cost estimates	Cost estimates highly unstable	Cost estimates highly stable

APPENDIX C. SCORING WORKSHOPS ATTENDEES

Name	Organisation
Walter Kennedy	British Nuclear Group Chapelcross
Philip Jones	British Nuclear Group Chapelcross
Bob Millard	British Nuclear Group Chapelcross
Norman McMurray	British Nuclear Group Chapelcross

The workshop was facilitated by Enviros Consulting Ltd.

APPENDIX D. ILW SCORES

Attributes	Sub-attributes	No. sub-attributes	Decontaminate to LLW	Condition and interim store	Scoring Notes
Group 1: Human health and safety					
1. Public H&S individuals	1.1 Routine radiation doses		**3**	**4**	
	1.2 Rad accident risks		**3**	**4**	
	1.3 Non-rad hazards and risks		**4**	**4**	
2. Public H&S collective	2.1 Routine radiation doses		**3**	**4**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**3**	
	3.2 Rad accident risks		**3**	**3**	
	3.3 Non-rad hazards and risks		**3**	**3**	
	Totals		***22***	***25***	
		7			
Group 2: Environmental impact					
4. Physical environment	4.1 Air quality		**3**	**4**	
	4.2 Water quality		**2**	**3**	
	4.3 Land quality		**3**	**3**	
	4.4 Visual impact		**4**	**3**	
	4.5 Nuisance		**3**	**3**	
	4.6 Use of natural resources		**3**	**3**	
	4.7 Transport		**3**	**3**	
5. Flora and fauna	5.1 Preservation of ecosystems		**4**	**3**	
	Totals		***25***	***25***	
		8			
Group 3: Environmental objectives					
6. Environmental objectives	6.1 Waste volume		**4**	**2**	Decontamination has the potential to reduce volume; conditioning and storage leads to overall increase.
	6.2 Waste hierarchy		**1**	**1**	
	6.3 Hazard reduction		**4**	**3**	
	6.4 Concentrate and contain		**3**	**3**	Decontamination has potential to concentrate (depending on method) but not necessarily contain. Conditioning and storage contains but does not concentrate.
	6.5 Generation of secondary wastes		**2**	**4**	
	6.6 Greenhouse gas emmissions		**3**	**4**	
	6.7 Proximity principle		**3**	**4**	
	Totals		***20***	***21***	
		7			
Group 4: Technical					
7. Viability	7.1 Maturity of technology		**3**	**3**	
	7.2 Continued availability of option		**3**	**4**	
	7.3 Throughput/capacity of option		**3**	**3**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**3**	
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	
	10.2 Minimising project risk to NDA		**3**	**3**	
	10.3 Discharge of NDA liabilities		**4**	**3**	Decontamination has the potential to reduce liabilities; Conditioning and interim storage results in liabilities remaining on site.
	10.4 Consistency with site End State		**3**	**4**	
	Totals		***25***	***26***	
		8			
Group 5: Socio-economic					
11. Local community	11.1 Economic impacts		**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	
	Totals		***6***	***6***	
		2			
Group 6: Regulatory issues					
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**3**	**4**	
	Totals		***3***	***4***	
		1			
Group 7: Financial					
13. Financial cost	13.1 Total undiscounted cost		**3**	**3**	
	13.2 Rate of spend compared to LTP		**3**	**3**	
	13.3 Stability of cost estimates		**2**	**3**	
	Totals		***8***	***9***	
		3			
	Total less Group 7 scores		***101***	***107***	
	Overall Total		***109***	***116***	
	No. of 5s		0	0	
	No. of 0s		0	0	

	Weighting factor	No. sub-attributes	Decontaminate to LLW	Condition and interim store
UNWEIGHTED				
Group 1: Human health and safety	1	7	22	25
Group 2: Environmental impact	1	8	25	25
Group 3: Environmental objectives	1	7	20	21
Group 4: Technical	1	8	25	26
Group 5: Socio-economic	1	2	6	6
Group 6: Regulatory	1	1	3	4
Group 7: Financial	1	3	8	9
Overall unweighted total			**109**	**116**
TEAM WEIGHT				
Group 1: Human health and safety	10	7	31	36
Group 2: Environmental impact	10	8	31	31
Group 3: Environmental objectives	5	7	14	15
Group 4: Technical	8	8	25	26
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	5	1	15	20
Group 7: Financial	8	3	21	24
Overall team weighted total			**141**	**155**
TECHNOLOGY WEIGHT				
Group 1: Human health and safety	10	7	31	36
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	10	8	31	33
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	3	4
Group 7: Financial	10	3	27	30
Overall technology weighted total			**101**	**111**
ENVIRONMENTAL WEIGHT				
Group 1: Human health and safety	10	7	31	36
Group 2: Environmental impact	10	8	31	31
Group 3: Environmental objectives	10	7	29	30
Group 4: Technical	1	8	3	3
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	3	4
Group 7: Financial	1	3	3	3
Overall environmental weighted total			**103**	**110**
FINANCIAL WEIGHT				
Group 1: Human health and safety	1	7	3	4
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	1	8	3	3
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	3	4
Group 7: Financial	10	3	27	30
Overall financial weighted total			**45**	**50**

Attributes	Sub-attributes	No. sub-attributes	Condition and interim store	Transfer to another site	Dispose of ILW at Sellafield	Scoring Notes
Group 1: Human health and safety						
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	**3**	
	1.2 Rad accident risks		**4**	**3**	**3**	
	1.3 Non-rad hazards and risks		**4**	**3**	**3**	
2. Public H&S collective	2.1 Routine radiation doses		**4**	**3**	**3**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**4**	**4**	
	3.2 Rad accident risks		**3**	**3**	**4**	
	3.3 Non-rad hazards and risks		**4**	**3**	**3**	
	Totals		***26***	***22***	***23***	
		7				
Group 2: Environmental impact						
4. Physical environment	4.1 Air quality		**3**	**3**	**4**	
	4.2 Water quality		**3**	**3**	**3**	
	4.3 Land quality		**3**	**3**	**3**	No differentiation between options - similarity in waste volume, location not issue.
	4.4 Visual impact		**3**	**3**	**4**	
	4.5 Nuisance		**3**	**3**	**3**	
	4.6 Use of natural resources		**3**	**3**	**4**	
	4.7 Transport		**4**	**2**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**3**	**3**	
	Totals		***25***	***23***	***26***	
		8				
Group 3: Environmental objectives						
6. Environmental objectives	6.1 Waste volume		**3**	**3**	**3**	
	6.2 Waste hierarchy		**1**	**1**	**1**	All disposal options - score similarly.
	6.3 Hazard reduction		**3**	**3**	**3**	Score similiarly - all wastes conditioned and stored (in practice Sellafield will not accept due to H-3 levels).
	6.4 Concentrate and contain		**3**	**3**	**3**	
	6.5 Generation of secondary wastes		**3**	**3**	**3**	
	6.6 Greenhouse gas emmissions		**3**	**3**	**3**	
	6.7 Proximity principle		**4**	**3**	**3**	
	Totals		***20***	***19***	***19***	
		7				
Group 4: Technical						
7. Viability	7.1 Maturity of technology		**3**	**3**	**4**	
	7.2 Continued availability of option		**3**	**3**	**3**	
	7.3 Throughput/capacity of option		**3**	**3**	**4**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**2**	**1**	No established route for transfer to Sellafield for this waste stream and acceptance less likely than transfer to another site.
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	
	10.2 Minimising project risk to NDA		**3**	**3**	**4**	
	10.3 Discharge of NDA liabilities		**3**	**3**	**4**	Transfer to Sellafield involves complete removal of liability; transfer to another site involves return of material to site after conditioning - equivalent to condition and store option.
	10.4 Consistency with site End State		**4**	**3**	**4**	
	Totals		***25***	***23***	***27***	
		8				
Group 5: Socio-economic						
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	
		2				
Group 6: Regulatory issues						
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**2**	**4**	
	Totals		***4***	***2***	***4***	
		1				
Group 7: Financial						
13. Financial cost	13.1 Total undiscounted cost		**3**	**3**	**3**	
	13.2 Rate of spend compared to LTP		**3**	**3**	**3**	
	13.3 Stability of cost estimates		**2**	**3**	**3**	
	Totals		***8***	***9***	***9***	
		3				
	Total less Group 7 scores		***106***	***95***	***105***	
	Overall Total		***114***	***104***	***114***	
	No. of 5s		0	0	0	
	No. of 0s		0	0	0	

	Weighting factor	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
UNWEIGHTED					
Group 1: Human health and safety	1	7	26	22	23
Group 2: Environmental impact	1	8	25	23	26
Group 3: Environmental objectives	1	7	20	19	19
Group 4: Technical	1	8	25	23	27
Group 5: Socio-economic	1	2	6	6	6
Group 6: Regulatory	1	1	4	2	4
Group 7: Financial	1	3	8	9	9
Overall unweighted total			**114**	**104**	**114**
TEAM WEIGHT					
Group 1: Human health and safety	10	7	37	31	33
Group 2: Environmental impact	10	8	31	29	33
Group 3: Environmental objectives	5	7	14	14	14
Group 4: Technical	8	8	25	23	27
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	5	1	20	10	20
Group 7: Financial	8	3	21	24	24
Overall team weighted total			**152**	**134**	**153**
TECHNOLOGY WEIGHT					
Group 1: Human health and safety	10	7	37	31	33
Group 2: Environmental impact	1	8	3	3	3
Group 3: Environmental objectives	1	7	3	3	3
Group 4: Technical	10	8	31	29	34
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	2	4
Group 7: Financial	10	3	27	30	30
Overall technology weighted total			**108**	**101**	**110**
ENVIRONMENTAL WEIGHT					
Group 1: Human health and safety	10	7	37	31	33
Group 2: Environmental impact	10	8	31	29	33
Group 3: Environmental objectives	10	7	29	27	27
Group 4: Technical	1	8	3	3	3
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	2	4
Group 7: Financial	1	3	3	3	3
Overall environmental weighted total			**110**	**98**	**106**
FINANCIAL WEIGHT					
Group 1: Human health and safety	1	7	4	3	3
Group 2: Environmental impact	1	8	3	3	3
Group 3: Environmental objectives	1	7	3	3	3
Group 4: Technical	1	8	3	3	3
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	2	4
Group 7: Financial	10	3	27	30	30
Overall financial weighted total			**46**	**47**	**50**

Attributes	Sub-attributes	No. sub-attributes	Condition and interim store	Transfer to another site	Dispose of ILW at Sellafield	Scoring Notes
Group 1: Human health and safety						Transfer to another site (Winfrith) involves washing by sea with return of LLW to site.
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	**3**	
	1.2 Rad accident risks		**4**	**3**	**3**	
	1.3 Non-rad hazards and risks		**4**	**3**	**3**	
2. Public H&S collective	2.1 Routine radiation doses		**4**	**3**	**4**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**4**	**4**	
	3.2 Rad accident risks		**3**	**3**	**3**	
	3.3 Non-rad hazards and risks		**4**	**3**	**3**	
	Totals		***26***	***22***	***23***	
		7				
Group 2: Environmental impact						
4. Physical environment	4.1 Air quality		**3**	**3**	**3**	
	4.2 Water quality		**3**	**4**	**3**	
	4.3 Land quality		**3**	**3**	**3**	No discrimination - similar to ceramics.
	4.4 Visual impact		**2**	**3**	**4**	
	4.5 Nuisance		**3**	**3**	**3**	
	4.6 Use of natural resources		**2**	**3**	**3**	
	4.7 Transport		**4**	**2**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**4**	**2**	**2**	
	Totals		***24***	***23***	***23***	
		8				
Group 3: Environmental objectives						
6. Environmental objectives	6.1 Waste volume		**3**	**3**	**3**	
	6.2 Waste hierarchy		**1**	**1**	**1**	
	6.3 Hazard reduction		**3**	**4**	**2**	Transfer to another site involves hazard reduction - ideally leading to decontamination to LLW; On-site conditioning involves passivation; conditioning at Sellafield prior to disposal unknown.
	6.4 Concentrate and contain		**3**	**3**	**3**	
	6.5 Generation of secondary wastes		**3**	**2**	**3**	
	6.6 Greenhouse gas emmissions		**4**	**3**	**2**	
	6.7 Proximity principle		**4**	**2**	**3**	Conditioning and storage - waste remains on site; the other site (Winfrith) is more distant than Sellafield.
	Totals		***21***	***18***	***17***	
		7				
Group 4: Technical						
7. Viability	7.1 Maturity of technology		**3**	**3**	**4**	
	7.2 Continued availability of option		**4**	**3**	**3**	
	7.3 Throughput/capacity of option		**4**	**2**	**2**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**3**	**3**	
10. Programme	10.1 Scheduling variance compared to LTP		**4**	**3**	**3**	
	10.2 Minimising project risk to NDA		**4**	**3**	**3**	
	10.3 Discharge of NDA liabilities		**3**	**4**	**4**	Conditioning and storage - liabilities remain on-site; transfers off-site lead to complete discharge of responsibility (returned LLW from the other site would be disposed of at national LLWR).
	10.4 Consistency with site End State		**4**	**3**	**3**	
	Totals		***29***	***24***	***25***	
		8				
Group 5: Socio-economic						
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	
		2				
Group 6: Regulatory issues						
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**2**	**3**	
	Totals		***4***	***2***	***3***	
		1				
Group 7: Financial						
13. Financial cost	13.1 Total undiscounted cost		**3**	**3**	**4**	
	13.2 Rate of spend compared to LTP		**4**	**2**	**3**	
	13.3 Stability of cost estimates		**4**	**3**	**3**	
	Totals		***11***	***8***	***10***	
		3				
	Total less Group 7 scores		***110***	***95***	***97***	
	Overall Total		***121***	***103***	***107***	
	No. of 5s		0	0	0	
	No. of 0s		0	0	0	

	Weighting factor	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
UNWEIGHTED					
Group 1: Human health and safety	1	7	26	22	23
Group 2: Environmental impact	1	8	24	23	23
Group 3: Environmental objectives	1	7	21	18	17
Group 4: Technical	1	8	29	24	25
Group 5: Socio-economic	1	2	6	6	6
Group 6: Regulatory	1	1	4	2	3
Group 7: Financial	1	3	11	8	10
Overall unweighted total			**121**	**103**	**107**
TEAM WEIGHT					
Group 1: Human health and safety	10	7	37	31	33
Group 2: Environmental impact	10	8	30	29	29
Group 3: Environmental objectives	5	7	15	13	12
Group 4: Technical	8	8	29	24	25
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	5	1	20	10	15
Group 7: Financial	8	3	29	21	27
Overall team weighted total			**163**	**131**	**143**
TECHNOLOGY WEIGHT					
Group 1: Human health and safety	10	7	37	31	33
Group 2: Environmental impact	1	8	3	3	3
Group 3: Environmental objectives	1	7	3	3	2
Group 4: Technical	10	8	36	30	31
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	2	3
Group 7: Financial	10	3	37	27	33
Overall technology weighted total			**123**	**99**	**109**
ENVIRONMENTAL WEIGHT					
Group 1: Human health and safety	10	7	37	31	33
Group 2: Environmental impact	10	8	30	29	29
Group 3: Environmental objectives	10	7	30	26	24
Group 4: Technical	1	8	4	3	3
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	2	3
Group 7: Financial	1	3	4	3	3
Overall environmental weighted total			**111**	**97**	**98**
FINANCIAL WEIGHT					
Group 1: Human health and safety	1	7	4	3	3
Group 2: Environmental impact	1	8	3	3	3
Group 3: Environmental objectives	1	7	3	3	2
Group 4: Technical	1	8	4	3	3
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	2	3
Group 7: Financial	10	3	37	27	33
Overall financial weighted total			**57**	**43**	**51**

Attributes	Sub-attributes	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield	Scoring Notes
						It was noted that this waste stream corresponds primarily to reactor components and the magnox and graphite components could be segregated - with metals being treated as part of the metal waste stream. Independent disposal routes exist for graphite and magnox. Physically both are stored together in the beta/gamma waste store. Treatment options likely to be similar - therefore considered together for the purposes of this study.
Group 1: Human health and safety						
1. Public H&S individuals	1.1 Routine radiation doses		**3**	**3**	**3**	
	1.2 Rad accident risks		**4**	**3**	**3**	
	1.3 Non-rad hazards and risks		**4**	**3**	**3**	
2. Public H&S collective	2.1 Routine radiation doses		**4**	**3**	**3**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**3**	**3**	
	3.2 Rad accident risks		**3**	**4**	**4**	Risks associated with conditioning wastes for disposal - transferral of material offsite (to Sellafield or another site therefore equivalent).
	3.3 Non-rad hazards and risks		**3**	**3**	**4**	
	Totals		***24***	***22***	***23***	
		7				
Group 2: Environmental impact						
4. Physical environment	4.1 Air quality		**3**	**3**	**3**	
	4.2 Water quality		**3**	**3**	**3**	
	4.3 Land quality		**3**	**3**	**3**	
	4.4 Visual impact		**3**	**4**	**4**	
	4.5 Nuisance		**3**	**3**	**3**	
	4.6 Use of natural resources		**3**	**3**	**3**	
	4.7 Transport		**4**	**2**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**4**	**4**	
	Totals		***25***	***25***	***25***	
		8				
Group 3: Environmental objectives						
6. Environmental objectives	6.1 Waste volume		**3**	**3**	**3**	
	6.2 Waste hierarchy		**1**	**1**	**1**	
	6.3 Hazard reduction		**4**	**3**	**2**	
	6.4 Concentrate and contain		**3**	**3**	**3**	
	6.5 Generation of secondary wastes		**3**	**2**	**3**	
	6.6 Greenhouse gas emmissions		**4**	**2**	**2**	
	6.7 Proximity principle		**4**	**2**	**2**	
	Totals		***22***	***16***	***16***	
		7				
Group 4: Technical						
7. Viability	7.1 Maturity of technology		**3**	**3**	**5**	
	7.2 Continued availability of option		**3**	**3**	**4**	
	7.3 Throughput/capacity of option		**3**	**3**	**4**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**3**	**4**	
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	
	10.2 Minimising project risk to NDA		**3**	**2**	**3**	
	10.3 Discharge of NDA liabilities		**3**	**3**	**4**	Transfer to another site results in conditioned wastes being returned to site - conditioning and interim storage and transfer are therefore equivalent.
	10.4 Consistency with site End State		**4**	**4**	**4**	
	Totals		***25***	***24***	***31***	
		8				
Group 5: Socio-economic						
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	
		2				
Group 6: Regulatory issues						
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**3**	**4**	
	Totals		***4***	***3***	***4***	
		1				
Group 7: Financial						
13. Financial cost	13.1 Total undiscounted cost		**3**	**2**	**3**	
	13.2 Rate of spend compared to LTP		**3**	**2**	**3**	
	13.3 Stability of cost estimates		**3**	**2**	**3**	
	Totals		***9***	***6***	***9***	
		3				
	Total less Group 7 scores		***106***	***96***	***105***	
	Overall Total		***115***	***102***	***114***	
	No. of 5s		0	0	1	
	No. of 0s		0	0	0	

	Weighting factor	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
UNWEIGHTED					
Group 1: Human health and safety	1	7	24	22	23
Group 2: Environmental impact	1	8	25	25	25
Group 3: Environmental objectives	1	7	22	16	16
Group 4: Technical	1	8	25	24	31
Group 5: Socio-economic	1	2	6	6	6
Group 6: Regulatory	1	1	4	3	4
Group 7: Financial	1	3	9	6	9
Overall unweighted total			**115**	**102**	**114**
TEAM WEIGHT					
Group 1: Human health and safety	10	7	34	31	33
Group 2: Environmental impact	10	8	31	31	31
Group 3: Environmental objectives	5	7	16	11	11
Group 4: Technical	8	8	25	24	31
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	5	1	20	15	20
Group 7: Financial	8	3	24	17	24
Overall team weighted total			**153**	**133**	**154**
TECHNOLOGY WEIGHT					
Group 1: Human health and safety	10	7	34	31	33
Group 2: Environmental impact	1	8	3	3	3
Group 3: Environmental objectives	1	7	3	2	2
Group 4: Technical	10	8	31	30	39
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	3	4
Group 7: Financial	10	3	30	21	30
Overall technology weighted total			**109**	**94**	**114**
ENVIRONMENTAL WEIGHT					
Group 1: Human health and safety	10	7	34	31	33
Group 2: Environmental impact	10	8	31	31	31
Group 3: Environmental objectives	10	7	31	23	23
Group 4: Technical	1	8	3	3	4
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	3	4
Group 7: Financial	1	3	3	2	3
Overall environmental weighted total			**110**	**97**	**101**
FINANCIAL WEIGHT					
Group 1: Human health and safety	1	7	3	3	3
Group 2: Environmental impact	1	8	3	3	3
Group 3: Environmental objectives	1	7	3	2	2
Group 4: Technical	1	8	3	3	4
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	3	4
Group 7: Financial	10	3	30	21	30
Overall financial weighted total			**50**	**39**	**50**

Attributes	Sub-attributes	No. sub-attributes	Decontaminate to LLW	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield	Scoring Notes
Group 1: Human health and safety							
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	**3**	**3**	Discussed Decontamination only - low doses from H-3 releases expected; present critical group doses of order of 10 µSv/y - scored 4 in view of uncertainties.
	1.2 Rad accident risks		**4**	**3**	**3**	**3**	Decontamination - low consequence - similar argument to 1.1.
	1.3 Non-rad hazards and risks		**3**	**3**	**3**	**3**	All options discussed - processes would be engineered to high standards; scoring reflects additional risk from off-site transport.
2. Public H&S collective	2.1 Routine radiation doses		**3**	**3**	**3**	**3**	
3. Worker H&S individuals	3.1 Routine radiation doses		**4**	**4**	**4**	**4**	
	3.2 Rad accident risks		**3**	**3**	**3**	**3**	
	3.3 Non-rad hazards and risks		**4**	**4**	**3**	**3**	
	Totals		***25***	***23***	***22***	***22***	
		7					
Group 2: Environmental impact							
4. Physical environment	4.1 Air quality		**4**	**4**	**4**	**4**	Little discernible impact -operations would be custom build and within buildings.
	4.2 Water quality		**4**	**4**	**4**	**4**	No discernible impact permitted; but cannot guarantee zero.
	4.3 Land quality		**3**	**3**	**3**	**3**	
	4.4 Visual impact		**3**	**3**	**3**	**3**	
	4.5 Nuisance		**2**	**3**	**3**	**3**	
	4.6 Use of natural resources		**4**	**2**	**2**	**3**	
	4.7 Transport		**3**	**4**	**2**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**4**	**3**	**3**	
	Totals		***26***	***27***	***24***	***25***	
		8					
Group 3: Environmental objectives							
6. Environmental objectives	6.1 Waste volume		**4**	**3**	**3**	**3**	Potential for volume reduction with decontamination; conditioned disposal waste volumes greater - all assumed equivalent.
	6.2 Waste hierarchy		**1**	**1**	**1**	**1**	
	6.3 Hazard reduction		**4**	**3**	**2**	**2**	
	6.4 Concentrate and contain		**4**	**4**	**3**	**4**	
	6.5 Generation of secondary wastes		**2**	**4**	**3**	**4**	
	6.6 Greenhouse gas emmissions		**4**	**3**	**2**	**3**	
	6.7 Proximity principle		**4**	**4**	**3**	**3**	
	Totals		***23***	***22***	***17***	***20***	
		7					
Group 4: Technical							
7. Viability	7.1 Maturity of technology		**3**	**4**	**3**	**4**	
	7.2 Continued availability of option		**3**	**4**	**2**	**4**	
	7.3 Throughput/capacity of option		**3**	**5**	**2**	**3**	Condition and interim store = LTP option (5); decontamination and disposal at Sellafield have potential to impact on LTP, but less than tranfer to another site where there is complete dependence on third party and no existing arrangements.
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**2**	**3**	**2**	**3**	
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**4**	**3**	**3**	
	10.2 Minimising project risk to NDA		**3**	**4**	**2**	**3**	
	10.3 Discharge of NDA liabilities		**4**	**2**	**3**	**3**	Decontamination reduces liabilities to a greater extent than removal of material off-site; condition and interim store - liabilities remain on-site.
	10.4 Consistency with site End State		**3**	**4**	**3**	**3**	
	Totals		***24***	***30***	***20***	***26***	
		8					
Group 5: Socio-economic							
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	***6***	
		2					
Group 6: Regulatory issues							
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**3**	**4**	**3**	**4**	Arrangements exist for disposal at Sellafield for some metals; condition and store precedents exist at other sites; doubts over feasibility of decontamination affects scoring and transfer to another site not established.
	Totals		***3***	***4***	***3***	***4***	
		1					
Group 7: Financial							
13. Financial cost	13.1 Total undiscounted cost		**3**	**3**	**2**	**3**	
	13.2 Rate of spend compared to LTP		**2**	**3**	**3**	**3**	
	13.3 Stability of cost estimates		**3**	**4**	**3**	**3**	
	Totals		***8***	***10***	***8***	***9***	
		3					
	Total less Group 7 scores		***107***	***112***	***92***	***103***	
	Overall Total		***115***	***122***	***100***	***112***	
	No. of 5s		0	1	0	0	
	No. of 0s		0	0	0	0	

	Weighting factor	No. sub-attributes	Decontaminate to LLW	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
UNWEIGHTED						
Group 1: Human health and safety	1	7	25	23	22	22
Group 2: Environmental impact	1	8	26	27	24	25
Group 3: Environmental objectives	1	7	23	22	17	20
Group 4: Technical	1	8	24	30	20	26
Group 5: Socio-economic	1	2	6	6	6	6
Group 6: Regulatory	1	1	3	4	3	4
Group 7: Financial	1	3	8	10	8	9
Overall unweighted total			**115**	**122**	**100**	**112**
TEAM WEIGHT						
Group 1: Human health and safety	10	7	36	33	31	31
Group 2: Environmental impact	10	8	33	34	30	31
Group 3: Environmental objectives	5	7	16	16	12	14
Group 4: Technical	8	8	24	30	20	26
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	5	1	15	20	15	20
Group 7: Financial	8	3	21	27	21	24
Overall team weighted total			**148**	**162**	**133**	**150**
TECHNOLOGY WEIGHT						
Group 1: Human health and safety	10	7	36	33	31	31
Group 2: Environmental impact	1	8	3	3	3	3
Group 3: Environmental objectives	1	7	3	3	2	3
Group 4: Technical	10	8	30	38	25	33
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	1	1	3	4	3	4
Group 7: Financial	10	3	27	33	27	30
Overall technology weighted total			**105**	**117**	**95**	**107**
ENVIRONMENTAL WEIGHT						
Group 1: Human health and safety	10	7	36	33	31	31
Group 2: Environmental impact	10	8	33	34	30	31
Group 3: Environmental objectives	10	7	33	31	24	29
Group 4: Technical	1	8	3	4	3	3
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	1	1	3	4	3	4
Group 7: Financial	1	3	3	3	3	3
Overall environmental weighted total			**113**	**112**	**97**	**105**
FINANCIAL WEIGHT						
Group 1: Human health and safety	1	7	4	3	3	3
Group 2: Environmental impact	1	8	3	3	3	3
Group 3: Environmental objectives	1	7	3	3	2	3
Group 4: Technical	1	8	3	4	3	3
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	1	1	3	4	3	4
Group 7: Financial	10	3	27	33	27	30
Overall financial weighted total			**46**	**54**	**44**	**49**

Attributes	Sub-attributes	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield	Scoring Notes
Group 1: Human health and safety						
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	**3**	
	1.2 Rad accident risks		**4**	**2**	**2**	
	1.3 Non-rad hazards and risks		**4**	**3**	**3**	
2. Public H&S collective	2.1 Routine radiation doses		**4**	**3**	**2**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**3**	**3**	Small, high activity waste stream; doses limited by remote handling methods - likelihood of dose rates from packaged wastes.
	3.2 Rad accident risks		**3**	**3**	**3**	Small, high activity waste stream; risks limited by remote handling methods.
	3.3 Non-rad hazards and risks		**3**	**3**	**3**	Low volume waste stream; risks limited by remote handling methods.
	Totals		***25***	***20***	***19***	
		7				
Group 2: Environmental impact						
4. Physical environment	4.1 Air quality		**4**	**3**	**3**	
	4.2 Water quality		**4**	**3**	**3**	No discrimination between different options.
	4.3 Land quality		**3**	**3**	**3**	No discrimination between different options.
	4.4 Visual impact		**3**	**4**	**3**	
	4.5 Nuisance		**4**	**3**	**3**	
	4.6 Use of natural resources		**3**	**2**	**3**	
	4.7 Transport		**4**	**2**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**3**	**3**	
	Totals		***28***	***23***	***23***	
		8				
Group 3: Environmental objectives						
6. Environmental objectives	6.1 Waste volume		**3**	**3**	**3**	
	6.2 Waste hierarchy		**1**	**1**	**1**	
	6.3 Hazard reduction		**3**	**3**	**2**	Conditioning and interim storage and tranfer to another site involve conditioning waste to passive form; Level of conditioning for disposal at Sellafield unknown.
	6.4 Concentrate and contain		**4**	**4**	**3**	
	6.5 Generation of secondary wastes		**3**	**3**	**3**	
	6.6 Greenhouse gas emmissions		**3**	**3**	**2**	
	6.7 Proximity principle		**5**	**3**	**3**	
	Totals		***22***	***20***	***17***	
		7				
Group 4: Technical						
7. Viability	7.1 Maturity of technology		**2**	**2**	**2**	No discrimination.
	7.2 Continued availability of option		**3**	**3**	**2**	
	7.3 Throughput/capacity of option		**3**	**3**	**2**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**2**	**0**	Sellafield does not accept liquid wastes; activity level may affect transfer to another site; encapsulation presently under consideration by NIREX.
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	
	10.2 Minimising project risk to NDA		**4**	**3**	**2**	Risks associated with transfer elsewhere due to dependance on third party - relatively greater for Sellafield due to known concerns about liquid waste.
	10.3 Discharge of NDA liabilities		**3**	**3**	**4**	Disposal at Sellafield implies complete removal of liability; transfer to another site involves return of the condioned waste to the site and so is equivalent to the conditioning and interim store option
	10.4 Consistency with site End State		**4**	**3**	**3**	
	Totals		***25***	***22***	***18***	
		8				
Group 5: Socio-economic						
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	
		2				
Group 6: Regulatory issues						
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**3**	**3**	
	Totals		***4***	***3***	***3***	
		1				
Group 7: Financial						
13. Financial cost	13.1 Total undiscounted cost		**3**	**2**	**3**	
	13.2 Rate of spend compared to LTP		**3**	**3**	**3**	
	13.3 Stability of cost estimates		**3**	**2**	**2**	
	Totals		***9***	***7***	***8***	
		3				
	Total less Group 7 scores		***110***	***94***	***86***	
	Overall Total		***119***	***101***	***94***	
	No. of 5s		1	0	0	
	No. of 0s		0	0	1	

	Weighting factor	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Dispose of ILW at Sellafield
UNWEIGHTED					
Group 1: Human health and safety	1	7	25	20	19
Group 2: Environmental impact	1	8	28	23	23
Group 3: Environmental objectives	1	7	22	20	17
Group 4: Technical	1	8	25	22	18
Group 5: Socio-economic	1	2	6	6	6
Group 6: Regulatory	1	1	4	3	3
Group 7: Financial	1	3	9	7	8
Overall unweighted total			**119**	**101**	**94**
TEAM WEIGHT					
Group 1: Human health and safety	10	7	36	29	27
Group 2: Environmental impact	10	8	35	29	29
Group 3: Environmental objectives	5	7	16	14	12
Group 4: Technical	8	8	25	22	18
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	5	1	20	15	15
Group 7: Financial	8	3	24	19	21
Overall team weighted total			**158**	**130**	**125**
TECHNOLOGY WEIGHT					
Group 1: Human health and safety	10	7	36	29	27
Group 2: Environmental impact	1	8	4	3	3
Group 3: Environmental objectives	1	7	3	3	2
Group 4: Technical	10	8	31	28	23
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	3	3
Group 7: Financial	10	3	30	23	27
Overall technology weighted total			**111**	**91**	**88**
ENVIRONMENTAL WEIGHT					
Group 1: Human health and safety	10	7	36	29	27
Group 2: Environmental impact	10	8	35	29	29
Group 3: Environmental objectives	10	7	31	29	24
Group 4: Technical	1	8	3	3	2
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	3	3
Group 7: Financial	1	3	3	2	3
Overall environmental weighted total			**115**	**97**	**91**
FINANCIAL WEIGHT					
Group 1: Human health and safety	1	7	4	3	3
Group 2: Environmental impact	1	8	4	3	3
Group 3: Environmental objectives	1	7	3	3	2
Group 4: Technical	1	8	3	3	2
Group 5: Socio-economic	1	2	3	3	3
Group 6: Regulatory	1	1	4	3	3
Group 7: Financial	10	3	30	23	27
Overall financial weighted total			**50**	**41**	**43**

Attributes	Sub-attributes	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross	Scoring Notes
Group 1: Human health and safety					
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	
	1.2 Rad accident risks		**4**	**3**	
	1.3 Non-rad hazards and risks		**4**	**3**	
2. Public H&S collective	2.1 Routine radiation doses		**4**	**3**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**3**	
	3.2 Rad accident risks		**3**	**3**	
	3.3 Non-rad hazards and risks		**4**	**3**	
	Totals		***26***	***21***	
		7			
Group 2: Environmental impact					
4. Physical environment	4.1 Air quality		**3**	**4**	
	4.2 Water quality		**3**	**4**	
	4.3 Land quality		**3**	**3**	
	4.4 Visual impact		**3**	**4**	
	4.5 Nuisance		**3**	**3**	
	4.6 Use of natural resources		**3**	**3**	
	4.7 Transport		**4**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**4**	**3**	
	Totals		***26***	***26***	
		8			
Group 3: Environmental objectives					
6. Environmental objectives	6.1 Waste volume		**3**	**3**	
	6.2 Waste hierarchy		**3**	**2**	
	6.3 Hazard reduction		**4**	**3**	
	6.4 Concentrate and contain		**3**	**3**	
	6.5 Generation of secondary wastes		**3**	**2**	
	6.6 Greenhouse gas emmissions		**3**	**3**	
	6.7 Proximity principle		**3**	**3**	
	Totals		***22***	***19***	
		7			
Group 4: Technical					
7. Viability	7.1 Maturity of technology		**4**	**3**	
	7.2 Continued availability of option		**4**	**3**	
	7.3 Throughput/capacity of option		**4**	**3**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**3**	
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	
	10.2 Minimising project risk to NDA		**4**	**3**	
	10.3 Discharge of NDA liabilities		**2**	**2**	Transfer to another site results in conditioned wastes being returned to site - the two options are therefore equivalent.
	10.4 Consistency with site End State		**4**	**3**	
	Totals		***28***	***23***	
		8			
Group 5: Socio-economic					
11. Local community	11.1 Economic impacts		**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	
	Totals		***6***	***6***	
		2			
Group 6: Regulatory issues					
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**3**	
	Totals		***4***	***3***	
		1			
Group 7: Financial					
13. Financial cost	13.1 Total undiscounted cost		**3**	**3**	
	13.2 Rate of spend compared to LTP		**4**	**3**	
	13.3 Stability of cost estimates		**4**	**3**	
	Totals		***11***	***9***	
		3			
	Total less Group 7 scores		***112***	***98***	
	Overall Total		***123***	***107***	
	No. of 5s		0	0	
	No. of 0s		0	0	

	Weighting factor	No. sub-attributes	Condition and interim store	Transfer to another site for processing and return to Chapelcross
UNWEIGHTED				
Group 1: Human health and safety	1	7	26	21
Group 2: Environmental impact	1	8	26	26
Group 3: Environmental objectives	1	7	22	19
Group 4: Technical	1	8	28	23
Group 5: Socio-economic	1	2	6	6
Group 6: Regulatory	1	1	4	3
Group 7: Financial	1	3	11	9
Overall unweighted total			**123**	**107**
TEAM WEIGHT				
Group 1: Human health and safety	10	7	37	30
Group 2: Environmental impact	10	8	33	33
Group 3: Environmental objectives	5	7	16	14
Group 4: Technical	8	8	28	23
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	5	1	20	15
Group 7: Financial	8	3	29	24
Overall team weighted total			**166**	**141**
TECHNOLOGY WEIGHT				
Group 1: Human health and safety	10	7	37	30
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	10	8	35	29
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	3
Group 7: Financial	10	3	37	30
Overall technology weighted total			**122**	**101**
ENVIRONMENTAL WEIGHT				
Group 1: Human health and safety	10	7	37	30
Group 2: Environmental impact	10	8	33	33
Group 3: Environmental objectives	10	7	31	27
Group 4: Technical	1	8	4	3
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	3
Group 7: Financial	1	3	4	3
Overall environmental weighted total			**115**	**102**
FINANCIAL WEIGHT				
Group 1: Human health and safety	1	7	4	3
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	1	8	4	3
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	3
Group 7: Financial	10	3	37	30
Overall financial weighted total			**57**	**48**

Attributes	Sub-attributes	No. sub-attributes	Condition and interim store	Dispose of ILW at Sellafield	Scoring Notes
Group 1: Human health and safety					
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	Disposal of waste at Sellafield slightly lower dose than alternative - scored for differentiation.
	1.2 Rad accident risks		**3**	**3**	Risks arise during waste processing - similar for both options.
	1.3 Non-rad hazards and risks		**3**	**3**	Risks from off-site movement of materials; both involve bulk movement of grouting materials.
2. Public H&S collective	2.1 Routine radiation doses		**4**	**4**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**4**	
	3.2 Rad accident risks		**2**	**3**	
	3.3 Non-rad hazards and risks		**3**	**4**	
	Totals		***22***	***24***	
		7			
Group 2: Environmental impact					
4. Physical environment	4.1 Air quality		**3**	**4**	
	4.2 Water quality		**3**	**4**	
	4.3 Land quality		**3**	**4**	
	4.4 Visual impact		**2**	**4**	
	4.5 Nuisance		**3**	**3**	
	4.6 Use of natural resources		**3**	**3**	
	4.7 Transport		**4**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**3**	
	Totals		***24***	***27***	
		8			
Group 3: Environmental objectives					
6. Environmental objectives	6.1 Waste volume		**4**	**3**	
	6.2 Waste hierarchy		**1**	**1**	
	6.3 Hazard reduction		**4**	**3**	
	6.4 Concentrate and contain		**4**	**3**	
	6.5 Generation of secondary wastes		**3**	**4**	
	6.6 Greenhouse gas emmissions		**3**	**4**	
	6.7 Proximity principle		**4**	**2**	
	Totals		***23***	***20***	
		7			
Group 4: Technical					
7. Viability	7.1 Maturity of technology		**3**	**4**	
	7.2 Continued availability of option		**4**	**2**	
	7.3 Throughput/capacity of option		**3**	**3**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**4**	**2**	
10. Programme	10.1 Scheduling variance compared to LTP		**4**	**3**	
	10.2 Minimising project risk to NDA		**4**	**3**	
	10.3 Discharge of NDA liabilities		**3**	**4**	
	10.4 Consistency with site End State		**4**	**4**	
	Totals		***29***	***25***	
		8			
Group 5: Socio-economic					
11. Local community	11.1 Economic impacts		**4**	**3**	
	11.2 Culture and heritage		**3**	**3**	
	Totals		***7***	***6***	
		2			
Group 6: Regulatory issues					
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**3**	
	Totals		***4***	***3***	
		1			
Group 7: Financial					
13. Financial cost	13.1 Total undiscounted cost		**3**	**4**	
	13.2 Rate of spend compared to LTP		**3**	**3**	
	13.3 Stability of cost estimates		**3**	**2**	
	Totals		***9***	***9***	
		3			
	Total less Group 7 scores		***109***	***105***	
	Overall Total		***118***	***114***	
	No. of 5s		0	0	
	No. of 0s		0	0	

	Weighting factor	No. sub-attributes	Condition and interim store	Dispose of ILW at Sellafield
UNWEIGHTED				
Group 1: Human health and safety	1	7	22	24
Group 2: Environmental impact	1	8	24	27
Group 3: Environmental objectives	1	7	23	20
Group 4: Technical	1	8	29	25
Group 5: Socio-economic	1	2	7	6
Group 6: Regulatory	1	1	4	3
Group 7: Financial	1	3	9	9
Overall unweighted total			**118**	**114**
TEAM WEIGHT				
Group 1: Human health and safety	10	7	31	34
Group 2: Environmental impact	10	8	30	34
Group 3: Environmental objectives	5	7	16	14
Group 4: Technical	8	8	29	25
Group 5: Socio-economic	1	2	4	3
Group 6: Regulatory	5	1	20	15
Group 7: Financial	8	3	24	24
Overall team weighted total			**155**	**149**
TECHNOLOGY WEIGHT				
Group 1: Human health and safety	10	7	31	34
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	10	8	37	31
Group 5: Socio-economic	1	2	4	3
Group 6: Regulatory	1	1	4	3
Group 7: Financial	10	3	30	30
Overall technology weighted total			**112**	**108**
ENVIRONMENTAL WEIGHT				
Group 1: Human health and safety	10	7	31	34
Group 2: Environmental impact	10	8	30	34
Group 3: Environmental objectives	10	7	33	29
Group 4: Technical	1	8	4	3
Group 5: Socio-economic	1	2	4	3
Group 6: Regulatory	1	1	4	3
Group 7: Financial	1	3	3	3
Overall environmental weighted total			**108**	**109**
FINANCIAL WEIGHT				
Group 1: Human health and safety	1	7	3	3
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	1	8	4	3
Group 5: Socio-economic	1	2	4	3
Group 6: Regulatory	1	1	4	3
Group 7: Financial	10	3	30	30
Overall financial weighted total			**51**	**49**

APPENDIX E. SCORES FOR LLW

Attributes	Sub-attributes	No. sub-attributes	Decontaminate to SoLA	On-site landscaping	On-site disposal in a purpose built facility	Dispose of vLLW separately to a national facility	Dispose to National LLWR near Drigg	Scoring Notes
								incl. consideration of soil wastes (only 4 out of 5 options - no decontamination?
Group 1: Human health and safety								
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**4**	5	**4**	5	vLLW score changed to be consistent with that for on-site disposal (both assumed to relatively unengineered but more than landscaping.
	1.2 Rad accident risks		**4**	**4**	**4**	**4**	**4**	
	1.3 Non-rad hazards and risks		**4**	**4**	**4**	**3**	**3**	Transport risks dominate - distance to vLLW and LLW facilities assumed similar.
2. Public H&S collective	2.1 Routine radiation doses		**4**	**4**	**4**	**4**	**4**	Potential for collective dose > 1 manSv if worldwide population considered.
3. Worker H&S individuals	3.1 Routine radiation doses		**4**	**4**	**4**	**4**	**4**	All likely to be less than 2 mSv/y.
	3.2 Rad accident risks		**4**	**4**	**4**	**4**	**4**	Batch processes - limited potential for significant consequences from loss of control.
	3.3 Non-rad hazards and risks		**3**	**3**	**3**	**3**	**4**	ISO container characteristics limit risks from disposal at LLWR; other processes involve less rigorous containment; decontamination significantly risky operation.
	Totals		***27***	***27***	***28***	***26***	***28***	
		7						
Group 2: Environmental impact								
4. Physical environment	4.1 Air quality		**4**	**4**	**4**	**4**	**4**	No obvious polluting processes involved.
	4.2 Water quality		**4**	**3**	**4**	**3**	**3**	Decontamination dry process; landscaping carry potential for leachate and scores reduced accordingly.
	4.3 Land quality		**2**	**2**	**4**	**3**	**3**	
	4.4 Visual impact		**3**	**3**	**4**	**4**	**4**	
	4.5 Nuisance		**1**	**3**	**4**	**2**	**3**	
	4.6 Use of natural resources		**3**	5	**3**	**3**	**3**	On-site disposal requires significant use of concrete and capping materials.
	4.7 Transport		**3**	5	**4**	**1**	**1**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**3**	**3**	**4**	**3**	
	Totals		***23***	***28***	***30***	***24***	***24***	
		8						
Group 3: Environmental objectives								
6. Environmental objectives	6.1 Waste volume		**4**	**4**	**3**	**2**	**2**	Decontamination has potential to reduce waste volume; on-site landscaping does not affect the volume of waste for disposal; other options result in increased volume.
	6.2 Waste hierarchy		**4**	**4**	**1**	**1**	**1**	Decontamination and landscape counted as forms of recycling.
	6.3 Hazard reduction		**4**	**3**	**3**	**3**	**3**	Decontamination has potential to reduce the hazard; on-site disposal renders hazard passive while landscaping has no effect on hazard.
	6.4 Concentrate and contain		**3**	**2**	5	**4**	**4**	
	6.5 Generation of secondary wastes		**2**	5	**4**	**3**	**3**	
	6.6 Greenhouse gas emmissions		**2**	**4**	**3**	**1**	**1**	Relative consolidated scoring reviewed and concluded to be OK.
	6.7 Proximity principle		**3**	**4**	5	**1**	**1**	
	Totals		***22***	***26***	***24***	***15***	***15***	
		7						
Group 4: Technical								
7. Viability	7.1 Maturity of technology		**4**	**4**	**3**	**3**	**4**	Techniques for decontamination are established but not at Chapelcross;
	7.2 Continued availability of option		**4**	**3**	5	5	**3**	On-site & VLLW facility do not exist but assumed would have appropriate capacity.
	7.3 Throughput/capacity of option		**1**	**3**	**4**	**3**	**2**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**2**	**3**	**4**	**3**	**3**	
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	**3**	**3**	
	10.2 Minimising project risk to NDA		**2**	**3**	**3**	**3**	**2**	LLWR is likely to cease acceptance of Aggregate
	10.3 Discharge of NDA liabilities		**4**	**2**	**2**	**4**	**4**	Uncertainties related to on-site landscaping and disposal - least discharge of NDA liabilities.
	10.4 Consistency with site End State		**4**	0	**2**	**4**	**4**	On-site landscaping inconsistent with greenfield site endstate; on-site disposal preferrable but still low-scoring.
	Totals		***24***	***21***	***26***	***28***	***25***	
		8						
Group 5: Socio-economic								
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	***6***	***6***	
		2						
Group 6: Regulatory issues								
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**1**	**2**	**4**	**4**	On-site landscaping would require a waste management licence exemption (otherwise accumulation of waste); on-site disposal requires planning permission etc.
	Totals		***4***	***1***	***2***	***4***	***4***	
		1						
Group 7: Financial								
13. Financial cost	13.1 Total undiscounted cost		**3**	**2**	**3**	**3**	**3**	Landscaping would imply change to the end-state therefore necessary to consider that final remediation of landscaping will eventually be necessary.
	13.2 Rate of spend compared to LTP		**3**	**4**	**3**	**3**	**3**	Landscaping - delayed rate of spend
	13.3 Stability of cost estimates		**4**	**4**	**4**	**3**	**2**	Reflect the level of third party involvement.
	Totals		***10***	***10***	***10***	***9***	***8***	
		3						
	Total less Group 7 scores		***106***	***109***	***116***	***103***	***102***	
	Overall Total		***116***	***119***	***126***	***112***	***110***	
	No. of 5s		0	3	4	1	1	
	No. of 0s		0	1	0	0	0	

	Weighting factor	No. sub-attributes	Decontaminate to SoLA	On-site landscaping	On-site disposal in a purpose built facility	Dispose of vLLW separately to a national facility	Dispose to National LLWR near Drigg
UNWEIGHTED							
Group 1: Human health and safety	1	7	27	27	28	26	28
Group 2: Environmental impact	1	8	23	28	30	24	24
Group 3: Environmental objectives	1	7	22	26	24	15	15
Group 4: Technical	1	8	24	21	26	28	25
Group 5: Socio-economic	1	2	6	6	6	6	6
Group 6: Regulatory	1	1	4	1	2	4	4
Group 7: Financial	1	3	10	10	10	9	8
Overall unweighted total			**116**	**119**	**126**	**112**	**110**
TEAM WEIGHT							
Group 1: Human health and safety	10	7	39	39	40	37	40
Group 2: Environmental impact	10	8	29	35	38	30	30
Group 3: Environmental objectives	5	7	16	19	17	11	11
Group 4: Technical	8	8	24	21	26	28	25
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	5	1	20	5	12	20	20
Group 7: Financial	8	3	27	27	26	24	21
Overall team weighted total			**157**	**148**	**161**	**153**	**150**
TECHNOLOGY WEIGHT							
Group 1: Human health and safety	10	7	39	39	40	37	40
Group 2: Environmental impact	1	8	3	4	4	3	3
Group 3: Environmental objectives	1	7	3	4	3	2	2
Group 4: Technical	10	8	30	26	33	35	31
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	1	1	4	1	2	4	4
Group 7: Financial	10	3	33	33	32	30	27
Overall technology weighted total			**115**	**109**	**117**	**114**	**110**
ENVIRONMENTAL WEIGHT							
Group 1: Human health and safety	10	7	39	39	40	37	40
Group 2: Environmental impact	10	8	29	35	38	30	30
Group 3: Environmental objectives	10	7	31	37	34	21	21
Group 4: Technical	1	8	3	3	3	4	3
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	1	1	4	1	2	4	4
Group 7: Financial	1	3	3	3	3	3	3
Overall environmental weighted total			**112**	**121**	**124**	**102**	**104**
FINANCIAL WEIGHT							
Group 1: Human health and safety	1	7	4	4	4	4	4
Group 2: Environmental impact	1	8	3	4	4	3	3
Group 3: Environmental objectives	1	7	3	4	3	2	2
Group 4: Technical	1	8	3	3	3	4	3
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	1	1	4	1	2	4	4
Group 7: Financial	10	3	33	33	32	30	27
Overall financial weighted total			**53**	**51**	**52**	**49**	**46**

Attributes	Sub-attributes	No. sub-attributes	Dispose to National LLWR near Drigg	Thermal treatment followed bys disposal to non-hazardous landfill	Scoring Notes
Group 1: Human health and safety					
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**4**	
	1.2 Rad accident risks		**4**	**4**	
	1.3 Non-rad hazards and risks		**3**	**4**	Transport dependent; thermal treatment - no off-site movement and controlled process.
2. Public H&S collective	2.1 Routine radiation doses		**4**	**4**	Up to 1 manSv year possible (from all ops and depending on summation terms).
3. Worker H&S individuals	3.1 Routine radiation doses		**4**	**4**	Controlled processes.
	3.2 Rad accident risks		**4**	**4**	
	3.3 Non-rad hazards and risks		**3**	**3**	Some residual risks - but exposure to pre-bagged materials. Thermal treatment - additional risk (not sufficient to discriminate).
	Totals		***26***	***27***	
		7			
Group 2: Environmental impact					
4. Physical environment	4.1 Air quality		**4**	**2**	
	4.2 Water quality		**3**	**4**	
	4.3 Land quality		**3**	**4**	
	4.4 Visual impact		**3**	**2**	
	4.5 Nuisance		**3**	**2**	
	4.6 Use of natural resources		**3**	**2**	Thermal treatment more energy intensive than LLWR conditioning requirements.
	4.7 Transport		**3**	**4**	LLWR near Drigg is relatively local. Thermal treatment on-site followed by local disposal of residue.
5. Flora and fauna	5.1 Preservation of ecosystems		**2**	**3**	
	Totals		***24***	***23***	
		8			
Group 3: Environmental objectives					
6. Environmental objectives	6.1 Waste volume		**3**	**4**	
	6.2 Waste hierarchy		**1**	**1**	Both disposal endpoints.
	6.3 Hazard reduction		**2**	**4**	
	6.4 Concentrate and contain		**3**	**3**	
	6.5 Generation of secondary wastes		**4**	**3**	Thermal treatment will involve some scrubbing of effluent.
	6.6 Greenhouse gas emmissions		**3**	**2**	
	6.7 Proximity principle		**2**	**4**	
	Totals		***18***	***21***	
		7			
Group 4: Technical					
7. Viability	7.1 Maturity of technology		**4**	**2**	
	7.2 Continued availability of option		**3**	**3**	
	7.3 Throughput/capacity of option		**3**	**3**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**4**	Uncertainties related to LLWR acceptance of tritiated asbestos. After thermal treatment - no longer needs to be treated as asbestos (and H-3 removed in process).
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**2**	
	10.2 Minimising project risk to NDA		**3**	**3**	Dependance on both technologies risky - Drigg continued acceptance questioned and doubts over maturity of thermal treatment.
	10.3 Discharge of NDA liabilities		**3**	**4**	LLWR disposal discharges NDA liabilities most quickly.
	10.4 Consistency with site End State		**4**	**4**	
	Totals		***26***	***25***	
		8			
Group 5: Socio-economic					
11. Local community	11.1 Economic impacts		**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	
	Totals		***6***	***6***	
		2			
Group 6: Regulatory issues					
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**2**	
	Totals		***4***	***2***	
		1			
Group 7: Financial					
13. Financial cost	13.1 Total undiscounted cost		**4**	**2**	Thermal treatment more expensive than disposal to LLWR which is baseline.
	13.2 Rate of spend compared to LTP		**3**	**2**	
	13.3 Stability of cost estimates		**3**	**3**	
	Totals		***10***	***7***	
		3			
	Total less Group 7 scores		***104***	***104***	
	Overall Total		***114***	***111***	
	No. of 5s		0	0	
	No. of 0s		0	0	

	Weighting factor	No. sub-attributes	Dispose to National LLWR near Drigg	Thermal treatment followed bys disposal to non-hazardous landfill
UNWEIGHTED				
Group 1: Human health and safety	1	7	26	27
Group 2: Environmental impact	1	8	24	23
Group 3: Environmental objectives	1	7	18	21
Group 4: Technical	1	8	26	25
Group 5: Socio-economic	1	2	6	6
Group 6: Regulatory	1	1	4	2
Group 7: Financial	1	3	10	7
Overall unweighted total			**114**	**111**
TEAM WEIGHT				
Group 1: Human health and safety	10	7	37	39
Group 2: Environmental impact	10	8	30	29
Group 3: Environmental objectives	5	7	13	15
Group 4: Technical	8	8	26	25
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	5	1	20	10
Group 7: Financial	8	3	27	19
Overall team weighted total			**156**	**139**
TECHNOLOGY WEIGHT				
Group 1: Human health and safety	10	7	37	39
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	10	8	33	31
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	2
Group 7: Financial	10	3	33	23
Overall technology weighted total			**116**	**104**
ENVIRONMENTAL WEIGHT				
Group 1: Human health and safety	10	7	37	39
Group 2: Environmental impact	10	8	30	29
Group 3: Environmental objectives	10	7	26	30
Group 4: Technical	1	8	3	3
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	2
Group 7: Financial	1	3	3	2
Overall environmental weighted total			**106**	**108**
FINANCIAL WEIGHT				
Group 1: Human health and safety	1	7	4	4
Group 2: Environmental impact	1	8	3	3
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	1	8	3	3
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	2
Group 7: Financial	10	3	33	23
Overall financial weighted total			**53**	**41**

Attributes	Sub-attributes	No. sub-attributes	Incineration	On-site disposal in a purpose built facility	Dispose of vLLW separately to a national facility	Dispose to National LLWR near Drigg	Scoring Notes
Group 1: Human health and safety							
1. Public H&S individuals	1.1 Routine radiation doses		**3**	**4**	**2**	**3**	
	1.2 Rad accident risks		**3**	**4**	**3**	**3**	
	1.3 Non-rad hazards and risks		**3**	**4**	**3**	**4**	
2. Public H&S collective	2.1 Routine radiation doses		**3**	**4**	**3**	**4**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**4**	**3**	**3**	
	3.2 Rad accident risks		**3**	**4**	**3**	**3**	
	3.3 Non-rad hazards and risks		**3**	**4**	**3**	**3**	
	Totals		***21***	***28***	***20***	***23***	
		7					
Group 2: Environmental impact							
4. Physical environment	4.1 Air quality		**3**	**4**	**3**	**3**	
	4.2 Water quality		**3**	**4**	**3**	**3**	
	4.3 Land quality		**3**	**3**	**2**	**3**	
	4.4 Visual impact		**2**	**4**	**4**	**3**	
	4.5 Nuisance		**2**	**3**	**3**	**3**	
	4.6 Use of natural resources		**2**	**3**	**3**	**3**	Incineration most energy intensive.
	4.7 Transport		**3**	5	**2**	**2**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**4**	**3**	**4**	
	Totals		***21***	***30***	***23***	***24***	
		8					
Group 3: Environmental objectives							
6. Environmental objectives	6.1 Waste volume		**4**	**3**	**3**	**3**	
	6.2 Waste hierarchy		**2**	**1**	**1**	**1**	Incineration > disposal options - not thought to involve energy recovery.
	6.3 Hazard reduction		**4**	**2**	**2**	**4**	Incineration and LLWR disposal options currently available - prompt hazard reduction; other options not yet available.
	6.4 Concentrate and contain		**4**	**3**	**3**	**3**	Incineration potential for concentration; disposal leads to containment but questions over leachate management.
	6.5 Generation of secondary wastes		**4**	**3**	**3**	**3**	Incineration less waste than disposal options - modern technology and abatement technologies.
	6.6 Greenhouse gas emmissions		**1**	**4**	**3**	**3**	
	6.7 Proximity principle		**2**	5	**2**	**3**	Incineration and vLLW more distant than LLWR.
	Totals		***21***	***21***	***17***	***20***	
		7					
Group 4: Technical							
7. Viability	7.1 Maturity of technology		**3**	**3**	**3**	**4**	
	7.2 Continued availability of option		**3**	**3**	**3**	**3**	On-site facility not available - scoring consistent with other options.
	7.3 Throughput/capacity of option		**3**	**4**	**3**	**3**	
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**4**	**3**	**3**	**3**	No particular issues related to conditions for incineration.
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	**3**	
	10.2 Minimising project risk to NDA		**3**	**3**	**3**	**3**	
	10.3 Discharge of NDA liabilities		**4**	**2**	**4**	**3**	On-site disposal - long-term continuing on-site liability.
	10.4 Consistency with site End State		**4**	**2**	**3**	**4**	
	Totals		***27***	***23***	***25***	***26***	
		8					
Group 5: Socio-economic							
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	**3**	
	11.2 Culture and heritage		**3**	**3**	**3**	**3**	
	Totals		***6***	***6***	***6***	***6***	
		2					
Group 6: Regulatory issues							
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**2**	**3**	5	LLWR route open; no difficulties with incineration foreseen; on-site facility requires more permissions (under site responsibility) than vLLW.
	Totals		***4***	***2***	***3***	***5***	
		1					
Group 7: Financial							
13. Financial cost	13.1 Total undiscounted cost		**3**	**2**	**3**	**3**	On-site disposal involves additional construction costs.
	13.2 Rate of spend compared to LTP		**3**	**2**	**3**	**3**	Rate of spend for on-site disposal accelerated relative to LTP.
	13.3 Stability of cost estimates		**3**	**4**	**3**	**2**	Disposal costs for LLWR most uncertain; other sites reflect level of third party dependence.
	Totals		***9***	***8***	***9***	***8***	
		3					
	Total less Group 7 scores		***100***	***110***	***94***	***104***	
	Overall Total		***109***	***118***	***103***	***112***	
	No. of 5s		0	2	0	2	
	No. of 0s		0	0	0	0	

	Weighting factor	No. sub-attributes	Incineration	On-site disposal in a purpose built facility	Dispose of vLLW separately to a national facility	Dispose to National LLWR near Drigg
UNWEIGHTED						
Group 1: Human health and safety	1	7	21	28	20	23
Group 2: Environmental impact	1	8	21	30	23	24
Group 3: Environmental objectives	1	7	21	21	17	20
Group 4: Technical	1	8	27	23	25	26
Group 5: Socio-economic	1	2	6	6	6	6
Group 6: Regulatory	1	1	4	2	3	5
Group 7: Financial	1	3	9	8	9	8
Overall unweighted total			**109**	**118**	**103**	**112**
TEAM WEIGHT						
Group 1: Human health and safety	10	7	30	40	29	33
Group 2: Environmental impact	10	8	26	38	29	30
Group 3: Environmental objectives	5	7	15	15	12	14
Group 4: Technical	8	8	27	23	25	26
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	5	1	20	10	15	25
Group 7: Financial	8	3	24	21	24	21
Overall team weighted total			**145**	**150**	**136**	**152**
TECHNOLOGY WEIGHT						
Group 1: Human health and safety	10	7	30	40	29	33
Group 2: Environmental impact	1	8	3	4	3	3
Group 3: Environmental objectives	1	7	3	3	2	3
Group 4: Technical	10	8	34	29	31	33
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	1	1	4	2	3	5
Group 7: Financial	10	3	30	27	30	27
Overall technology weighted total			**106**	**107**	**101**	**106**
ENVIRONMENTAL WEIGHT						
Group 1: Human health and safety	10	7	30	40	29	33
Group 2: Environmental impact	10	8	26	38	29	30
Group 3: Environmental objectives	10	7	30	30	24	29
Group 4: Technical	1	8	3	3	3	3
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	1	1	4	2	3	5
Group 7: Financial	1	3	3	3	3	3
Overall environmental weighted total			**100**	**118**	**94**	**105**
FINANCIAL WEIGHT						
Group 1: Human health and safety	1	7	3	4	3	3
Group 2: Environmental impact	1	8	3	4	3	3
Group 3: Environmental objectives	1	7	3	3	2	3
Group 4: Technical	1	8	3	3	3	3
Group 5: Socio-economic	1	2	3	3	3	3
Group 6: Regulatory	1	1	4	2	3	5
Group 7: Financial	10	3	30	27	30	27
Overall financial weighted total			**49**	**45**	**47**	**47**

Attributes	Sub-attributes	No. sub-attributes	Decontaminate to SoLA	On-site disposal in a purpose built facility	Dispose of vLLW separately in a national facility	Dispose to national LLWR near Drigg	Thermal treatment	Transfer to another site for processing and return to Chapelcross	Scoring Notes
Group 1: Human health and safety									
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**5**	**4**	**4**	**4**	**4**	Low probability of any off-site impact; greatest for decontamination to SoLA. All off-site transfers equivalent; on-site maximum.
	1.2 Rad accident risks		**4**	**5**	**4**	**4**	**3**	**4**	As above, except thermal treatment - additional potential accidental risk.
	1.3 Non-rad hazards and risks		**5**	**4**	**3**	**3**	**3**	**3**	SoLA decontamination non-hazardous operation; other options involve conditioning and transport except on-site which does not involve the transport component.
2. Public H&S collective	2.1 Routine radiation doses		**4**	**4**	**3**	**3**	**3**	**3**	Follows pattern of low individual doses.
3. Worker H&S individuals	3.1 Routine radiation doses		**4**	**4**	**4**	**4**	**4**	**4**	All options expected to lead to worker doses of 4 mSv per year or less (current practice).
	3.2 Rad accident risks		**4**	**4**	**4**	**4**	**4**	**4**	All involve similar levels of waste treatment - in low risk batch processes. High T higher risk but takes place elsewhere.
	3.3 Non-rad hazards and risks		**5**	**4**	**4**	**4**	**4**	**4**	All involve similar levels of handling (smelting workers not included in this consideration).
	Totals		***30***	***30***	***26***	***27***	***25***	***26***	
		7							
Group 2: Environmental impact									
4. Physical environment	4.1 Air quality		**4**	**5**	**4**	**4**	**4**	**4**	Decontamination wet operation to reduce aerial emmissions; conditioning processes similar for other options - on-site does not involve transport emissions.
	4.2 Water quality		**3**	**4**	**3**	**4**	**4**	**4**	Decontamination involves wet operations and liquid discharge (appropriately treated); Likely that vLLW facility less engineered than other disposal options - therefore potential for leachate.
	4.3 Land quality		**4**	**3**	**3**	**3**	**3**	**3**	Decontamination would take place in existing building; other options require additional land utilisation; high T returns very low volume so only single land use consideration involved for this option.
	4.4 Visual impact		**4**	**3**	**4**	**4**	**4**	**4**	Decontamination in existing building; on-site only option where there is a potential addition to visible buidlings on site.
	4.5 Nuisance		**4**	**3**	**3**	**3**	**3**	**3**	Decontamination benign process - some grinding noise; on-site disposal involves some noise and dust during placement of wastes - balancing the off-site transport involved in other options.
	4.6 Use of natural resources		**4**	**3**	**4**	**3**	**2**	**3**	Thermal treatment - energy intensive process; Containers and concrete required for LLW disposal options - not required for decontamination and vLLW options.
	4.7 Transport		**4**	**5**	**2**	**3**	**1**	**2**	Off-site disposal of wastes not required for on-site disposal; SoLA decontaminated waste could be disposed at local site; the vLLW site and 'other site' assumed to be more distant than LLWR; thermal treatment at greatest distance (Sweden).
5. Flora and fauna	5.1 Preservation of ecosystems		**4**	**4**	**3**	**4**	**3**	**4**	Related to off-site transport and level of engineering at waste disposal facility .
	Totals		***31***	***30***	***26***	***29***	***24***	***27***	
		8							
Group 3: Environmental objectives									
6. Environmental objectives	6.1 Waste volume		**4**	**3**	**3**	**3**	**4**	**3**	Decontamination and thermal treatment result in roughly equivalent reduction in the volume of LLW requiring disposal. Transfer to another site could include additional super-compaction which would then be scored similarly.
	6.2 Waste hierarchy		**4**	**1**	**1**	**1**	**4**	**3**	Transfer to another site given central score in recognition that it may be possible to recycle the product - although disposal also possibility.
	6.3 Hazard reduction		**4**	**3**	**3**	**4**	**4**	**4**	Related to disposal faciltiy engineering - on site least?
	6.4 Concentrate and contain		**4**	**3**	**3**	**3**	**4**	**3**	Decontamination and thermal treatment potential for concentration followed by appropriate containment; other options - containment only.
	6.5 Generation of secondary wastes		**3**	**4**	**3**	**4**	**4**	**4**	Decontamination and vLLW segregation give rise to greatest secondary waste - liquid efflent for decontamination and PPE for segregation.
	6.6 Greenhouse gas emmissions		**3**	**3**	**3**	**3**	**2**	**3**	Thermal treatment - use of high energy processes; other options neutral.
	6.7 Proximity principle		**5**	**5**	**2**	**3**	**1**	**2**	Decontamination and on-site disposal on-site - maximum; vLLW and 'other site' equidistant and further than LLWR. Thermal treatment at greatest distance.
	Totals		***27***	***22***	***18***	***21***	***23***	***22***	
		7							
Group 4: Technical									
7. Viability	7.1 Maturity of technology		**4**	**4**	**4**	**4**	**4**	**4**	All proven processes.
	7.2 Continued availability of option		**4**	**3**	**2**	**4**	**3**	**3**	Decontamination under site control; LLWR option available over necessary timescale (5 year authorisation period); Thermal treatment and transfer options exist but dependent on third party. Confident that on-site facility could be in operation within LTP - and more likely than construction of off-site vLLW facility.
	7.3 Throughput/capacity of option		**3**	**4**	**2**	**4**	**2**	**2**	On-site facility would be built with necessary capacity; no problems anticipated with LLWR during the timescale of 5 y authorisation period. Decontamination is dependent on workforce. The vLLW, thermal treatment and transfer to another site options likely to require segregation and capacities uncertain.
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**4**	**4**	**4**	**4**	**3**	**4**	There may be issues related to the thermal treatement requirements on metal type; LLWR disposal is current practice; decontamination requires development of appropriate sampling methodologies but once established - simple procedure; CfAs for other site and vLLW unlikely to be more onerous than LLWR.
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	**4**	**3**	**3**	Disposal at LLWR current baseline but difficult to achieve; others involve additional uncertainty.
	10.2 Minimising project risk to NDA		**3**	**3**	**2**	**4**	**2**	**2**	LLWR disposal baseline - others involve additional uncertainty - greatest for options dependent on third parties.
	10.3 Discharge of NDA liabilities		**4**	**2**	**3**	**4**	**3**	**3**	Decontamination involves reputational risk alone while disposal at LLWR implies prompt removal of waste from site books; on-site disposal implies long-term continuing liability; other options involve potential delays.
	10.4 Consistency with site End State		**5**	**2**	**3**	**5**	**4**	**4**	Decontamination and disposal at LLWR allow the end state to be achieved. Thermal treatment and transfers to another site options are available and does not affect the end state; disposal at the vLLW facility or on site imply potential or actual signicant departures from the end state - onsite greatest with additional on-site structure.
	Totals		***30***	***25***	***23***	***33***	***24***	***25***	
		8							
Group 5: Socio-economic									
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	**3**	**3**	**3**	No change
	11.2 Culture and heritage		**3**	**3**	**3**	**3**	**3**	**3**	No change
	Totals		***6***	***6***	***6***	***6***	***6***	***6***	
		2							
Group 6: Regulatory issues									
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**4**	**2**	**3**	**5**	**3**	**3**	LLWR disposal currently established process; decontamination - once policy for demonstration of SoLA agreed regulatory framework in place; Transfer, thermal treatment and vLLW require new practice to be established, while on-site disposal implies planning requirements in addition to authorisation considerations.
	Totals		***4***	***2***	***3***	***5***	***3***	***3***	
		1							
Group 7: Financial									
13. Financial cost	13.1 Total undiscounted cost		**3**	**2**	**3**	**3**	**3**	**3**	Disposal at LLWR - baseline; only on-site disposal likely to give rise to significant extra costs.
	13.2 Rate of spend compared to LTP		**3**	**2**	**3**	**3**	**3**	**3**	Rate of spend similar to baseline for all options with exception of on-site disposal - significant accelerated spend.
	13.3 Stability of cost estimates		**4**	**4**	**3**	**2**	**3**	**3**	Decontamination and on-site disposal are under site control; disposal at Drigg - significant fluctuations.
	Totals		***10***	***8***	***9***	***8***	***9***	***9***	
		3							
	Total less Group 7 scores		***128***	***115***	***102***	***121***	***105***	***109***	
	Overall Total		***138***	***123***	***111***	***129***	***114***	***118***	
	No. of 5s		4	5	0	1	0	0	
	No. of 0s		0	0	0	0	0	0	

	Weighting factor	No. sub-attributes	Decontaminate to SoLA	On-site disposal in a purpose built facility	Dispose of vLLW separately in a national facility	Dispose to national LLWR near Drigg	Thermal treatment	Transfer to another site for processing and return to Chapelcross
UNWEIGHTED								
Group 1: Human health and safety	1	7	30	30	26	27	25	26
Group 2: Environmental impact	1	8	31	30	26	29	24	27
Group 3: Environmental objectives	1	7	27	22	18	21	23	22
Group 4: Technical	1	8	30	25	23	33	24	25
Group 5: Socio-economic	1	2	6	6	6	6	6	6
Group 6: Regulatory	1	1	4	2	3	5	3	3
Group 7: Financial	1	3	10	8	9	8	9	9
Overall unweighted total			**138**	**123**	**111**	**129**	**114**	**118**
TEAM WEIGHT								
Group 1: Human health and safety	10	7	43	43	37	39	36	37
Group 2: Environmental impact	10	8	39	38	33	37	30	34
Group 3: Environmental objectives	5	7	19	16	13	15	16	16
Group 4: Technical	8	8	30	25	23	33	24	25
Group 5: Socio-economic	1	2	3	3	3	3	3	3
Group 6: Regulatory	5	1	20	10	15	23	15	15
Group 7: Financial	8	3	27	21	24	22	24	24
Overall team weighted total			**181**	**155**	**148**	**171**	**148**	**154**
TECHNOLOGY WEIGHT								
Group 1: Human health and safety	10	7	43	43	37	39	36	37
Group 2: Environmental impact	1	8	4	4	3	4	3	3
Group 3: Environmental objectives	1	7	4	3	3	3	3	3
Group 4: Technical	10	8	38	31	29	41	30	31
Group 5: Socio-economic	1	2	3	3	3	3	3	3
Group 6: Regulatory	1	1	4	2	3	5	3	3
Group 7: Financial	10	3	33	27	30	28	30	30
Overall technology weighted total			**128**	**113**	**108**	**121**	**108**	**111**
ENVIRONMENTAL WEIGHT								
Group 1: Human health and safety	10	7	43	43	37	39	36	37
Group 2: Environmental impact	10	8	39	38	33	37	30	34
Group 3: Environmental objectives	10	7	39	31	26	30	33	31
Group 4: Technical	1	8	4	3	3	4	3	3
Group 5: Socio-economic	1	2	3	3	3	3	3	3
Group 6: Regulatory	1	1	4	2	3	5	3	3
Group 7: Financial	1	3	3	3	3	3	3	3
Overall environmental weighted total			**134**	**122**	**107**	**120**	**111**	**114**
FINANCIAL WEIGHT								
Group 1: Human health and safety	1	7	4	4	4	4	4	4
Group 2: Environmental impact	1	8	4	4	3	4	3	3
Group 3: Environmental objectives	1	7	4	3	3	3	3	3
Group 4: Technical	1	8	4	3	3	4	3	3
Group 5: Socio-economic	1	2	3	3	3	3	3	3
Group 6: Regulatory	1	1	4	2	3	5	3	3
Group 7: Financial	10	3	33	27	30	28	30	30
Overall financial weighted total			**56**	**46**	**48**	**50**	**49**	**49**

Attributes	Sub-attributes	No. sub-attributes	Decontaminate to SoLA	Incineration	On-site disposal in a purpose built facility	Dispose of vLLW to a national facility	Dispose to national LLWR near Drigg	Scoring Notes
Group 1: Human health and safety								
1. Public H&S individuals	1.1 Routine radiation doses		**4**	**3**	**4**	**4**	**4**	
	1.2 Rad accident risks		**3**	**3**	**3**	**3**	**2**	
	1.3 Non-rad hazards and risks		**4**	**3**	**3**	**3**	**4**	Decontamination and disposal at LLWR near Drigg highest scoring due to limited off-site transportation.
2. Public H&S collective	2.1 Routine radiation doses		**4**	**3**	**4**	**3**	**3**	
3. Worker H&S individuals	3.1 Routine radiation doses		**3**	**3**	**3**	**3**	**3**	
	3.2 Rad accident risks		**3**	**2**	**4**	**3**	**3**	
	3.3 Non-rad hazards and risks		**3**	**3**	**3**	**3**	**3**	
	Totals		***24***	***20***	***24***	***22***	***22***	
		7						
Group 2: Environmental impact								
4. Physical environment	4.1 Air quality		**3**	**3**	**4**	**3**	**3**	Related to air quality arising from transport (on-site max score); incineration modified to be consistent with other options - abatement systems would be in place.
	4.2 Water quality		**3**	**3**	**4**	**4**	**3**	
	4.3 Land quality		**3**	**3**	**3**	**3**	**3**	All involve disposal or significant site - no differentiation.
	4.4 Visual impact		**3**	**2**	**2**	**4**	**2**	Incineration modified - large building but not necessarily on-site - equivalent to on-site disposal and disposal at LLWR near Drigg.
	4.5 Nuisance		**5**	**2**	**3**	**3**	**2**	
	4.6 Use of natural resources		**4**	**2**	**2**	**2**	**2**	Incineration is energy intensive; other disposal options requirements for aggregate and building materials.
	4.7 Transport		**4**	**3**	**5**	**3**	**3**	
5. Flora and fauna	5.1 Preservation of ecosystems		**3**	**3**	**2**	**4**	**3**	
	Totals		***28***	***21***	***25***	***26***	***21***	
		8						
Group 3: Environmental objectives								
6. Environmental objectives	6.1 Waste volume		**3**	**5**	**1**	**2**	**2**	
	6.2 Waste hierarchy		**5**	**4**	**2**	**2**	**1**	
	6.3 Hazard reduction		**5**	**3**	**2**	**2**	**2**	
	6.4 Concentrate and contain		**3**	**3**	**3**	**1**	**3**	
	6.5 Generation of secondary wastes		**2**	**2**	**5**	**3**	**4**	
	6.6 Greenhouse gas emissions		**3**	**2**	**4**	**4**	**3**	Relative scoring reflects - incineration energy intensive processes; Disposal at LLWR near Drigg and decontamination less energy intensive but more so than on-site disposal and vLLW.
	6.7 Proximity principle		**4**	**3**	**5**	**3**	**3**	
	Totals		***25***	***22***	***22***	***17***	***18***	
		7						
Group 4: Technical								
7. Viability	7.1 Maturity of technology		**3**	**4**	**2**	**2**	**4**	
	7.2 Continued availability of option		**3**	**3**	**3**	**3**	**4**	Consistent with scoring for metals - score for on-site disposal reflects fact that the facility does not yet exist.
	7.3 Throughput/capacity of option		**3**	**3**	**4**	**2**	**3**	vLLW facility does not exist but would be designed appropriately but under control of third party; on-site capacity would be under site control.
8. Nuclear Safety	8.1 Likelihood of meeting CFA		**3**	**3**	**4**	**2**	**4**	On-site score similar to metals - more likely than vLLW
10. Programme	10.1 Scheduling variance compared to LTP		**3**	**3**	**3**	**2**	**3**	
	10.2 Minimising project risk to NDA		**3**	**3**	**3**	**2**	**3**	
	10.3 Discharge of NDA liabilities		**4**	**4**	**2**	**3**	**4**	
	10.4 Consistency with site End State		**4**	**4**	**2**	**3**	**4**	
	Totals		***26***	***27***	***23***	***19***	***29***	
		8						
Group 5: Socio-economic								
11. Local community	11.1 Economic impacts		**3**	**3**	**3**	**3**	**3**	No change
	11.2 Culture and heritage		**3**	**3**	**3**	**3**	**3**	No change
	Totals		***6***	***6***	***6***	***6***	***6***	
		2						
Group 6: Regulatory issues								
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		**3**	**2**	**2**	**3**	**4**	
	Totals		***3***	***2***	***2***	***3***	***4***	
		1						
Group 7: Financial								
13. Financial cost	13.1 Total undiscounted cost		**3**	**3**	**2**	**3**	**3**	Disposal at LLWR near Drigg - baseline; on-site more expensive (construction costs) - other options similar.
	13.2 Rate of spend compared to LTP		**3**	**3**	**2**	**3**	**3**	On-site disposal requires accelerated expenditure
	13.3 Stability of cost estimates		**4**	**3**	**4**	**3**	**2**	Decontamination and on-site disposal are more under site control and less uncertain than other options; incineration depends on third party, but is less uncertain than LLWR disposal costs.
	Totals		***10***	***9***	***8***	***9***	***8***	
		3						
	Total less Group 7 scores		***112***	***98***	***102***	***93***	***100***	
	Overall Total		***122***	***107***	***110***	***102***	***108***	
	No. of 5s		3	1	3	0	0	
	No. of 0s		0	0	0	0	0	

	Weighting factor	No. sub-attributes	Decontaminate to SoLA	Incineration	On-site disposal in a purpose built facility	Dispose of vLLW to a national facility	Dispose to national LLWR near Drigg
UNWEIGHTED							
Group 1: Human health and safety	1	7	24	20	24	22	22
Group 2: Environmental impact	1	8	28	21	25	26	21
Group 3: Environmental objectives	1	7	25	22	22	17	18
Group 4: Technical	1	8	26	27	23	19	29
Group 5: Socio-economic	1	2	6	6	6	6	6
Group 6: Regulatory	1	1	3	2	2	3	4
Group 7: Financial	1	3	10	9	8	9	8
Overall unweighted total			**122**	**107**	**110**	**102**	**108**
TEAM WEIGHT							
Group 1: Human health and safety	10	7	34	29	34	31	31
Group 2: Environmental impact	10	8	35	26	31	33	26
Group 3: Environmental objectives	5	7	18	16	16	12	13
Group 4: Technical	8	8	26	27	23	19	29
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	5	1	15	10	10	15	20
Group 7: Financial	8	3	27	24	21	24	21
Overall team weighted total			**158**	**135**	**139**	**137**	**144**
TECHNOLOGY WEIGHT							
Group 1: Human health and safety	10	7	34	29	34	31	31
Group 2: Environmental impact	1	8	4	3	3	3	3
Group 3: Environmental objectives	1	7	4	3	3	2	3
Group 4: Technical	10	8	33	34	29	24	36
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	1	1	3	2	2	3	4
Group 7: Financial	10	3	33	30	27	30	27
Overall technology weighted total			**113**	**103**	**101**	**97**	**107**
ENVIRONMENTAL WEIGHT							
Group 1: Human health and safety	10	7	34	29	34	31	31
Group 2: Environmental impact	10	8	35	26	31	33	26
Group 3: Environmental objectives	10	7	36	31	31	24	26
Group 4: Technical	1	8	3	3	3	2	4
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	1	1	3	2	2	3	4
Group 7: Financial	1	3	3	3	3	3	3
Overall environmental weighted total			**118**	**98**	**108**	**100**	**97**
FINANCIAL WEIGHT							
Group 1: Human health and safety	1	7	3	3	3	3	3
Group 2: Environmental impact	1	8	4	3	3	3	3
Group 3: Environmental objectives	1	7	4	3	3	2	3
Group 4: Technical	1	8	3	3	3	2	4
Group 5: Socio-economic	1	2	3	3	3	3	3
Group 6: Regulatory	1	1	3	2	2	3	4
Group 7: Financial	10	3	33	30	27	30	27
Overall financial weighted total			**53**	**47**	**44**	**47**	**46**

Attributes	Sub-attributes	No. sub-attributes	Treatment and discharge	Discharge	Scoring Notes
Group 1: Human health and safety					
1. Public H&S individuals	1.1 Routine radiation doses		5	4	Discharge greater potential for public doses - difference reflects differentiation rather than magnitudes of impact.
	1.2 Rad accident risks		4	4	
	1.3 Non-rad hazards and risks		5	5	No off-site hazard foreseen.
2. Public H&S collective	2.1 Routine radiation doses		5	5	Routine doses small proportion of dose limit therefore limited potential for high collective dose.
3. Worker H&S individuals	3.1 Routine radiation doses		3	4	Greater handling with treatment operations.
	3.2 Rad accident risks		3	4	Greater handling with treatment operations.
	3.3 Non-rad hazards and risks		4	4	No significant hazard.
	Totals		***29***	***30***	
		7			
Group 2: Environmental impact					
4. Physical environment	4.1 Air quality		5	5	
	4.2 Water quality		4	3	
	4.3 Land quality		3	4	Reflects land take from new treatment and discharge plant.
	4.4 Visual impact		4	4	No change in visual impact off-site.
	4.5 Nuisance		4	4	No significant impact.
	4.6 Use of natural resources		3	4	Treatment - greater use of natural resources for running facility.
	4.7 Transport		4	4	
5. Flora and fauna	5.1 Preservation of ecosystems		4	4	Large volume into which discharged - insignificant impact.
	Totals		***31***	***32***	
		8			
Group 3: Environmental objectives					
6. Environmental objectives	6.1 Waste volume		3	3	
	6.2 Waste hierarchy		1	1	
	6.3 Hazard reduction		4	1	Discharge with no treatment disperses the hazard.
	6.4 Concentrate and contain		4	1	Discharge with no treatment disperses the hazard.
	6.5 Generation of secondary wastes		2	5	Treatment gives rise to wastes from abatement facility. Discharge in absence of treatment - no significant production of such wastes. Attribute primarily intended to reflect solid waste treatment processes. So scoring differs from other waste streams.
	6.6 Greenhouse gas emissions		4	4	
	6.7 Proximity principle		3	3	
	Totals		***21***	***18***	
		7			
Group 4: Technical					
7. Viability	7.1 Maturity of technology		5	5	Available technology (has been employed on site in past).
	7.2 Continued availability of option		3	5	Treatment requires additional treatment plant to be built on site.
	7.3 Throughput/capacity of option		3	4	
10. Programme	10.1 Scheduling variance compared to LTP		4	5	Treatment requires additional treatment plant to be built on site - possible within timeframe.
	10.2 Minimising project risk to NDA		3	4	Development and operation of treatment plant would divert resources from elsewhere.
	10.3 Discharge of NDA liabilities		3	5	Treatment results in residue and additional plant remaining on-site.
	10.4 Consistency with site End State		5	5	Treatment plant would be temporary and could be removed to provide full site-clearance.
	Totals		***26***	***33***	
		6			
Group 5: Socio-economic					
11. Local community	11.1 Economic impacts		3	3	
	11.2 Culture and heritage		3	3	
	Totals		***6***	***6***	
		2			
Group 6: Regulatory issues					
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance		4	4	Regulator has authorised the direct discharge route; development of treatment plant may require additional permissions (not significant to differentiate).
	Totals		***4***	***4***	
		1			
Group 7: Financial					
13. Financial cost	13.1 Total undiscounted cost		2	3	Discharge alone is the baseline. Treatment will result in additional costs.
	13.2 Rate of spend compared to LTP		2	3	Rate of spend accelerated by treatment plant development.
	13.3 Stability of cost estimates		3	3	Equally predictable.
	Totals		***7***	***9***	
		3			
	Total less Group 7 scores		***117***	***123***	
	Overall Total		***124***	***132***	
	No. of 5s		6	9	
	No. of 0s		0	0	

	Weighting factor	No. sub-attributes	Treatment and discharge	Discharge
UNWEIGHTED				
Group 1: Human health and safety	1	7	29	30
Group 2: Environmental impact	1	8	31	32
Group 3: Environmental objectives	1	7	21	18
Group 4: Technical	1	6	26	33
Group 5: Socio-economic	1	2	6	6
Group 6: Regulatory	1	1	4	4
Group 7: Financial	1	3	7	9
Overall unweighted total			**124**	**132**
TEAM WEIGHT				
Group 1: Human health and safety	10	7	41	43
Group 2: Environmental impact	10	8	39	40
Group 3: Environmental objectives	5	7	15	13
Group 4: Technical	8	6	35	44
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	5	1	20	20
Group 7: Financial	8	3	19	24
Overall team weighted total			**172**	**187**
TECHNOLOGY WEIGHT				
Group 1: Human health and safety	10	7	41	43
Group 2: Environmental impact	1	8	4	4
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	10	6	43	55
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	4
Group 7: Financial	10	3	23	30
Overall technology weighted total			**122**	**141**
ENVIRONMENTAL WEIGHT				
Group 1: Human health and safety	10	7	41	43
Group 2: Environmental impact	10	8	39	40
Group 3: Environmental objectives	10	7	30	26
Group 4: Technical	1	6	4	6
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	4
Group 7: Financial	1	3	2	3
Overall environmental weighted total			**124**	**124**
FINANCIAL WEIGHT				
Group 1: Human health and safety	1	7	4	4
Group 2: Environmental impact	1	8	4	4
Group 3: Environmental objectives	1	7	3	3
Group 4: Technical	1	6	4	6
Group 5: Socio-economic	1	2	3	3
Group 6: Regulatory	1	1	4	4
Group 7: Financial	10	3	23	30
Overall financial weighted total			**46**	**53**

APPENDIX F. BRIEFING MATERIALS FOR OPTIONEERING WORKSHOP

ENVIROS

TODAY'S BUSINESS TOMORROW'S WORLD

Chapelcross site-wide BPEO study

Briefing materials for optioneering workshop

February 2007

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CONTENTS

1. Introduction

Chapelcross Power Station ceased generation in 2004. Defuelling is underway and planned for completion by April 2009.

Initial decommissioning of the site is being undertaken in parallel with the defuelling. Redundant plant and buildings are being removed or made safe, and waste materials are disposed of or will be placed in a safe condition and location for interim storage.

This initial work will prepare the site for 'Care and Maintenance' where the reactor block and remaining wastes will be left in a safe state pending final site clearance. This work is planned to be completed in 2021.

Scottish Environment Protection Agency (SEPA) wishes to issue a revised multi-media discharge authorisation under the Radioactive Substances Act to reflect both the change in focus of site operations and an update to the issuing of discharge authorisations under the Radioactive Substances Act. As part of the authorisation revision British Nuclear Group anticipate that SEPA will require justification that the plans for the management of the wastes represent the Best Practicable Environmental Option (BPEO).

This workshop marks an initial phase of such supporting studies.

2. BPEO

The BPEO concept has been developed in the United Kingdom as a result of the work of the Royal Commission on Environmental Pollution (RCEP) who defined BPEO as follows in its Twelfth Report:

"... the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term."

A BPEO study is a particular example of the more general process of options appraisal. An options appraisal is an appraisal carried out by any person or organisation of a range of possible options for achieving a specified objective. A BPEO study is a particular form of options appraisal in which, given that waste creation has already been minimised, the waste disposal option is sought that achieves the minimum impact on the environment of the waste that is nevertheless

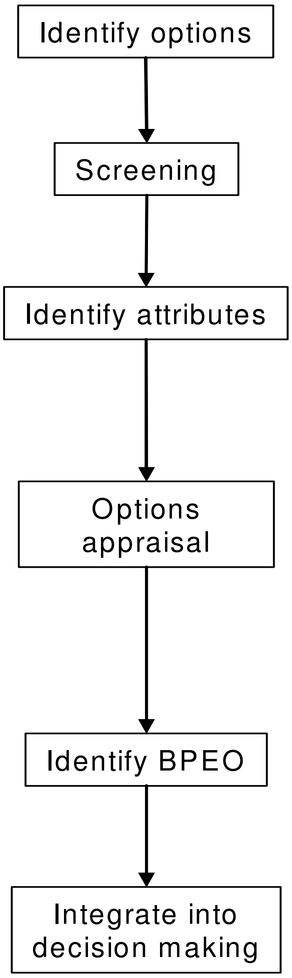
BPEO studies have the following attributes:

- The process is essentially strategic – it is geared towards identifying a preferred overall strategy from the perspective of the environment as a whole, as opposed to detailed optimisation of the selected scheme.
- A structured and systematic process is used to identify and compare strategic options. The presumption is that a BPEO study will generally be an open and transparent process, documented to make explicit the reasoning, data and assumptions.
- Alternatives are evaluated in terms of their projected implications for environmental quality. Consideration also needs to be given to questions of practicability (including financial costs and/or benefits, as well as wider social and economic considerations), as well as the overall strategic objectives, in order to reflect the wider context in which the decision is being taken.
- The process should involve consideration of environmental effects in both the short term and the long term, requiring consideration to be given to the relative importance of different indicators of environmental performance (e.g. short-lived versus persistent pollutants).

- Effects on the environment are not necessarily restricted to direct emissions of pollutants to land, air and water from the process (or activity) itself; life cycle considerations (such as energy demand) may also have a part to play in the decision process.

- There is an accent on consultation as an integral part of the study process – an informed study of alternatives necessarily involves taking into account the values and perspectives of a range of stakeholders.

The general methodology for BPEO studies follows a step wise appraisal of alternatives. The steps are:



- **Identification of options -** A broad list of options is drawn up and characterised in sufficient depth for initial screening.

- **Screening -** Decisions are made regarding the principles to be applied in deciding the criteria for screening out options from further consideration, and then the criteria themselves are defined. The criteria are applied in order to select a short list of options from the initial broad list of alternatives.

- **Selection of attributes -** The principles to be applied in deciding the attributes against which options are to be compared need to be decided, and then the attributes themselves.

- **Options analysis -** Each option on the short list is evaluated against each attribute. The results of the evaluation are recorded either as a ranking (e.g. best to worst) or a numerical 'score'.

- **Weighting factors -** Weightings may be applied to each attribute to reflect its relative importance in establishing a preferred option. If used as part of the analysis, weightings need to be systematically derived and justified. Alternative weighting sets can be used to test the sensitivity of the conclusions to different perceptions of relative importance (e.g. in order to reflect the perspectives of different stakeholder groups).

- **Identification of the BPEO -** A 'logic flowchart' based on the results of option analysis and application of weighting factors identifies the BPEO. If a numerical scoring system is used, the top scoring option may be the starting point, but the conclusion may still be that this is not the BPEO.

- **Integration into decision making -** Identification of the BPEO is an important input to strategic decision making. In practice, however, few decisions are made solely on the basis of such a study. The selection and approval of a preferred option may be modified by other factors that are not taken directly into account in the BPEO study. These other factors may include political considerations or the results of more detailed safety, economic and technical optimisation studies.

Stakeholder participation in the BPEO process is important because of:

- The technical and societal significance of the decision.

- The information that stakeholders can bring to the process.

- The extent to which sensitivity analysis to examine the effect of different perspectives is to be included.

- The extent to which stakeholder 'ownership' of the process is an objective.

Stakeholder involvement and consultation requirements should be identified and the objectives defined at an early stage in the process. The environment agencies' BPEO guidance emphasises that as an important part of a BPEO exercise '*the format for stakeholder interaction within the*

BPEO study should be designed to emphasise collaborative working'. Furthermore, the Guidance continues that '*it is generally more effective to obtain and use stakeholder input when communication has started early in the process*'.

Whilst stakeholder input and views are not a basis in themselves for selecting the BPEO, they provide information and insight to support the decision making process.

For the BPEO study to be robust, and to ensure it gains the confidence of the regulators and wider stakeholder groups, the study should address a number of principal issues in the following ways:

- it must demonstrate that it is founded on a thorough understanding of current UK and international best practice in waste management and of likely future technological developments, as well as the overlapping health and safety, and environmental regulations that apply to the management of radioactive and non-radioactive wastes on a nuclear licensed site;
- that it takes account of recent and relevant experience in options studies as applied to the development of complex and optimised strategies for the management of multiple wastestreams, as well as the appropriate guidance on the subject; and
- shows a full appreciation of the role and expectations of various stakeholders in the BPEO process, how BPEO fits within a wider context of making a business case and informing the site Integrated Waste Strategy, and the need to ensure the entire process is transparent and auditable.

3. Chapelcross Decommissioning waste streams

The waste groups to be considered within the study are those arising from Care and Maintenance preparations:

- Intermediate Level Waste (ILW)[1] but also including that generated during the operational lifetime of the reactors
- Low Level Waste (LLW)[2]

4. Constraints on waste management

The management of wastes on a nuclear licensed site must conform to the appropriate health and safety, and environmental regulations, and to the conditions of the permits granted by the regulators. The primary legislative instruments that control the management of radioactive and non-radioactive waste respectively are the Nuclear Installations Act 1965 (NIA'65), the Radioactive Substances Act 1993 (RSA'93) and the Environmental Protection Act 1990 (EPA'90) with its associated regulations.

A key consideration in the management of waste at Chapelcross is the determination of which regulations apply to each wastestream and treatment.

4.1.1 Radioactive wastes

There are 2 standard licence conditions under NIA'65 that affect the management of radioactive wastes and which will need to be considered:

- *Licence Condition 32: Accumulation of radioactive waste*. The purpose of this licence condition is to ensure that the production rate and accumulation of radioactive waste on the site is minimised, held under suitable storage arrangements, and that adequate records are made.

[1] Waste with radioactivity levels which exceed the upper boundary for low-level waste, but which does not generate significant amounts of heat.
[2] Waste which contains radioactive materials which do not exceed 4 GBq/tonne alpha or 12 GBq/tonne beta/gamma activity.

- *Licence Condition 33: Disposal of radioactive waste*. The purpose of this licence condition is to give discretionary powers to NII in order to direct that radioactive waste is disposed of in a specified manner. This is related to the similar powers available to the environment agencies under RSA'93. Such disposals will need to be in accordance with the authorisations granted under RSA'93.

The management of all waste arising on a nuclear site will also be subject to the requirements of RSA'93 unless it can be demonstrated to the satisfaction of the regulators that the wastes are radioactively clean or excluded from the Act. In general wastes which do not fall under the scope of RSA'93 will fall under the scope of EPA'90.

Additionally, some forms of radioactive waste may be released from certain requirements of RSA'93 such as wastes subject to Exemption Orders. The key exemption order to be recognised in the BPEO process at Chapelcross is the Radioactive Substances (Substances of Low Activity) Exemption Order 1986 (as amended), known as the SoLA Exemption Order. The appropriate use of SoLA exemption is a primary tool in decommissioning waste management to avoid sentencing some forms of very lightly contaminated or activated wastes to the LLW disposal facility at Drigg, where disposal space is limited and disposal costs are high. The industry has published a 'Code of Practice on Clearance and Exemption' that sets out guidance on how this may be best achieved. The Radioactive Substances (Phosphatic and Rare Earths etc.) Exemption Order 1962, known as the PSRE Exemption Order may also apply to certain wastestreams at Chapelcross containing only naturally occurring radionuclides.

RSA'93 sets out the regime which controls the keeping and use of radioactive materials, and the accumulation and disposal of radioactive waste. Sections 13 and 14 of RSA'93 require the disposal and accumulation of radioactive waste to be carried out in accordance with an Authorisation granted by the competent authorities which, for Chapelcross, is SEPA. The requirement for British Nuclear Group to undertake a BPEO of its decommissioning wastes will be exercised under this Act.

Any option that is adopted must meet the appropriate regulatory controls, and both BPEO and BPM must be applied to ensure that radioactive wastes are not generated unnecessarily and that those arisings that do occur are either reused or recycled in preference to being disposed. Although BPM and optimisation issues are outside of the scope of this study, they must still be borne in mind given the costs of abating discharges from certain types of waste conditioning and processing plants which, in some circumstances, may not be proportional to the benefits they offer. There are complexities around demonstrating proportionality (cost benefit) in both BPEO and BPM and guidance exists for SEPA on this topic.

4.1.2 Non-radioactive wastes

EPA'90 defines and contains provisions for controls on *controlled waste* under Part II, notably Section 33 (Prohibition of unauthorised treatment or disposal) and Section 34 (Duty of care). The Act prohibits the unlicensed management or disposal of waste and requires that a waste management licensing system is established.

Various regulations under EPA'90 will apply to the management and disposal of wastes arising on the Chapelcross site. Which set of regulations apply depends, in part, on the physical and chemical properties of the waste, its potential for causing harm to the environment, and the manner in which the waste is planned to be disposed. The relevant regulations are:

- Waste Management Licensing Regulations 1994 (WML Regulations) which sets-out the waste management licensing regime and related provisions required under EPA'90.

- Controlled Waste Regulations 1992 which define in more detail the categories of controlled waste

- Waste Management Regulations 1994 which make amendments of a mainly administrative nature to other regulations

– The Landfill (England and Wales) Regulations 2002 which implement the EU Landfill Directive 1999 and set out the requirements for the classification and management of landfill sites

– The Hazardous Waste (England and Wales) Regulations 2005 which detail requirements covering the production, movement, receipt and disposal of hazardous waste and replace the Special Waste Regulations 1996

– The EU Waste Oil Directive 1987 which aims to promote the safe collection and disposal of waste oils

– The Waste Electrical and Electronic Equipment Regulations 2006

Waste which is *exempt* under any of the Exemption Orders associated with RSA'93 remains radioactive for the purposes of regulation provided that it is not excluded by Schedule 1 of RSA'93. Exempt waste is not, therefore, subject to the WML Regulations but if its properties make it a special waste (e.g. radioactively contaminated asbestos) then it is subject to the Hazardous Waste Regulations. It is good industry practice to treat exempt waste which is not hazardous waste as if it were controlled waste, although this is not mandatory under legislation

Waste which is *clean* or *excluded* is not radioactive for the purposes of regulation and is subject to control as a controlled or special waste according to its other properties and is subject to the WML Regulations. The WML Regulations define a waste as either:

– discarded, disposed or got rid of by the holder, or

– intended to be discarded, disposed or got rid of by the holder, or

– required to be discarded, disposed or got rid of by the holder.

Schedule 3 of the WML Regulations lists a number of activities which are exempt from waste management licensing, and two of these may be applicable to waste management at Chapelcross and will need to be considered within the context of the site waste BPEO:

– *land reclamation* the spreading of waste consisting of soil, rock, ash or waste arising from construction or demolition work may be deposited on land in connection with the reclamation or improvement of that land subject to certain conditions; and

– *reuse and recycling* for the manufacture of specified materials from specified wastes, all of which are related to construction.

To determine a comprehensive BPEO which covers all wastestreams on the Chapelcross site, clear consideration is needed of the chemical and physical properties, including whether the waste is radioactive or hazardous. This initial consideration lays the foundation for the identification of options for each of the waste streams. For example certain properties of the waste may constrain the options available and consideration of the waste streams at an early stage in the BPEO should aim to exclude options which are clearly inappropriate. Consideration of the properties of the waste also feeds into the development of the screening criteria as it informs decisions about which legislation or policies are relevant and the constraints they impose.

5. Optioneering workshops

These first set of optioneering workshops would be intended to:

- confirm the materials assigned to each waste group
- draw-up a long-list of management options for each wastestream;
- draw-up a list of screening criteria;

- undertake a screening exercise to draw-up a short-list of options for more detailed assessment in the second round of assessments;
- draw-up an initial list of assessment criteria (attributes); and
- identify the information needs to enable the detailed assessment to be undertaken.

Each workshop will ensure that the initial long-list of management options is comprehensive, so as to meet the expectations of the regulators. Then the workshop will progress to consider screening so as to define a short-list of options that could be applied to each group of wastes. Screening will be based on fundamental yes/no decisions and should not, therefore, be subjective. A typical example of a screening criterion is consistency with UK law.

Once the waste groupings and short lists of options for each group are defined, it will be necessary to draw-up a preliminary list of assessment criteria (attributes) against which the performance of each option will be assessed. In parallel with these, consideration will need to be given to the information needs. As an example, a typical assessment criterion is capital cost and, therefore, an example of an information need is the construction cost of different types of waste treatment plant.

6. Subsequent work

Following these optioneering workshops the following tasks will be undertaken as part of the project

- Development of information for assessment workshops
- Convening of assessment workshops to score options
- Documentation of workshops

The anticipated end date for this project is 30th March 2007.

Waste material name	Current location	Total amount	Description
LLW			
Operational waste			
CXPP tritiated waste	CXPP	4 m^3	Stored in alkathene containers in 205 l drums. Not suitable for super compaction as H-3 may be released
Reactor and associated areas LLW		74 m^3	Stored in 205 l drums
Cooling ponds LLW		6.4 m^3	Stored in 205 l drums
Large Items from Reactor Areas		892.0 m^3	Wrapped and stored in HHISO
Large items from Cooling Ponds		15.6 m^3	Wrapped and loose stored in HHISO
UO_3 contaminated LLW		16.0 m^3	Stored in 205 l drums
Oils	Tank farm	164.5 m^3	Stored in four mild steel tanks
Hydraulic fluids	B151	0.9 m^3	Stored in stainless steel drums. Unsuitable for further treatments
C&M preps waste			
Reactor LLW		4370.6 m^3	Not suitable for super compaction
Ponds LLW		2330.0 m^3	Not suitable for super compaction
Active effluent pipeline concrete LLW		1335.0 m^3	Not suitable for super compaction
Active effluent pipeline steel LLW		28.0 m^3	Not suitable for super compaction
North site LLW		270.0 m^3	Not suitable for super compaction
CXPP dismantling LLW		325.0 m^3	Not suitable for super compaction
ILW			
Operational waste			
Miscellaneous Activated Components	Storage building	1.5 m^3	Activated components comprising compacted ?liners? dry stored in stainless steel containers.
Miscellaneous Reactor Components	Cooling ponds	38.6 m^3	Activated components comprising ??. Stored in skips.
Ion exchange resins	Fuel storage ponds	48.8 m^3	Spent AW500 zeolite ion exchange resins
Sludges	Cooling ponds	8 m^3	Stored in skips
CXPP ceramic pellets		9.7 m^3	Dry stored in stainless steel cans in temporary storage vessels

Waste material name	Current location	Total amount	Description
Contaminated plant components	Storage building	3.6 m^3	Stored in disposable flask liners.
Rotary Pump Oil	Storage building	0.25 m^3	Stored in stainless steel cans
Miscellaneous βγ waste	Storage building	25.3 m^3	Stored in boxes
Skip decontamination sludge ponds R1 & R2	Ponds R1 & R2?	4 m^3	
Fuel skips in ponds R1 & R2	Ponds R1 & R2?	200 m^3	
Dessicant		4 m^3	
C&M preps waste			
CXPP Dismantling ILW		237.0 m^3	

APPENDIX G. BRIEFING MATERIALS FOR ILW SCORING

Scoring workshop – ILW briefing materials

Objective:

To score the potential management options for ILW identified within the study and to determine the BPEO.

Stages:

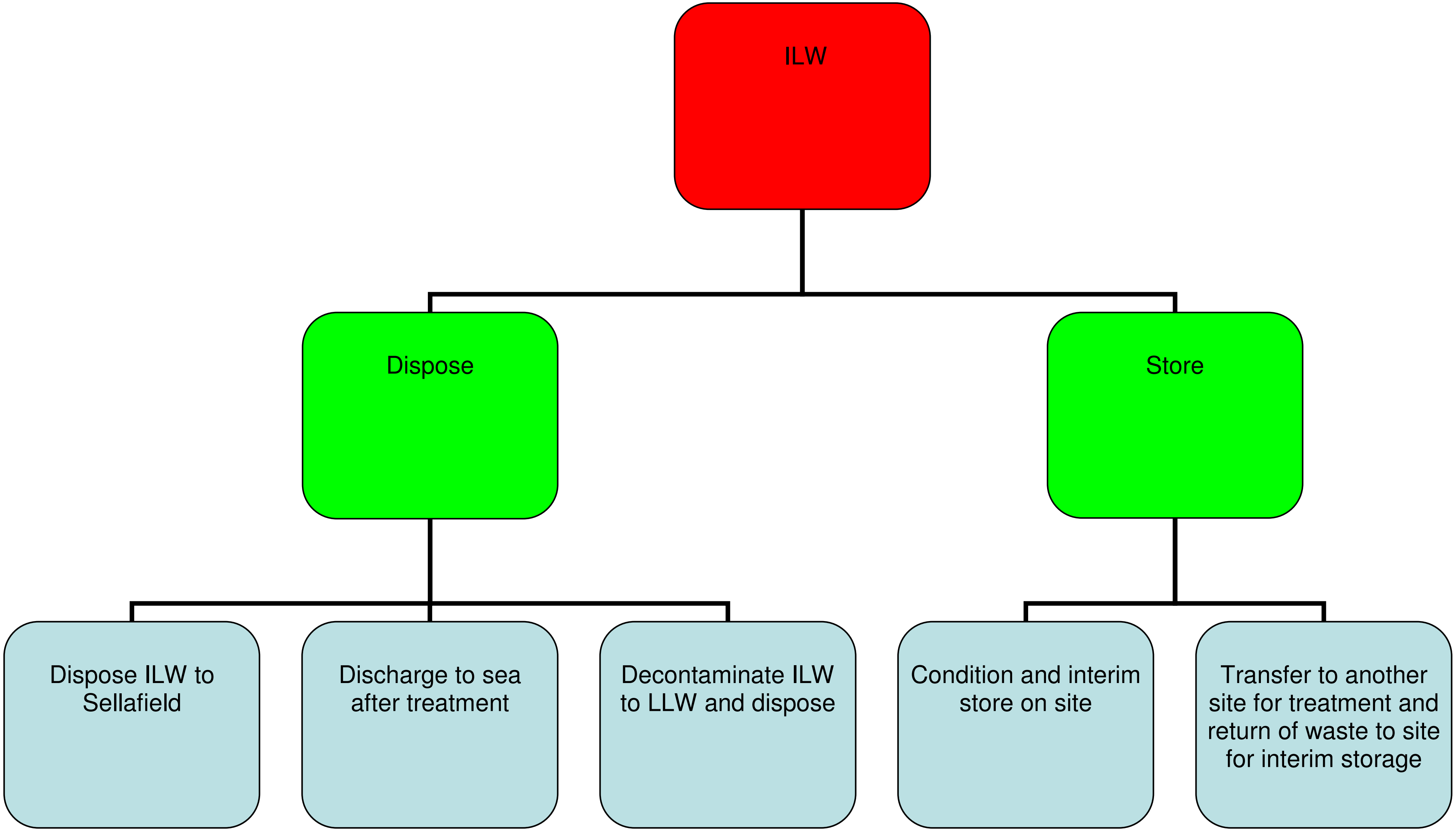
1. Review the options and their definitions
2. Review the screening criteria and then screen out any options that are not viable
3. Review the attributes and their calibration schemes
4. Score the options
5. Agree and apply weighting schemes
6. Determine the BPEO

Julie Tooley, Carol Robinson and Gavin Thomson
Enviros Consulting
1 March 2007

Waste groupings for ILW
To ensure the BPEO is comprehensive yet manageable certain ILW waste streams have been grouped.

	Segregatable	Metal	Ceramics	Magnox sludges	Sludges	Resins	Aggregate	Magnox	Magnox & Graphite	Dessicant	Oils & Oily wastes	Cellulose
Operational waste												
Miscellaneous Activated Components	✓	✓										
Miscellaneous Reactor Components	✓	✓							✓			✓
Ion exchange resins	X					✓						
Sludges	X			✓								
CXPP ceramic pellets	X		✓									
Contaminated plant components	✓	✓										✓
Rotary Pump Oil	X										✓ (with vermiculite)	
Misc BG waste		✓						✓				
Fuel skips in ponds 1 & 2	✓	✓										
Pond skip decontamination sludges					✓							
Dessicant	X									✓		
Spent furnaces	✓	✓										
Spent sources	X											
C&M Preps												
CXPP Dismantling ILW	✓	✓					✓					

Flowchart for options for the management of ILW



Options for management of ILW

Principles:

- All waste will be sorted and segregated and decontaminated then conditioned by some process
- Wastes with similar characteristics can be grouped

	Decontaminate ILW to LLW	Condition and interim store ILW	Treatment and discharge to sea	Transfer to another site	Dispose of ILW to Sellafield	No. of Options
Metal	✓	✓		✓	✓	4
Ceramics		✓		✓	✓	3
Magnox sludges		✓			✓	2
Sludges		✓			✓	2
Aggregate	✓	✓				2
Resins		✓		✓		2
Magnox		✓	✓	✓	✓	4
Magnox and Graphite		✓		✓	✓	3
Dessicant		✓		✓	✓	3
Oily waste		✓		✓	✓	3
Cellulosic		✓		✓	✓	3

Description of options

Dispose

Dispose ILW to Sellafield

Waste would be packaged suitability and conditioned and then disposed by transfer to Sellafield where it is placed in the miscellaneous beta gamma waste store.

Discharge to sea after treatment

This option relates to the dissolution of Magnox Fuel Element Debris (FED) in carbonic acid followed by treatment to ensure compliance with the sites RSA93 authorisation then discharge to sea.

Decontaminate ILW to LLW and dispose to LLWR near Drigg

Decontamination of ILW using wet or dry techniques to remove loose or surface contamination resulting in waste complying with LLW activity limits and meeting CFA for the LLWR near Drigg.

Store

Condition and interim store on site

Waste would be conditioned to passive safety and stored in an interim store on site. This would require the granting of a LoC and the building of an interim store.

Transfer to another site for treatment and return of waste to site for interim storage

This option would involve transfer to another UK Nuclear Licensed Site where it would be conditioned to passive safety. The conditioned waste product would be returned to Chapelcross for interim storage. This would require the granting of a LoC and the building of an interim store.

Screening criteria

Derived from regulation

Criterion	Name	Description
1	London Convention	Disposal of solid radioactive waste at sea is suspended indefinitely.
2	OSPAR Convention	Waste producers are required to take all possible steps to reduce concentrations of natural radionuclides in the north eastern Atlantic to close to background, and close to zero for artificial radionuclides, by 2020.
3	Groundwater Regulations	The disposal of liquid wastes containing certain listed substances into groundwater is forbidden by the Groundwater Regulations.
4	Dose limits	The annual individual dose to members of the public must not exceed 1 mSv/yr. Doses to workers are limited to 20 mSv/yr averaged over five years (other limits also apply).

Derived from Government policy and guidance

5	Waste import and export	Radioactive waste may only be exported to (or imported from) elsewhere in small quantities and under special conditions.

Attributes

Relevant attributes developed at the optioneering workshop

Attribute group and attribute	Sub-attribute
Human health and safety:	
1. Public health and safety (individuals)	1.1 Routine radiation doses 1.2 Radiological accident risks 1.3 Non-radioactive hazards and risks
2. Public health and safety (societal collective dose)	2.1 Routine radiation doses
3. Worker health and safety (individuals)	3.1 Routine radiation doses 3.2 Radiological accident risks 3.3 Non-radioactive hazards and risks
Environmental impact:	
4. Physical environment	4.1 Air quality 4.2 Water quality of receiving body 4.3 Land 4.4 Visual impact 4.5 Nuisances (noise, light, dust, odour, vibration) 4.6 Use of natural resources 4.7 Transport
5. Flora and fauna	5.1 Preservation of ecosystems
6. Environmental objectives	6.1 Waste volumes 6.2 Waste hierarchy 6.3 Hazard reduction rate 6.4 Concentrate and contain 6.5 Generation of secondary wastes 6.6 Greenhouse gas emissions 6.7 Proximity principle
Technical:	

7. Viability	7.1 Maturity of technology 7.2 Continued availability of option 7.3 Throughput/capacity of option
8. Nuclear safety	8.1 Likelihood of meeting CfA
9. Flexibility	9.1 Foreclosing of options
10. Programme	10.1 Scheduling variance compared to LTP 10.2 Minimising project risk to NDA 10.3 Discharge of NDA liabilities 10.4 Consistency with site end state
Socio-economic:	
11. Local community	11.1 Economic impacts 11.2 Culture and heritage
Regulatory issues:	
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance
Financial cost:	
13. Overall cost	13.1 Total undiscounted cost 13.2 Rate of spend compared to LTP 13.3 Stability of cost estimates

Scoring criteria

In the absence of appropriate data on the performance of some options, only the calibration of scores 0 and 5 has been provided. Scores 1 – 4 can be awarded on the basis of expert judgement on the relative performance of options against the 0 and 5 requirements, and relative performance between options.

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
1. Public health and safety (individuals)		
1.1 Routine radiation doses	Difficult to demonstrate doses <1 mSv y^{-1} (Basic Safety Limit – BSL)	Easy to demonstrate doses <10 $\mu Svyr^{-1}$ ('below regulatory concern')
1.2 Radiological accident consequences	Unacceptably high consequence	Low consequence
1.3 Non-radioactive hazards and risks	Difficult to demonstrate risk $<10^{-4}$ yr^{-1}	Easy to demonstrate risk $<10^{-6}$ yr^{-1} ('below regulatory concern')
2. Public health and safety (societal collective dose		
2.1 Routine radiation doses	Difficult to demonstrate doses <100 person Sv	Easy to demonstrate doses <1 person Sv
3. Worker health and safety (individuals)		
3.1 Routine radiation doses	Difficult to demonstrate doses <20 mSv y^{-1} (Basic Safety Limit – BSL)	Easy to demonstrate doses <2 mSv y^{-1} (Basic Safety Objective – BSO)
3.2 Radiological accident consequences	Unacceptably high consequence	Low consequence
3.3 Non-radioactive hazards and risks	Difficult to demonstrate risk $<10^{-3}$ yr^{-1} (largest tolerated risk where activity is crucial for society and economy)	Easy to demonstrate risk $<10^{-5}$ yr^{-1} (consistent with typical 'safe' practice in non nuclear industry)
4. Physical environment		
4.1 Air quality	Persistent objectionable substances in air in buildings off site	No discernible reduction in air quality
4.2 Water quality	Sterilisation of water resource off site or affects ability to reach site end-point	No discernible reduction in water quality
4.3 Land quality	Sterilisation of substantial area of land off site or affects ability to reach site end-point	No discernible reduction in land quality
4.4 Visual impact	Construction completely out of keeping with existing landscape	No discernible visual impact

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
4.5 Nuisances (noise, light etc)	Long-term disturbance/disruption of local life	No outward signs of the material management scheme
4.6 Use of natural resources	Unacceptably high use of resources and practice not sustainable	Limited use of resources and managed in a sustainable way
4.7 Transport	Unacceptably high increase in off site transport operations	No increase in off site transport operations
5. Flora and fauna		
5.1 Preservation of ecosystems	Complete loss of natural ecosystem	No discernible reduction in quality of the natural ecosystem
6. Environmental objectives		
6.1 Waste volume	Unacceptably high volumes of waste generated	Lowest volumes of waste generated
6.2 Waste hierarchy	Inconsistent with waste hierarchy and no material is reused or recycled, and there is no possibility that it ever can be	Consistent with waste hierarchy and all material is reused and none disposed
6.3 Hazard reduction	No reduction in hazard or hazard is increased over the long term	Hazards associated with the materials are reduced to a minimum, as rapidly as feasible
6.4 Concentrate and contain	Radioactivity is dispersed to the wider environment and no long remains under engineering or management control	Radioactivity is contained by passive engineered systems, and remains under management controls
6.5 Generation of secondary wastes	Large amounts of secondary waste produced far in excess of original waste volume	Limited secondary waste produced
6.6 Greenhouse gas emissions	Increase in greenhouse gas emissions	Reduction in greenhouse gas emissions [N.B. Score of 3 = no change]
6.7 Proximity principle	Waste management option undertaken at distant location	Waste management option undertaken on-site
7. Viability		
7.1 Maturity of technology	Unproven and not achievable with existing technology in timescale of LCBL	Established approach, with good track record and applied under similar circumstances.
7.2 Continued availability of option	Not existing and could not be procured in timescale of LCBL	Existing and is available

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
7.3 Throughput/capacity of option	Throughput or capacity is very low and will adversely affect LTP	Throughput or capacity meets or exceeds demand and results in no impact on LTP
8. Nuclear safety		
8.1 Likelihood of meeting Conditions for Acceptance	Significant dialogue required to meet Conditions for Acceptance	Conditions for Acceptance previously meet for similar wastestream
9. Flexibility		
9.1 Foreclosing of options	Once implemented, no possibility for reversible steps or retrieval of material	Flexible option that allows for reversibility and easy retrieval of material
10. Programme		
10.1 Scheduling variance compared to LTP	Would cause substantial delays to activities on site that lie on critical path, causing failure to meet LCBL objectives and timescales	Can be achieved independently of other activities on site and without impacting on the timing and ordering of other activities
10.2 Minimising project risk to NDA	Significant project risk to NDA	No additional project risk to NDA
10.3 Discharge of NDA liabilities	NDA liabilities increase in scale or in time	NDA liabilities significantly reduced in scale or period of liabilities significantly shortened
10.4 Consistency with site end state	Completely inconsistent with defined site end state	Consistent with defined site end state
11. Local community		
11.1 Economic impacts	Collapse of local economy	Major enhancement to the local economy [NB Score of 3 = no change]
11.2 Culture and heritage	Collapse of local community through depopulation	Major enhancement of local community [NB Score of 3 = no change]
12 Acceptability		
12.1 Likelihood of gaining regulatory acceptance	Significant dialogue required to gain approval	Demonstrable precedent exists
13. Overall cost		
13.1 Total undiscounted cost	Significant undiscounted cost above LTP cost estimates	Undiscounted cost likely to remain within LTP cost estimates [NB Score of 3 = no change]
13.2 Rate of spend compared to LTP	Significantly different to LTP cash flow forecast	Likely to remain within LTP cash flow forecast

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
		[NB Score of 3 = no change]
13.3 Stability of cost estimates	Cost estimates highly unstable	Cost estimates highly stable

Scoring

Score each of the 11 waste groups (Metal, Ceramics etc…) on separate Excel spreadsheets using the attributes and scoring schemes presented above. A master version for ILW is provided electronically, create one for each waste group using Save As noting that not all management options are relevant to all waste groups (an example for Metals is also provided).

Please return to gavin.thomson@enviros.com by close of play 9th March 2007.

Weighting schemes

Weightings are usually applied to the total scores for each attribute group, and often normalised to take account of the number of sub-attributes in each group to avoid biasing those with the most sub-attributes.

Example: If the unweighted score for an option in the Technical attribute group is 25, the chosen weighting factor is 10, and there are 6 sub-attributes in the group, then the normalised weighted score for the group is (25 x 10) / 6 = 41.7 (to 1 decimal place)

The weighting schemes applied the Chapelcross wastes option study were.

Attribute group	Enviros Team Weighting	Technology position	Environmental position	Financial position
1. Human health	5	10	10	1
2. Environmental impact	5	1	10	1
3. Environmental objectives	5	1	10	1
4. Technical	5	10	1	1
5. Socio-economic	5	1	1	1
6. Stakeholder issues	1	1	10	1
7. Financial cost	1	10	1	10

Determine the BPEO

The BPEO may be determined by comparing:

- the total unweighted scores for the options (which gives the highest score ?)
- the total unweighted scores, less costs, for the options (which gives the highest score without cost bias ?)
- the number of scores of 0 and 5 awarded to each option (which performs well across all attributes ?)
- the various total weighted scores for the options, and the sensitivity to the weighting factors (is the ranking robust to weighting ?)

Determining the preferred management strategy

The determination of a BPEO is only one factor that should be taken into account when choosing a management strategy, for example:

- An option that performs ***better*** environmentally than the BPEO could be adopted if there are other business factors to take into account (e.g. to protect or to foster the environmental reputation of the organisation – the 'Brent Spar' example).

- An option that performs ***marginally worse*** than the BPEO could be adopted if there is a large financial saving to be made and the environmental performance of the adopted option still meets appropriate constrains and conditions (the proportionality argument)

ILW waste material description

Waste material name	Current location	Total amount	Description
Operational waste			
Miscellaneous Activated Components	Reactors and Ponds	1.5 m^3 (amount thought to be rather low- PJ to check)	Activated components including stainless steel compacted liners dry stored in stainless steel containers, shield plugs and coupling. Various components will be left in the reactor including: control rods, boron balls, and neutron sources (latter may be LLW). It was confirmed that there was no FED.
Miscellaneous Reactor Components	Reactors (90%) and Cooling ponds (10%)	38.6 m^3	Activated components include reactor furniture (2-3 m^3); holding down weights, support struts, and thermocouples. Mainly steel but some magnox and Al cladding and graphite materials. Stored in skips (wet and dry storage).
Ion exchange resins	Fuel storage ponds	48.8 m^3	Spent AW500 zeolite ion exchange resins. 48 spent resin components in storage and up to another 12 in use.
Sludges	Cooling pond building	8 m^3	Sludges containing corrosion products from the ponds. Corrosion products from ponds. Around 2 m^3 is stored in skips; the remainder is in detention tanks.
CXPP ceramic pellets		9.7 m^3 18.5 m^3 (may include materials at Harwell)	Dry stored in 2020 bottles and stainless steel cans in temporary storage vessels. BM and PJ checking these figures.
Contaminated plant components	CXPP	3.6 m^3	Includes tritium contaminated steel plant (pipes, valves, etc) and graphite. Stored in disposable flask liners.

Waste material name	Current location	Total amount	Description
Rotary Pump Oil	CXPP	Max 0.5 m^3	Tritium contaminated oil. Stored in stainless steel cans
Fuel skips in ponds 1 & 2	Ponds 1 & 2	200 m^3	190 skips of mild steel with Cs surface contamination present in the paint. This could be cleaned by jet washing – possibly to LLW levels.
Dessicant	Reactor building	0.4 m^3	800 kg Al in the form of pellets, heavily loaded with tritium in humidriers; no activity assessment at moment.
Spent furnaces	CXPP	6 units (0.25 m3)	Tritium and depleted uranium contamination. Composed of a steel outer case and uranium inner lining.
Spent sources	Health Physics source store	97	Sources with maximum activity of 300 Bq each. Possibility of being disposed of as LLW.
C&M preps waste			
CXPP Dismantling ILW		237.0 m^3	POCO and plant cleanout wastes e.g. vacuum furnace, pipework. Materials include stainless steel some alloys, plastic, o-rings and stack pumps with tritium and some activation product contamination. Rotary and diffusion pumps and motors may also be contaminated – these have yet to be tested (this would presumably increase the volume for disposal)
Heat Exchanger dismantling		Amounts?	It is possible that the heat exchanger components may be contaminated with graphite dust. If so, would be considered as ILW (contamination levels to be verified by testing).

APPENDIX H. BRIEFING MATERIALS FOR LLW SCORING

Scoring workshop – LLW briefing materials

Objective:

To score the potential management options for LLW identified within the study and to determine the BPEO.

Stages:

1. Review the options and their definitions
2. Review the screening criteria and then screen out any options that are not viable
3. Review the attributes and their calibration schemes
4. Score the options
5. Agree and apply weighting schemes
6. Determine the BPEO

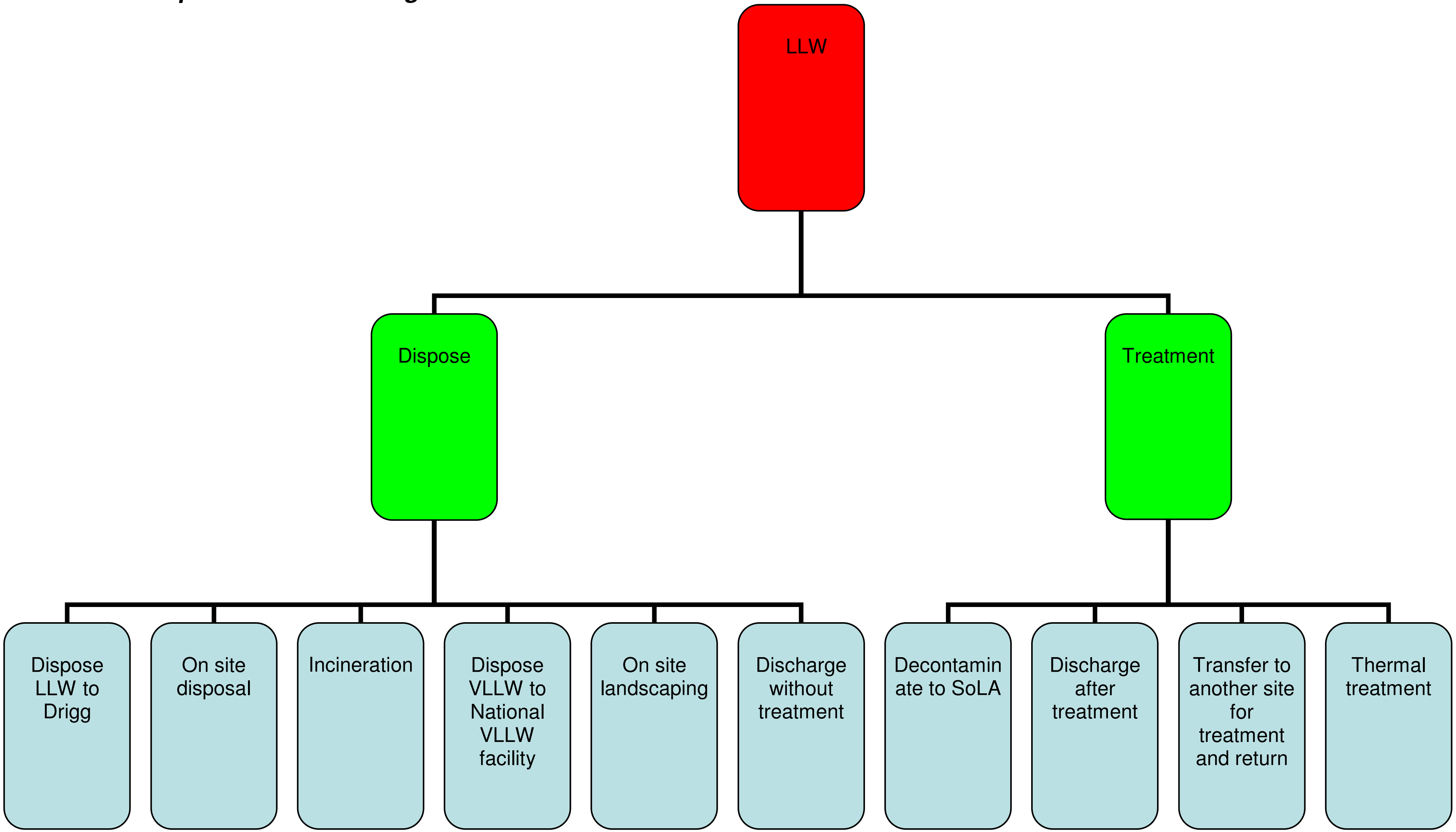
Julie Tooley, Carol Robinson and Gavin Thomson
Enviros Consulting
1 March 2007

Waste groupings for LLW
To ensure the BPEO is comprehensive yet manageable certain LLW waste streams have been grouped.

	Segregatable	**Metal**	**Asbestos**	**Aggregate**	**Chemicals**	**Glass**	**Oils and Oily wastes**	**Cellulose**	**Plastic**	**Rubber**	**Soil**	**Contaminate d water**	**Contaminate d air**
Operational waste													
CXPP tritiated waste	✓							✓	✓				
Reactor and associated areas LLW	✓		✓					✓	✓	✓			
Cooling ponds LLW	✓			✓				✓	✓				
Large Items from Reactor Areas	✓	✓						✓	✓	✓			
Large items from Cooling Ponds	✓	✓						✓	✓	✓			
UO3 contaminated LLW	✓							✓	✓	✓			
Oils (lubricating and hydraulic)	X						✓						
Other liquid organic wastes	X				✓								
Hydraulic fluids	X				✓								
Liquid effluent discharges (Pond)												✓	
Liquid effluent discharges (CXPP)												✓	
Aerial effluents													✓
C&M Preps													
Reactor LLW	✓	✓											
Ponds LLW	✓	✓		✓							✓		

	Segregatable	Metal	Asbestos	Aggregate	Chemicals	Glass	Oils and Oily wastes	Cellulose	Plastic	Rubber	Soil	Contaminated water	Contaminated air
Active effluent pipeline concrete LLW	✓			✓									
Active effluent pipeline steel LLW	✓	✓											
North Site LLW	✓	✓		✓									
CXPP dismantling LLW	✓	✓		✓									
General reactor LLW	✓								✓				

Flowchart for options for the management of LLW



Options for management of LLW

Principles:

- All waste will be sorted and segregated and decontaminated then conditioned by some process
- Wastes with similar characteristics can be grouped

	Decontaminate to SoLA	Incineration	On-site landscaping	On-site disposal (facility)	Dispose of vLLW separately	LLW to Drigg	Treatment and discharge	Discharge	Thermal treatment	Transfer to another site	No. of Options
Metal	✓			✓	✓	✓			✓	✓	6
Asbestos						✓			✓		2
Aggregate	✓		✓	✓	✓	✓					5
Chemicals	✓	✓				✓					3
Oily wastes	✓	✓									2
Cellulosic		✓		✓	✓	✓					4
Plastic & Rubber	✓	✓		✓	✓	✓					5
Soil			✓	✓	✓	✓					4
Water							✓	✓			2
Air							✓	✓			2

Description of options

Low level waste

Disposal

Dispose at Drigg

Disposal at Drigg is an established route for LLW which falls within the specification set out in the Conditions for Acceptance. Wastes which fall outside the specification set out in the conditions for acceptance may under certain circumstances be disposed under special arrangements. Drigg has limits on the radionuclides and activity it is able to accept set out in the authorisation granted under RSA93. Generally waste of a conventional hazardous nature such as putrescible, pyrophoric and explosive are not accepted and in general waste has to be immobilised to prevent migration of radionuclides from the containers into the facility and beyond.

Dispose on site

This would require the building of a new disposal facility. Waste may need further conditioning or treatment to passive safety whilst the facility becomes available. It is foreseen that this option would require the construction of a new store on the site because existing buildings on the Chapelcross site are not suitable or are planned to be decontaminated or demolished as part of the planned site restoration programme.

Incineration

Solid radioactive waste that is combustible or is not suitable for disposal to landfill because of hazardous properties can be authorised for disposal by incineration at an authorised incinerator. Incineration often results in a large volume reduction and release of volatile radionuclides from the waste. It is normal for the resultant ash to be disposed of as a solid waste.

Dispose VLLW to a National VLLW facility

It is now widely agreed that there is a significant amount of waste from decommissioning that contains low levels of radionuclides at the bottom end of the levels currently considered to be LLW and often referred to as VLLW (or sometimes the terminology High Volume Low Activity HVLA or Very Low Radioactive Material VLRM). DEFRA is currently reviewing the waste management policy for LLW within the UK. As part of this it is possible that separate waste management options for the disposal of VLLW could be identified and promoted.
Currently no such disposal route exists in the UK, although some landfill sites do accept radioactive wastes under special precautions burial (Option 2.1.5). It is generally considered that VLLW will be defined as an inert waste.

On site landscaping
This is envisaged to be the use of inert construction and demolition material predominately for the infill of turbine hall basements or other landscaping remediation.

Discharge without treatment
This is primarily considered to be an option for liquid wastes such as cooling pond water and groundwater control practices.

Treatment

Decontaminate to SoLA
The removal of areas of surface contamination would allow material to be exempted from the RSA93 using, for example, the Substances of Low Activity Exemption Order. Such decontamination may be possible using simple techniques such as wiping or washing or more aggressive techniques such as high-pressure jet washing.

Discharge after treatment
This is envisaged to include the discharge of liquid waste following treatment at the effluent treatment plant or aerial discharges from active ventilation systems.

Transfer to another site for treatment and return
This is an interim option which would result in the waste product returning to Chapelcross for inclusion in another final disposal option.

Thermal treatment
This option in envisaged for waste contaminated only with tritium. The waste would be heated to volatilise the tritium which would be disposed as an aerial discharge. The aim would be that the heated waste would be below SoLA levels.

Screening criteria

Derived from regulation

Criterion	Name	Description
1	London Convention	Disposal of solid radioactive waste at sea is suspended indefinitely.
2	OSPAR Convention	Waste producers are required to take all possible steps to reduce concentrations of natural radionuclides in the north eastern Atlantic to close to background, and close to zero for artificial radionuclides, by 2020.
3	Groundwater Regulations	The disposal of liquid wastes containing certain listed substances into groundwater is forbidden by the Groundwater Regulations.
4	Dose limits	The annual individual dose to members of the public must not exceed 1 mSv/yr. Doses to workers are limited to 20 mSv/yr averaged over five years (other limits also apply).

Derived from Government policy and guidance

5	Waste import and export	Radioactive waste may only be exported to (or imported from) elsewhere in small quantities and under special conditions.

Attributes

Relevant attributes developed at the optioneering workshop

Attribute group and attribute	Sub-attribute
Human health and safety:	
1. Public health and safety (individuals)	1.1 Routine radiation doses 1.2 Radiological accident risks 1.3 Non-radioactive hazards and risks
2. Public health and safety (societal collective dose)	2.1 Routine radiation doses
3. Worker health and safety (individuals)	3.1 Routine radiation doses 3.2 Radiological accident risks 3.3 Non-radioactive hazards and risks
Environmental impact:	
4. Physical environment	4.1 Air quality 4.2 Water quality of receiving body 4.3 Land 4.4 Visual impact 4.5 Nuisances (noise, light, dust, odour, vibration) 4.6 Use of natural resources 4.7 Transport
5. Flora and fauna	5.1 Preservation of ecosystems
6. Environmental objectives	6.1 Waste volumes 6.2 Waste hierarchy 6.3 Hazard reduction rate 6.4 Concentrate and contain 6.5 Generation of secondary wastes 6.6 Greenhouse gas emissions 6.7 Proximity principle
Technical:	

7. Viability	7.1 Maturity of technology 7.2 Continued availability of option 7.3 Throughput/capacity of option
8. Nuclear safety	8.1 Likelihood of meeting CfA
9. Flexibility	9.1 Foreclosing of options
10. Programme	10.1 Scheduling variance compared to LTP 10.2 Minimising project risk to NDA 10.3 Discharge of NDA liabilities 10.4 Consistency with site end state
Socio-economic:	
11. Local community	11.1 Economic impacts 11.2 Culture and heritage
Regulatory issues:	
12. Acceptability	12.1 Likelihood of gaining regulatory acceptance
Financial cost:	
13. Overall cost	13.1 Total undiscounted cost 13.2 Rate of spend compared to LTP 13.3 Stability of cost estimates

Scoring criteria

In the absence of appropriate data on the performance of some options, only the calibration of scores 0 and 5 has been provided. Scores 1 – 4 can be awarded on the basis of expert judgement on the relative performance of options against the 0 and 5 requirements, and relative performance between options.

Attribute/ sub-attribute	**Requirement for intolerable performance (Score = 0)**	**Requirement for ideal performance (Score = 5)**
1. Public health and safety (individuals)		
1.1 Routine radiation doses	Difficult to demonstrate doses <1 mSv y^{-1} (Basic Safety Limit – BSL)	Easy to demonstrate doses <10 µSvyr^{-1} ('below regulatory concern')
1.2 Radiological accident consequences	Unacceptably high consequence	Low consequence
1.3 Non-radioactive hazards and risks	Difficult to demonstrate risk $<10^{-4}$ yr^{-1}	Easy to demonstrate risk $<10^{-6}$ yr^{-1} ('below regulatory concern')
2. Public health and safety (societal collective dose		
2.1 Routine radiation doses	Difficult to demonstrate doses <100 person Sv	Easy to demonstrate doses <1 person Sv
3. Worker health and safety (individuals)		
3.1 Routine radiation doses	Difficult to demonstrate doses <20 mSv y^{-1} (Basic Safety Limit – BSL)	Easy to demonstrate doses <2 mSv y^{-1} (Basic Safety Objective – BSO)
3.2 Radiological accident consequences	Unacceptably high consequence	Low consequence
3.3 Non-radioactive hazards and risks	Difficult to demonstrate risk $<10^{-3}$ yr^{-1} (largest tolerated risk where activity is crucial for society and economy)	Easy to demonstrate risk $<10^{-5}$ yr^{-1} (consistent with typical 'safe' practice in non nuclear industry)
4. Physical environment		
4.1 Air quality	Persistent objectionable substances in air in buildings off site	No discernible reduction in air quality
4.2 Water quality	Sterilisation of water resource off site or affects ability to reach site end-point	No discernible reduction in water quality
4.3 Land quality	Sterilisation of substantial area of land off site or affects ability to reach site end-point	No discernible reduction in land quality

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
4.4 Visual impact	Construction completely out of keeping with existing landscape	No discernible visual impact
4.5 Nuisances (noise, light etc)	Long-term disturbance/disruption of local life	No outward signs of the material management scheme
4.6 Use of natural resources	Unacceptably high use of resources and practice not sustainable	Limited use of resources and managed in a sustainable way
4.7 Transport	Unacceptably high increase in off site transport operations	No increase in off site transport operations
5. Flora and fauna		
5.1 Preservation of ecosystems	Complete loss of natural ecosystem	No discernible reduction in quality of the natural ecosystem
6. Environmental objectives		
6.1 Waste volume	Unacceptably high volumes of waste generated	Lowest volumes of waste generated
6.2 Waste hierarchy	Inconsistent with waste hierarchy and no material is reused or recycled, and there is no possibility that it ever can be	Consistent with waste hierarchy and all material is reused and none disposed
6.3 Hazard reduction	No reduction in hazard or hazard is increased over the long term	Hazards associated with the materials are reduced to a minimum, as rapidly as feasible
6.4 Concentrate and contain	Radioactivity is dispersed to the wider environment and no long remains under engineering or management control	Radioactivity is contained by passive engineered systems, and remains under management controls
6.5 Generation of secondary wastes	Large amounts of secondary waste produced far in excess of original waste volume	Limited secondary waste produced
6.6 Greenhouse gas emissions	Increase in greenhouse gas emissions	Reduction in greenhouse gas emissions [N.B. Score of 3 = no change]
6.7 Proximity principle	Waste management option undertaken at distant location	Waste management option undertaken on-site
7. Viability		
7.1 Maturity of technology	Unproven and not achievable with existing technology in timescale of LCBL	Established approach, with good track record and applied under similar circumstances.

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
7.2 Continued availability of option	Not existing and could not be procured in timescale of LCBL	Existing and is available
7.3 Throughput/capacity of option	Throughput or capacity is very low and will adversely affect LTP	Throughput or capacity meets or exceeds demand and results in no impact on LTP
8. Nuclear safety		
8.1 Likelihood of meeting Conditions for Acceptance	Significant dialogue required to meet Conditions for Acceptance	Conditions for Acceptance previously meet for similar wastestream
9. Flexibility		
9.1 Foreclosing of options	Once implemented, no possibility for reversible steps or retrieval of material	Flexible option that allows for reversibility and easy retrieval of material
10. Programme		
10.1 Scheduling variance compared to LTP	Would cause substantial delays to activities on site that lie on critical path, causing failure to meet LCBL objectives and timescales	Can be achieved independently of other activities on site and without impacting on the timing and ordering of other activities
10.2 Minimising project risk to NDA	Significant project risk to NDA	No additional project risk to NDA
10.3 Discharge of NDA liabilities	NDA liabilities increase in scale or in time	NDA liabilities significantly reduced in scale or period of liabilities significantly shortened
10.4 Consistency with site end state	Completely inconsistent with defined site end state	Consistent with defined site end state
11. Local community		
11.1 Economic impacts	Collapse of local economy	Major enhancement to the local economy [NB Score of 3 = no change]
11.2 Culture and heritage	Collapse of local community through depopulation	Major enhancement of local community [NB Score of 3 = no change]
12 Acceptability		
12.1 Likelihood of gaining regulatory acceptance	Significant dialogue required to gain approval	Demonstrable precedent exists
13. Overall cost		

Attribute/ sub-attribute	Requirement for intolerable performance (Score = 0)	Requirement for ideal performance (Score = 5)
13.1 Total undiscounted cost	Significant undiscounted cost above LTP cost estimates	Undiscounted cost likely to remain within LTP cost estimates [NB Score of 3 = no change]
13.2 Rate of spend compared to LTP	Significantly different to LTP cash flow forecast	Likely to remain within LTP cash flow forecast [NB Score of 3 = no change]
13.3 Stability of cost estimates	Cost estimates highly unstable	Cost estimates highly stable

Scoring

Score each of the 10 waste groups (Metal, Asbestos etc…) on separate Excel spreadsheets using the attributes and scoring schemes presented above. A master version for LLW is provided electronically, create one for each waste group using Save As noting that not all management options are relevant to all waste groups (an example for Metals is also provided).

Please return to gavin.thomson@enviros.com by close of play 9th March 2007.

Weighting schemes

Weightings are usually applied to the total scores for each attribute group, and often normalised to take account of the number of sub-attributes in each group to avoid biasing those with the most sub-attributes.

Example: If the unweighted score for an option in the Technical attribute group is 25, the chosen weighting factor is 10, and there are 6 sub-attributes in the group, then the normalised weighted score for the group is (25 x 10) / 6 = 41.7 (to 1 decimal place)

The weighting schemes applied the Chapelcross wastes option study are.

Attribute group	Enviros Team Weighting	Technology position	Environmental position	Financial position
1. Human health	5	10	10	1
2. Environmental impact	5	1	10	1
3. Environmental objectives	5	1	10	1
4. Technical	5	10	1	1
5. Socio-economic	5	1	1	1
6. Stakeholder issues	1	1	10	1
7. Financial cost	1	10	1	10

Determine the BPEO

The BPEO may be determined by comparing:

- the total unweighted scores for the options (which gives the highest score ?)
- the total unweighted scores, less costs, for the options (which gives the highest score without cost bias ?)
- the number of scores of 0 and 5 awarded to each option (which performs well across all attributes ?)
- the various total weighted scores for the options, and the sensitivity to the weighting factors (is the ranking robust to weighting ?)

Determining the preferred management strategy

The determination of a BPEO is only one factor that should be taken into account when choosing a management strategy, for example:

- An option that performs ***better*** environmentally than the BPEO could be adopted if there are other business factors to take into account (e.g. to protect or to foster the environmental reputation of the organisation – the ‘Brent Spar’ example).

- An option that performs ***marginally worse*** than the BPEO could be adopted if there is a large financial saving to be made and the environmental performance of the adopted option still meets appropriate constrains and conditions (the proportionality argument)

LLW waste material description

Waste material name	Current location	Total amount	Description
Operational waste			
CXPP tritiated waste	CXPP	4 m^3 per year. Around 20 m^3 in total	Mainly soft waste (clothes, gloves, tissues etc). Stored in alkathene containers in 205 l drums (waste and containers combustible). Not suitable for super compaction (due to potential for H-3 release).
Reactor and associated areas LLW	In reactors and CXPP	Current arisings 74 m^3 per year (3 isofreights) during normal operations. Expected to increase to 120 m^3 per year (peak at 300 m^3/y) during defuelling.	Soft waste (PPE and fabric) Stored in 205 l drums (as above).
Groundwater ingress into reactor basements		300,000 gallons per year Annual average - subject to seasonal variations with greatest amount during winter.	Groundwater tritiated to around 0.2-0.4 Bq/ml. Removed by pump and discharged through existing discharge pipeline.
Cooling ponds LLW		Current average 6.4 m^3 per year. Will peak during decommissioning	Soft waste arising from flask cleaning (wipes etc.) primary contaminant Cs. The peak expected during repackaging of waste from ponds. Stored in 205 l drums.
Large Items from Reactor Areas		892.0 m^3 (Total figure)	Comprises steel plant and equipment (primarily various grades of steel and some lead) including: contaminated charge baskets; redundant flasks (PRDO); grabs, BCGDs (cast steel). Not expected to be activated or contaminated with PCBs.

Waste material name	Current location	Total amount	Description
			Wrapped and stored in HHISO
Large items from Cooling Ponds		15.6 m^3 per year (current operational arisings). Underestimates of the total during C&M preps	Comprises grabs, pumps, lights, scaffold boards. Wrapped and loose stored in HHISO
UO_3 contaminated LLW	Building 141	16.0 m^3 (reasonable estimate of total value)	Soft waste and plywood boards Stored in 205 l drums
Oils	Hanger 39 (following dismantling of Tank Farm)	84,000 l 164.5 m^3	Comprises a mix of liquid organic waste stored in plastic double lined tanks. Approx. 50,000 l of this amount exempt under SoLA. Remainder (approaching 40,000 l) will be stored on site pending authorisation. Trace beta contamination (H-3 and C-14 activities below 0.4 Bq/g). An additional 50,000 l oily waste in blowers (levels of activity to be tested).
Other liquid organic wastes		400 MBq H-3 200 kBq C-14 and S-35	Scintillant
Hydraulic fluids	B151 (CXPP) ?	0.25 m^3 0.7 m^3	Stored in 55 plastic bottles mixed with vermiculite within stainless steel drums. Unsuitable for further treatment. Oil in free state (not mixed with vermiculite) – Norman to check?

Waste material name	Current location	Total amount	Description
Liquid effluent discharges from Pond		Total volume of 3 ponds around 1.2 million gallons (400,000 gallons each)	Discharge pipeline common to ponds and CXPP. Present discharge rate approximately 20 discharges of 13,000 gallons per year (3% of current discharge authorisation).
Liquid effluent discharges from CXPP		850 gallons discharged 2-3 times per year	See above
Aerial effluents	Processing plant (little from reactors)	200 TBq per year (Current authorised limit 5000 TBq/y)	Aerial discharge primarily H-3. Some C-14 is discharged from reactors. Residual discharge of C-14 expected during C & M Preps.
C&M preps waste			
Reactor LLW		4370.6 m^3 (70% confidence in this total value)	Comprises large plant components, including: defuelling machines; turbo generators; heat exchanger pipework; blowers; building fabric; iron ductwork; transformers; generators; large lead acid batteries; MMMF; switch gear scaffolding poles. Materials include cast steel (not much stainless steel); cement-bound asbestos; brickwork and reinforced concrete. All surface contaminated. Metals may be decontaminated but decontamination of other materials would be difficult. Not suitable for super compaction The amount is based on the assumption that building slabs left intact and that rail and related structures remain (subject to confirmation of plans for rail links).
Ponds LLW		2330.0 m^3	Comprises full pond structure (assuming walls contaminated to depth) including the walls; redundant

Waste material name	Current location	Total amount	Description
		(confident of this value based on Quantity Survey figures)	flasks; furniture and concrete. Not suitable for super compaction
Redundant Active effluent pipeline concrete LLW		1335.0 m^3	Cast concrete. Not suitable for super compaction. The management option for this pipeline is still under debate – removal not certain).
Replacement active effluent pipeline steel LLW		28.0 m^3 Number considered to be low - TBC	Spun Steel (4 miles long, 15 inch diameter, inch thick); Surface contaminated with Cs and Sr. Not suitable for super compaction
North site LLW	Currently in temporary storage building – expected to be removed before C&M Preps	270.0 m^3	Not suitable for super compaction. This amount does not include cooling towers – considered to be clean (due for demolition in April 2007).
CXPP dismantling LLW (of the process line)		325.0 m^3	This category relates to the containment of the process line (not including building structure). It comprises tritiated equipment (pumps, valves etc) of largely metal construction. Not suitable for super compaction Additional information from Norman?
Contaminated land			Not included in the scope of this BPEO. It was noted that decisions related to Regulatory issues related to H-3 contaminated groundwater is interfering with management of hydrocarbon contaminated land.