LLW Repository Ltd

The LLWR Environmental Safety Case

ESC Periodic Review

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Executive Summary

The 2011 ESC is a 'live' safety case, subject to established and proven safety case processes, including change control. As part of this, it is required that annual and periodic reviews are undertaken to meet the following objectives:

- to review the current ESC and confirm that it is still adequate;
- to identify and evaluate changes to the ESC or at the LLWR that have occurred since the submission of the ESC in 2011;
- to identify and evaluate changes to the ESC or at the LLWR that might be required over the period until the next major review and update of the ESC, assumed to be in 2021;
- to identify the key documents that comprise and support the ESC.

This document reports the first periodic review undertaken of the 2011 ESC.

The scope of the Periodic Review is defined and underpinned by the following assumptions:

- it considers changes to the ESC or at the LLWR that might be required over the period until the next major review and update of the ESC, assumed to be in 2021;
- it identifies any changes to the ESC or site since the time of submission of the last ESC i.e. in May 2011 and prior to May 2014;
- it deems that the *Developments Since the 2011 ESC* report [4], which supported the Permit Application, records a summary and update of the ESC;
- it considers whether documents issued during the period May 2011-April 2014 comprise or support the ESC;
- it addresses the Period of Authorisation (PoA) and thereafter.

The Periodic Review is intended to draw upon material in the ESC Annual Review. However, the first Annual Review is yet to be undertaken and is scheduled for 2015.

As a live safety case, the 2011 ESC is being implemented on site through a clearance certificate and underpinning instructions, changes to the waste acceptance criteria (WAC) and emplacement strategies, revised monitoring arrangements, and requirements on construction projects and closure engineering. The Management of Change (MoC) process will be used to maintain an appropriate structure for LLWR's organisation and introduce the necessary procedures and processes. The Periodic Review identifies all past and expected future changes in each of these key areas, and assesses whether they constitute updates to the ESC.

The Periodic Review process considers the following key areas:

- **General issues,** including events in the LLWR Events Register deemed relevant to the ESC.

- **Changes and developments,** including expected engineering changes (identified through review of Plant Modification Proposals (PMPs) deemed relevant to the ESC) and management changes (identified through review of MoC forms). This area includes regulatory changes.

- **Technical approach in the ESC,** including Environment Agency issues (identified in Issue Resolution Forms (IRFs)), liaison meetings and regulatory correspondence); ESC technical reports and memos; ESC Issues Register; issues identified by the Peer Review Group (PRG); and the ESC Uncertainties and Features Events and Processes (FEPs) Register.

- **Wastes,** including key changes in the WAC and any arising ESC issues, and major changes in the waste acceptance process.

- **Monitoring,** including identifying major changes recorded in the annual review reports of LLWR's environmental monitoring programme designed to fulfil the Schedule 9 Requirement 8 of LLWR's Permit.

The Periodic Review has been undertaken in accordance with the requirements set out in LLWR Repository Site Procedure (RSP) 2.25, and the process used to conduct the review draws upon the approach set out in RSP 1.25 and used in the 2013 Operational Safety Case Periodic Review. A number of review activities, including a workshop, have been undertaken to review the ESC against the topics listed above, and to identify issues. Each of these identified issues has been classified according to the following scheme:

- change to the ESC not required;
- change required, but already implemented in an update to the ESC;
- change required and already included in ESC Issues Register or some other LLWR action list or issues register;
- further action required to update ESC.

The Periodic Review findings include a large number of changes, many of which are being, or have been, implemented and thus require no further action. These changes have been included for completeness. The main focus of this review has been to identify those issues where further actions are required to update the ESC, and would otherwise not have been identified.

The ESC issues identified as a result of this review have been grouped and synthesised to identify key high-level themes. Only those issues identified as requiring further action were included within the grouping and synthesis exercise. All issues identified as requiring further action have been apportioned to a high-level theme to help demonstrate completeness and traceability. For each theme, actions were identified, which will be recorded in the ESC Issues Register. When they are recorded, those responsible for the action will be identified by the ESC Project Manager together with a close-out date. Not all actions identified as necessary are equally urgent: some may need to be undertaken before the next major revision of the ESC, while others may be undertaken when the next major revision occurs.

A number of actions (see Section 4) have been identified as outcomes of this review. These will be logged and closed out using the ESC Issues Register. The Periodic Review has identified only a relatively small number of themes and key actions that

would otherwise not have been captured and none of these are urgent. These are presented in Table 26. With the possible exception of 'Defining engineering requirements', none of these actions will, when addressed, have a major effect upon the ESC. Developing a methodology for the definition of engineering requirements has the potential to represent a significant methodological improvement. That the number of significant actions is small builds confidence in the processes employed by LLWR to manage the ESC. It further indicates that there is no requirement for a major update of the ESC before 2021.

This Periodic Review has established a recognised document baseline for the ESC.

A number of lessons learnt have been derived from the review process that may be used to refine and develop the process to be used in subsequent Periodic Reviews.

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1 Introduction

The Low Level Waste Repository (LLWR) is the United Kingdom's principal facility for the disposal of solid low-level radioactive waste (LLW). LLW has been disposed at the LLWR since 1959, initially tipped into trenches and, since the late-1980s, packed in containers and placed in engineered vaults.

The LLWR is owned by the Nuclear Decommissioning Authority (NDA), which is a non-departmental public body created under the Energy Act 2004. The NDA is a strategic authority that owns the 19 civil nuclear sites, and associated nuclear liabilities and assets, previously under the control of the United Kingdom Atomic Energy Authority and British Nuclear Fuels. LLW Repository Ltd is the Site Licence Company that operates the LLWR on behalf of the NDA.

The disposal of radioactive waste at or from the Low Level Waste Repository (LLWR) is regulated by the Environment Agency. The LLWR currently holds a Permit [1] under the Environmental Permitting Regulations allowing it to dispose of and transfer radioactive wastes. The LLWR submitted a fully revised Environmental Safety Case (ESC) to the Environment Agency in May 2011, referred to as the 2011 ESC [2]. This submission satisfied a requirement in the LLWR's Permit. Based on a detailed review, the Environment Agency has stated that, together with work carried out and additional information provided since May 2011, the 2011 ESC provides an adequate basis for an application to vary LLWR's permit; the LLWR submitted such an application in October 2013 [3,4].

The 2011 ESC is a 'live' safety case, subject to established and proven safety case processes, including change control. As part of this, it is required that annual and periodic reviews are undertaken to meet the following objectives:

- to review the current ESC and confirm that it is still adequate;
- to identify and evaluate changes to the ESC or at the LLWR that have occurred since the submission of the ESC in 2011;
- to identify and evaluate changes to the ESC or at the LLWR that might be required over the period until the next major review and update of the ESC, assumed to be in 2021;
- to identify the key documents that comprise and support the ESC.

This document reports the first periodic review undertaken of the 2011 ESC.

The scope of the Periodic Review is defined and underpinned by the following assumptions:

- it considers changes to the ESC or at the LLWR that might be required over the period until the next major review and update of the ESC, assumed to be in 2021;
- it identifies any changes to the ESC or site since the time of submission of the last ESC i.e. in May 2011 and prior to May 2014;

- the *Developments Since the 2011 ESC* report [4] supported the Permit Application and is deemed to record a summary and update of the ESC;

- it considers whether documents issued during the period May 2011-April 2014 comprise or support the ESC;

- it addresses the Period of Authorisation (PoA) and thereafter.

The Periodic Review is intended to draw upon material in the ESC Annual Review. However, the first Annual Review is yet to be undertaken and is scheduled for 2015.

As a live safety case, the 2011 ESC is being implemented on site through a clearance certificate and underpinning instructions, changes to the waste acceptance criteria (WAC) and emplacement strategies, revised monitoring arrangements, and requirements on construction projects and closure engineering. The Management of Change (MoC) process will be used to maintain an appropriate structure for LLWR's organisation and introduce the necessary procedures and processes. The Periodic Review identifies all past and expected future changes in each of these key areas, and assesses whether they constitute updates to the ESC.

This report is structured as follows:

- Section 2 discusses the approach and methodology used to carry out the Periodic Review;

- Section 3 presents the detailed findings of the review;

- Section 4 presents the results of a grouping exercise that synthesises the detailed review findings to identify high-level themes;

- Section 5 identifies lessons learnt from the review process that may be used to inform and refine future Periodic Reviews;

- Section 6 presents the review conclusions.

2 Approach and Methodology

The Periodic Review is consistent with the requirements set out in LLWR Repository Site Procedure (RSP) 2.25 [5], and the process used to conduct the review draws upon the approach set out in RSP 1.25 [6,7] and used in the 2013 'Long-term Periodic Review of the Low Level Waste Continued Operations Safety Case' [8]. It should be understood that the ESC Periodic Review process does not exactly replicate the continued operations safety case periodic review process. Rather, the Periodic Review process is tailored to allow for the differences in structure, content and presentation between the ESC and the continued operations safety case.

2.1 Periodic Review Topics

The Periodic Review process considers the following key areas:

- **General issues,** including events in the LLWR Events Register deemed relevant to the ESC.
- **Changes and developments,** including expected engineering changes (identified through review of Plant Modification Proposals (PMPs) deemed relevant to the ESC) and management changes (identified through review of MoC forms). This area includes regulatory changes.
- **Technical approach in the ESC,** including Environment Agency issues (identified in Issue Resolution Forms (IRFs)), liaison meetings and regulatory correspondence); ESC technical reports and memos; ESC Issues Register; issues identified by the Peer Review Group (PRG); and the ESC Uncertainties and Features Events and Processes (FEPs) Register.
- **Wastes,** including key changes in the WAC and any arising ESC issues, and major changes in the waste acceptance process.
- **Monitoring,** including identifying major changes recorded in the annual review reports of LLWR's environmental monitoring programme designed to fulfil the Schedule 9 Requirement 8 of LLWR's Permit.

2.2 Process

The Periodic Review included the following key activities:

- agreement of review scope and data collection (e.g. collection of reports, memos, PMPs, databases etc.);
- identification of reports that support or comprise the ESC;
- identification of data relevant to the ESC;
- systematic review and categorisation of ESC issues identified in these data. This review included contributions from relevant LLWR experts where required. Each issue identified was classified according to the following

scheme:

  - change to the ESC not required;
  - change required, but already implemented in an update to the ESC;
  - change required and already included in ESC Issues Register or some other LLWR action list or issues register;
  - further action required to update ESC.

- identification of a Review Team of experts with knowledge covering the key topics listed in Subsection 2.1;

- a review workshop attended by the Review Team. The aim of this workshop was to identify key issues and changes that might otherwise have been omitted;

- grouping and synthesis of ESC issues to identify key themes. Only those issues identified as requiring further action were included within the grouping and synthesis exercise. For each theme, actions (to be recorded in the appropriate ESC Issues Register) were identified;

- validation and endorsement of Periodic Review conclusions at a review meeting attended by the Science and Engineering Manager, ESC Technical Integrator and an ESC Technical Specialist.

The review process was iterative, with the output from the workshop used to refine the systematic review.

2.2.1 Periodic Review Data Sources

The reasons for the inclusion of, and the process used to review, each type of data source (e.g. technical reports, memos, PMPs) used in the Periodic Review are given in the appropriate subsections detailing the review findings.

2.2.2 Workshop

The workshop brought together representatives from LLWR whose expertise covered the following topic areas:

- ESC
- Nuclear Safety Case (NSC)
- Monitoring
- Engineering
- Environment
- Operations

These representatives comprised the Review Team and are listed in Table 1.

Table 1 ESC Periodic Review Team

Richard Cummings (Chairman)	Ian Wills
Andy Baker (Facilitator)	John Hillary
Amy Huntington	Alessandro Proverbio
John Shevelan	Frank Taylor
Paul Tulip (recorder)	

Prior to the workshops, each attendee was provided with a pre-meeting information pack [9]. The information pack summarised the context, scope and objectives of the workshop, and included a question set used to structure the workshop. The question set is presented in [9,10]. These questions were taken from RSP 1.25, tailored to more appropriately address an ESC. The question set was designed to identify the key issues, events, processes and developments from each topic area that could significantly affect the ESC.

A series of systematic review activities of events, Management of Changes (MoCs), reports, memos, regulatory correspondence etc. was undertaken independently of the workshop. The workshop did not, therefore, need to discuss everything in detail; rather, the intent of the workshop was to focus upon key issues that needed to be discussed, or which might otherwise have been missed.

The workshop discussions were led by a facilitator. The chairman ensured that the views of the Review Team were clearly expressed and verified that the discussions were adequately captured by the workshop recorder. The workshop discussions were recorded in tabular format, and were displayed to the Review Team throughout the workshop. The workshop record is provided in [10]. It should be noted that the categorisation scheme used in the workshop record is different to that used in this report: the scheme was identified as being ambiguous, and was refined subsequently to the meeting. The refined scheme is used in this report.

In addition to the review workshop, one-to-one sessions were held with environmental, operations and waste acceptance personnel to identify issues not considered within the workshop. Records of these discussions are also presented in reference [10].

2.2.3 Review Meeting

The purpose of the review meeting was to validate and endorse the key themes identified as results of the review, and to agree appropriate actions. The attendees are listed in Table 2.

Table 2 Review meeting attendees

Richard Cummings (Chairman)	Amy Huntington
Andy Baker	Paul Tulip (recorder)

The discussions were led by a chairman who ensured that the views of the attendees were clearly expressed and verified that the discussions were adequately captured by the recorder. The discussions were recorded in a table (see Section 4), which was visible to the attendees.

2.2.4 Review Outputs and Traceability to High-level Themes

For each detailed review activity undertaken, the findings have been recorded in a table stating:

- the issue;
- the issue categorisation;
- a justification of the categorisation.

These tables are reproduced in Section 3 of this report. Note that the review findings include a large number of changes, many of which are being, or have been, implemented and thus require no further action. These changes have been included for completeness. The main focus of the review has been to identify those issues where further actions are required to update the ESC, and would otherwise not have been identified. Not all actions identified as necessary are equally urgent: some may need to be undertaken before the next major revision of the ESC, while others may be undertaken when the next major revision occurs.

Those issues identified as requiring further action, and not captured as Environment Agency Forward Issues or Recommendations or Peer Review Group (PRG) recommendations, have been grouped to identify high-level key themes. A spreadsheet tool was developed to support this grouping activity and to demonstrate both completeness and traceability; i.e. that all issues identified as requiring further action have been apportioned to a high-level theme, and that this apportioning is traceable. In the review findings presented in Section 3, for each issue requiring further action, the relevant high-level theme has also been recorded to provide evidence of traceability.

3 Review Findings

In this section the findings of the Periodic Review are presented.

3.1 Workshop

The workshop findings are recorded, by topic area, in the following subsections. For each issue requiring further action, the relevant high-level theme is given in brackets in the ‘Issue’ column.

3.1.1 General

Table 3 Workshop responses for general LLWR issues that may affect the ESC

Question/area	Issue	Categorisation	Justification	Comments
What is LLWR's business strategy?	Potential changes to wastes and repository design.	Change to the ESC not required.	Changes will be assessed as they arise; no need for further consideration here.	Business strategy is, for this phase, to deliver against Lifetime Plans (LTPs). ESC strategy to deliver LTP. Consideration of business strategy for future years. ESC to support strategy, e.g. questions such as how to use repository (optimisation)? Disposal against safety case, rather than against definitions.
	Changes driven by national strategy.	Change to the ESC not required.	Not expected; also would be treated as above.	
	Decision to reuse low specific activity material (LSAM) in profiling.	Change to the ESC not required.	Would be assessed if intent to implement.	Assessment of this has already been carried out (for ESC).
	Reuse/disposal of LSAM in vaults, e.g. from LLWR decommissioning	Change to the ESC not required.	Would be assessed if intent to implement.	

Question/area	Issue	Categorisation	Justification	Comments
	projects.			
	Request to dispose of orphan wastes requiring variations.	Change to the ESC not required.	Would be assessed if intent to implement.	
What key projects are planned or likely to take place?	Capping of repository.	Change to the ESC not required.	In ESC Site Development Plan (but see below *).	
	Interim trench cap (including perimeter drain work). (Trench cap remediation)	Further action required to update ESC.	Current ongoing project; further changes to ESC may be required.	
	Decommissioning projects. (Decommissioning wastes)	Further action required to update ESC.	Decommissioning wastes will need disposal. Not included within current ESC.	
	Security enhancement programme. (Security enhancement)	Unclear.		Could affect capping. Action to engage with security project and assess significance.
	Leachate management system remediation work. (Leachate management)	Unclear.		Engage with project to assess significance of this work.
	Manhole 11.	Change to the ESC not required.	Localised remedial work.	
	Disposal concept (e.g. disposal container, drums, soft-sided bags). (Disposal concept)	Further action required to update ESC.		Current commitment.

Question/area	Issue	Categorisation	Justification	Comments
	Asset refurbishment and replacement. (Asset refurbishment and replacement)	Further action required to update ESC.		Activities may affect ESC/monitoring in ways not understood by project teams. Decision to be made as to appropriate action.
	Vault 8 high stacking. (Voidage and higher stacking)	Further action required to update ESC.		Changes to assumptions of high stacking in ESC (e.g. failure to provide engineering substantiation).
	New waste tracking system. (New waste tracking system)	Further action required to update ESC.		Use of commercial off-the-shelf (COTS) system may require changes to waste acceptance process or affect data that can be recorded.
	Optimisation of grout formulation. (Optimisation of grout formulation)	Further action required to update ESC.		Work ongoing on superplasticiser. Replacement for pulverised fuel ash (PFA) may be required in future if PFA no longer available from Drax.
	Vegetation clearance from Vault 8.	Change to the ESC not required.	Captured in Engineering Forward Plan to Support ESC.	
	New build.	Change required, but already implemented in an update of the ESC.	ESC includes variant case with inventory including new build wastes.	
What is current site	*Uncertainties in site	Further action required to		Repository processes

Question/area	Issue	Categorisation	Justification	Comments
strategy/LTP? Are there any changes that could affect the facility or the ESC?	development deriving from planning process, e.g. different vault capacities and cap footprint. Uncertainties derived from funding, e.g. need to protect wastes in Vault 8 prior to final capping (if capping delayed). Uncertainty in required timing of capping (e.g. Vault 8 will need capping). Uncertainty in timing of vault construction. (Uncertainty management)	update ESC (if and when they occur).		need review to ensure changes would be addressed in ESC. Availability of materials may affect times. Timescales already delayed from assumptions in ESC Site Development Plan. Requires review at appropriate point.
	Waste tracking system – obtaining Vault 8 data from current tracking system is difficult. (New waste tracking system)	Further action required to update ESC.		Inclusion of historical disposals not covered by project scope developing new waste tracking system. Difficult to obtain data from current waste tracking system.

Question/area	Issue	Categorisation	Justification	Comments
What is the ESC needed for in future (e.g. optimisation, decisions on engineering)?	Lack of systematic approach to assessing the implications of new information for the ESC[1]. (Systematic assessment approach)	Further action required to update ESC.		Need to consider whether additional procedures required.
	Lack of systematic approach to defining ESC engineering requirements. (Defining engineering requirements)	Further action required to update ESC.		
	Weaknesses in LLWR processes to ensure project coordination and optimisation. (Coordination and optimisation processes)	Further action required to update ESC.		Need for a site coordination committee supported by appropriate processes.

3.1.2 ESC

Table 4 Workshop categorisation of ESC issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
What is the strategy for the ESC project? What changes are implied?	Implementation of ESC as live safety case. (ESC implementation)	Further action required to update ESC.		ESC has been implemented as a live safety case (no longer a

[1] Note that this entry was refined as a result of discussions at the LLWR Nuclear Safety Committee (NSC) after the workshop.

Question/area	Issue	Categorisation	Justification	Comments
				LLWR “project”). Further work is required to develop processes.
	Revised Permit anticipated. (Revised Permit)	Further action required to update ESC.		Review process required when any revised permit issued. Expect to need to make changes to LLWR processes, including waste acceptance. Expect that there will be a new set of requirements.
	Development programme for next major update to ESC. (ESC development programme)	Further action required to update ESC.		Plan for development programme being prepared.
	Availability of SQEP resource.	Change to the ESC not required.		Risk already recognised and managed.
What are the key safety case issues and are any developments required?	There are a number of key safety case developments required. (ESC development programme)	Further action required to update ESC.		Being addressed in planning of ESC’s Development Programme.
Are there any external changes that mean the ESC needs to be revised?	Additional substances may be reclassified as hazardous, or the required assessment process may change. (Hazardous substances reclassification)	Further action required to update ESC.		Remain aware of, and provide input to, forthcoming consultation processes.

Question/area	Issue	Categorisation	Justification	Comments
	Guidance on Requirements for Authorisation (GRA) being reviewed in 2016. (Reviewed GRA)	Further action required to update ESC.		Remain aware of, and provide input to, forthcoming consultation.
Do ESC 'users' understand the safety case, safety case documents and requirements?	Users do not yet fully understand ESC and its requirements. (User understanding of ESC)	Further action required to update ESC.		It is noted that Environmental Awareness training is mandatory and should provide an overview of the ESC. Further training is being planned. New ED and C contractor needs to be included in training. **Comments from J Hillary, post-workshop:** LLWR have taken on a number of new staff, in particular within Project Delivery. Similarly, LLWR have now engaged two consortia to deliver project and project-related works to LLWR. May be worthwhile to 'roll out' ESC briefing to help ensure that these users

Question/area	Issue	Categorisation	Justification	Comments
				understand the ESC.
What issues are outstanding from previous periodic reviews – issues, actions and recommendations? How have these been closed out? **N.B.** this question will not be relevant for this periodic review, as it is the first to be held.				
What significant changes to the ESC have there been?				Agree that this will be considered outside workshop.
Are there any audit reports and recommendations (including from the regulator) that impact on the ESC?				See Table 16.
What events or incidents have there been over the review period? What is their significance for the ESC?	Manhole 11 event.	Change to ESC not required.		Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
	Vault 8 and 9 leachate pumps.	Change to ESC not required.		Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by

Question/area	Issue	Categorisation	Justification	Comments
				LLWR.
				Agree that other events will be considered outside workshop.
What key organisational changes or MoCs have occurred: do any of these have implications for the ESC?	Proposed programmisation.	Change to ESC not required.		If implemented should lead to improved delivery of ESC-related projects.
	Proposed move of Inventory team into Science and Engineering.	Change to ESC not required.		If implemented should lead to additional focus on LLWR's inventory and source term.
	Appointment of ESC Manager and Owner.	Change to ESC not required.		ESC Manager and Owner are now repository roles.
	New Repository Site Procedures (RSPs).	Change to ESC not required.		New RSPs for managing the ESC and monitoring.

3.1.3 Nuclear Safety Case

Table 5 Workshop categorisation of nuclear safety case issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
What changes have there been to the NSC and could they potentially impact the ESC?	LLW and plutonium-contaminated material (PCM) safety cases have been revised. (Nuclear safety case)	Further action required to update ESC.		Part of baseline comparison **.
What changes have been		Change to ESC not		

Question/area	Issue	Categorisation	Justification	Comments
made to NSC controls that could potentially impact the ESC?		required.		
What NSC 'events' have there been that could impact the ESC and need to be allowed for?				See discussion of engineering events above. Events will be considered outside of the workshop.
Is there anything else that pertains to the nuclear safety case that impacts the ESC and needs to be allowed for?	Need to ensure that processes in place to take into account requirements of NSC when WAC defined. (Revised WAC and associated processes)	Further action required to update ESC.		
	Effects of changes above may need to be assessed against NSC, e.g. new containers, grout formulation, LSAM reuse.	Change to the ESC not required.	Action here is on NSC team, rather than ESC team.	
Is there any requirement for consistency between assumptions in radiological impact calculations between the NSC and ESC?	(Nuclear safety case)	Further action required to update ESC.		**Action to review NSC and ESC assumptions. NSC team and ESC teams to do desk-based study; identify relevant cases, then liaise.

3.1.4 Waste Management and Acceptance

Table 6 Workshop categorisation of waste management and acceptance issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Are there any changes to waste management that could impact the ESC?	Changes in assumptions in waste arisings, diversions and packing efficiency.	Change to the ESC not required.	Captured in annual review.	
	Uncertainties in timings and volumes of arisings. (Waste uncertainty management)	Further action required to update ESC.		Waste receipts are less than would be suggested by United Kingdom Radioactive Waste Inventory (UKRWI) data. There are uncertainties in rates of future wastes arising, e.g. from reactor decommissioning. Need to consider and review implications. May affect presentation in next major update of ESC.
	Particles and discrete items.	Change required, but already implemented in an update to the ESC.	See *Developments* report.	
	Sources. (Revised WAC and	Further action required to update ESC.		Addressed in 2011 ESC (see *Developments*

Question/area	Issue	Categorisation	Justification	Comments
	associated processes)			report). However, sum-of-fractions is still to be implemented, while new controls stipulate “at least 100 ml of grout”; current WAC stipulate “approximately 100 ml of grout”. Further work may therefore be required once a revised Permit has been issued.
	Significant work to develop WAC, e.g. non-radiological contaminants, complexants, asbestos, leach tests.	Change required, but already implemented in an update to the ESC.	See *Developments* report.	
What changes, if any, have been made to the waste acceptance process, and how do these impact, if at all, upon the ESC?	Significant changes need to be made to waste acceptance process to implement ESC. (Revised WAC and associated processes)	Further action required to update ESC.		Many changes already made; further work required on, e.g. non-radiological contaminant capacity, asbestos, complexants, annual limits. Some of these will result from the implementation of a revised Permit.
Are there any significant changes to the WAC that are not driven by the ESC?	None, except fewer types of containers permitted.	Change to the ESC not required.		

Question/area	Issue	Categorisation	Justification	Comments
Are the wastes that have been accepted since the 2011 ESC consistent with the ESC's assumptions?	Stored wastes (including ungrouted wastes) might not be consistent with ESC. Requires further action. (Stored wastes)	Further action required to update ESC.		Some Bradwell skips not consistent with WAC. Work currently ongoing looking at the stored wastes.
Are there any other waste acceptance or management issues that impact the ESC and need to be accounted for?	Now have separate Waste Compliance and Service Delivery teams.	Change to the ESC not required.		No further action required. Improves technical scrutiny and independence of waste acceptance.

An interview was held with the Waste Acceptance Manager on 13th February 2015. This yielded the contributions listed in Table 7.

Table 7 Waste acceptance and management issues and their effect upon the ESC.

Question/area	Issue	Categorisation	Justification	Comments
Are there any changes to waste management that could impact the ESC?				
What changes, if any, have been made to the waste acceptance process, and how do these impact, if at all, upon the ESC?				
Are there any significant changes to the WAC that	Re-word reactive metals WAC.	Change to the ESC not required.		Does not affect ESC, merely clarifies existing

Question/area	Issue	Categorisation	Justification	Comments
are not driven by the ESC?				WAC.
	Changes in WAC driven by new Permit.			See assessment of 'Revised Permit anticipated' in 'General'.
	Fissile limits: confusion over meaning of term 'enrichment'.	Change to the ESC not required.	Effect on ESC would be assessed when appropriate.	Work to clarify interpretation of this. Driver is from nuclear safety case.
Are the wastes that have been accepted since the 2011 ESC consistent with the ESC's assumptions?				
Are there any other waste acceptance or management issues that impact the ESC and need to be accounted for?	Non-radiological contaminants: LLWR only collects information by consignment, not by waste stream.	Change to the ESC not required.		Proposal was to manage non-radiological contaminants as per radioactive wastes. This would imply the need to gather waste stream-specific non-radioactive data. This is not compatible with the current approach. Resolution tied up with work on complexants and non-radiological contaminants.
	Driver to move away from WCI for some wastes;	See categorisation of changes in assumptions in		Characterisation docs still needed for

Question/area	Issue	Categorisation	Justification	Comments
	WCIs would only be for compaction or direct disposal.	waste arisings, diversions and packing efficiency.		secondary wastes. Impact on capacity model unclear (captured under waste assumptions?).
	No. of radionuclides captured in characterisation docs increased.	Change to the ESC not required.		Improves characterisation of consignment data. Does not affect ESC.
	Clarity of terms in WAC, e.g. discrete items, active particles. (Revised WAC and associated processes)	Further action required to update ESC.		Work still needs to be done to clarify what constitutes discrete items and active particles.
	Clarity of arguments for discrete items. (Revised WAC and associated processes)	Further action required to update ESC.		Arguments about populations etc.

3.1.5 Monitoring

Table 8 Workshop categorisation of monitoring issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Have there been any findings from the monitoring programme (e.g. coastline changes, concentrations of	Elevated tritium levels at Lonesome Pine.	Change to the ESC not required.	Final cut-off wall (CoW) will eliminate this.	Site Characterisation Manager is writing a Memo addressing this under ESC assessment process.

Question/area	Issue	Categorisation	Justification	Comments
contaminants, discharges from the facility, radiological doses within the facility) that could potentially impact the ESC and need to be allowed for?				
	Tritium exceedances in borehole 8670.	Change to the ESC not required.	No additional action required.	Enhanced monitoring implemented for a period. Will continue to review monitoring data on tritium in groundwater.
	Adequacy of non-radiological contaminant monitoring programme.	Change to the ESC not required.	Justified in 2013 Requirement 8 report.	
	Changed view of data from trench cap water balance data. (Trench cap water balance)	Further action required to update ESC.		Changed view needs to be considered in future assessment calculations. Issue relates closely to remediation of interim trench cap (see above).
Have there been any significant changes to the monitoring regime that could impact the ESC?	Trace gas monitoring scheduled. (Gas monitoring)	Further action required to update ESC.		Results to be reviewed when programme completed.
	Radon gas monitoring.	Change to the ESC not required.		Recorded in *LLWR Radon Data Review: April 2012-December 2013*, LLWR/P4600/CE66

Question/area	Issue	Categorisation	Justification	Comments
				Issue 3.
	EDTA sampling. (Complexants)	Further action required to update ESC.		Regular monitoring ongoing. Data will require interpretation.
	Single-hole dilution tests. (Single-hole dilution tests)	Further action required to update ESC.		Dilution tests were initial trials to see if the proposed method was applicable. These may be repeated in the future, but there is no firm plan to do so at present.
	System for acquiring trench cap water balance data required remediation.	Change to the ESC not required.		Reliability of trench cap water balance data improved.
Is there anything else that pertains to the monitoring programme that could impact the ESC that LLWR needs to be aware of?	Development of long-term monitoring programme. (Long-term monitoring programme)			Further work has been carried out to develop long-term monitoring programme. Requirements specification about to be developed. Related forward issue under review.
	New LLWR department created covering Monitoring and Site Characterisation and ESC teams.	Change required, but already implemented in an update to the ESC.	Recorded in Permit application.	Better coordination. Note that Environmental Manager (13/2/15) expressed an opinion that this was not significant, on the basis that the monitoring to support the ESC had not

Question/area	Issue	Categorisation	Justification	Comments
				been delivered via this route.

The Environmental and Technical Manager was unable to attend the Periodic Review workshop. An interview was therefore held with him on 13th February 2015. This yielded the contributions listed in Table 9.

Table 9 Categorisation of monitoring issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Have there been any findings from the monitoring programme (e.g. coastline changes, concentrations of contaminants, discharges from the facility, radiological doses within the facility etc.) that could potentially impact the ESC and need to be allowed for?	Flows from Trench 7. (Trench cap remediation)	Further action required to update ESC.		Relates to trench cap. It is still unresolved as to why there are high flows from Trench 7. It may indicate an issue with cap over that area, although trial work suggests that this is not the case. There is a disconnect between flows from Trench 7 and the proposed BAT solution for the trench cap (i.e. do not do anything on Trench 7 cap).
	Groundhog monitoring. Activity in ground on top of Drigg Stream banks.			Drigg Stream may have been dredged and spoil put on top of its banks. Are these unauthorised disposals? It could be a possible contaminated

Question/area	Issue	Categorisation	Justification	Comments
				land issue.
	Cliff closest point to MH 11 – significant erosion.	Change to the ESC not required.		Identified by continuous monitoring. It may need to be considered further: is this an issue with the pipeline being affected, or an issue with localised weakness? To be kept under routine review. Possibly captured under work to review and understand coastal erosion.
Have there been any significant changes to the monitoring regime that could impact the ESC?	Ecological surveys.	Change to ESC not required.		Species surveys have been undertaken at LLWR. These surveys are undertaken regularly and have no impact on the ESC.
Is there anything else that pertains to the monitoring programme that could impact the ESC that LLWR needs to be aware of?	Security Enhancement Programme will involve replacing site fence. Current statutory monitoring programme has points on or at the fence line. There is a risk that they could be affected.	Change to the ESC not required.		Surface monitoring point North could be affected by fence. Impact likely to be short-term, and if it occurred, would be remedied.

3.1.6 Engineering

Table 10 Workshop categorisation of engineering issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Have there been changes with respect to site engineering, and in particular, those aspects of the engineering that pertain to the repository (e.g. engineered barriers) that impact the ESC and need to be allowed for?	Timing of construction delayed as a result of delay in planning and permitting processes.			Captured in Table 3 *.
	Timing of decommissioning.			Affects vault construction and material availability. Captured in Table 3 *.
	ESC proposal included min 1 m profiling below cap. Planning application included min 2 m profiling below cap.	Change to the ESC not required.	No action required.	Change not confirmed; if it is adopted, it will need to be assessed.
	1 m profiling determined from structural considerations. Can LSAM go up to underside of cap, or is 1 m of profiling between the two required?	Change to the ESC not required.	No action required.	LSAM proposal would be assessed. Current assessments (2011 ESC and LSAM) assume 1 m clean profiling.

Question/area	Issue	Categorisation	Justification	Comments
Have there been changes in the assumptions, planning and design of planned engineered features that impact the ESC and need to be accounted for?	Short-term planning different from Site Development Plan. (Short-term planning and SDP)	Further action required to update ESC.		Need to consider what action, if any, is required.
	Changes arising from detailed design optimisation will need to be assessed and incorporated into the ESC. (Optimisation)	Further action required to update ESC.		
	Plans for interim trench cap remediation currently being developed. (Trench cap remediation)	Further action required to update ESC.		Potential effects of later surcharging will need to be considered.
Have there been any changes in the engineering management arrangements that impact the ESC and need to be accounted for?	ESC Manager now statutory signatory of PMPs with environmental significance.	Change required, but already implemented in an update to the ESC.		
	ESC Manager now also Head of Science & Engineering.			See Subsection 4.3 of the *Developments* report.
Are there any other engineering changes that impact the ESC and need to be accounted for?				

Question/area	Issue	Categorisation	Justification	Comments
Are any of the PMPs significant?	Trench cap remedial PMP.			Reviewed and categorised in Table 17.
	Drainage PMP.			Reviewed and categorised in Table 17.
	Need to comprehensively review PMPs.			Reviewed and categorised in Table 17.

3.1.7 Environment

Table 11 Workshop categorisation of environment issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Have there been any changes to the environmental management strategy that could impact the ESC?				
Have there been, or are there, any environmental issues that could impact the ESC and need to be accounted for?	Future Environmental Management Plan. (Future Environmental Management Plan)	Further action required to update ESC.		Managed by Environmental Team Lead. Indirect effect: could affect how repository works are carried out. Should have been described in L2 *Management and Dialogue* report. Add to

Question/area	Issue	Categorisation	Justification	Comments
				Issues Register.
	Site Landscape and Wildlife Management Plan. (Site Landscape and Wildlife Management Plan)	Further action required to update ESC.		Indirect effect: could affect how repository works are carried out. Should have been described in L2 *Management and Dialogue* report. Add to Issues Register. It is noted that this is to be incorporated into a site Environmental Management Plan.
	Drigg Stream will be diverted.	Change required, but already implemented in an update to the ESC.		
	Plans to develop surface water management in future.	Change to the ESC not required.		To be assessed if necessary.

An interview was held with the Environmental and Technical Manager on the 13th February 2015. No further Environmental issues were identified.

3.1.8 Operations

Table 12 Workshop categorisation of operations issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Have there been any changes to procedures that impact the ESC and need to be accounted for?	Implementation of Environmental Clearance Certificate (ECC). (ESC implementation)	Further action required to update ESC.		Live document. Specifically will require revision on receipt of any revised permit and when disposals in Vault 9 commence.
	Topping up of grout in containers to reduce ullage voidage – revised operating instruction.	Change to the ESC not required.		Operating Instruction (OI) revised to restrict ullage allowed after grouting – due to discovery of additional voidage in Vault 8 containers. *Added after discussion with Operations Manager, 13/2/15:* Topping up of partially-grouted containers currently stored in Vault 9 is a separate issue. It is distinct from any operation to further grout Vault 8 containers to reduce ullage, which would require pressure grouting. See below.
Have there been any other	Changes to	Change to the ESC not		Need for superplasticiser

Question/area	Issue	Categorisation	Justification	Comments
changes in Ops that could impact the ESC and need to be accounted for?	superplasticiser – change from Sikament 10 to Sikament 700.	required.		optimisation noted above, and currently being addressed by experimentation.
	Need to implement waste emplacement strategy. (Implementation of waste emplacement strategy)	Further action required to update ESC.		Implemented in ECC for Vault 8. Detailed procedure needs to be developed for Vault 9. *Added after discussion with Operations Manager, 13/2/15:* Vault 9 may be used as additional buffer storage for leachate if MHT overflows. Developed procedure would need to take this into account.

An interview was held with the LLW Operations Manager on the 13th February 2015. This yielded the outputs listed in Table 13.

Table 13 Categorisation of operations issues and their effect upon the ESC

Question/area	Issue	Categorisation	Justification	Comments
Have there been any changes to procedures that impact the ESC and need to be accounted for?	Pressure grouting of Vault 8 containers.	Change to the ESC not required.		Not scoped. Part of site optimisation and closure plan to fill ullage in disposed containers.
	Removal of vegetation from grout ports – do they need to be removed, and	Change to the ESC not required.		Already considered under ‘General’; see above.

Question/area	Issue	Categorisation	Justification	Comments
	do they need to be prevented from growing?			
Have there been any other changes in Ops that could impact the ESC and need to be accounted for?	Redesign of TC03s so overlid not required.	Change to the ESC not required.		Would remove grout skim lid, but should not affect ESC assumptions. Only possible impact if issues with disposal occur as a result of this (e.g. quantity of grout in container). If successful with TC03s, possible redesign of TC01s?

3.1.9 Review

There were no issues identified that had not been captured under any of the questions asked.

3.2 Technical Reports

The 2011 ESC [2] consists of documents at two levels:

- A single 'Level 1' report outlines the plan for the development of the LLWR and the main arguments concerning environmental safety and how this is achieved.

- A series of 'Level 2' reports present the evidence that underpins the safety arguments, including descriptions of the management framework, system understanding, design and management choices, and assessments.

These documents establish the technical content of the ESC. In addition, the ESC is supported by a large number of technical and scientific references that are referred to as 'Level 3' documents. These documents provide the detailed scientific and technical understanding of the repository that are marshalled in, and hence underpin and support, the Level 2 reports.

An important output from the Periodic Review is the establishment of a recognised document baseline for the ESC, and to understand how the ESC documentation set has evolved since May 2011. It is important to also identify where documents imply commitments to further work that need to be captured in the forward work programme.

This necessitates the review of technical reports issued between May 2011 and April 2014 to identify those that support[2] or comprise the ESC, and those that imply further work commitments that have not otherwise been captured.

In the Periodic Review, a wider definition of the ESC has been used. Thus, in addition to the *Developments* report [4], documents detailing ESC strategic plans, ESC governance, ESC procedures, revised assessment calculations, and revised technical approaches have been taken to be constituent parts of the ESC.

Some documents (irrespective of whether they support, or are part of, the ESC) will imply changes to, and hence update, the technical content of the ESC. These updates may have been captured already within the ESC (e.g. in the *Developments* report [4]). In the case of supporting documents, the technical updates may not yet have been captured within the ESC, but will support future revisions of the ESC.

The results of this review are summarised in Table 14. Management of the continued evolution of the ESC documentation is addressed in Section 5.

[2] 'Support' in the sense of being Level 3 documents, i.e. they provide the detailed scientific and technical understanding that underpins current, or will underpin future revisions of, Level 2 documents.

Table 14 Categorisation of technical reports relevant to the ESC

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
Guidance to Underpin Waste Acceptance Criteria at the LLWR, NNL(11)11889, Issue 1.0, August 2013	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Supports current ESC.
Review of the Formation and Degradation of Isosaccharinic Acid Under LLWR Vault Conditions, NNL(12)12150, Issue 2, September 2013	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Supports current ESC.
GRM Models of Carbon-14 Release at the Container Scale, NNL(12)12266, Issue 1.0, October 2013	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Supports current ESC.
Review of Leaching Data for Pulverised Fuel Ash Relevant to Assessing the Release of Contaminants from LLWR Grout, NNL(12)12271, October 2013.	Further action required to update ESC.	This report underpins the response to IRF RI-INF-002, and implies a methodological change that will need to be taken into account at the next major revision of the ESC.	This will support future revisions of the ESC. LLWR expects to consider the leaching of contaminants from Pulverised Fuel Ash in the next major ESC. (Optimisation of grout formulation)
Methodology for the Derivation of the Trench Inventory at the LLWR, NNL(12)12632, April 2013.	Further action required to update ESC.	The ESC will be updated taking this into account at the next major revision.	This will support future revisions of the ESC in terms of providing an understandable account of LLWR's inventory derivation methodology. (Revised LLWR radionuclide inventory)
A Guide to the Structure and Use of the LLWR Trench Inventory Calculations, NNL(13)12969, March 2014.	Further action required to update ESC.	The ESC will be updated taking this into account at the next major revision.	This will support future revisions of the ESC. (Revised LLWR radionuclide inventory)
Guide to the LLWR Trench Inventory Methodology and Development,	Further action required to update	The ESC will be updated taking this into account at the next major	This will support future revisions of the ESC in terms of providing an

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
NNL(13)12970, March 2014.	ESC.	revision.	understandable account of LLWR's inventory derivation methodology. (Revised LLWR radionuclide inventory)
ESC Project Execution Plan -2011/2012, LLWR/ESC/PM(12)001	Change to ESC not required.	Project management documents do not update, or comprise part of, the ESC.	Neither.
QA and Data Management Procedures, LLWR/ESC/QA(0)001	Change to ESC not required.	This does not update the technical content of the ESC, but it does comprise a key part of it.	Comprises part of ESC.
ESC Forward Programme, LLWR/ESC/R(11)10040	Further action required to update ESC.	Outlines ESC forward programme and will thus detail updates to the ESC.	Comprises part of ESC. (ESC development programme)
Response to 'Peer Review of the 2011 ESC', LLWR/ESC/R(11)10041, Issue 1, February 2012	Further action required to update ESC.	Outlines LLWR responses to the ESC Peer Review.	Key supporting document to ESC.
Optimisation of Vault Sequencing, LLWR/ESC/R(11)10042, November 2011.	Change to ESC not required.	See categorisation of IRF RI-ASO-001	Neither.
Optimisation of Vault Operational Conditions, LLWR/ESC/R(11)10043.	Further action required to update ESC.	See categorisation of IRF RI-ASO-001	Supports future revisions of the ESC. (Vault optimisation)
Optimisation in Relation to Possible Future Interventions, LLWR/ESC/R(11)10044	Change to ESC not required.	See categorisation of IRF RI-ASO-003.	Neither.
Updated Assessment Calculations Based on the 2010 UK Radioactive Waste Inventory, LLWR/ESC/R(12)10045, March 2012	Change required, but already implemented in an update to the ESC.	The results of the updated assessment calculations are included in the *Developments* report.	Key reference underpinning ESC.
Scoping Assessment of Carbon-14 Bearing Gas, LLWR/ESC/R(12)10046,	Change to ESC not required.	The results of this scoping assessment are superseded by the more	Neither.

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
February 2012.		detailed revised C-14 assessments carried out.	
Assessment of Radiological Impacts in the Very Long Term if the LLWR is Not Eroded, LLWR/ESC/R(12)10047, February 2012.	Further action required to update ESC.	The report comprises a key extension to the technical approach in the ESC and will comprise part of an updated ESC.	Comprises part of ESC. (Radiological assessment)
Monitoring Review Programme – Post-2011 ESC, LLWR/ESC/R(12) 10048, November 2012.	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Comprises part of ESC.
2011 ESC Implementation Plan, LLWR/ESC/R(12) 10049, December 2012.	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Comprises part of ESC.
2011 ESC Implementation: Strategy Paper, LLWR/ESC/R(13) 10051, February 2013.	Change required, but already implemented in an update to the ESC.	Describes implementation and governance of ESC.	Comprises part of ESC.
Environmental Safety Assessment of the Proposal to Reuse Low Specific Activity Material as part of the Final Cap Profile, LLWR/ESC/R(13) 10052, March 2013.	Change to ESC not required.	No decision taken on this course of action. If decision was made to proceed, classification may change.	Neither.
Review of the Potential Effects of Complexants on Contaminant Transport at the LLWR, LLWR/ESC/R(13)10054, September 2013.	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Comprises part of the ESC until such time as replaced by status report.
Assessment of Discrete Items and Basis for WAC, LLWR/ESC/R(13) 10055, August 2013.	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Key part of ESC as this underpins the WAC for discrete items.
Assessment of Individual Radioactive Particles and WAC for Active Particles,	Change required, but already implemented in an	This report underpins the *Developments* report.	Key part of ESC as this underpins the WAC for active particles.

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
LLWR/ESC/R(13) 10056, August 2013.	update to the ESC.		
Application to Vary LLWR's Permit, LLWR/ESC/R(13) 10057, October 2013.	Change required, but already implemented in an update to the ESC.	Report supports application for revised permit, summarising LLWR technical position and changes requested to the Permit.	Comprises part of the ESC.
Developments Since the 2011 ESC, LLWR/ESC/R(13)1005, October 2013.	Change required, but already implemented in an update to the ESC.	Summarises LLWR's technical position.	Comprises part of the ESC.
Assessment of Carbon-14 Bearing Gas, LLWR/ESC/R(13) 10059, September 2013.	Change required, but already implemented in an update to the ESC.	This report underpins the *Developments* report.	Comprises part of ESC.
Slope Stability of the Eroding Waste Mass, QRS-1443ZO-1, May 2012.	Further action required to update ESC.	See categorisation of IRF TQ-SUE-011.	Neither. (Mass stability)
LLWR Trench Hydrological Management BAT: Final Report, QRS 1443S ZN R3, November 2012.	Further action required to update ESC.	Further work is required as part of ongoing trench cap management.	Comprises part of the ESC. (Trench cap remediation)
Assessment of the Implications of Voidage in Vault 8, QRS-1443ZP-1, May 2013.	Further action required to update ESC.	Further work is required to refine the understanding of voidage for stored wastes and substantiation of higher stacking in Vault 8.	Neither, as the position on voidage in Vault 8 has not been finalised. (Voidage and higher stacking)
Assessment of C-14 Bearing Gas: Update to the Biosphere Model, QRS-1443ZQ-1, October 2013.	Change required, but already implemented in an update to the ESC.	Underpins C-14 work described in the *Developments* report.	Neither; superseded by complete carbon-14 assessment in LLWR/ESC/R(13)10059.
Updated Assessment Model and Assessment Calculations for C-14-Bearing Gas, QRS-1443ZQ-2, October 2013.	Change required, but already implemented in an update to the ESC.	Underpins C-14 work described in the *Developments* report.	Neither; superseded by complete carbon-14 assessment in LLWR/ESC/R(13)10059.

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
Design Optimisation Study for the Re-use of Low Specific Activity Waste within the Profiling Material for the LLWR Final Cap, QRS-1443ZS-R2, December 2012.	Change to ESC not required.	See categorisation of LLWR/ESC/R(13)10052.	Neither.
Key Uncertainties in the 2011 ESC Period of Authorisation Assessment, QRS-1669A-1, January 2014.	No change to ESC required.	This does not constitute an update to the ESC itself, but would inform future work to address uncertainties.	Neither.
Key Uncertainties in the 2011 ESC Radon Gas Assessment, QRS-1669A-2, February 2014.	No change to ESC required.	This does not constitute an update to the ESC itself, but would inform future work to address uncertainties.	Neither.
Key Uncertainties in the 2011 ESC Coastal Erosion Assessment, QRS-1669A-3, February 2014.	No change to ESC required.	This does not constitute an update to the ESC itself, but would inform future work to address uncertainties.	Neither.
A Forward Inventory for LLWR based on the 2010 UKRWI, SERCO/E005766/001, March 2012.	Further action required to update ESC	See categorisation of IRF RI-INF-001.	Key reference underpinning ESC. (Revised LLWR radionuclide inventory)
Radiological Capacities for the RDA and EDA LLWR Repository Design for the Groundwater Pathway, SERCO/E005758/001, January 2012.	Change required, but already implemented in an update to the ESC.	Underpins work described in the *Developments* report.	Underpins ESC.
Reconciliation of Differences Between the RDA and EDA Calculations in the 2011 ESC for the Groundwater Pathway, SERCO/E005758/002, January 2012.	Change required, but already implemented in an update to the ESC.	Report described work to reconcile differences the groundwater assessment models, and to develop a modified model rectifying these inconsistencies.	Comprises part of the ESC.
Integration of the Geology and Hydrogeology at the LLWR, D005864/002, July 2012.	Further action required to update ESC.	This report is significant, but findings have not yet been carried through to the assessment models. Outcomes have not yet	Neither, but will be part of the ESC when hydrogeology and geology is revised. (Groundwater, geology

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
		been incorporated into the ESC, and will need to wait until an update of the hydrogeology and geology.	and hydrogeology)
The Effect of Faults on the Hydrogeology at the LLWR, D005864/003, August 2012.	Further action required to update ESC.	This report is significant, but findings have not yet been carried through to the assessment models. Outcomes have not yet been incorporated into the ESC, and will need to wait until an update of the hydrogeology and geology.	Neither, but will be part of the ESC when hydrogeology and geology is revised. (Groundwater, geology and hydrogeology)
Review of the Impact of EDTA and Related Complexants on Contaminant Sorption and Solubility, 006357/001, May 2013.	Change required, but already implemented in an update to the ESC.	Underpins *Developments* report.	Supporting document to ESC.
LLWR C-14 Inventory: The Impact of Different Waste Processing Assumptions, D006358/001, October 2013.	Change required, but already implemented in an update to the ESC.	Report underpins the revised C-14 assessment work in LLWR/ESC/R(13)10059.	Supports ESC.
Modelling the Uptake of Carbon-14 by Plants: Transport Through Plant Canopies, 006407/001, February 2013.	Change required, but already implemented in an update to the ESC.	Report underpins the revised C-14 assessment work in LLWR/ESC/R(13)10059.	Supports ESC.
Developing an Approach for Managing the LLWR's Capacity for Various Non-radiological Contaminants, SF6817/001, September 2013.	Change required, but already implemented in an update to the ESC.	Referenced in *Developments* report.	Comprises part of the ESC.
Review of Leach Testing Procedures, P&P-EUR-CE-2013-1301/001, March 2014.	No change to ESC required.	The report does not update the ESC; rather, it reviews potential leach tests that could be used to support the WAC. This may update the ESC in future.	Neither.
Technical Note: Updated Non-radiological Assessment Calculations,	Further action required to update ESC.	Not yet carried through to the WAC, so not part of the ESC. There is an	Neither. (Non-radiological

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
SF9817, April 2014.		action on developing the methodology and including it in future assessment calculations.	assessment)
Radiological and Non-radiological Capacities for the LLWR in the Presence of EDTA, AMEC/8577/001, October 2013.	Change required, but already implemented in an update to the ESC.	Underpins discussion in *Developments* report.	Supporting document.
Elicitation of the Corrosion Rate of the Lead in the LLWR, AMEC/200594/002, August 2013.	Change required, but already implemented in an update to the ESC.		Supporting document.
Preliminary Evaluation of Possible Improvements to the 3D Modelling Approach for the LLWR, 201372/001, March 2014.	No change to ESC required.	This report does not, in itself, update the ESC. It may, however, lead to work that forms part of an update to the ESC.	Neither.
Assessment of the Impact of the Proposal for Use of Low Specific Activity Material in the LLWR Cap, AMEC/000112/002, March 2013.	No change to ESC required.	See categorisation of LLWR/ESC/R(13)10052.	Neither.
Assessment of Long-term Risks from Disposal of Asbestos Waste at the LLWR and Options for Treatment and Conditioning of Asbestos Wastes, 34552RR036, February 2014.	Further action required to update ESC.	This underpins the asbestos work summarised in the *Developments* report. This work has implications for WAC, but has not yet been implemented.	Supports ESC. (Asbestos)
Environmental Fate of Citric Acid and Citrate, Hudd/LLWR/1/12, September 2012.	Change required, but already implemented in an update to the ESC.	Significant update captured as part of the *Developments* report.	Supporting document.
Regulatory Review of Final Cap Placement, 1635 R 011, April 2013.	No change to ESC required.		Neither.
Response to Technical Query Regarding Wells, D.000215/001, 2013.	Change required, but already implemented in an	Part of the revised Permit application.	Comprises part of ESC.

Report	Categorisation	Justification	Constituent or support to ESC (High-level theme in brackets)
	update to the ESC.		
Response to Technical Query ESC-ASO-009A Regarding Wells, AMEC/200719/001, August 2013.	Change required, but already implemented in an update to the ESC.	Part of the revised Permit application.	Comprises part of ESC.
Transcription of RECALL Interviews, D.00255/001, April 2013.	No change to ESC required.	Does not imply any change to the technical approach in the ESC.	Neither.
Beach Springs Investigation, AMEC/D.000232.01/Report, July 2013.	No change to ESC required.	Does not imply any change to the technical approach in the ESC.	Neither.
Key Uncertainties in the Assessment of Human Intrusion for the LLWR 2011 ESC, 1403-1, February 2014.	No change to ESC required.	This does not constitute an update to the ESC itself, but would inform future work to address uncertainties.	Neither.

3.3 Memos

A number of technical memos have been issued between May 2011 and April 2014. These have been reviewed to identify those that update the technical content of the ESC and may therefore become part of the ESC baseline, and to identify any commitments that need to be reflected in the ESC forward programme of work. In the interests of clarity, memos produced in response to IRFs are excluded from this review; instead, see the categorisation of IRFs in Subsection 3.8.

In Table 15 the outcomes of this review are summarised. Where appropriate, high-level themes are given in parentheses after the memo title.

Table 15 Categorisation of memos relevant to the ESC

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(11)128	Audit Note- Criticality (Serco)	No change to ESC required.	The audit outcome does not affect the technical content of the ESC.
LLWR/ESC/Mem(11)129	Second Audit Note- CE and Gas (Quintessa)	No change to ESC required.	The audit outcome does not affect the technical content of the ESC.
LLWR/ESC/Mem(11)130	Comparison of WAC between the RDA and the EDA Assessment calculations	No change to ESC required.	Does not update technical content of ESC.
LLWR/ESC/Mem(11)131	Choice of assessed well in the LTRA	No change to ESC required.	The memo discusses the choice of an isolated dwelling well in the groundwater assessment model. Does not update technical content of ESC.
LLWR/ESC/Mem(11)132	Long Term Trench and Vault Experiments	No change to ESC required.	Does not update technical content of ESC.
LLWR/ESC/Mem(11)134	Management of the Implementation of the 2011 ESC	No change to ESC required.	Memo was prepared to support a meeting on ESC implementation led by LLWR MD. Content largely superseded.
LLWR/ESC/Mem(11)135	ESC lessons learnt	No change to ESC required.	This memo does not alter the content of the ESC, but may help inform future development of the ESC.
LLWR/ESC/Mem(11)136	Borehole 8670 monitoring	No change to ESC required.	Does not update technical content of ESC.
LLWR/ESC/Mem(11)137	EA leachate analysis query	No change to ESC required.	Note provides details of the trench leachate analyses that have been carried out and what is planned for the future. It does not update the ESC.
LLWR/ESC/Mem(11)138	Well Biosphere Dose Factor for Tritium	No change to ESC required.	This technical memo provides background to the biosphere factor used in assessment calculations; it

Reference	Title	Categorisation	Justification
			does not update the ESC.
LLWR/ESC/Mem(11)140	'Current Radiological Impacts from Tritium in Groundwater'	Change required, but already reflected in an update to the ESC.	Underpins *Developments* report.
LLWR/ESC/Mem(12)141	Event Investigation Report: Event 11110568 - Error in ESC WAC Calculations	Change required, but already reflected in an update to the ESC.	The effects of correcting the error are discussed in the *Developments* report.
LLWR/ESC/Mem(12)142	Environment Agency ESC Review	No change to ESC required.	Memo details current and future LLWR position on management of ESC records. It does not imply any update to the ESC.
LLWR/ESC/Mem(12)143	Outline costs for dealing with LTVEs	No change to ESC required.	Memo does not update LLWR's position on the technical content of the ESC.
LLWR/ESC/Mem(12)144	ESC commitments	No change to ESC required.	These commitments are captured elsewhere; this memo describes where and how.
LLWR/ESC/Mem(12)145	SSSI hydrogeology clarifications	No change to the ESC required.	The memo provides information to support answers provided to Environment Agency at meeting of

Reference	Title	Categorisation	Justification
			21/10/11. As such, it does update the ESC.
LLWR/ESC/Mem(12)149	MoD Waste - RESTRICTED	No change to the ESC required.	This memo contains an analysis of some wastes that might have been of interest/disposed to the LLWR. There is no intent to receive the wastes and hence the memo has no relevance to the ESC.
LLWR/ESC/Mem(12)150	Key Messages from the Main BAT Options Assessment Workshop for the Hydrological Management of the Interim Cap	No change to the ESC required.	These are captured elsewhere.
LLWR/ESC/Mem(12)151	ESC requirements for container grout	No change to the ESC required.	The memo summarises the technical requirements. It does not update the technical content of the ESC.
LLWR/ESC/Mem(12)152	Response to information request from Japanese government	No change to the ESC required.	Response to information request does not update technical content in ESC.
LLWR/ESC/Mem(12)155	Agency feedback on Non Rad May 2012	No change to the ESC required.	Content of this memo is captured as part of forward issue ESC-FI-006.
LLWR/ESC/Mem(12)156	Response to NDA request of information on impact on changes to End States	No change to the ESC required.	Response to information request does not update technical content in ESC.
LLWR/ESC/Mem(12)161	Scoping Assessment of Single Items against the ESC	Change required, but already reflected in an update to the ESC.	Forms part of the discrete items work discussed in the *Developments* report.

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(12)162	Revised PoA Calculations	Change required, but already reflected in an update to the ESC.	
LLWR/ESC/Mem(12)163	NNL Tech Memo Ref LLWR06502/06/10/01 *Correlation of logs obtained Drigg Beach Characterisation Data with Lithofacies Geological & Hydrogeological Modelling*	Change to the ESC not required.	This does not update the ESC's technical content, but could inform future work.
LLWR/ESC/Mem(12)164	NNL Tech Memo LLWR06502/06/10/02 *Lithofacies-based interpretation of 2009 Drigg Spit Geophys*	Change to the ESC not required.	This does not update the ESC's technical content, but could inform future work.
LLWR/ESC/Mem(12)166	NNL Memo LLWR06488/06/10/01 *Gas generation rate plots from GRM ESC calculations*	Change to the ESC not required.	Does not update ESC technical content.
LLWR/ESC/Mem(12)170	Response to Variation 4ROS-WCV-2012-6240 (Rosyth Resins)	Change to the ESC not required.	Waste acceptance issue; does not update ESC technical content.
LLWR/ESC/Mem(12)171	Stream Monitoring and Robin Weir Replacement	Change to the ESC not required.	Operational issue; does not update ESC technical content.
LLWR/ESC/Mem(12)172	Waste Acceptance - Sellafield 2x26. Clinoptilolite Contaminated Wastes.	Change to the ESC not required.	Waste acceptance issue; does not update ESC technical content.
LLWR/ESC/Mem(12)173	Waste Acceptance - Sizewell A. Sand and Gravel Filter. 1MXN-WCV-2012-6248	Change to the ESC not required.	Waste acceptance issue; does not update ESC technical content.
LLWR/ESC/Mem(12)180	NNL Memo LLWR06488/06/10/02 *Plots of methane gas generation from GRM ESC calculations*	Change to the ESC not required.	This does not update the technical content of the ESC.
LLWR/ESC/Mem(12)181	*Variant calculation relating to differing assumptions about uranium solubility and sorption in the ESC*	Change to the ESC not required.	This does not update the technical content of the ESC.

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(12)182	Non-radiological monitoring - Response to EA	Change to the ESC not required.	This does not update the technical content of the ESC.
LLWR/ESC/Mem(12)183	Response to EA Query - Vault 8 flowpaths	Change to the ESC not required.	This does not update the technical content of the ESC.
LLWR/ESC/Mem(12)184	Hypothetical dose to a person engaged in clearing the Drigg Stream channel off-site	Change to the ESC not required.	This does not update the technical content of the ESC.
LLWR/ESC/Mem(12)185	Tech Memo *Citrate Complexation Modelling* NNL LLWR06488/06/10/04	Change to the ESC not required.	This does not update the technical content of the ESC.
LLWR/ESC/Mem(12)191	ESC Sanction Request	Change to the ESC not required	This is a project management memo that does not update the technical content of the ESC.
LLWR/ESC/Mem(13)192	Comparison of LLWR and Dounreay ESCs	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)193	Halcrow - *Significance of the Dunes System*	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)194	Development and Assessment of waste fire scenarios during the post operational period (Waste fire scenarios)	Further action required to update ESC.	Part of forward issue ESC-FI-003.
LLWR/ESC/Mem(13)196	Halcrow *Feasibility of a GPS Station to Monitor LLWR Isostatic uplift*	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)197	Consignor query - Berkeley boilers 9A315 secondary waste	Change to ESC not required.	Waste acceptance issue; does not update ESC technical content.
LLWR/ESC/Mem(13)199	Site query about the acceptability for disposability of flocculants	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)207	Progress update on complexants work	Change to ESC not required.	Status update: does not update technical content of ESC.
LLWR/ESC/Mem(13)208	Waste acceptance - 1S WCV 2012 6302 Harwell encapsulated mixer	Change to ESC not required.	Waste acceptance issue; does not update ESC technical content.

Reference	Title	Categorisation	Justification
	containing oil		
LLWR/ESC/Mem(13)209	Collective dose to populations of UK, Europe and the World	Change to ESC not required.	While this does not update the ESC, it will need to be included in future revisions of the ESC.
LLWR/ESC/Mem(13)210	Potential impacts from drilling into sources	Change to ESC not required.	
LLWR/ESC/Mem(13)213	Response to Agency questions about WAC	Change to ESC not required.	Does not update technical content of the ESC.
LLWR/ESC/Mem(13)215	Case for change for superplasticiser (Optimisation of grout formulation)	Further action required to update ESC.	Forms part of ongoing work on superplasticiser optimisation.
LLWR/ESC/Mem(13)216	Halcrow - *Feasibility, Practicality and Cost of Installing GPS to Monitor Land Level Change* (related to IRF TQ-SUE-010)	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)217	Waste acceptance - Emplacement Strategy Requirements	Change to ESC not required.	Memo captures ESC emplacement strategy requirements; does not update technical content of ESC.
LLWR/ESC/Mem(13)218	Waste acceptance - Capacity Management Requirements (revised WAC and associated processes)	Further action required to update ESC.	Memo discusses, amongst other things, emplacement strategy. Wastes are currently being assessed against the emplacement strategy requirements as part of the stored wastes work.
LLWR/ESC/Mem(13)219	Error in Calculating External Radiation Dose in the Period of Authorisation Assessment	Change to ESC required, but already reflected in an update of the ESC.	This is discussed in the *Developments* report.

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(13)220	Interim cap performance monitoring	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)221	Comparison of Asbestos disposal in landfills and at the LLWR.	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)222	Revision of Estimated Dust and Direct Radiation Doses for the Period of Authorisation	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)223	NNL Memo LLWR07146/10/06/1 *Contributing Waste Streams to Specific Bays in LLWR Trenches*	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)224	Evolution of the Drigg Coast SAC and SSSI and impact of developments on the LLWR site	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)225	Leachate discharges during the Period of Authorisation	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)226	Interim Cap Repairs	Change to ESC not required.	Captured as part of ongoing trench cap remediation work.
LLWR/ESC/Mem(13)227	Consignor query - Sizewell B pressurised heater elements	Change to ESC not required.	Waste acceptance issue; does not update ESC technical content.
LLWR/ESC/Mem(13)229	Results from Capacity Calculations for Radionuclides in the Presence of Reference Level of EDTA	Change to ESC not required.	Captured in *Radiological and Non-radiological Capacities for the LLWR in the Presence of EDTA,* AMEC/8577/001.
LLWR/ESC/Mem(13)230	WAC consultation feedback	Change to ESC not required.	The changes identified as a result of this consultation exercise have been incorporated in the most recent version of the WAC, and do not update the technical content of the ESC.
LLWR/ESC/Mem(13)231	Schedule 8 data comparison	Change to ESC not required.	This memo was superseded by Mem(14)260, which is outside the time period for this review.

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(13)232	Amec Memo in response to EA Audit Action	Change to ESC not required.	Provides information in response to Environment Agency request. Does not update technical content of ESC.
LLWR/ESC/Mem(13)233	Comparative CO2 emissions from disposal of super-compacted organic wastes and incinerated waste residues at LLWR	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)234	Response to UU on risk to services	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)235	Key Uncertainties in the Recent Assessment of Carbon-14 Bearing Gas	Change to ESC not required.	Does not update the technical content of the ESC, but may form part of a programme of work that does update the ESC.
LLWR/ESC/Mem(13)236	ESC Assumptions and how they are addressed EHSC/NSC version	Change to ESC required, but already reflected in an update of the ESC.	Explains actions required to ensure validity of assumptions in the ESC. As part of the process of identifying ESC assumptions and considering how they might be addressed, a requirement for a new environmental monitoring repository site procedure has been identified. This would provide a formal framework for the management and development of the environmental monitoring programme.
LLWR/ESC/Mem(13)237	Key challenges facing consignors in implementing the WAC	Change to ESC not required.	This memo sets out what LLWR perceive to be the main challenges facing customers in meeting the new WAC. It does not update the technical content of the ESC.

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(13)238	Response to EA query - TBP in trench leachate	Change to ESC not required.	Provides information in response to Environment Agency request. Does not update technical content of ESC.
LLWR/ESC/Mem(13)239	Assessment cases and data for assessment of hazard from asbestos disposed at LLWR (Asbestos)	Further action required to update ESC.	Memo provides data that may be used to support assessment of asbestos disposal at LLWR.
LLWR/ESC/Mem(13)240	Response to Environment Agency Further Information Notice: Well Pathway Calculations and Other Issues.	Change to ESC not required.	Provides information in response to Environment Agency request. Does not update technical content of ESC.
LLWR/ESC/Mem(13)241	NNL Drigg Spit Geophysics NNL - LLWR06642/06/10/01	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)242	Investigating the doses arising from terrestrial discharges of radionuclides overtopping the LLWR near field	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)243	NNL Response to ESC Memo LLWR/ESC/Mem(13)215 - NNL Ref LLWR07176/06/10/01	Further action required to update ESC.	Forms part of ongoing work on superplasticiser optimisation.
LLWR/ESC/Mem(13)245	Amec Memo - EA Audit Action EA1	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)246	Discussion of Approach Used for Assessments of Non-radiological Impacts	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(13)247	AMEC Response to EA Non rad assessment EA2	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(14)248	Information to demonstrate that there is no linkage between the surface water features within the Drigg Coast SAC and the Upper groundwater	Change to ESC not required.	Does not update technical content of ESC.

Reference	Title	Categorisation	Justification
LLWR/ESC/Mem(14)250	Lot 3 Geological/Hydrogeology Task 1.5 Incorporation of Geophysics data in 3D Geological Model (Groundwater, geology and hydrogeology)	See categorisation of *Integration of the Geology and Hydrogeology at the LLWR,* D005864/002.	
LLWR/ESC/Mem(14)251	Amec - RFQ 5772 elating to non-destructive testing of HHISO containers at LLWR	Change to ESC not required.	None of the proposed non-destructive testing techniques were selected for progression. Thus the memo does not update the technical content of the ESC.
LLWR/ESC/Mem(14)252	Implications of implementing the LLWR's 2011 ESC	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(14)253	WAMAC Pucks	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(14)254	Discrete Item Limits	Change to ESC not required.	Does not update technical content of ESC.
LLWR/ESC/Mem(14)256	Sellafield Memo To RC from Ged Pugh - *Refined Quantification & Underpinning for Volumes of Decontamination Chelating Agents in Solid Wastes*	Change to ESC required, but already reflected in an update of the ESC.	This underpins complexant work discussed in *Developments* report.
LLWR/ESC/Mem(14)257	Sellafield Memo To Ged Pugh from Alex Jenkins - *Volumes of Decontamination Chelating Agents in Solid Wastes*	Change to ESC required, but already reflected in an update of the ESC.	This underpins complexant work discussed in *Developments* report.

3.4 Audits

Two audit reports relevant to the ESC were identified:

- the audit of ESC records undertaken on 16 November 2011 by LLWR;
- the independent 'deep slice' inspection of the ESC undertaken in February 2012 by LLWR.

These were reviewed to assess whether there were any recommendations that could affect the ESC. The first of these audits does not imply that any changes to the ESC are required; only two minor non-conformances were found (related to fortnightly technical and financial progress updates and 'at-home' risk assessments). The second audit made a number of observations and recommendations. These are summarised, together with their categorisation in Table 16. Where appropriate, high-level themes are given in parentheses in the 'Issue' column.

Table 16 Categorisation of issues identified from 2012 'deep slice' audit

Issue	Categorisation	Justification
ESC project manager now signs waste variation forms (Revised WAC and associated processes)	Further action required to update ESC.	This constitutes a change in the waste acceptance process that is not recorded in the ESC or supporting documentation.
Assessment of stored wastes (Stored wastes)	Further action required to update ESC.	This assessment is currently being undertaken. The ESC will need to be updated with the results of this assessment.
Training of Waste Services staff and further engagement with consignors	Change to ESC not required.	Training improves the standard of technical scrutiny and the quality of waste acceptance, but does not update the ESC, and no further action is thus required.
SQEP resource and staffing of ESC team	Change to ESC not required.	Issue is recognised and is being managed, so no update to ESC required.
Formalisation of Project Sponsor.	Change to ESC required, but already reflected in an update of the ESC.	The ESC is no longer a project, so the issue of a sponsor is no longer relevant. However, the ESC owner is LLWR MD. This is outlined in the appropriate RSP, and is thus reflected in an update to the ESC.
Development of a 'commitments log' or	Further action required to update	Issue has been identified and is now being managed appropriately through the use of

Issue	Categorisation	Justification
actions list for any promissory statements made in the close-out of regulatory issue resolutions. (Revised trackers)	ESC.	the issues register, so does not imply that any general update to the ESC is required.

3.5 PMPs

The PMP process is one of the means by which the ESC is implemented and managed on site as a live safety case [11]. A PMP must be completed prior to temporary or permanent modification of existing buildings, plant or processes, including changes to a safety case, and must categorise the potential of the modification to affect environmental performance regardless of any additional radiological, nuclear or conventional safety implications. It requires the endorsement of the appropriate LLWR subject matter experts and LLWR safety committees.

Information or proposed changes raised via the PMP process in the period May 2011 to April 2014 need to be assessed as part of the Periodic Review to understand and categorise their significance to the ESC, and in particular, whether they update the ESC or necessitate further action to be undertaken. The LLWR PMP database was therefore reviewed to identify ESC-relevant PMPs. The categorisation of these PMPs is given in Table 17. Where appropriate, high-level themes are given in parentheses in the 'Issues' column. There are no documents in the PMP database for certain live PMPs. These have not been reviewed.

Table 17 Categorisation of PMPs relevant to the ESC

PMP Number	Title	Classification	Justification
LLWR/PMP/2008/191	Ground investigation for LLWAM	Change to ESC not required.	PMP concerns digging holes for installation of monitoring equipment. Does not update ESC.
LLWR/PMP/2008/202	Interim diversion of leachate system from B743	Change to ESC not required.	This concerns the installation of a temporary leachate system so does not update the ESC.
LLWR/PMP/2008/204	Construction inactive commissioning of Vault 9	Change to ESC not required.	Concerns building of V9. This does not update the ESC.
LLWR/PMP/2008/206	Operation of the whole of Vault 9	Change to ESC not required.	This concerns an operational matter. It does not affect the ESC.
LLWR/PMP/2008/209	Trench cap monitoring installation phase 1 v-notch weir upgrade	Change to ESC not required.	Installation of monitoring equipment does not necessitate update of ESC.
LLWR/PMP/2008/212	Trench cap monitoring installation phase 2 – installation of water level data loggers in boreholes	Change to ESC not required.	Installation of monitoring equipment does not necessitate update of ESC.

PMP Number	Title	Classification	Justification
LLWR/PMP/2008/216	Removal of old radiometric measuring system and installation of new ICAM system	Change to ESC not required.	This concerns monitoring for the grout facility. It does not necessitate an update to the ESC.
LLWR/PMP/2008/234	Acceptance, receipt and segregation of LLW on the B726 and B755	Change to ESC not required.	Concerns temporary storage of segregated waste prior to opening onward routes to treatment. Does not imply any update to the ESC.
LLWR/PMP/2010/270	Replacement of trench cap run-off system	Change to ESC not required.	Replacement of run-off drain system; does not update ESC.
LLWR/PMP/210/282	Replacement of marine holding tank (MHT) flow sensors	Change to ESC not required.	Replacement of sensors – almost like-for-like. No effect on ESC.
LLWR/PMP/2011/320	Installation of Vault 8 and Vault 9 gates	Change to ESC not required.	Manages access to controlled areas. Does not affect ESC.
LLWR/PMP/208/201	Diversion of existing service to Vault 8 and installation of new services	Change to ESC not required.	Provision of services is a facilities issue. No effect on ESC.

PMP Number	Title	Classification	Justification
LLWR/PMP/2010/295	Alteration of MHT discharge level	Change to ESC not required.	In the ESC the assumption is that the MHT and associated leachate system manages discharges to sea. This PMP does not change this assumption.
LLWR/PMP/2009/245	Trench cap phase 3 works (Trench cap remediation)	Further action required to update ESC.	Installation of leachate loggers and flow meters to better understand water balance. This has led to a changed view of the data from the trench cap water balance. This changed view needs to be considered in future assessment calculations. Issue relates closely to remediation of interim trench cap.
LLWR/PMP/2011/334	Acceptance, receipt and interim storage in Vault 9 and onward dispatch of 10 half-height ISOs containing Bradwell skips	Change to ESC not required.	Temporary storage and onward shipping of containers. No effect on ESC.
LLWR/PMP/2012/372	Replacement and upgrade of marine discharge system soft start unit	Change to ESC not required.	Upgrade to address obsolescence issues. Does not affect ESC.
LLWR/PMP/2012/392	Fitment of plug to spigot in Manhole 11 (MH11)	Change to ESC not required.	Remediation in response to an event. No long-term effect, and thus does not affect the ESC.

PMP Number	Title	Classification	Justification
LLWR/PMP/2013/432	Plant scale trials of Sikament 700 superplasticiser (Optimisation of grout formulation)	Further action required to update ESC.	While these trials are complete, the categorisation is on the basis that this forms part of an ongoing piece of work to optimise the superplasticiser employed at LLWR.
LLWR/PMP/2007/148	Labelling and designation of environmental equipment on LLWR site	Change to ESC not required.	Superseded by LLWR/PMP/2010/298.
LLWR/PMP/2007/170	Site-wide designation of environmental equip at LLWR	Change to ESC not required.	Superseded by LLWR/PMP/2010/298.
LLWR/PMP/2012/383	Falling head test to holding tanks 1 and 2 single tank configuration	Change to ESC not required.	This was a system test and does not necessitate updating the ESC.
LLWR/PMP/2012/385	Adjustment of trip amp activation levels on Vault 8 and Vault 9 leachate chamber sump pumps	Change to ESC not required.	An asset management issue. Does not affect the ESC.
LLWR/PMP/2012/390	Replacement of obsolete diverter valve actuator	Change to ESC not required.	Replacement of obsolete part; no effect on ESC.

PMP Number	Title	Classification	Justification
LLWR/PMP/2013/407	Temporary change of pump in pump chamber	Change to ESC not required.	Temporary trial of new pump; no effect on ESC.
LLWR/PMP/2013/410	Service and firmware update on trench cap perimeter drain loggers	Change to ESC not required.	Routine maintenance, does not affect ESC.
LLWR/PMP/2013/412	Trench cap improvements phase 1 (Trench cap remediation)	Further action required to update ESC.	This is closely related to ongoing interim trench cap remediation work.
LLWR/PMP/2014/436	Replacement of superplasticiser Sikament 700 in LLWR grout	Change to ESC not required.	Need for superplasticiser optimisation noted elsewhere, and currently being addressed by experimentation.
LLWR/PMP/2011/308	Replacement of MHT alarm system	Change to ESC not required.	Asset management issue; does not affect ESC.
LLWR/PMP/2010/298	Implementation of the LLWR site ECC and 'on-plant' implementation of the ESC	Change to ESC required, but already reflected in an update of the ESC.	Implements phase 1 of the ESC as detailed in the *Developments* report.

PMP Number	Title	Classification	Justification
LLWR/PMP/2011/356	Replacement of activity-in-air monitor vacuum pipe & standardisation of radiometric pumps across site.	Change to ESC not required.	Asset management issue, no effect on ESC.
LLWR/PMP/2013/395	Replacement of MHT discharge flow sensors	Change to ESC not required.	Asset management issue, no effect on ESC.
LLWR/PMP/2013/401	Removal and dewatering of sediment from MHT including implementation of SCD275 RSA of removal of sediment from MHT	Change to ESC not required.	Asset management issue, no effect on ESC.
LLWR/PMP/2013/405	Removal and return to site of water from MH11	Change to ESC not required.	Asset management issue, no effect on ESC.
LLWR/PMP/2013/419	Vault 8 leachate walkway	Change to ESC not required.	Asset management issue, no effect on ESC.

3.6 Peer Review Group Comments

The LLWR is committed to an ongoing process of peer review as part of the process of building a robust safety case, and has appointed an independent PRG to review the 2011 ESC (including supporting reports) and LLWR's forward programme of work. The PRG comprises suitably qualified individuals with competencies in:

- radioactive waste management;
- geology and hydrogeology;
- near-field chemistry and radionuclide transport;
- repository engineering and optimisation;
- safety case management;
- safety assessment methodology;
- stakeholder engagement.

In September 2011 the PRG produced a report synthesising the outcome of their peer review of the 2011 ESC [12]. Many of the key PRG comments relate to the PRG's views of the issues that should be addressed in future work, and these have been considered in developing the current forward programme. In February 2012, LLWR produced a *Response to 'Peer Review of the 2011 ESC'* [13].

These two documents have been reviewed to identify PRG comments implying that updates to the ESC are necessary. It should be noted that detailed PRG comments on ESC development work will result in many actions to be undertaken; these are currently outside the scope of the Periodic Review. When the PRG produces an overview report synthesising these comments, they will be included in a future Periodic Review.

The assessment of the PRG comments is summarised in Table 18. Note that PRG comments are not mapped to high-level themes. Instead, consideration will be given as to how PRG comments are taken forwards when the ESC Issues Register is reviewed and the forward programme developed.

Table 18 Categorisation of PRG comments (Paragraph refers to the paragraph in reference [12] from where the comment is taken).

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
ESC Context	40	Hard to imagine that a new disposal facility would be established at a location like that of the LLWR which was known to be under such a threat from coastal erosion for anything other than short-lived inert wastes.	Decision to develop LLWR site for rad waste was appropriate at the time. ESC presents the arguments for the safety of continued use of the site for rad waste disposal. EA formal view is that, provided that formal requirements of GRA are met, potential for disruption of the site by coastal erosion at some point in the future is an acceptable risk. This is taken into account by setting limits on the types and activities of waste that may be disposed.	Change to ESC not required.
Management & Dialogue	58	The development of the 2011 ESC has led to the accumulation of a great deal of data, knowledge and competence relating to the current and likely future environmental performance of the LLWR, which is important to the ongoing management of environmental safety. As the current ESC project team (including its contractors) cannot be held together indefinitely, a particular challenge for LLW Repository Ltd will be preserving this knowledge and competence within the organisation in the long term. LLW Repository Ltd is clearly aware of this challenge and is considering how best it can be met.	See ESC level 2 report *Management and Dialogue*.	Change to ESC not required (see categorisation of 'Availability of SQEP resource' in workshop 1).

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
Assessment basis	63	Level 2 report *Site History and Description* does not fully address the issue of faults within the site boundary. The PRG believes that faulting and the influence of faults on hydrology may need to be a subject for more detailed investigation in the future.	The possible influence of faults in the bedrock on the movement of groundwater through and beneath the repository have been discussed in the Level 3 geological understanding report and the hydrogeological conceptual model report, although not in the Site History and Description Level 2 report. It is observed that the flows of most interest from a safety perspective are in the Quaternary sediments that are unaffected by regional faulting. Further work was carried to assess the potential impact of faults on the hydrogeology of the site in 2012 [Woollard H. and Jackson C. P. The effect of faults on the hydrogeology at the LLWR, Amec report no. D005864/003 Issue 1, August 2012]. The work concluded that faults have little effect on the groundwater pathway from LLWR.	Change to ESC not required, but report on faults is a supporting document for future ESCs.
	65	The PRG suggests that it would be useful to identify the locations of the nearest water supply wells to the LLWR.	The locations of licensed and known unlicensed abstractions are given in a note by Brassington. This note was used as input to the elicitation session on wells. LLWR accepts that inclusion of such a reference in the Level 2 Report on Site History and Description would have been helpful. The note is available and indicates that there are no known water abstraction boreholes within 5 km of the LLWR.	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	66	The PRG notes that the Level 2 Site History and Description report 'does not provide much information on Hydrologically Effective Rainfall or on the occurrence of extreme high intensity storms in the vicinity of the site.'	LLWR acknowledges that the Level 2 Site History and Description report does not provide much information on these issues. An analysis of monthly average temperature, precipitation, evapotranspiration and hence Hydrologically Effective Rainfall (HER), for possible future climate conditions, is given in a LLWR technical Memorandum [14]. This is reference 62 in the Level 2 'Long Term Radiological Assessment' report [15], although not referenced in the Level 2 'Site Evolution' [16] or 'Site Description' [17] reports. The main hydrogeological model uses average conditions, but in assessing the calibration of the model, transient calculations have been carried out based on the variation of HER over an extended period. The LLWR's assumption relating to extreme high intensity storms is that such events may have surficial effects in terms of increased immediate run-off, but are not a major influence on the hydrogeology of the site.	Change to ESC not required.
	67	The PRG suggests that the distribution and condition of boreholes across the site should be addressed in the *Site History and Description* Level 2 Report.	It is acknowledged that such data are not provided in the specific report. However, a borehole condition survey was carried out on all the boreholes used in the monitoring programme in 2008 by Westlakes and was referred to in reference [18]. The positions of the monitoring boreholes and depths are given in reference [19]. All the boreholes used in the monitoring programme are in good condition and are	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
			checked regularly.	
	70	The PRG notes that the ESC will need to be updated periodically in the light of new inventory data e.g. the 2010 UKRWI.	The LLWR agrees with this comment and is currently undertaking a review of the potential implications of the 2010 UKRWI for the ESC. There is a commitment to revise, where required, the ESC in light of new data.	Further action required to update ESC.
	73	... the PRG considers that it is somewhat unfortunate that there is not an inventory case within the 2011 ESC that excludes the LLW identified in the UKRWI as being destined for a Geological Disposal Facility.'	In response, it is noted that the LLWR did consider such a case, but decided that the reasons for identifying some of the waste streams as unsuitable for disposal at the LLWR were not particularly well founded. LLWR believes that many of the waste streams in question could be disposed to the LLWR, on the basis of current understanding. Also, this waste only comprised nine streams with a volume of 872 m^3 and represents much less than 1% of the total site volume and inventory (to be disposed in vaults up to Vault 14), so its exclusion would have a minimal effect.	Change to ESC not required.
	75	The PRG highlights increases in the inventories of various radionuclides since the 2002 safety case.	Context might be added by noting that there are many reasons for changed inventory estimates. In 2002, it was assumed that disposals ceased in 2050 and little account was taken of the waste treatments that are now implemented or planned.	Change to ESC not required.
	76	The inclusion within the 2011 ESC of the LLW identified as destined for a GDF and the 'final stage' decommissioning wastes, and the exclusion from the 2002 PCSC of some waste streams that were not expected to arise before 2060, makes comparison of the assessed		Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
		impacts in the 2002 and 2011 assessments less than straightforward.		
	77	Section 6 of the Level 2 Inventory report discusses the inventory of potentially hazardous but non-radioactive waste materials at or destined for the LLWR. The PRG notes that relatively little data are available on this aspect and that there may be a need for improvements in the UKRWI to refine the inventory of non-radioactive hazardous waste materials.	Actions are proceeding to refine the inventory of non-radioactive hazardous waste materials.	Further action required to update ESC.
	80	The PRG suggests that the bases of future vaults could be more permeable than currently planned.	The Vault 9 base is less permeable than the Vault 8 or future vault bases because the total thickness of BES is greater for Vault 9. The Vault 9 base was already under construction before the engineering design optimisation work was concluded. The optimised design requires the base of the vaults to provide containment of leachate during the PoA and, as such, a low permeability liner will be required for future vaults. However, the PRG's comments are noted and will be considered in future design reviews.	Further action required to update ESC.
	81	... The PRG has noted that the justification for the gas vent does not seem particularly strong and we therefore support LLW Repository Ltd.'s position that the need for a gas vent should be the subject of future assessments and discussions, e.g. with the regulators. It is noted by the PRG that the cap design does allow for upward gas migration.'	As the PRG observes, the justification comes from landfill practice, in which gas venting is standard, and relates to preventing the build-up of landfill gases. It is proposed to first establish a firmer technical view on the long-term need for the vent, which may then be discussed with the Environment Agency. LLWR's position, however, is that the decision does not need to be made at this time and the possible impact on long-term performance is limited (see section on the	Further action required to update ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
			'Implications of the Vent', pp.133-134 in reference [15]).	
	85	Given the importance of the cap in controlling flow within the LLWR, the PRG considers that it would be useful to review the monitoring programme for water levels, leachate and groundwater heads to ensure that it provides a suitable baseline for the evaluation of the cap performance and can be used to build confidence in predictions of cap performance and near-field behaviour.'	Review of the monitoring programme carried out after the 2011 ESC [Peachey, J. and Shevelan, J., 2012. ESC Review of the monitoring programme: Post 2011. LLWR/SC/R(12)10048. November 2012.] with subsequent work on the development of the long-term monitoring programme under way.	Further action required to update ESC.
	90 & 94	These two paragraphs provide the PRG's views on the need for further work on processes in the unsaturated zone. Specifically, they identify processes associated with radionuclide release and the development of detailed scoping models.	The LLWR agrees that further work in this area would be desirable and has identified the area in its forward technical programme [2]. However, LLWR is as yet uncommitted in terms of the detailed content of that technical programme. It may be that experimental work would be desirable as a basis for building confidence in current models.	Further action required to update ESC – LLWR is considering such action.
	97	The PRG identifies the limited data available to support the LLWR's model for the release of C-14 from graphite.	Further assessment of the C-14 gas pathway has been undertaken since this comment was raised (LLWR/ESC/R(12)10046 and LLWR/ESC/R(13)10059). The LLWR also participates in the NDA C-14 Integrated Project Team, which has included a review of the evidence on release of C-14 from graphite (aqueous and gaseous species) and model elicitation for such release. As a result the LLWR is confident that the model parameters used in the LLWR C-14 assessments to date (including the most recent assessment) are assuredly cautious.	Change to ESC required, but already reflected in an update of the ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	98	The PRG notes their support for the LLWR's plans to undertake further work on C-14. They also suggest that further work should be undertaken on the biogeochemical reactions of 14CO2 with cement grouts.	Further work has been undertaken (LLWR/ESC/R(12)10046 and LLWR/ESC/R(13)10059), which included consideration of the reactions of 14CO2 with cement grouts (primarily to carbonate) and stability of the carbonate. The key question is over the stability of carbonate; but even allowing very cautious estimates for re-mobilisation, the rate of release of C-14 from carbonate is very low compared to rates of primary release of C-14 as gas species from the waste.	Change to ESC required, but already reflected in an update of the ESC.
	102	The PRG suggests that future site characterisation should focus on key assessment issues, including: · 'distribution and continuity of B3 lithofacies unit; · magnitude and direction of regional groundwater flow in B3; · location of discharge zones.'	The LLWR agrees with the PRG comments on the focus for future hydrogeological site characterisation. However, at present it is considered that there is sufficient information upon which to base the hydrogeological models. Additional boreholes would allow some refinement of the geological model, but would not fundamentally change LLWR's understanding of the distribution and continuity of B3. Further work has been carried out to consider the magnitude and direction of regional groundwater flow in B3 through the use of dilution tests [Amec, 2014 LLWR Single-hole Dilution Tests, AMEC reference: 202061-AA-0001 STT, October 2014] and on the location of discharge locations [Amec, Beach Springs Investigation, AMEC reference: D.000232.01, Issue 3, November2013].	Change to ESC required, but already reflected in an update of the ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	103	The geological models can be tested against future boreholes where high quality core logging is possible and against exposures created during the excavation of future vaults (as has been performed for Vault 9).	The LLWR agrees with the PRG comments that the geological models can be updated with site investigation data collected as part future works such as future vaults, cut-off wall construction and other site activities. Further information can be gained from mapping changes to beach exposures. Further work to maintain the 3D geological model and enable incorporation of future investigation data has been carried out [Amec, Update of the 3D Geological Model, AMEC reference: 202539 Issue 001, November 2014]	Further action required to update ESC.
	104	The PRG states that 'Monitoring of groundwater heads and their responses to tidal and annual cycles and site activities ... could be used to test the current hydrogeological models.'	The LLWR agrees with the PRG that this is a sensible approach and such tests have already been undertaken. The hydrogeological modelling work detailed in reference [20] illustrates how the tidal response in a number of boreholes has been used to improve the understanding of the hydrogeology. Groundwater levels across the site are recorded as part of the annual monitoring programme and will be used to investigate the effects of new construction in the future.	Change to ESC not required.
	105	While there have been problems in the past with isolating specific lithologies within the Quaternary for hydro-testing, consideration could be given to hydraulic testing in B3 and the Upper Sandstones to confirm current model parameter ranges.	Further work has been carried out to confirm the hydrogeological properties of B3 through the use of dilution tests [Amec, 2014 LLWR Single-hole Dilution Tests, AMEC reference: 202061-AA-0001 STT, October 2014]. Further tests are being considered.	Further action required to update ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	106	The PRG advises that '... consideration should be given to the disposition of the boreholes [drilled into the B3 lithofacies unit or the upper sandstones] to ensure that they have no significant impact.'	The LLWR agrees with the PRG's view that consideration should be given to the final disposition of the boreholes to ensure that they have no significant adverse impact. LLWR has procedures in place to ensure that any borehole that is being decommissioned is treated in accord with the Environment Agency guidance on decommissioning of boreholes [21]. They should thus be sealed so that they do not provide groundwater pathways.	Change to ESC not required.
	113 & 115	The question is raised of the influence of faulting on groundwater flow.	See response to comment in paragraph 63.	See categorisation of comment in paragraph 63.
	121 & 122	The PRG indicates that '… uncertainty associated with future climate should be addressed with suitable model variants'. Further, 'the PRG recommends that improved understanding be sought of the possible variation in climate at the site, in particular the possible range of precipitation, HER and recharge.'	The need for rainfall measurement is captured in the long-term monitoring report. The commitment to a watching brief on developments in the science and prediction of climate change was included in the Level 1 ESC report.	Further action required to update ESC.
	133	The PRG recommends further work on the 'groundwater mound'.	LLWR recognises the importance of continuing to investigate the groundwater mound and further work has been carried out [Jackson C. and Woollard H., Integration of Geology and Hydrogeology at the LLWR Site, AMEC report D005864/002 Issue 2, 2012.] to consider the potential reasons for the mound. The work done to maintain the 3-D geological model [Amec, Update of the 3D Geological Model, AMEC reference: 202539 Issue 001, November 2014] has also considered the groundwater mound and	Further action required to update ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
			it is recognised as an area for further investigation.	
	135 - 137	The PRG considers that the consideration of heterogeneity over a range of scales and the development of spatially heterogeneous models for the Quaternary B2 and B3 units within the 2011 ESC is a significant advance on previous modelling. Furthermore, the up-scaled hydraulic conductivity estimates appear to be in reasonable agreement with those from model calibration. The ability to link local hydraulic conductivity with lithology is still somewhat limited and reflects: · The highly heterogeneous nature of the Quaternary deposits. · Changing operational methods and data quality (borehole core logging and hydraulic testing). Given the historical nature of much of the data, it is not clear that the quality of the bulk of the data can be improved, although focussed hydraulic testing together with high-quality drilling and geological analysis could potentially provide some confirmation of the approach taken.	LLWR recognises the importance of understanding and representing the heterogeneous nature of the Quaternary sediments. Further work has been commissioned to consider whether the detailed lithologies in B2 can be represented in the 3D geological model.	Further action required to update ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	140	The PRG suggests that further work should be undertaken to address the possibility of large-scale preferential flow channels.	LLWR recognises the influence of the structure of B3 on the hydrogeological model and have commissioned further work to refine the geological model and improve the link between the geological representation and the observed hydrogeological conditions.	Further action required to update ESC.
	150	The PRG notes that there is potential for 're-assessment' of evidence on climate evolution during the period of institutional control.	LLWR's case provides the basis for decisions in the next decade or so, taking account of uncertainties in current evidence and understanding. LLWR agrees that some improvement (reduction of uncertainty) may be had in the next few decades, but probably this would not be definitive. Even if climate and sea level changes can be re-assessed during the post-closure period of active control, this will be too late to alter disposal decisions.	Change to ESC not required.
	153	Importance of maintaining periodic reviews of monitoring programmes, reflecting changes in operation of facility, surrounding environment, and the data emerging from the programme.	Annual review of monitoring programme incorporated into Repository Site Procedure.	Change to ESC required, but already reflected in an update of the ESC.
	155	The PRG notes that the LLWR's approach with regard to the treatment of adverse trends in monitoring data is quite complex and not set out in any detail.	The LLWR acknowledges this comment and notes that some aspects were not fully developed at the time of writing the ESC. Since then, LLWR has developed its approach further.	Change to ESC required, but already reflected in an update of the ESC.
	158	In this paragraph, the PRG addresses uncertainties over control and compliance levels for tritium.	The World Health Organisation quality guideline is 10,000 Bq l^{-1}. However, LLWR notes that the primary regulatory requirement is to be consistent with a dose limit of 20 mSv y^{-1}. The compliance level for tritium has been defined to be consistent with this dose level.	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	159	Some consideration should be given to evolution of tritium concentrations in groundwater, and whether their evolution is consistent with the ESC. PRG hopes that review of control and compliance levels will encompass considerations of this kind.	This is addressed in the Requirement 8 monitoring.	Change to ESC not required.
	160	The PRG raises the issue of C-14, Cl-36 and Tc-99 measurements in leachate and the desirability of monitoring the concentrations of these radionuclides in groundwater.	Detailed analysis of the leachate from the trenches has been carried out in the past but further analysis is scheduled for 2015.	Further action required to update ESC.
	161	The PRG suggests that there should be 'commissioning of further work to check the expectations of coastal erosion and other key aspects of site evolution'.	Part of the coastal monitoring programme includes reviewing developments in climate change and coastal erosion and highlighting whether further work is required.	Further action required to update ESC.
	167	PRG suggests improving traceability of expert views in records of elicitation sessions.	Forward issue ESC-FI-029 is concerned with this.	Further action required to update ESC.
	168	The PRG raises the question of potential correlations between the properties of different engineered features. A specific example is raised - that high flows might lead to early clogging of drains.	The LLWR acknowledges the potential for such correlations, particularly in relation to the example cited; however, vertical drains are no longer part of the adopted design and LLWR feels that strong correlations are less likely in other instances. It is agreed that a review of such potential correlations would be a valuable part of any future elicitation exercises. There is a forward issue (ESC-FI-029) concerning this.	Further action required to update ESC.
	169	PRG notes that it may be useful to describe how significant uncertainties identified in elicitation sessions are fed back into the strategy for uncertainty analysis.		Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
Assessments	177	The PRG notes that '... it may be possible to achieve some validation by a careful monitoring programme for radon on the trench cap, where concentrations should be higher.'	Further work has been carried out to establish radon levels across the cap and at the site perimeter [Amec, LLWR Radon Data Review: April 2012 – December 2013, Amec Ref: LLWR/P4600/CE66, February 2014], which inform future assessments.	Further action required to update ESC.
	179-181	The PRG notes that much of the measured activity at the site perimeter will be natural in origin and that doses from the food chain pathway should be considered for the release of contaminated dust.	The LLWR agrees with the PRG that much of the measured activity will be natural in origin and noted this on page 46 of the PoA Level 2 report [22]: 'It is likely that authorised discharges from Sellafield, fall-out and natural sources are significant contributors to the measured concentrations'. The LLWR acknowledges that the fugitive dust calculation is deliberately pessimistic and that the measured concentrations in the high volume air sampler are a more accurate indication of actual levels of airborne radionuclides in the vicinity (although LLWR is not the primary source). For H-3 and C-14, radiation doses via foodstuffs are calculated in Subsection 5.1.2 of reference [21]. The cautious estimate of contaminated dust concentration (Table 5.2) has been used to estimate radionuclides inhaled by a person at the site boundary. Knowing the cautious nature of the assumptions entailed, and that the concentrations are estimated for the site boundary, it would not have been appropriate, in LLWR's view, to estimate an additional dose via foodstuffs.	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	182	The PRG considers that a 'more definitive assessment' would be appropriate of doses occurring during the PoA and resulting from emissions to atmosphere. They note that 'this could best be undertaken as part of the iterative review of the monitoring programme in relation to the ESC ...'.	Any off-site monitoring will be heavily influenced by Sellafield. No further monitoring of local produce is planned apart from the ongoing grass and milk monitoring.	Change to ESC not required.
	186	In reviewing the LLWR's approach to the estimation of potential doses to non-human biota, the PRG notes that '… it would have been more appropriate to make an assessment of the impact on flora and fauna of the specific sources of emission and receptor locations that were used in the assessment of impacts on humans', rather than to focus on the SSSI.	Special attention was given to the Drigg Coast SSSI, which is also a Special Area of Conservation (SAC) under the European Habitats Directive, because of its special protected status. An issue with assessments using the same pathways and release as for human assessments is that these refer to exposure outside the site boundary whereas flora and fauna of interest occur both within and outside the site boundary. It was judged that demonstration of protection of the SSSI and SAC formed an important step, regardless that the impacts are not related to the LLWR. Impacts due to releases during the PoA are addressed in Subsection 5.3 of the Level 2 report on impacts to non-human biota [23], including consideration of activity in the Drigg Stream and measured does rates adjacent to Vault 8. Thus it is concluded that 'releases of radionuclides from the LLWR at the present day are assessed as giving dose rates to non-human biota that are generally below the screening threshold of 10 μGy h^{-1}. Furthermore, throughout the rest of the operational period at the LLWR, controls on	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
			environmental radioactivity due to releases in leachates from the site will be at least as rigorous as those that have applied to date.'	
	190	"The PRG also considers it highly unlikely that the Delayed Coastal Evolution scenario will be representative of site evolution."	The LLWR acknowledges this and state the purpose of the scenario in Subsection 3.5.2 of reference [15]. In response to a formal request from the Environment Agency, LLWR has assessed impacts in the longer term, should the site not be eroded. LLWR is committed to a monitoring programme and commitment to remain abreast of technical developments.	Further action required to update ESC.
	195	The PRG notes that 'the assessments justify the final definition of PEGs on the basis that some habit sets and their localisation are more likely to occur than others. Such judgments should be regarded with a degree of caution'.	The LLWR agrees that care is required, but consider that likelihood arguments are valid, since LLWR seeks to assess annual risk, not worst case conditions or assumptions on human behaviour.	Change to ESC not required.
	205	The PRG identifies some key issues related to the groundwater pathway for testing and consideration in future assessments. These include: · infiltration through the cap; · dilution in the regional groundwater; · dilution from flow through B2 and changes to HER.	See comments on dilution tests and beach spring monitoring in response to paragraph 102.	

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	217	In commenting on the calculated radiological impacts from coastal erosion, it is noted that 'the PRG considers that it is not appropriate to rely on the inclusion of probability of occurrence when assessing impacts, but rather to present assessment results in terms of the annual doses to defined PEGs at the time erosion is taking place …'.	Of course, the 'estimated probability ... that this dose will be received" (paragraph 6.3.13 of reference [24]) is an intrinsic part of the calculation of annual individual risk. When discussing the PEGs for coastal erosion, LLWR noted that the inshore fisherman PEG had a probability of occurrence of less than one. This was because the inshore fisherman PEG had habits and behaviour that were chosen very cautiously. It is not proposed that any quantitative probability should be attached to the existence of this PEG, but rather that the calculation should be viewed as a pessimistic what-if calculation, the result of which is not intended for simple comparison with the risk guidance level.	Change to ESC not required.
	218	The PRG refers to Subsection 7.4.4 and Figures 7.18 and 7.19 in the Assessment of Long-term Radiological Impacts report [15] and notes that these figures 'might be interpreted as representing an example of risk dilution …'	LLWR believes that it would be appropriate, against the requirements set out in the GRA [24], to calculate the annual risk, multiplying by the estimated probability that the dose will be received (see LLWR's response to Paragraph 217). However, as LLWR does not feel content that the relevant uncertainties associated with the timing of coastal erosion have been adequately characterised, the approach is not presented as the central basis for showing consistency with the risk guidance level, but only as an indication that the approach adopted may be cautious.	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	227	The PRG notes that it is not normal practice to take credit for the probability of existence of [potentially exposed groups] PEGs, … The PRG considers that choosing a 'reference PEG' based on probability arguments is questionable, but notes that in this case it makes little difference which PEG is considered because the uncertainties around the precise assessment results have to be considered.'	In principle, LLWR considers that the likelihood (probability) of PEG behaviours is a valid factor to take into account. The characterisation of PEGs necessarily involves judgements on likelihood of given habits. In this case, the four PEGs can be regarded as a sensitivity analysis around the characteristics of what is actually a single PEG – a presumed family or small community making agricultural use of the cap. LLWR further considers that there is a probability that no such PEG will be present in any given year or period, i.e. the cap area will be under some other use or protected. LLWR did not, however, choose to make this argument on annual probability in the 2011 ESC.	Change to ESC not required.
	230, 231, 235	The Level 2 Near Field report stated that 'the main processes affecting cap performance will be settlement-induced cracking of the clay layer.' The PRG suggests that there might need to be an assessment of radon release through such cracks: 'There may, therefore, need to be further consideration of the release of radon through the repository cap via cracks formed by natural processes as the cap degrades.'	The statement on cracking was made in the context of estimating infiltration. The expected process would involve partial drying and some cracking from the upper and (less likely) lower surface of the clay layer. For permeability to radon to increase, cracks must penetrate entirely though the cap. This is thought to be unlikely and therefore was not assessed. However, the case is bounded by the 'Event B8: dwelling with cellar', in which a direct connection is made between the dwelling and the gas collection layer in the cap. For this event, with the emplacement strategy applied, the maximum calculated dose (for Vault 8) is 0.6 mSv y^{-1} (see Table 8.4 of reference [15]). Doses and risks related to open air exposure on the cap would be very low.	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	235	PRG assumes that for wastes with high Ra-226 content, a BPEO assessment will have to be made to determine whether disposal to LLWR rather than, for example, to a GDF is the most appropriate disposal option.	Such options assessments are the responsibility of consignors. The LLWR will accept the wastes provided that they are consistent with the ESC.	Change to ESC not required.
	239	The PRG notes that the assessment results (e.g. in Figure 8.11 {of reference [15]}) do not take account of surficial erosion of the cap, which could be significant over a 10,000-year timeframe. Thus, the human intrusion assessment results at long times are not really indicative of, and probably underestimate, those that could hypothetically be received if the site was not eroded by the sea as expected in a few hundred to a few thousand years.'	LLWR agrees that human intrusion doses in the long term may be underestimated from this perspective, if indeed the site still exists at longer times. The increase may, however, be mainly related to increased uncertainty over the choice of intrusion cases for consideration. In response to a formal request from the Environment Agency, LLWR is currently considering an approach to assessment of impacts in the longer term should the site not be eroded. This will include considering impacts from human intrusion. Also, the PRG observes that relatively high radiation doses are estimated for intrusion into the north-west end of Trench 2. 'The PRG suggests, therefore, that further consideration might sensibly be given to measures that could reduce the probability of intrusion into this small area of Trench 2 (e.g., by thickening the cap).' Measures to reduce the risk of intrusion at this point, e.g. construction of an intrusion-resistant slab, were considered as part of studies of trench remediation. It is considered that an addition of another metre or two of cover thickness over this location would not provide a robust defence, and the ability to do so is limited by the adjacent site boundary.	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	242	From the information presented in the ESC documentation, the PRG supports the statement that, by extension of the conclusions applied to the potential remediation of the trenches in relation to significant radionuclides, there would be disproportionate costs associated with remediation in respect of chemotoxic substances. However, this is an area where the presentation of more direct evidence could be considered in the future.	Records of disposal to the trenches do not provide sufficient information on chemotoxic substances to locate possible waste masses for targeted disposal. Assessments based on estimated total inventory of non-radiological contaminants indicate that cautiously estimated impacts are broadly acceptable. Note if lead is the problem, this would be impossible to recover effectively - it is wide spread in the trenches.	Change to ESC not required.
	245	As noted on page 70 of the Level 2 Assessment of Non-radiological Impacts report, the consumption of sea food is neglected as a potential exposure pathway to non-radiological contaminants following coastal erosion of the facility. This is probably a justifiable position given the marine dilution of contaminants that would be likely to occur. However, given public sensitivity to possible bio-accumulation of heavy metals and other substances in fish, this is an area where presentation of evidence could be considered in the future.		Further action required to update ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	247	The PRG notes that 'we consider that any further measures such as changes to existing WAC need to be proportionate to the hazard posed and to take account of the approach to dealing with such hazards more generally. The proposed further discussions with the environmental regulators on these matters, therefore, represent an appropriate next step. Such discussions will be well served by the information provided in the Level 2 Assessment of Non-radiological Impacts report and its supporting references.	Changes to existing WAC have been made in consultation with Environment Agency.	Change to ESC not required.
	251-252	LLW Repository Ltd's assessment of impacts during the PoA relies heavily on the measured concentrations of a suite of radionuclides in organisms from the Drigg Dunes SSSI. In the view of the PRG, a preferable approach would have been to make an explicit assessment for each of the human exposure pathways considered in the PoA report. Section 5.3 of the Level 2 Non-Human Biota report provides some qualitative arguments to cover this point (which are not summarised in the report on Impacts in the PoA). These arguments are mostly sound, although that in respect of fugitive dust emissions considers inhalation doses only; the most important source of exposure to non-human organisms will be the deposition and accumulation of radionuclides in the soil and vegetation of their habitat.	In the 2011 ESC LLWR followed advice that it would be important to describe current radiological conditions in the Drigg SSSI and SAC (even though the current radiological conditions are not attributable to the LLWR) since this is relevant to satisfying wider environmental regulations on habit protection. Further assessments were made of the impacts actually attributable to the LLWR in response to an Agency IRF (ESC-RO-ASO-001 responded in LLWR/ESC/Mem(13)202). LLWR's response included an assessment of impacts to non-human biota based on LLWR monitoring data.	Change to ESC required, but already reflected in an update of the ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
	257	Overall, the PRG considers that the Level 2 Non-Human Biota report provides a sound and balanced account of the potential impacts of the LLWR on non-human biota. We would, however, expect these assessments to be re-visited from time to time in future as methodologies in this area develop further.	This will be re-visited at each major ESC review; no further commitment is required.	Change to ESC not required.
	262	The PRG observes that there will be a need to dispose of other LLW after 2130 and that the design does not maximise the capacity of the site.	It is noted that the 2007 UKRWI only has disposals up until 2127. The claim that the design maximises the capacity should be taken in the context of the inventory data that are available to work with.	Change to ESC not required.
	263	PRG suggests that further design optimisation of the cap should be considered to optimise run-off and minimise infiltration and erosion.	Forward issue ESC-FI-027 concerns this.	Further action required to update ESC.
	263	The PRG suggests that if the current model assumptions and results do not prove supportable, risks from carbon-14 in excess of the guidance level could persist beyond 300 years for the scenario of agriculture on the cap'.	LLWR recognises the importance of improved assessment of the carbon-14 pathway and have undertaken work in this area.	Change to ESC required, but already reflected in an update of the ESC.
	264	The PRG suggests that there is a mismatch in the assumed periods of institutional control between the RDA and EDA assessments.	Assessments of RDA were against an assumption of completion of disposals at 2080, and hence withdrawal of active control at 2180. If disposals were continued into the EDA up to 2130 then, of course, active control would be maintained over the whole disposal area until 2230.	Change to ESC not required.
	269	The PRG has also considered carefully the possible future disposal of C-14 bearing wastes; this is a topic on which the PRG considers further work is needed.	Since PRG comments revised C-14 assessment model has been developed, that removes many of the cautions present in the 2011 ESC C-14 assessment. This results in C-14 doses that are	Change to ESC required, but already reflected in an update of the ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
			lower than the RGL, and allows a larger inventory of C-14.	
Optimisation & Development Plan	272	The PRG considers that additional assurance should be provided by active institutional control.'	The LLWR can confirm that security, monitoring and capability for remediation will be preserved in period of active institutional control.	Change to ESC not required.
	275-279	The PRG raises a number of issues with respect to active institutional control of the site. It is suggested that active institutional control might persist for as long as is practicable and could be maintained until coastal erosion of the facility begins.	The LLWR seeks to distinguish between institutional control as it may actually develop in future, and the assumptions made now in order to demonstrate safety and for assessing future costs. Of course (as in Paragraph 278): 'decisions on whether and, if so, when to release the LLWR from active management control should not be taken now, but should be kept under review' and (as in 279) 'Proposals for control of the site after the completion of disposals for active institutional control will be finalised in consultation with stakeholders and the Environment Agency as site development and operation proceeds'. Nevertheless, defined assumptions on schedule for disposals, closure, control and release from control, need to be made for the purpose of demonstration of safety and for assessing future costs. It is LLWR's case that the site could, under present day regulatory regime and guidance, be released at about 100 years after last disposals, and this should be the basis for NDA long-term planning.	Change to ESC not required.
	282	The PRG would, however, like to see stronger links to consideration of transport and operational (non-ESC) factors that might affect the determination of WAC.'	The LLWR recognises the need for such links and its WAC take account of transport and operational requirements, however, they are not a strong focus for its reports, since the	Change to ESC not required.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
			relevant issues are not regulated by the Environment Agency.	
	284	The PRG supports LLW Repository Ltd's proposal that there should be further engagement with the EA and others on revised waste acceptance limits and controls.	This is an ongoing task as there is a requirement for the Environment Agency to be consulted.	Further action required to update ESC.
	285	PRG suggests that further consideration could focus on 'The disposal of cellulosic wastes and their degradation mechanisms. We consider that LLW Repository Ltd has conducted a broad and thorough review of the existing conditions for acceptance of waste at the LLWR, and has considered the influences of waste form, the physical composition of the wastes, and the biogeochemical properties of the wastes. The PRG suggests that further consideration might be given to the mechanisms of cellulose-bearing wasteform degradation under the biogeochemical conditions that can be expected in the LLWR vaults.	Work to better understand the degradation mechanisms of cellulosic wastes has been completed.	Change to ESC required, but already reflected in an update of the ESC.
	285	The PRG states that '… One might, for example, expect the report to provide a systematic and more comprehensive identification of potential criticality situations and assessments of those situations (e.g., could criticality occur in the grouting facility, in the facility drains, in the marine diffusers, or during closure?).'	The LLWR believes that it has provided an assessment of criticality that meets the requirements of the environmental regulators' guidance and is proportionate to the hazard associated with LLW.	Change to ESC not required.
Key Uncertainties and Forward	290	The PRG identifies a number of technical areas where they think that further work could be sensibly considered.	The LLWR has reviewed these suggestions in developing its forward technical programme, which has been submitted to the Environment	Further action required to update ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
programme			Agency [25]. The detailed forward programme is still to be produced.	
		Planning for periodic updates of the ESC and the Site Development Plan to reflect new information. The process of optimisation should be a continuing and iterative process through which the site development plan might be changed in the future to respond to new information and analyses.		Change to ESC required, but already reflected in an update of the ESC.
		Maintaining continued focus on waste stream characterisation and waste inventory estimation.	Part of LLWR's current approach.	Change to ESC not required.
		Reviewing the monitoring programme to ensure that it provides a suitable baseline for the evaluation of cap performance, and can be used to build confidence in predictions of cap performance and near-field behaviour	Part of LLWR's current approach.	Change to ESC not required.
		Periodically commissioning further work to check expectations of coastal erosion and other key aspects of site evolution.	Part of LLWR's current approach.	Change to ESC not required.
		Reviewing and updating the monitoring programme to address conservatisms in the PoA assessment and also to reflect any changes in the operation of the facility, the surrounding environment, and data emerging from the programme itself.	The LLWR has undertaken a comparison of the Retrospective Dose Assessment, which is largely based on monitoring, and Assessment of the PoA in response to action from the NSC. The consistency of the RD and POA assessments and supporting monitoring programme will be kept under review.	Change to ESC required, but already reflected in an update of the ESC.

Topic	Paragraph	PRG Comment	LLWR response	Categorisation
		Assessing the impacts of the release of radon through the repository cap via cracks formed by natural processes as the cap degrades.	LLWR's assessment is that cracks can generate through the clay layer provided the target on differential settlement is met and the overlying layers are intact. A human intrusion case is assessed that bounds the effect of damage to the cap and direct connection to building on the cap.	Change to ESC not required.
		Further consideration and stakeholder dialogue on the period and plans for active institutional control.	LLWR feels that there is sufficient engagement with stakeholders at present.	Change to ESC not required.

3.7 Events

The LLWR event reporting system is used to capture any safety-related issues and any corrective actions required. An Investigation Report is completed if an incident/accident occurs or could have occurred as a result of an event.

The LLWR Events Database was reviewed to identify events relevant to the ESC, and to assess whether they update the ESC and any required further work. In Table 19 those identified as requiring change to the ESC are listed. All but two events relate to observed damage in the interim trench cap, and thus form part of the ongoing trench cap remediation work.

Table 19 Events requiring changes to the ESC

Event ID	Event title	Categorisation	Justification
131101912	Gap between membranes on trench cap. Trench 4 probe 12	Further action required to update ESC.	Part of ongoing trench cap remediation work.
131101927	Tear in membrane at probe hole on trench cap	Further action required to update ESC.	Part of ongoing trench cap remediation work.
131101928	Large area of membrane missing on trench cap. Trench 4 probe location 13	Further action required to update ESC.	Part of ongoing trench cap remediation work.
131101952	Tear in trench cap membrane	Further action required to update ESC.	Part of ongoing trench cap remediation work.
131202007	Unexpected Membrane conditions on trench cap	Further action required to update ESC.	Part of ongoing trench cap remediation work.
140202099	Further splits discovered in trench cap membrane	Further action required to update ESC.	Part of ongoing trench cap remediation work.
140202122	Further hole in trench cap membrane	Further action required to update ESC.	Part of ongoing trench cap remediation work.
11100568	Error in ESC WAC calculations	Change required - already implemented in an update to ESC.	Discussed in *Developments Since the 2011 ESC* report.

In Table 20 events deemed not to require changes to the ESC are listed. It should be noted that several relate to the Low Level Waste Tracking System (LLWTS).

While individually, these events are relatively minor, and have been identified and managed appropriately by LLWR's processes, taken together, they may be indicative of difficulties with the management and access of data from the LLWTS.

Table 20 Events that do not require changes to the ESC

Event ID	Event title	Categorisation	Justification
11050375	Vault 9 leachate pumps not operating	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
11050389	Receipt of IP2 container containing free liquids	Change to ESC not required.	Free liquid drained out. No contamination
11060432	Contamination found local to LLW container vent port	Change to ESC not required.	Contaminated vent replaced.
11070454	High radon in B704.6	Change to ESC not required.	Operational issue, rather than an ESC issue.
11090504	Assumed rainwater in B740 void space	Change to ESC not required.	Not an ESC issue.
12060911	Loss of power to the automatic sampling system at GD11 (Drigg Stream)	Change to ESC not required.	48 hours' worth of sampling data lost. Temporary fault, now corrected.
12060930	ISOs in Vault 8	Change to ESC not required.	No containers in wrong locations; old serial numbers visible. Impracticable to move containers.
130201376	Bore hole DDS 94 cover plate open	Change to ESC not required.	Assessed to have minimal environmental consequences.
11100525	No bounding limits given to consignor on approval given to consignor.	Change to ESC not required.	
11100532	Radiation levels exceeding area designation	Change to ESC not required.	Operational issue, not of ESC significance.
11100559	Hole in LLW bag	Change to ESC not required.	Hole was identified, waste re-

Event ID	Event title	Categorisation	Justification
			packaged.
11100585	Unlabelled/open ISO freight containing possible contaminated items	Change to ESC not required.	
11120626	Failure of GD11 automatic sampler	Change to ESC not required.	Temporary equipment fault.
11120642	Consignment references are different	Change to ESC not required.	
12010644	Typographical error identified in the LLWTS on fissile content	Change to ESC not required.	Error was corrected within three days.
12010696	TCRW datalogger incorrectly recording measurement date	Change to ESC not required.	Fault corrected.
12020723	Waste Services Tracker fault	Change to ESC not required.	File corruption problem. Work-round exists.
12030760	Failure of marine holding tanks chart recorder	Change to ESC not required.	Minor operational issue.
12030767	Grout leak from container	Change to ESC not required.	Grout leak sealed and container in Vault 9.
12040805	Receipt of out of spec Sikament 10 plasticiser	Change to ESC not required.	Operational issue.
12040821	Calibration of environmental equipment	Change to ESC not required.	
12050836	Initial leachate sample suspended solids result above discharge consent limit	Change to ESC not required.	
12050842	Problem with the HVAS sampling operation	Change to ESC not required.	Operating at sub-optimal efficiency for one week. Temporary.
12050858	WAC approval	Change to ESC not required.	Relates to document management: docs being used before complete sign-off.
12060872	Elevation in Quarter 1 aerial discharge results	Change to ESC not required.	No activities identified that could result in an increase.

Event ID	Event title	Categorisation	Justification
12070936	Potential mismatch between LLWTS specific activity values and reference values	Change to ESC not required.	Mismatch is approx 2%.
12070976	Apparent breach of discharge consent for sewage effluent	Change to ESC not required.	Sewage not relevant for ESC.
120701004	Incorrect update of data within a statutory reporting template	Change to ESC not required.	Technical breach of consent, although no actual levels breached.
120701009	Assumed radon contamination in end of Trench 1 leachate drain	Change to ESC not required.	Operational issue, rather than an ESC issue.
120801050	Hole discovered adjacent Man Hole 7224	Change to ESC not required.	Perimeter drain still operating satisfactorily.
120801059	Trench surface water drain (East Weir) over-topped by rainwater run-off	Change to ESC not required.	
120901072	Containers have been supplied to customers by LLWR that may not meet required manufacturing quality standards	Change to ESC not required.	IP-2 status relevant to transport regulations; not relevant to ESC.
121001110	Borehole sampling procedure inadequately followed	Change to ESC not required.	Only one case of incorrect sampling occurred - verified by analysis of historical data.
121101190	Abnormality associated with Manhole 11	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Localised remedial work. Being addressed by LLWR.
121101196	Substandard condition of electrical distribution equipment in MHT	Change to ESC not required.	

Event ID	Event title	Categorisation	Justification
121101222	WMSNRO - and wrong information on consignment paperwork	Change to ESC not required.	Detailed Waste Acceptance issue. Not of relevance to ESC.
121201233	MHTs failure to produce discharge data	Change to ESC not required.	Localised remedial work.
120601240	WMSNRO - small amount of liquor in drum consignment to WAMAC	Change to ESC not required.	Issue has been identified and is being managed.
121201263	Weight discrepancy 2910-7248	Change to ESC not required.	One container overweight.
121201265	MHTs level reached 'tanks at overflow level'	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
121201266	WMS NRO New TC14 drum outside WAMAC acceptance criteria on cross-section dimension	Change to ESC not required.	
121201269	Weight discrepancy for Sellafield consignment 2910-7244	Change to ESC not required.	One container overweight.
121201271	Weight discrepancy for consignment 2910-7249	Change to ESC not required.	One container overweight.
121201274	Weight discrepancy for Magnox consignment 2910-6549	Change to ESC not required.	One container overweight.
121201275	Compactable waste verification monitoring identified a radionuclide (Ra226) not declared by consignor	Change to ESC not required.	Identified and raised as a non-conformance

Event ID	Event title	Categorisation	Justification
130101285	GD11 stream sampler lost samples	Change to ESC not required.	Localised problem, identified and remedied.
120101288	Discrepancy between monitored and declared values for Hartlepool consignment 2910-6774	Change to ESC not required.	
130101301	Suspected loss of MHT's discharge data	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Localised remedial work. Being addressed by LLWR.
130101310	MHT's alarm panel at B722 - spurious alarms	Change to ESC not required.	Temporary fault, identified and corrected. Fault only affected alarm reporting and would not have affected a discharge event.
130101348	Problems with GD11 stream sampler	Change to ESC not required.	Localised remedial work to correct this.
130101354	Inconsistency between declared radionuclides and waste stream for AWE Aldermaston consignment	Change to ESC not required.	Issue identified and managed by internal procedures
130201394	Incorrect consignment of waste	Change to ESC not required.	Issue identified and managed: containers on hold.
130201421	Error in the regression analysis of the Vault 8 waste densities	Change to ESC not required.	Error identified and corrected; latest version of report has correct densities.
120301439	LLW container pierced by fork lift truck	Change to ESC not required.	Pierced container repaired.
130301441	Customer exceeded waste	Change to ESC not required.	

Event ID	Event title	Categorisation	Justification
	forecasting form allocation		
130401480	Consignments exceeded allocations in WFO	Change to ESC not required.	
130401502	Customer exceeded Co60 allocation	Change to ESC not required.	
130401504	B728 biological sewage treatment plant just below BOD limit	Change to ESC not required.	Requires localised remedial work.
130401506	Leak of leachate from backwash filter during MHT discharge	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
130401526	Deterioration in biological sewage treatment plant performance	Change to ESC not required.	Requires localised remedial work.
130401531	Customer exceeded allocation	Change to ESC not required.	
130401532	Burnt out capacitor Vault 9 leachate pump PC5	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
130401533	Incorrect weight declared by consignor in weight consignment information form.	Change to ESC not required.	
130401540	Issue with 2 containers of secondary waste from Studsvik MRF	Change to ESC not required.	
130401541	RSRL consignment with weight discrepancy	Change to ESC not required.	

Event ID	Event title	Categorisation	Justification
130401545	Consignment received at WAMAC 3 drums number on LLWTS not on consignors drum list	Change to ESC not required.	
130501564	Anomalies with MHT discharge data	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
130601614	NWP REP 015 reporting inaccuracies	Change to ESC not required.	Issue identified and managed.
130601642	Non-compliant bagged waste sent to WAMAC	Change to ESC not required.	
130601652	Suspected free liquid in WAMAC	Change to ESC not required.	Excess liquid evaporated.
130601662	Delayed awareness of Mean +4 environmental monitoring result	Change to ESC not required.	Identified inadequacy in IT system management. Being addressed.
130701676	Incorrect fingerprint declared by RSRL	Change to ESC not required.	
130701686	Container reached 42 te limit before filling to correct level	Change to ESC not required.	ISO not on hold; has been grouted.
130701703	Lost data due to installation of isolator switch	Change to ESC not required.	Operational monitoring issue
130801736	Undeclared Cs 137 detected in Sellafield container during assurance monitoring at LLWR	Change to ESC not required.	
130801762	Groundwater drain ruptured in excavation	Change to ESC not required.	Localised remedial work undertaken.
130901803	Delay in internal notification of Mean +4 SD result from Drigg Stream	Change to ESC not required.	Procedural issue.

Event ID	Event title	Categorisation	Justification
130901813	Undeclared radionuclide (Nb94) found in secondary waste after verification monitoring	Change to ESC not required.	
130901820	Multiple entries for certain radionuclides on LLWTS for WAMAC product container 2947-2838	Change to ESC not required.	LLWTS had fix applied to prevent further occurrences.
130901846	New sewage treatment plant went into alarm	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
131101908	Undeclared radionuclide detected during waste monitoring	Change to ESC not required.	
131101920	Oil spillage	Change to ESC not required.	Spill contained and remediated. No oil entered site drainage system.
111301921	Power failure to existing Sewage Treatment Plant	Change to ESC not required.	Being addressed by LLWR
131101923	Loss of samples GD11 sampling point	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
131301926	Raised area of ground discovered beneath Membrane	Change to ESC not required.	Already captured in trench cap remediation work.
131101948	Elevated water level in trench probe 2.7	Change to ESC not required.	Increased water level due to surface ingress.

Event ID	Event title	Categorisation	Justification
131101949	Supply/use of wrong superplasticiser	Change to ESC not required.	All mixes placed into product ISOs within the limits specified in OI 0.8.12. Relevant OI amended to prevent repeat. See also ESC Mem(14)262.
131101950	Hydraulic oil leak Vault 9	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR.
131101951	Issues found during electrical inspection and testing in B1412 MHTs	Change to ESC not required.	Identified inadequacies in LLWR approaches to system engineering and asset management. Being addressed by LLWR. Electrical issues revealed have not impacted upon the operation of the facility.
131101979	Multiple entries for certain radionuclides on LLWTS for WAMAC product container consignments	Change to ESC not required.	LLWTS had fix applied to prevent further occurrences.
131201986	Smoke/steam from inside an ISO being grouted	Change to ESC not required.	No activity released. Container grouted.
140102040	Inability of LLWTS to allow consignment of waste stream from non-originating site (treatment facility)	Change to ESC not required.	Issue identified; plans are in place to replace LLWTS
140102061	B740 compound flooded	Change to ESC not required.	
140202097	Potential	Change to ESC not	

Event ID	Event title	Categorisation	Justification
	overdeclared activity	required.	
140202126	Asbestos material uncovered in trench cap	Change to ESC not required.	Licensed asbestos worker in team to deal with asbestos finds immediately. No effect therefore on ESC
140202141	Long-term Vault Experiment drain pipe detached	Change to ESC not required.	Fault remediated.
140202142	Asbestos material uncovered in trench cap	Change to ESC not required.	Licensed asbestos worker in team to deal with asbestos finds immediately. No effect therefore on ESC.
140202143	Non-production of discharge print-out	Change to ESC not required.	Operational issue.
140302182	Discharge failure of marine holding tanks	Change to ESC not required.	Operational issue.
140302159	Over-flow of storm water adjacent TCRE	Change to ESC not required.	Localised remedial work required.
140302202	Asbestos material uncovered in trench cap	Change to ESC not required.	Licensed asbestos worker in team to deal with asbestos finds immediately. No effect therefore on ESC.
140302203	Uncovering of asbestos material in trench cap	Change to ESC not required.	Licensed asbestos worker in team to deal with asbestos finds immediately. No impact therefore on ESC.
140302204	ISO containers containing items that exceed LLWR discrete item limits	Change to ESC not required.	Issue has been identified and is being managed appropriately.
140402241	MHT discharge pump failure	Change to ESC not required.	Operational issue.
140402248	MHT pump failed to start	Change to ESC not required.	Operational issue.
140302215	Magnox Bradwell container weight discrepancy	Change to ESC not required.	
1107034	Potentially incorrect guidance provided to	Change to ESC not required.	Revised WAC include cadmium as a Category 2

Event ID	Event title	Categorisation	Justification
	customer for cadmium disposal		non-radiological contaminant, i.e. it is managed through the definition of a site capacity. These WAC have been implemented and the waste acceptance team have been briefed accordingly.
11010403	Consignment of loose drums inappropriately accepted by LLWR	Change to ESC not required.	Operational issue. No effect on ESC.
11100545	LLWTS/LLW Storage Report	Change to ESC not required.	Impacts of revised LLWTS data were examined in Mem(14)260. Data changes have minimal impact on radionuclide capacity.
12010678	Elevated alpha result from October 2011 bulk sampler (high volume air sampler)	Change to ESC not required.	No ongoing issues or trends were observed. The result may be a 'one-off' or spurious.
12030774	Phase 1 leachate test failure	Change to ESC not required.	Sediment in the system responsible for failure. Subsequent CCTV inspections reveal pipeline in acceptable state. There is a project in place to remove sediment. This is more of a Permit issue than an ESC issue, as leak would constitute discharge by an unauthorised route.

Event ID	Event title	Categorisation	Justification
12040810	Molehills on the trench cap	Change to ESC not required.	Moles are unlikely to dig through trench cap membrane; they are more likely to be diverted by it. Moles are unlikely to dig to depths greater than 30 cm.
12050824	Small amount of grout added to containers	Change to ESC not required.	Wastes were already grouted prior to arrival; owing to nature of wastes, could only take small quantity of additional grout. No effect on ESC.
120801051	Marine holding tanks in overflow condition	Change to ESC not required (but see notes to the right).	This was a short-term asset management issue. There are, however, potential conditions of excessive rainfall where MHTs may have insufficient capacity to buffer. There is ongoing work to identify solutions. Position is to utilise Vault 9 as additional buffer storage (believed to be BAT as containers may be moved); fallback is buffer storage in Vault 8, which may be BAT for short-term storage.
121201253	Issues with Hunterston A shipment 2989/0617	Change to ESC not required.	Duplicate WCI and failure to check radionuclide information. No implications for updates to ESC.
121201256	Allocation and specific radionuclide limits	Change to ESC not required.	Issue with LLWTS. This issue has been resolved.

Event ID	Event title	Categorisation	Justification
	exceeded for two Harwell consignments		
130901806	High voidage container 2910/7473	Change to ESC not required.	Shortcoming in acceptance process. Identified and remedied. No effect on ESC.
140402273	Loss of data from marine discharge system	Change to ESC not required.	Technical breach of Discharge Permit. Investigation into root causes and corrective actions to be conducted. Likely that this will be undertaken by Environmental team, rather than ESC team.

3.8 IRFs

During their review of the 2011 ESC, the Environment Agency established an 'issues resolution' process whereby any significant questions, queries or further information requests could be formally raised with the LLWR. Issues were documented in Issue Resolution Forms (IRFs) to which the LLWR responded. The issues were in three categories:

- Regulatory Issue (RI): The most significant issues, which if not adequately addressed could lead to the Environment Agency being unable to permit further disposals or to severely limit or condition disposals.
- Regulatory Observation (R): Significant issues, which if not adequately addressed, could lead to significant limitation of disposals or permit conditions.
- Technical Query (TQ): Simple questions, unlikely on their own to affect any regulatory decision.

Seventy-two IRFs were received after the submission of the ESC and the LLWR responded appropriately to all of them. These responses included clarifications and requests for further information, including assessment calculations. A comprehensive summary of the IRFs and the responses provided by the LLWR is included in reference [4]. Each IRF and response has been reviewed to assess whether they constitute updates to the ESC or require action. The results of this review are summarised in Table 21.

The Environment Agency has closed all IRFs, with any outstanding actions included within forward issues and recommendations. As these actions are therefore captured, no attempt has been made to map to high-level themes.

Table 21 Categorisation of IRFs

IRF	Categorisation	Justification
RI-ASO-001: Optimisation of vault sequencing	Change to ESC not required.	There are no clear demonstrable benefits to alternative vault sequencing. Alternative approaches would be incompatible with proposed strip capping.
RI-ASO-002: Optimisation of the vault operational conditions	Further action required to update ESC.	This is part of Environment Agency Forward Issue ESC-FI-025.
RI-ASO-003: Optimisation of disposal system in relation to possible future waste retrieval or facility protection	Change to ESC not required.	The possibility of future intervention does not impact upon the principles set out in the ESC.
RI-ASO-005: Assessment of the impacts of C-14 bearing gases	Change required, but already implemented in an update to the ESC.	This work is discussed in the *Developments* report.
RI-ASO-006: Very long term impacts if the LLWR does not erode	Further action required to update ESC.	There is a need to ensure an enhanced treatment in the next major revision of the ESC.
RI-ASO-007: Treatment of decay chains in deriving WAC for groundwater pathway	Change required, but already implemented in an update to the ESC.	The WAC derived using the correct treatment of decay chains are presented in the *Developments* report.
RI-ASO-010: Inventory heterogeneity and PEGs in coastal erosion dose assessment	Change required, but already implemented in an update to the ESC.	Addressed in reference [26].
RI-ASO-011: Inventory heterogeneity and events in human intrusion dose assessment	Change required, but already implemented in an update to the ESC.	Addressed in reference [27].
RI-ASO-012: Dose calculations from marine foodstuffs during coastal	Change to ESC not required.	Assessment in reference [26] yields risks consistent with GRA. No possibility of deterministic effects.

IRF	Categorisation	Justification
erosion		
RI-ASO-013: Dose calculations for human intrusion into radioactive sources	Further action required to update ESC.	This needs to be reviewed after the issue of any Permit.
RI-ASO-014: Total doses to a representative person from the LLWR during the Period of Authorisation	Change to ESC not required.	Doses well below 20 µSv y^{-1} post-closure risk guidance level. Note that this is a candidate for potential inclusion in future revisions of the ESC.
RO-ASO-001: Impacts to non-human biota during the Period of Authorisation	Further action required to update ESC.	May require revision for next major iteration of ESC.
RO-ASO-002: Post-closure impacts to non-human biota	Further action required to update ESC.	May require revision for next major iteration of ESC.
RO-ASO-003: Assessment of non-human biota impacts associated with intrusion into waste materials	Change to ESC not required.	Assumption that whole body dose rates to non-human biota following intrusion into the facility will be of a similar magnitude to those for non-human biota arising from the cliff erosion pathway is reasonably well-founded. Assessment calculations presented are cautious and will underestimate doses to non-human biota for intrusion events, at least at the local population level. The possibilities for exposure to undiluted waste as might occur during coastal erosion of the LLWR have been examined and dose rates are found to be not much greater than assessed for exposure to the cliff average in the 2011 ESC. Work undertaken in response to a separate IRF (see Subsection 2.13 of Appendix 1 in reference [4]) is also relevant and provides additional reassurance that dose rates to non-human biota during coastal erosion will be such that there is no potential for significant harm to local populations.
RO-ASO-004: Management of	Further action required to	Further action here would be in connection with future revisions of the ESC.

IRF	Categorisation	Justification
uncertainty	update ESC.	Developments in methodology may be required. Note that this is also a forward issue (ESC-FI-008).
RO-ASO-005: Safety functions	Further action required to update ESC.	Further action here would be in connection with future revisions of the ESC. Developments in methodology may be required. Note that this is also an Environment Agency Recommendation (SCM23).
RO-ASO-006: Effective Linkage between the ESC and single item limits within the WAC	Change required, but already implemented in an update to the ESC.	This forms the basis of the WAC for disposal of discrete items to the LLWR's engineered vaults.
RO-ASO-007: Environmental Safety Case assessment code documentation and quality assurance	Further action required to update ESC.	Further action here would be in connection with future revisions of the ESC. Developments in methodology may be required. Note that this is also covered by Environment Agency Recommendation SCM18).
RO-ASO-009 and TQ-ASO-009A: Well calculations	Further action required to update ESC.	Further action here would be in connection with future revisions of the ESC. Developments in methodology may be required. Note that Environment Agency Recommendations ASS14-19 address the well pathway.
TQ-ASO-001: Implementation of emplacement strategies within Vault 8	Further action required to update ESC.	There is ongoing work to assess whether containers meet the emplacement strategy in the 2011 ESC, which forms part of an activity to assess how to most appropriately manage stored wastes in the vaults. There is ongoing work to substantiate higher-stacking in Vault 8, which will include consideration (and development if necessary) of the emplacement strategies.
TQ-ASO-003: Coastal and marine biosphere and PEG definitions	Change to ESC not required.	Response explained the differences between groundwater and coastal erosion pathway biosphere models, and the PEGs used in the assessment calculations. This does not imply that any change to the ESC is required.
TQ-ASO-004: Incorporation of sea-level change	Change to ESC not required.	Discrepancies between the timeframes for coastal erosion in the SCAPE and CONNECTFLOW models has no

IRF	Categorisation	Justification
in the CONNECTFLOW model		implications for the definition of the groundwater model cases and thus no impact on the calculation of risk.
TQ-ASO-005: Human intrusion - aircraft impact	Change to ESC not required.	Assessment concluded that associated radiological impacts are consistent with cases investigated as part of the human intrusion assessment and therefore do not constitute a 'limiting case'. Note that inclusion of this case is a possible candidate for inclusion in future revisions of the ESC.
TQ-ASO-006: Radiological impacts to humans from direct shine and foodstuff pathways in a coastal erosion scenario that involves close contact with exposed, undiluted wastes	Change to ESC not required.	Suggested possibilities do not offer potential for significant radiation doses.
TQ-ASO-007: Selective retrievals study: GDF disposal costs	Change to ESC not required.	The only practicable option for consideration for selective retrievals and alternate disposal at this time is the proposed Geological Disposal Facility (GDF). Conclusion is that, even with a cost reduction for disposal of waste to a GDF, the overall costs would still be disproportionate to that of managing the waste in place, given that the risks associated with the waste in the trenches are currently consistent with the guidance level.
TQ-ASO-008: Integration between the Period of Authorisation and reference case assessments	Further action required to update ESC.	LLWR is currently planning to address this.
TQ-ASO-010: Human intrusion into sources	Change to ESC not required.	A maximum dose of 90 mSv is calculated for ingestion of a 1 mm fragment bearing 10% of the highest activity Pu-239 source present. The probability of this event, even assuming the source is intercepted and fragmented into ten 1 mm particles, is estimated as about one

IRF	Categorisation	Justification
		chance in two million, i.e. very unlikely. If the probability of intercepting the single pot that actually contains the Pu-239 source is also taken into account, the probability of the above ingestion event falls to one in 80 billion. This case does not therefore require any change to the ESC.
RI-INF-001: Impact of the 2010 national inventory	Further action required to update ESC.	There is a commitment to monitor the UKRWI and, where required, to revise future revisions of the ESC.
RI-INF-002: Impact of Grout on vault leachate composition	Further action required to update ESC.	Implies a methodological change.
RI-INF-005: Container condition monitoring and sampling plan	Change required and already included in ESC Issues Register or some other LLWR action list or issues register.	
RO-INF-002: Authorised disposals, storage and forward inventory storage to Vault 8	Change to ESC not required.	Response clarifies basis for calculations and terminology used to describe the Vault 8 inventory. Does not imply any change to the ESC necessary.
RO-INF-003 and RO-INF-003b: Non-standard disposals to Vault 8	Change to ESC not required.	Response provides inventory of non-standard disposals, and summarised process for handling such disposals. This does not necessitate change to the ESC.
TQ-INF-003: Radionuclide forward inventory data	Change to ESC not required.	Any action with respect to review of future inventories is captured in the response to RI-INF-001: Impact of the 2010 national inventory.
TQ-INF-004: Analysis of RECALL interviews	Change to ESC not required.	Response explains the RECALL process. LLWR confirm that, on the basis of the evidence available, it is highly improbable, given the circumstances, that any breaches of the conditions for acceptance of wastes for disposal, or breaches of the authorisation limits, would substantially modify the inventory of the LLWR in a way that materially affected safety arguments.

IRF	Categorisation	Justification
TQ-INF-005 and TQ-INF-005a: MoD waste streams	Change to ESC not required.	LLWR responses to these technical queries clarify LLWR inventory of wastes from MoD waste streams. They do necessitate any change to the ESC.
TQ-INF-006: Ratio of waste to grout fill	Further action required to update ESC.	Forms part of ongoing work on voidage in the vaults.
TQ-INF-007: Understanding the optimisation of surcharge requirements and final cap placement	Further action required to update ESC	The settlement and application of surcharge will be managed along with any consequential issues such as leachate management. This will be fully detailed prior to the implementation of each phase.
TQ-INF-018: Trench cap leakage	Further action required to update ESC.	Forms part of the ongoing work on trench cap remediation.
TQ-INF-020: Future inventory combination of Cases B, C and D	Change to ESC not required.	Any action with respect to review of future inventories is captured in the response to RI-INF-001: Impact of the 2010 national inventory.
TQ-INF-021: Key Radionuclides: Am-241 contribution to Vault 8 and overall inventory	Change to ESC not required.	Technical query requests clarification of LLWR position on Am-241 in Vault 8. Response provides this clarification and does not necessitate change to the ESC.
TQ-INF-024: Uncertainty of isotopic plutonium ratios within the trench inventory	Change to ESC not required.	Uncertainties in burn-up and cooling time are small compared to the decay allowed for in the assessment calculations, and will therefore have no material effect. There is therefore no need to change the ESC.
TQ-INF-026: Understanding and modelling the behaviour of disposed uranium	Further action required to update ESC	Developments in the understanding of the behaviour of uranium and other key radionuclides will continue to be reviewed and amendments to future revisions of the ESC incorporated as appropriate.
TQ-INF-032: Containers located in Vault 8 and tracking	Further action required to update ESC	Part of ongoing work on developing understanding of voidage and implementation of emplacement strategies in Vault 8.
TQ-INF-035: Impacts on the radon gas pathway	Change to ESC not required	Response to this technical query provides substantiation of the radon assessment used in the ESC. Does not imply that any change to the ESC is required.
TQ-INF-036: Asbestos management	Further action required to update ESC	The LLWR is considering whether any further controls on the disposal of asbestos at the facility are required. Further work, beyond that mentioned above (in the Statement of Technical Query) is underway

IRF	Categorisation	Justification
		to assess the potential impacts of the disposal of asbestos should the wastes become exposed through human intrusion or coastal erosion. The results of this work will inform the consideration of whether further waste acceptance controls are justified.
RI-SCM-001 and RI-SCM001b: Maintenance of the ESC expertise and knowledge	Further action required to update ESC.	IRF response commits LLWR to continual programme.
RI-SCM-002: Engagement with national stakeholders	Change required and already included in ESC Issues Register or some other LLWR action list or issues register.	Stakeholder engagement is an ongoing activity. The LLWR notes that the stakeholder engagement plan will continue to develop.
RO-SCM-001: Change control for the ESC	Further action required to update ESC.	IRF relates to implementation of change control for ESC and its relationship to site operations. Four related aspects to implementing the ESC: 1. Change control – achieved through including ESC in LLWR formal change control processes (of which this review is part); 2. Changes to WAC, capacity management arrangements, associated processes, procedures and forms; 3. Waste emplacement strategy for stacking certain waste packages in order to optimise the potential for reducing impacts in the future; and, 4. Engineering – substantiation of higher stacking and changes to future vault designs and closure engineering (including final cap and cut-off wall). There is ongoing work against each of these aspects. As part of 1), ESC is integrated into LLWR change control processes using approach based on LLWR's nuclear safety cases, in particular the use of the Plant Modification Process (PMP). There is a

IRF	Categorisation	Justification
		Repository Site Procedure governing development and application of the ESC. Work may be required to develop further processes.
RO-SCM-002: Ensuring continuing consistency between bulk waste properties and ESC assumptions	Further action required to update ESC.	This will be addressed in the ESC Annual Review.
RO-SCM-003: Internal scrutiny of the ESC Project	Change required and already included in ESC Issues Register or some other LLWR action list or issues register.	The LLWR will continue to develop and implement its QA/QMS procedures as part of a commitment to continuous improvement.
RO-SCM-004: Long-term management of ESC related records	Further action required to update ESC.	This is part of Forward Issue ESC-FI-022 and Recommendations SCM14-17 and SCM37.
RO-SCM-005: Forward work programme for the ESC	Further action required to update ESC.	This is part of Forward Issue ESC-FI-004.
TQ-SCM-001: Board involvement in promoting environmental safety	Change required and already included in ESC Issues Register or some other LLWR action list or issues register	The promotion of an environmental safety culture is linked to broader QA/QMS objectives and is continually reviewed to promote continuous improvement.
TQ-SCM-002: Risk of a tsunami affecting the LLWR	Change to ESC not required	The potential for a tsunami-like event to impinge on the site increases as sea level rises and coastal recession occurs. It is considered, however, that once the facility is capped, there could be no significant impact from such events beyond some limited erosion of the site restoration layers of the cap. If the event occurred after erosion of the disposed waste has commenced, the effect would be similar to that of a major storm event causing some immediate

IRF	Categorisation	Justification
		erosion and dispersal of wastes onto the shore and marine environment. Such processes and their effects are considered in the long-term assessment.
TQ-SCM-003: Establishing the scope of the 'local community'	Change to ESC not required.	LLWR have developed and continue to maintain a good working understanding of its local and regional stakeholders and hence engage appropriate individuals and organisations on the development of the ESC and other issues.
RO-SUE-001: Final capping of the trenches	Further action required to update ESC.	The LLWR will continue to monitor cap performance and present to the Environment Agency an annual review as required by Schedule 9 Requirement 7 of the Permit [1]. A BAT assessment [28] was carried out in 2012 to identify an optimal strategy for the management of environmental hazard through hydrological controls and monitoring of the LLWR trenches prior to the completion of final capping. The BAT assessment recommended that a targeted remediation and monitoring strategy should be pursued based around remediation of the trench probe perforations. Given the possible importance of these perforations in terms of their potential to provide a conduit for infiltration, the approach is that all such perforations will be remediated, not only those that show water level responses to rainfall or are otherwise known to be potentially problematic These remedial works commenced in Autumn 2013 and are currently ongoing.
RO-SUE-007: The use of future monitoring to reduce uncertainty in the ESC	Further action required to update ESC.	This is part of Forward Issue ESC-FI-005.
RO-SUE-008: Development of a long-term monitoring strategy to support the ESC	Further action required to update ESC.	This is under current development.
RO-SUE-009: Consolidation and resolution of engineering	Further action required to update ESC.	Further design work is required to develop the design to a maturity level that will support the installation and construction of the engineered features.

IRF	Categorisation	Justification
uncertainty		The development of the engineering design prior to implementation will provide the details required to enable the effective installation of the various engineered features and provide appropriate substantiation to demonstrate that the proposed details represent BAT and conform to, or improve on, the performance assumed in the assessments carried out within the 2011 ESC. This work will include the following areas: • container optimisation; • detailed design of the leachate management system; • specification of construction materials; • further detailing to ensure the resilience of the final cap can be assured; • detailed evaluation of the Vault 8 closure plan taking due account of the current status of the containers and optimising this with the long-term performance of the system and the benefits of disposing additional waste on top of those containers already disposed; • providing construction details to enable the permanent and temporary works to be installed within the envelope assessed within the 2011 ESC and detailed within the Site Optimisation and Closure works planning application.
TQ-SUE-010: Uncertainty associated with isostatic changes at the LLWR	Change to ESC not required.	Undertaking further work to reduce the uncertainties in isostatic uplift would not necessarily significantly reduce the uncertainties in relative sea-level change. This is because the uncertainty in relative sea level is dominated by sea-level change and not by isostatic effects. Therefore LLWR do not consider that collection of additional data on isostatic uplift would significantly enhance the ESC.
TQ-SUE-011: Slope stability assessment of the eroding waste mass	Further action required to update ESC.	A more realistic assessment is required.
TQ-SUE-019: The role of extreme surge events and	Change required and already included	The LLWR will continue to monitor the evolution of the coastline and any advances in coastal modelling approaches.

IRF	Categorisation	Justification
their impact on the rate and extent of coastal erosion	in ESC Issues Register or some other LLWR action list or issues register.	
TQ-SUE-022: Understanding of the role of the dune system in the ESC	Change to ESC not required.	The dunes have a limited significance in the evolution of the coastline over the timescale of a few hundred to a thousand years covered by the ESC.
TQ-SUE-023: Cap slope stability assessment request	Further action required to update ESC.	
TQ-SUE-024: Assumed concrete slab performance	Change to ESC not required.	The properties of the concrete slab have been incorporated into the modelling, they are not considered to be a significant component in providing containment capability of the vault base and side walls as the containment is primarily controlled by the underlying bentonite layer.
TQ-SUE-025: Timing of the disruption of the LLWR by coastal erosion	Further action required to update ESC.	Monitoring programme and commitment to remain abreast of technical developments.
TQ-SUE-026: Seismic assessment of the cap stability	Change to ESC not required.	Seismic resistance is not a requirement for any LLW facilities. Nonetheless, work has been undertaken to consider the impacts from seismic events. The impacts from seismic events are considered to be low and during the operational phase of the site, remediation work could be undertaken if required.
TQ-SUE-030: Development of the assessment of waste fire scenarios during a post operational period	Further action required to update ESC.	Forward Issue ESC-FI-003 concerns this.

3.9 FEP and Uncertainties Tracker

The FEP and Uncertainty tracker is a tool to manage identified FEPs and associated uncertainties, and is designed to allow identification of the means by which a specific

FEP has been considered within the 2011 ESC. It also provides a means by which uncertainties can be documented and tracked.

The content of the FEP tracker has been reviewed as part of the Periodic Review. The FEP tracker was written post-2011 to reflect the May 2011 ESC status, and has not been updated since. It thus forms part of the 2011 baseline and is in need of substantial effort to update it to reflect the current state of the ESC. There is a required action, therefore, to decide on what revised form the tracker should take, to implement any required changes and developments and then make the tracker align with the updated ESC.

3.10 ESC Issues Register and ESC Regulatory Issues Tracker

The ESC Issues Register and the ESC Regulatory Issues Tracker are tools to manage identified ESC issues and commitments and ESC-related regulatory interactions.

The ESC Issues Register and the ESC Regulatory Issues Tracker have been reviewed as part of the Periodic Review. The ESC Issues Register contains issues or commitments and is used to record the actionee, the date when action is required by, and to track progress. The Issues Register also contains the ESC errata list.

The ESC Regulatory Issues Tracker records ESC-related requests from the regulator and how and when the action was closed. The ESC Regulatory Issues Tracker includes IRF close-outs, document requests and responses to informal queries such as emails.

The review concluded that consideration should be given to ensuring that the ESC Issues Register covers all technical issues and outstanding actions that should be recorded - from regulators, the PRG, and LLWR itself (e.g. including the outcome of the Periodic Review and Annual Reviews).

3.11 Regulatory Correspondence

Regulatory correspondence issued between May 2011 and April 2014 was included in the Periodic Review to identify updates to the ESC or required actions that would otherwise not have been captured. The results of this review are presented in Table 22. Issues identified as requiring further action have been mapped to high-level themes, with the theme given in parentheses in the ‘Issue’ column.

Table 22 Issues identified from review of regulatory correspondence

Date of letter	Reference	Issue	Categorisation	Justification
10/05/2012	DRG/12/112/O	ISO condition inspections & investigations (Containment optimisation).	Further action required to update ESC.	There is ongoing work with voidage, container optimisation, vegetation removal etc, regular asset inspection, schedule for capping etc.
04/02/2013	LLWR/EA/12/0160/07	Review whether newer fingerprints to be used to recalculate trench inventory for next major periodic revision of ESC (Revised LLWR radionuclide inventory).	Further action required to update ESC.	There is a commitment to revise, where required, the ESC in light of new data.
4/02/2013	LLWR/EA/12/0160/07	Develop detailed working knowledge of derivation of trench inventory.	Change to ESC not required.	The LLWR is undertaking work to develop understanding and ownership. This will be reported in the next major revision of the ESC, but does not, in itself, constitute an update to the ESC.
04/02/2013	LLWR/EA/12/0160/07	Establish process for spot-checking locations of	Change to ESC not required.	This is a QA or operational issue. This would be reported upon in the next major revision of the ESC, and the action to do so

Date of letter	Reference	Issue	Categorisation	Justification
		containers in Vaults 8 and 9.		should be captured and implemented but does not, in itself, constitute an update to the ESC.
04/02/2013	LLWR/EA/12/0160/07	Refine studies of potential voidage in Vault 8 as part of justification for higher stacking and final capping. (Voidage and higher stacking)	Further action required to update ESC.	There is ongoing work to refine the understanding of voidage in the vaults. The ESC will need to be updated with the results of this work.
03/07/2013	LLWR/13/008/O	LLWR Trench Hydrological Management BAT - Further Response. (Trench cap remediation)	Further action required to update ESC.	Further work is ongoing, new understanding will need to be incorporated in the ESC and remedial actions will impact.

Date of letter	Reference	Issue	Categorisation	Justification
20/12/2013	LLWR/13/015/O	Audit programme to be reviewed.		
20/12/2013	LLWR/13/015/O	ESC issues register to record close-out of actions following audits. (Revised trackers)	Further action required to update ESC.	See assessment of ESC Regulatory Issues Tracker – this could be incorporated in a revised tracker.
20/12/2013	LLWR/13/015/O	Develop guidance note on good practice for undertaking calculations and data management and checking. (Software documentation and data management)	Further action required to update ESC.	This is a proposed future task.

3.12 MoCs

The LLWR MoC process is used to manage organisational changes. It identifies potential resource and capability gaps arising from change and places actions to ensure any deficiencies are addressed.

The LLWR MoCs were reviewed to identify organisational and management changes relevant to the ESC. In Table 23 the results of this review are summarised.

Table 23 Categorisation of MoCs

Reference	Title	Categorisation	Justification
0153	Resource and workload impacts from implementation of the LLWR Site Environmental Clearance Certificate (ECC) and "on-plant" implementation of the 2011 Environmental Safety Case (ESC)	Change to ESC not required.	Resource and workload impacts have been identified and managed by LLWR.
0148	External hosting of environmental monitoring database	Change to ESC not required.	Improves reliability and backup function of monitoring database. It does not imply any changes to the ESC.
0135	Transfer of responsibility for site monitoring from EHS&Q to Science and Engineering	Change required, but already implemented in an update to the ESC.	This is discussed in the *Developments* report.
0134	Transfer of Process Ownership for 3.04 (Waste Service-Acceptance)	Change to ESC not required.	Transfer managed by LLWR internal processes. Does not imply any change to ESC.

Reference	Title	Categorisation	Justification
0131	Removal of the Chief Engineering role and introduction of a Head of Engineering role.	Potentially significant, as it could impact implementation of ESC - discuss at w/shop.	Does not imply any change to ESC.
0130	Appointment of ESC Process Owner	Change required, but already implemented in an update to the ESC	This is discussed in the *Developments* report.
0127	Transfer of Statutory Environmental Ground Water Monitoring from LLW Operations to Environmental Monitoring Team	Change to ESC not required.	Transfer managed by LLWR internal processes. Does not imply any change to ESC.
0106	Transition of Non-Statutory Environmental Monitoring work between LLWR Contractors (NNL to new Contractor)	Change to ESC not required.	Transfer managed by LLWR internal processes. Does not imply any change to ESC.

3.13 Waste Management and WAC

Waste management, WAC and associated control arrangements were reviewed as part of the review workshop. These topics are therefore addressed in Subsection 3.1.4.

3.14 Monitoring

An important objective of the LLWR monitoring programme is to provide data to underpin and increase confidence in the conceptual and numerical models of the LLWR system that are used in the ESC. Monitoring data are used to ensure that the site is operating in a safe manner consistent with the assumptions and conclusions of the 2011 ESC. It is important therefore to include monitoring data within the Periodic Review to assess whether there are emerging issues that challenge the site conceptual model and system understanding employed in the 2011 ESC.

Annual review reports of LLWR's environmental monitoring programme designed to fulfil the Schedule 9 Requirement 8 of LLWR's Permit were therefore reviewed to identify and categorise issues that may necessitate updating the ESC. The results of this review are presented in Table 24. For those issues identified as requiring further action, the appropriate high-level theme is given in parentheses in the 'Issue' column.

It should be noted that the monitoring results are interpreted as generally supporting the site conceptual model, and show no significant emerging issues. Thus there are no significant challenges to the site conceptual model employed in the ESC.

Table 24 Categorisation of issues identified in annual monitoring review reports

Monitoring year	Issue	Categorisation	Justification
2013	Organisational change: formation of Site Characterisation & Environmental Monitoring team.	Change required, but already implemented in an update to the ESC.	Recorded in Permit application.
2013	LLWR Assessment Standards[3] extended from 32 to 100 (Non-radiological assessment).	Further action required to update ESC.	Need to review as to whether increased number of assessment standards requires revision of non-radiological assessment.
2013	Minor changes to monitoring programme identified.	Change to ESC not required.	Minor changes do not affect the ESC.
2013	Review of groundwater level data to be held during FY 14/15. (Groundwater, geology and hydrogeology).	Further action required to update ESC.	Work already undertaken [Jackson C. and Woollard H., Integration of Geology and Hydrogeology at the LLWR Site, AMEC report D005864/002 Issue 2, 2012.] to consider the potential reasons for the mound. SSSI groundwater level data relates to assessing the potential effect of dewatering on perched groundwater. Further work being scoped.
2013	Elevated radon levels found in	Change to ESC not required.	Radon monitoring continued during 2014 to establish baseline conditions.

[3] 'Assessment Standards' are water quality standards that are identified as being appropriate to a contaminant in a water body in order to assess the overall impact of the contaminant on leachate and water quality.

Monitoring year	Issue	Categorisation	Justification
	certain parts of leachate drainage system.		
2013	Perimeter drain deterioration: perimeter drain to be renewed. (Trench cap remediation)	Further action required to update ESC.	This forms part of the currently ongoing interim trench cap work; further changes to ESC may be required.
2013	Trench cap status. (Trench cap remediation)	Further action required to update ESC.	Current ongoing project; further changes to ESC may be required.
2013	Cs-137 river water sample from GD0011.	Change to ESC not required.	No current activities with the potential to increase Cs-137 levels within Drigg Stream have been identified. Mobilisation of sediments from previous authorised discharges identified as potential cause. No effect on ESC.
2013	Proposed combination of statutory CEAR monitoring with Monitoring Programme. (Long-term monitoring)	Further action required to update ESC.	Further discussion with the Environment Agency took place in January 2015. Environment Agency considering allowing removal of CEAR requirements and replacement with general condition for LLWR to have an environmental monitoring programme.
2013	Tritium exceedances: there are localised regions between LLWR and the coast where radiation doses	Further action required to update ESC.	Groundwater monitoring continues. Provides additional justification for trench cap repairs.

Monitoring year	Issue	Categorisation	Justification
	would currently be about 20 times greater than the 20 µSv y^{-1} dose guidance level. (Long-term monitoring)		
2012	LLWR to continue to review and analyse monitoring database to improve system and approaches. Ongoing work to identify and validate historical records that have not been added to the system. (Long-term monitoring)	Further action required to update ESC.	Work continues. Historical records have been cross-checked against database record to confirm the data are captured.
2012	Integration of geological and hydrogeological models. (Groundwater, geology and hydrogeology)	Further action required to update ESC.	Amec work on the integration of these models continues. Inconsistencies between geological and hydrogeological conceptual models identified, in particular the groundwater mound. However, they are not considered to be significant.

Monitoring year	Issue	Categorisation	Justification
2012	Ongoing programme to use run-off data, combined with rainfall and leachate level/flow data to help determine trench cap performance. (Trench cap remediation)	Further action required to update ESC.	This is part of an ongoing programme reported in the Requirement 7 report. This feeds into the ESC. Revised understanding of trench cap performance needs to be considered in future assessment calculations. Issue relates closely to remediation of interim trench cap.
2012	Complexants. (Complexants)	Further action required to update ESC.	Forward issue ESC-FI-009 relates to complexants.
2012	Coastal surveys. (Coastal erosion)	Further action required to update ESC.	Coastal surveys continue. Includes reviewing developments in climate change and coastal erosion and highlighting whether further work is required.
2012	Trench cap and CoW performance monitoring. (Trench cap remediation)	Further action required to update ESC.	The Annual Monitoring Review has a number of purposes: • to record significant new monitoring results or other new information and their implications to the assumptions in the ESC; • to determine whether any changes to the programme are required; • to ensure that the understanding of parts of the repository system, other than the engineered barriers, including other components of the near field, the geosphere and the biosphere remain consistent with the conceptual models set out in the ESC; • to determine whether monitoring infrastructure is fit for purpose and whether repairs are required. Thus the results of ongoing monitoring programmes will, where necessary, feed into ESC updates.

Monitoring year	Issue	Categorisation	Justification
2011	Trench cap water balance. (Trench cap water balance)	Further action required to update ESC.	The significance is based upon the observation that the site water balance informs the hydrogeological parameters, and is important to calculate and understand the cap's performance. This will govern water infiltration into the wastes, and hence leaching of wastes. This information is not captured in the ESC, but will need to be. It will form an input to revised modelling calculations in any future major update of the ESC.

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4 Synthesis of Findings

The issues identified as outcomes of the review in the previous section have been grouped to identify high-level themes. Only those issues that were identified as requiring further action have been included in the grouping exercise; those that are already captured, whether in some LLWR action list or issues register, or as Environment Agency Forward Issues or Recommendations, or as PRG recommendations have been excluded.

For each theme, an action, if appropriate, has been identified. These actions will be captured in the ESC Issues Register. When captured in the Issues Register, the responsibility and close-out date for the action will also be assigned by the ESC Manager. It is for this reason that responsibilities and close-out dates are not included within this report.

As discussed in Subsection 2.2.3, the identified themes and actions were discussed at a review meeting.

The agreed themes and actions are presented, together with grouped underlying issues, in Table 25.

Table 25 High-level themes identified from the Periodic Review

High-level theme	Description	Action	Underlying issues
Trench cap remediation	There is a programme of work ongoing to remediate the interim trench cap. Further changes to the ESC may be required as a result of this work. This work has several facets: ● Plans for interim trench cap remediation are currently being developed (to include the effects of surcharging). ● It is still unresolved as to why there are high flows from Trench 7. It may indicate an issue with cap over that area, although trial work suggests that this is not the case. ● Ongoing programme to use run-off data, combined with rainfall and leachate level/flow data to help determine trench cap performance. This is part of an ongoing programme reported in the Requirement 7 report. This feeds into the ESC. Revised understanding of trench cap performance needs to be considered in future assessment calculations. Issue relates closely to remediation of interim trench cap. ● A BAT assessment was carried out in 2012 to identify an optimal strategy for the management of environmental hazard through hydrological controls and monitoring of the LLWR trenches prior to the completion of final capping. The BAT assessment recommended that a targeted remediation and monitoring strategy should be pursued based around remediation of the trench probe perforations. Given the possible importance of these perforations in terms of their potential to provide a conduit for infiltration, the approach is that all such perforations will be remediated, not only those that show water level responses to rainfall or are otherwise known	Assess change to ESC using ESC change control process when decision has been made as to optimal solution. Capture action in Issues Register at this time because timescale unknown.	Interim trench cap. Flows from Trench 7. Plans for interim trench cap remediation currently being developed. *LLWR Trench Hydrological Management BAT: Final Report,* QRS 1443S ZN R3, November 2012. Trench cap phase 3 works. Trench cap improvements phase 1. Agency letter ref: LLWR/13/008/O LLWR Trench Hydrological Management BAT - Further Response. Perimeter drain deterioration: perimeter drain to be renewed. Trench cap status. Ongoing programme to use run-off data, combined with rainfall and leachate level/flow

High-level theme	Description	Action	Underlying issues
	to be potentially problematic These remedial works commenced in Autumn 2013 and are currently ongoing.		data to help determine trench cap performance. Trench cap and CoW performance monitoring.
Decommissioning wastes	PCM LSAM decommissioning wastes from the site are not, at present, included in the ESC or the design. As decommissioning progresses, there will be a need to dispose of the associated decommissioning wastes. Further work would be necessary to include these in the ESC.	BAT study is to be initiated by PCM team. ESC team will need to support.	Decommissioning projects.
Security enhancement	This concerns the security enhancement project. This could affect capping. There is a need to engage with the security project to assess the significance and effect of this upon the ESC.	Confirm that engagement is taking place.	Security enhancement programme.
Leachate management	This concerns remediation of the leachate management system. There should be an action to liaise with the project to assess the significance and effect of this work on the ESC.	Action to review outcome of leachate management project.	Leachate management system remediation work.
Disposal concept	There is a current commitment to review the disposal concept employed at LLWR (e.g. disposal container, soft-sided bags, etc.) in the Benefits Realisation Plan.	No further action required.	Disposal concept (e.g. disposal container, drums, soft-sided bags).
Asset refurbishment and replacement	Asset refurbishment and replacement may affect the ESC in ways that are not understood by the project teams concerned. In such cases, a decision would have to be made as to the appropriate action to take.	Significant changes should be identified through the PMP process. No further action required.	Asset refurbishment and replacement.

High-level theme	Description	Action	Underlying issues
Voidage and higher stacking	This concerns work to refine the understanding of voidage in the vaults and related efforts to provide the engineering substantiation to allow higher stacking and final capping of vault wastes.	Work in progress captured in the SDP. No further action required.	Vault 8 high stacking. *Assessment of the Implications of Voidage in Vault 8,* QRS-1443ZP-1, May 2013. Agency letter ref: LLWR/EA/12/0160/07 Refine studies of potential voidage in Vault 8 as part of justification for higher stacking and final capping.
New waste tracking system	It is difficult to obtain data from the current waste tracking system. For the new waste tracking system, use of a COTS system may require changes to waste acceptance process or affect data that can be recorded.	Specification for new waste tracking system (WTS) requires implementation of the requirements of the 2011 ESC.	New waste tracking system. Waste tracking system – obtaining Vault 8 data from current tracking system is difficult.
Optimisation of grout formulation	There is ongoing work by the ESC team on superplasticisers. A replacement for PFA may be required in future, as PFA is no longer available from Drax power station.	Latest information is that PFA will be available, at least in the medium term. Work on selecting a superplasticiser is ongoing. No further action required.	Optimisation of grout formulation. *Review of Leaching Data for Pulverised Fuel Ash Relevant to Assessing the Release of Contaminants from LLWR Grout,* NNL(12)12271, October 2013. LLWR/ESC/Mem(13)215 Case for change for superplasticiser.

High-level theme	Description	Action	Underlying issues
			LLWR/PMP/2013/432 Plant scale trials of Sikament 700 superplasticiser.
Uncertainty management	There are several types of uncertainties related to the future development of the site: ● Uncertainties in site development deriving from planning process, e.g. different vault capacities and cap footprint. ● Uncertainties derived from funding, e.g. need to protect wastes in Vault 8 prior to final capping (if capping delayed). ● Uncertainty in required timing of capping (e.g. Vault 8 will need capping). ● Uncertainty in timing of vault construction. If such uncertainties mean that there is a change in the forward plan, then there it will need to be considered whether the ESC requires an update.	LLWR's engineering design and business management processes should ensure that account is taken of any changes. No further action required.	Uncertainties in site development deriving from planning process, e.g. different vault capacities and cap footprint. Uncertainties derived from funding, e.g. need to protect wastes in Vault 8 prior to final capping (if capping delayed). Uncertainty in required timing of capping (e.g. Vault 8 will need capping). Uncertainty in timing of vault construction.
Systematic assessment approach	There is no systematic approach to assessing the implications of new information for the ESC. There may be a need to consider whether additional procedures are required.	A review only needs to be undertaken after more experience has been obtained of the process for assessing new information.	Lack of systematic approach to assessing the implications of new information for the ESC.
Defining engineering requirements	There is a lack of a systematic approach to defining ESC engineering requirements.	Will be addressed in the development programme for next ESC. Action to develop	Lack of systematic approach to defining ESC engineering requirements.

High-level theme	Description	Action	Underlying issues
		approach, discuss and review.	
Coordination and optimisation processes	There are weaknesses in LLWR processes to ensure project coordination and optimisation. There is a need for a site coordination committee supported by appropriate processes.	A site coordination committee is being set up. Action to review site procedures to determine that optimisation is appropriately addressed.	Weaknesses in LLWR processes to ensure project coordination and optimisation.
ESC implementation	The ESC has been implemented as a live safety case. The ESC is integrated into LLWR change control processes using an approach based on LLWR's nuclear safety cases, in particular the use of the PMP. There is a Repository Site Procedure governing development and application of the ESC. Work may be required to develop further processes. Implementation of ECC. This is a live document, which will specifically require revision on receipt of Permit and when disposals in Vault 9 commence. As part of the ESC implementation, the LLWR will continue to develop and implement its QA/QMS procedures as part of a commitment to continuous improvement. The promotion of an environmental safety culture is linked to broader QA/QMS objectives and is continually reviewed to promote continuous improvement.	LLWR's assurance processes require review of procedures at appropriate intervals. Review of the ECC is in the ESC Implementation schedule. Company-wide enhanced environmental training is underway.	Implementation of ESC as live safety case. Implementation of Environmental Clearance Certificate (ECC).

High-level theme	Description	Action	Underlying issues
Revised Permit	A revised Permit is anticipated. A review process will be required when the revised Permit issued. It is expected that there will be a need to make changes to LLWR processes, including waste acceptance. It is expected that there will be a new set of requirements.	There is an LLWR RSP for complying with the Permit. If, and when, a revised Permit is received, this RSP will be applied.	Revised permit anticipated.
ESC development programme.	The development programme for the next major update to the ESC is being prepared. This will address a number of required key safety case developments.	No further action required.	Development programme for next major update to ESC. There are a number of key safety case developments required. *ESC Forward Programme,* LLWR/ESC/R(11)10040.
Hazardous substances reclassification	Additional substances may be reclassified as hazardous, or the required assessment process may change. LLWR will remain aware of, and provide input to, forthcoming consultation processes.	Any changes will be assessed through ESC assessment of new information procedure.	Additional substances may be reclassified as hazardous, or the required assessment process may change.
Reviewed GRA	The environment agencies' GRA is being reviewed in 2016. LLWR will remain aware of, and provide input to, forthcoming consultation.	LLWR will remain aware of, and provide input to, forthcoming consultation.	Guidance on GRA being reviewed in 2016.

High-level theme	Description	Action	Underlying issues
User understanding of ESC	Users (e.g. LLWR staff outside the ESC team) do not yet understand the ESC and its requirements. Further training is being planned. New ED and C contractor needs to be included in training.	Further training is planned at different levels and for different parts of the organisation.	Users do not yet fully understand ESC and its requirements.
Nuclear safety case	There is a requirement to ensure that there is consistency between assumptions in radiological impact calculations between the NSC and ESC. As part of this, it is necessary to identify changes that have been made to the NSC and to understand potential impacts to the ESC and vice versa. For example, the LLW and PCM safety cases have been revised.	Action to review consistency of assumptions at an appropriate frequency.	LLW and PCM safety cases have been revised. There is a requirement to ensure that there is consistency between assumptions in radiological impact calculations between the NSC and ESC.

High-level theme	Description	Action	Underlying issues
Revised WAC and associated processes	There is a need to undertake work to revise WAC and associated processes. This may include: ● ensuring that processes are in place to take into account requirements of NSC when WAC defined; ● implementing new WAC to control sealed sources when the revised Permit is received; ● work on, for example, asbestos, complexants and non-radiological contaminants to implement the ESC once the revised Permit is received; ● clarifying the definitions of discrete items and active particles; ● clarifying the arguments for populations of discrete items and active particles.	Action to include a review of the waste acceptance development process in the new Waste Acceptance and Data Improvement Programme. Work currently underway assessing wastes against waste emplacement strategy. Other aspects will be addressed in the next revision of the WAC.	Need to ensure that processes in place to take into account requirements of NSC when WAC defined. Sources. Significant changes need to be made to waste acceptance process to implement ESC. Clarity of terms in WAC, e.g. discrete items, active particles. Clarity of arguments for discrete items. LLWR/ESC/Mem(13)218 Waste acceptance - Capacity Management Requirements. ESC project manager now signs waste variation forms.
Waste uncertainty management	There are uncertainties in the timings and volumes of waste arisings. Waste receipts are less than would be suggested by UKRWI data. There are uncertainties in rates of wastes arising, e.g. from reactor decommissioning.	LLWR continues to seek improvements to the UKRWI through work with NDA and customer organisations. In development programme need to decide how to address uncertainty in next revision of the	Uncertainties in timings and volumes of arisings.

High-level theme	Description	Action	Underlying issues
		ESC. Any actual changes in the expected inventory will be identified through review of the UKRWI or through annual review of the ESC.	
Stored wastes	Stored wastes (including ungrouted wastes) might not be consistent with ESC. Assessment work is currently being undertaken. The ESC will need to be updated with the results of this work.	Work in progress. No further action required.	Stored wastes (including ungrouted wastes) might not be consistent with ESC. Requires further action. Assessment of stored wastes.
Gas monitoring	A trace gas monitoring programme is scheduled. The results will be reviewed when the programme is complete.	Monitoring complete. Review required.	Trace gas monitoring scheduled.
Complexants	There is an ongoing monitoring programme of EDTA. The resulting monitoring data will require interpretation. An activity will be undertaken to better understand and characterise the nature and origins of complexants in the wastes.	Monitoring is in the plan. Work on characterising complexant nature and origins is underway.	EDTA sampling. Complexants (from review of monitoring reports).
Single-hole dilution tests	Dilution tests were initial trials to see if the proposed method was applicable.	View needed as basis for Development Programme.	Single-hole dilution tests.
Long-term monitoring programme	Post-2011, a review of the monitoring programme was undertaken. Further work has been carried out to develop long-term monitoring programme. Requirements specification about	FIs are being taken into account in developing the ESC Development Programme.	Proposed combination of statutory CEAR monitoring with Monitoring Programme.

High-level theme	Description	Action	Underlying issues
	to be developed. Related forward issue under review. Proposed combination of statutory CEAR monitoring with Monitoring Programme. Further discussion with the Environment Agency took place in January. Environment Agency considering allowing removal of CEAR requirements and replacement with general condition for LLWR to have an environmental monitoring programme. A BAT assessment is needed in support of this programme. LLWR to continue to review and analyse monitoring database to improve system and approaches. Ongoing work to identify and validate historical records that have not been added to the system. Detailed analysis of the leachate from the trenches has been carried out in the past but further analysis is scheduled for 2015. Forward Issue ESC-FI-005 concerns the use of future monitoring to reduce uncertainty in the ESC. Tritium exceedances: there are localised regions between LLWR and the coast where radiation doses would currently be about 20 times greater than the 20 µSv y^{-1} dose guidance level. Groundwater monitoring continues. Provides additional justification for trench cap repairs.		Tritium exceedances: there are localised regions between LLWR and the coast where radiation doses would currently be about 20 times greater than the 20 µSv y^{-1} dose guidance level. LLWR to continue to review and analyse monitoring database to improve system and approaches. Ongoing work to identify and validate historical records that have not been added to the system.
Short-term planning and SDP.	The short-term planning application may be different from the Site Development Plan (SDP). There is a need to consider what action, if any, is required.	Action to consider implications as short-term planning application is developed.	Short-term planning different from SDP.

High-level theme	Description	Action	Underlying issues
Optimisation.	Changes arising from detailed design optimisation will need to be assessed and incorporated into the ESC.	Changes will either be assessed through the design justification process or through the next major update of the ESC.	Changes arising from detailed design optimisation will need to be assessed and incorporated into the ESC.
Future Environmental Management Plan.	The Future Environmental Management Plan could affect the ESC and may need to be accounted for. This programme is managed by Engineering.	Consistency between the FEMP and the ESC will be ensured through the new site development committee.	Future Environmental Management Plan.
Site Landscape and Wildlife Management Plan.	This plan could have an indirect effect upon the ESC by affecting how repository works are carried out.	Consistency with the ESC will be ensured through the new site development committee.	Site Landscape and Wildlife Management Plan.
Implementation of waste emplacement strategy	Implemented in ECC for Vault 8. A detailed procedure needs to be developed for Vault 9. In addition, there is ongoing work to assess whether containers in Vault 8 and Vault 9 meet the emplacement strategy in the 2011 ESC, which forms part of an activity to assess how to most appropriately manage stored wastes in the vaults. There is also ongoing work to substantiate higher-stacking in Vault 8, which will include consideration (and development if necessary) of the emplacement strategies.	Work underway on higher stacking in Vault 8 and stored containers in Vault 8 and Vault 9. ECC will need to be revised at an appropriate point before final disposal of waste in Vault 9.	Need to implement waste emplacement strategy.

High-level theme	Description	Action	Underlying issues
Use of vaults for buffer storage of leachate	Account needs to be taken of the potential use of the vaults as buffer storage of leachate.	Any implications for the location of waste container stacking for the ESC will need to be assessed.	Use of vaults for buffer storage of leachate.
Groundwater, geology and hydrogeology	A review of groundwater level data is to be held during FY 14/15. LLWR recognise the importance of continuing to investigate the groundwater mound and further work has been carried out [Jackson C. and Woollard H., *Integration of Geology and Hydrogeology at the LLWR Site*, AMEC report D005864/002 Issue 2, 2012.] to consider the potential reasons for the mound. The work done to maintain the 3-D geological model [AMEC, *Update of the 3D Geological Model*, AMEC reference: 202539 Issue 001, November 2014] has also considered the groundwater mound and it is recognised as an area for further investigation. Further work is being scoped. LLWR recognise the importance of understanding and representing the heterogeneous nature of the Quaternary sediments. Further work has been commissioned to consider whether the detailed lithologies in B2 can be represented in the 3D geological model. LLWR recognise the influence of the structure of B3 on the hydrogeological model and have commissioned further work to refine the geological model and improve the link between the geological representation and the observed hydrogeological conditions.	Issues to be considered in the development of the hydrogeology forward programme.	*Integration of the Geology and Hydrogeology at the LLWR,* D005864/002, July 2012. *The Effect of Faults on the Hydrogeology at the LLWR,* D005864/003, August 2012. LLWR/ESC/Mem(14)250 Lot 3 Geological/Hydrogeology Task 1.5 Incorporation of Geophysics data in 3D Geological Model. Review of groundwater level data to be held during FY 14/15. Integration of geological and hydrogeological models.

High-level theme	Description	Action	Underlying issues
	Updating the understanding of the groundwater, geology and hydrogeology implies that changes to the assessment models may be necessary.		
Coastal erosion	LLWR is committed to a monitoring programme and remaining abreast of technical developments (including modelling) in coastal erosion. The programme of coastal surveys includes reviewing developments in climate change and coastal erosion and highlighting whether further work is required.	Any significant changes will be assessed and taken into account in LLWR's ESC Development Programme.	Coastal surveys.
Trench cap water balance	Work has been undertaken to develop a revised view of trench cap performance indicated by trench cap water balance data. This revised view needs to be taken into account in future assessment calculations.	Changes will be taken into account at next major revision of the ESC. Closely related to 'Trench Cap Remediation (above).	Changed view of data from trench cap water balance data. Trench cap water balance.
Containment optimisation	There is ongoing work with voidage, container optimisation, vegetation removal etc., regular asset inspection, schedule for capping etc.	Work is in progress. Any changes will be captured using existing processes.	Agency letter DRG/12/112/O ISO condition inspections & investigations.
Revised LLWR radionuclide inventory	There is a commitment to monitor the UKRWI and, where required, to revise future revisions of the ESC in light of new data.	Action to review implications of UKRWI changes on ESC.	*Methodology for the Derivation of the Trench Inventory at the LLWR,* NNL(12)12632, April 2013. *A Guide to the Structure and Use of the LLWR Trench Inventory Calculations,* NNL(13)12969, March 2014.

High-level theme	Description	Action	Underlying issues
			Guide to the LLWR Trench Inventory Methodology and Development, NNL(13)12970, March 2014. *A Forward Inventory for LLWR based on the 2010 UKRWI,* SERCO/E005766/001, March 2012. Agency letter LLWR/EA/12/0160/07 Review whether newer fingerprints to be used to recalculate trench inventory for next major periodic revision of ESC.
FEP tracker	The FEP tracker was written post-2011 ESC to reflect the May 2011 ESC status, and has not been updated since. It thus forms part of the 2011 baseline and is in need of substantial effort to update it to reflect the current state of the ESC. There is a required action, therefore, to decide on what revised form the tracker should take, to implement any required changes and developments and then make the tracker align with the updated ESC.	Review in hand. No further action required.	See Subsection 3.9.

High-level theme	Description	Action	Underlying issues
Issues Register	The review concluded that consideration should be given to ensuring that the ESC Issues Register covers all technical issues and outstanding actions that should be recorded - from regulators, the PRG, and LLWR itself (e.g. including the outcome of the Periodic Review and Annual Reviews).	Action to review the ESC Issues Register and ensure that it contains all technical issues and necessary outstanding actions.	See Subsection 3.10.
Software documentation and data management	ESC assessment code documentation and quality assurance. Further action here would be in connection with future revisions of the ESC. Developments in methodology may be required. (Note that this is also covered by Environment Agency Recommendation SCM18.)	To be taken into account during next revision of the ESC. Could be partly addressed by planned assessment manual.	Develop guidance note on good practice for undertaking calculations and data management and checking.

High-level theme	Description	Action	Underlying issues
Radiological assessment	This includes: ● *Assessment of Radiological Impacts in the Very Long Term if the LLWR is Not Eroded*, LLWR/ESC/R(12)10047, February 2012, which comprises a key extension to the technical approach in the ESC and will comprise part of an updated ESC. ● Dose calculations for human intrusion into radioactive sources may need revision after issue of a revised Permit. ● Assessment of impacts to non-human biota during the PoA may require revision for the next major revision of the ESC. ● Assessment of post-closure impacts to non-human biota may require revision for the next major revision of the ESC. ● Well calculations. Further action here would be in connection with future revisions of the ESC. Developments in methodology may be required. (Note that Environment Agency Recommendation ASS14-19 address the well pathway.) ● Integration between the PoA and reference case assessments. LLWR is currently planning to address this.	LLWR plan to address these as part of the development programme.	*Assessment of Radiological Impacts in the Very Long Term if the LLWR is Not Eroded*, LLWR/ESC/R(12)10047, February 2012.
Non-radiological assessment	The results of *Technical Note: Updated Non-radiological Assessment Calculations*, SF9817, April 2014 have not yet been implemented in the capacity management approach. There is an action on developing the methodology and including it in future assessment calculations.	LLWR will implement changes to capacities when appropriate.	Technical Note: Updated Non-radiological Assessment Calculations, SF9817, April 2014. LLWR Assessment Standards

High-level theme	Description	Action	Underlying issues
	The number of LLWR Assessment Standards has increased from 32 to 100. There is a need to review the implications of this for the non-radiological assessment.		extended from 32 to 100.
Asbestos	Work has been undertaken to assess the potential impacts of the disposal of asbestos should the wastes become exposed through human intrusion or coastal erosion. The results of this work will inform the consideration of whether further waste acceptance controls are justified.	Action is to consider whether any changes need to be made to the WAC.	*Assessment of Long-term Risks from Disposal of Asbestos Waste at the LLWR and Options for Treatment and Conditioning of Asbestos Wastes*, 34552RR036, February 2014. LLWR/ESC/Mem(13)239 Assessment cases and data for assessment of hazard from asbestos disposed at LLWR.

5 Lessons Learnt

This is the first Periodic Review of the ESC. It is useful, therefore, to consider what lessons learnt may be gleaned from the review process and results, and how these may be used to refine and improve subsequent Periodic Reviews:

- The process used to conduct the Periodic Review draws upon, and tailors where appropriate, the approach set out in RSP 1.25 and used in the 2013 Operational Safety Case Periodic Review. There may be merit in formalising the ESC review process, allowing reviewers to better understand the process employed, the scope, purpose and outputs of the review. This would aid in ensuring consistency of review.

- It is important to prevent the review becoming overwhelmed with 'spurious' issues that have already been captured in, for example, Agency Forward Issues, or PRG comments. Such source materials should be excluded from the scope of review. Exclusion of these issues then allows the review to better focus upon issues that have not otherwise been identified.

- In this Periodic Review, in addition to technical reports, procedures, plans, technical memos and governance documents have been taken to be constituents of the ESC. This is a broader definition of the ESC's constituents than that used at the time of the 2011 ESC's submission, where only Level 1 and 2 reports were considered to comprise the ESC. For future Periodic Reviews, it is important to ensure that the scope of the ESC is considered carefully.

- It is important to formally identify and capture a list of documents (technical reports, memos, etc.) that constitute updates to the ESC. This could be recorded on an ongoing basis in the ESC Document Status Tracker. As the ESC evolves between Periodic Reviews, this list of documents would then be used to record and manage the ESC baseline.

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6 Conclusions

The Periodic Review has been undertaken in accordance with the requirements set out in LLWR Repository Site Procedure (RSP) 2.25, and the process used to conduct the review draws upon the approach set out in RSP 1.25 and used in the 2013 Operational Safety Case Periodic Review. All aspects of the ESC have been reviewed.

A number of actions (see Section 4) have been identified as outcomes of this review. These will be captured in the ESC Issues Register, where they will be assigned actionees and close-out dates by the ESC Manager. The Periodic Review has identified only a relatively small number of themes and key actions that would otherwise not have been captured and none of these are urgent. These are presented in Table 26. With the possible exception of 'Defining engineering requirements', none of these actions will, when addressed, have a major effect upon the ESC. Developing a methodology for the definition of engineering requirements has the potential to represent a significant methodological improvement. That the number of significant actions is small builds confidence in the processes employed by LLWR to manage the ESC. It further indicates that there is no requirement for a major update of the ESC before 2021.

The Periodic Review has established a recognised document baseline for the ESC. This could be recorded on an ongoing basis in the ESC Document Status Tracker. As the ESC evolves between Periodic Reviews, this list of documents would then be used to record and manage the ESC baseline.

A number of lessons learnt have been derived from the review process that may be used to refine and develop the process to be used in subsequent Periodic Reviews.

Table 26 High-level themes and key actions identified solely as a result of the Periodic Review

High-level theme	Description	Action
Decommissioning wastes	PCM LSAM decommissioning wastes from the site are not, at present, included in the ESC or the design. As decommissioning progresses, there will be a need to dispose of the associated decommissioning wastes. Further work would be necessary to include these in the ESC.	BAT study is to be initiated by PCM team.
Security enhancement	This concerns the security enhancement project. This could affect capping. There is a need to engage with the security project to assess the significance and	Confirm that engagement is taking place.

High-level theme	Description	Action
	effect of this upon the ESC.	
Systematic assessment approach	There is no systematic approach to assessing the implications of new information for the ESC.	A review only needs to be undertaken after more experience has been obtained of the process for assessing new information.
Defining engineering requirements	There is a lack of a systematic approach to defining ESC engineering requirements.	Will be addressed in the development programme for next ESC. Action to develop approach, discuss and review.
Revised Permit	A revised Permit is anticipated. A review process will be required when the revised Permit issued. It is expected that there will be a need to make changes to LLWR processes, including waste acceptance. It is expected that there will be a new set of requirements.	There is an LLWR RSP for complying with the Permit. If, and when, a revised Permit is received, this RSP will be applied.
Nuclear safety case	There is a requirement to ensure that there is consistency between assumptions in radiological impact calculations between the NSC and ESC. As part of this, it is necessary to identify changes that have been made to the NSC and to understand potential impacts to the ESC. For example, the LLW and PCM safety cases have been revised.	Action to review consistency of assumptions at an appropriate frequency.
Revised WAC and associated processes	There is a need to undertake work to revise WAC and associated processes. This includes ensuring that processes are in place to take into account requirements of NSC when WAC are defined;	Action to include a review of the waste acceptance development process in the new Waste Acceptance and Data Improvement Programme.
Gas monitoring	A trace gas monitoring programme is scheduled. The results will be reviewed when the programme is complete.	Monitoring complete. Review required.

High-level theme	Description	Action
Single-hole dilution tests	Dilution tests were initial trials to see if the proposed method was applicable.	View needed as basis for Development Programme.
Short-term planning and SDP.	The short-term planning application may be different from the Site Development Plan (SDP). There is a need to consider what action, if any, is required.	Action to consider implications as short-term planning application is developed.
Implementation of waste emplacement strategy	Implemented in ECC for Vault 8. A detailed procedure needs to be developed for Vault 9. In addition, there is ongoing work to assess whether containers in Vault 8 and Vault 9 meet the emplacement strategy in the 2011 ESC. This forms part of an activity to assess how to most appropriately manage stored wastes in the vaults. There is also ongoing work to substantiate higher-stacking in Vault 8, which will include consideration (and development if necessary) of the emplacement strategies.	Work underway on higher stacking in Vault 8 and stored containers in Vault 8 and Vault 9. ECC will need to be revised at an appropriate point before final disposal of waste in Vault 9.
Use of vaults for buffer storage of leachate	Account needs to be taken of the potential use of the vaults as buffer storage of leachate.	Any implications for the location of waste container stacking for the ESC will need to be assessed.
Issues Register	The review concluded that consideration should be given to ensuring that the ESC Issues Register covers all technical issues and outstanding actions that should be recorded - from regulators, the PRG, and LLWR itself (e.g. including the outcome of the Periodic Review and Annual Reviews).	Action to ensure that ESC Issues Register contains all technical issues and necessary outstanding actions.

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