1 Introduction

This Appendix assesses the likely significant effects on the water environment of the proposed development at the LLWR site as detailed in Volume I of the ES. The associated Figure is also included in Volume I of the ES.

The proposed development will involve construction and operational activities that have the potential to impact on surface water quality and dynamics. This assessment considers the quality and quantity of the existing surface water and the changes that that might directly or indirectly result from the proposed development.

The key objectives of this assessment are:

- identify water features within the vicinity of the proposed development sites and appraise their value, characteristics and sensitivity to impacts;
- assess likely significance of the potential impacts of the proposed development on drainage and the water environment; and
- Propose appropriate mitigation measures.

This assessment is accompanied by:

- A Flood Risk Assessment (Appendix L2); and
- A Drainage Strategy Report including a Sustainable Drainage (SuDS) assessment (Appendix L3).

2 Methodology and Assessment Criteria

2.1 Study Area

The study area for consideration of water quality impacts comprises the surface water bodies that are hydrologically connected with the proposed scheme site, based on available data.

Impacts on groundwater are covered in a separate assessment forming part of the ESC and summarised in Chapter 12 and Appendix J to the ES, and is not considered further within this Technical Appendix.

2.2 Desk Study

In order to identify and characterise the surface water receptors considered as part of this assessment, available data on surface water quality and quantity within the vicinity of the site has been obtained.

A number of sources of information and websites were assessed, including:

- Previous environmental assessments (Wilkinson Associates (2007b));
- Ordnance Survey maps;
- MAGIC website (http://magic.defra.gov.uk/);
- Environment Agency website (http://www.environment-agency.gov.uk/); and
- North West River Basin Management Plan (RBMP).

The Environment Agency was consulted and provided data on water, surface water features (potable water sources, fisheries, consented discharges etc.), surface water quality.

2.3 Site Visit

A walkover of the study area was undertaken on the 20th January 2011 to identify, locate and describe water bodies. This was reviewed during subsequent ecological surveys over the period 2011 to 2015 (see Appendix H, Ecology and Nature Conservation).

2.4 Regulatory Framework

The water environment in the UK is regulated by a number of acts of legislation. These include the Water Resources Act 1991 and the Land Drainage Act 1991. Recent European legislation implemented includes the Water Framework Directive (WFD) (2000/60/EC), which requires all member states to achieve good ecological status of watercourses by 2015. This legislation puts emphasis on the ecological quality and value of waters as the principal parameter against which water bodies should be measured.

A full list of relevant water related legislation, policy and guidance is given in Table 2.1.

Table 2.1: Water related European and national legislation, policy and guidance

Directive/Legislation/Guidance	Description
Environment Act 1995	Sets out the role and responsibility of the Environment Agency.
Environmental Protection Act 1990	Integrated Pollution Control (IPC) system for emissions to air, land and water.
Future Water February 2008	Sets the Government's vision for water in England to 2030. The strategy sets out an integrated approach to the sustainable management of all aspects of the water cycle, from rainfall and drainage, through to treatment and discharge, focusing on practical ways to achieve the vision to ensure sustainable use of water. The aim is to ensure sustainable delivery of water supplies and help improve the water environment for future generations.
Habitats Directive 92/44/EEC	To conserve natural habitats and to conserve wild fauna and flora with the main aim to promote the maintenance of biodiversity taking account of social, economic, cultural and regional requirements. In relation to abstractions and discharges, can require changes to these through the Review of Consents (RoC) process if they are impacting on designated European Sites.
Bathing Water Directive (76/160/EEC and 2006/7/EC)	Aims to protect public health and the environment from faecal pollution at bathing waters. The Directive sets a number of microbiological and physico-chemical standards that bathing waters must either comply with ('mandatory' standards) or endeavour to meet ('guideline' standards).
Pollution Prevention and Control Act (PPCA) 1999	Implements the IPPC Directive. Replaces IPC with a Pollution Prevention and Control (PPC) system, which is similar but applies to a wider range of installations.
Environmental Permitting Regulations (England and Wales) 2010	The Environmental Permitting Regulations (England and Wales) 2007 combined the Pollution Prevention and Control (PPC) and Waste Management Licensing (WML) regulations. These were replaced by the Environmental Permitting Regulations (England and Wales) 2010 and the scope has been widened to include water discharge and groundwater activities, radioactive substances and provision for a number of Directives.
Water Act 2003	Implements changes to the water abstraction management system and to regulatory arrangements to make water use more sustainable.

Directive/Legislation/Guidance	Description
Water Framework Directive (WFD) 2000/60/EC	The WFD was passed into UK law in 2003. The overall requirement of the directive is that all river basins must achieve 'good ecological status' by 2015, or by 2027 if there are grounds for derogation. The WFD, for the first time, combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level has been adopted. It effectively supersedes all water related legislation which drives the existing licensing and consenting framework in the UK. The Environment Agency is the body responsible for the implementation of the WFD in the UK. The Environment Agency have been supported by UKTAG[1], an advisory body which has proposed water quality, ecology, water abstraction and river flow standards to be adopted in order to ensure that water bodies in the UK (including groundwater) meet the required status[2]. These have recently been finalised and issued within the River Basin Management Plans (RBMP).
Water Resources Act 1991	Protection of the quantity and quality of water resources and aquatic habitats. Parts have been amended by the Water Act 2003.

2.5 Assessment Criteria

There is no standard methodology for assessing the magnitude of impacts of the scheme on the water environment. Each project is evaluated according to its individual characteristics. A methodology for assessing the significance of any effect has therefore been developed by AECOM for projects throughout the UK, based on the most relevant legislation. The methodology developed is considered to be appropriate for the likely types of impact that may result from the proposed scheme.

Assessment criteria are based on the web-based DETR document 'Transport Analysis Guidance' (known as WebTAG) Unit 3.3.11 (DfT, 2003). This methodology provides an appraisal framework for taking the outputs of the environmental impact process and analysing the key information of relevance to the water environment. Although this guidance is intended for transport studies, it is suitable for application to other schemes in the absence of other suitable guidance.

For the purpose of this assessment, a number of modifications to the WebTAG criteria have been made in order to address recent legislative changes (notably the WFD). These modifications use professional judgement and are based on other more recent guidance, where possible (for example the Design Manual for Roads and Bridges (Highways Agency, 2009)).

The WebTAG methodology takes into account the importance and magnitude of predicted impacts on the water environment. Importance is based on the value of the feature or resource (see Table 2.2), while the magnitude of a potential impact is estimated based on the degree of impact and is independent of the importance of the feature (see Table 2.3).

The basic approach to assessing the impacts of the scheme on water features is to consider how sensitive the features may be to changes in surface water conditions, including flows and water quality. The indicators used in making a professional judgement on the importance of a water feature under consideration include quality, scale, rarity and substitutability where:

- quality is a measure of the physical condition of the attribute;

[1] The UKTAG (UK Technical Advisory Group) is a working group of experts drawn from environment and conservation agencies. It was formed to provide technical advice to the UK's government administrations and its own member agencies. The UKTAG also includes representatives from the Republic of Ireland.
[2] UK Environmental Standards and Conditions (Phase I) Final Report, April 2008. UK Technical Advisory Group on the Water Framework Directive.

- scale requires consideration of the geographical scale at which the attribute matters to both policy makers and stakeholders, at all levels;
- rarity requires consideration of whether the water feature is commonplace or scarce, at the scale at which it matters; and
- substitutability requires consideration of whether water attributes are replaceable over a given time frame.

Table 2.2: Importance of water feature or resource (modified from WebTAG Unit 3.3.11)

Importance	Criteria	Examples
Very High	Attribute with a high quality and rarity, regional or national scale and limited potential for substitution.	WFD Class "High" River providing potable water to a large population European Commission designated Salmonid fishery (Directive 79/659/EEC)
High	Attribute with a high quality and rarity, local scale and limited potential for substitution attribute with a medium quality and rarity, regional or national scale and limited potential for substitution.	WFD Class "Good" Cyprinid or Salmonid fishery
Medium	Attribute with a medium quality and rarity, local scale and limited potential for substitution or attribute with a low quality and rarity, regional or national scale and limited potential for substitution.	WFD Class "Moderate" River or aquifer providing abstraction water for agricultural or industrial use
Low	Attribute with a low quality and rarity, local scale and limited potential for substitution.	WFD Class "Poor" Floodplain with limited existing development

Impacts may be adverse or beneficial, depending on the circumstances. They are quantified where practicable and the degree or magnitude of impact is assessed on a qualitative scale, to facilitate comparison with impacts on other environmental receptors. The four-point scale used is described in Table 2.3.

For an impact on water quality to exist it is necessary for a source of pollution, a sensitive receptor to that pollution and a pathway by which the two are linked to exist (Source-Pathway-Receptor model). This model identifies the potential sources or 'causes' of impact as well as the receptors (water resources) that could potentially be affected. However, the presence of a potential impact source and a potential receptor does not always imply an impact, there needs to be a clear mechanism or 'pathway' via which the source can have an effect on the receptor; for example, sewer flooding does not necessarily increase the risk of flooding unless the sewer is local to the site and ground levels encourage surcharged water to accumulate.

The first stage in utilising the Source-Pathway-Receptor model is to identify the causes or 'sources' of potential impact from a development. The sources have been identified through a review of the details of the proposed development, including the size and nature of the development, potential construction methodologies and timescales. This has been undertaken in the context of local conditions relative to water resources near the application site, such as topography, geology, climatic conditions and potential sources of contamination.

The next step in the model is to undertake a review of the potential receptors, that is, the water resources themselves that have the potential to be affected. The identification of potential water resource receptors has been undertaken through:

- A review of baseline data; and
- a walkover survey of the application site.

The last stage of the model is therefore to determine if there is a viable exposure pathway or a 'mechanism' linking the source to the receptor.

Table 2.3: Magnitude of potential impacts (modified from WebTAG Unit 3.3.11)

Magnitude	Criteria	Example
Major	Results in loss of attribute.	Loss of EC designated Salmonid fishery Change in WFD status of river reach Compromise employment source Loss of flood storage/increased flood risk Pollution of potable source of abstraction
Moderate	Results in impact on integrity of attribute or loss of part of attribute.	Loss in productivity of a fishery Change in WFD status of watercourse Reduction in the economic value of the feature
Minor	Results in minor impact on attribute.	Measurable changes in attribute, but of limited size and/or proportion
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity.	Discharges to watercourse but no significant loss in quality, fishery productivity or biodiversity, and no significant impact on the economic value of the feature No increase in flood risk

The significance of a potential effect is derived by considering both the importance of the feature and the magnitude of the impact, using a matrix (see Table 2.4).

Table 2.4: Derivation of significance of potential effects (adapted from WebTAG Unit 3.3.11)

Magnitude of potential impact	Importance of Attribute			
	Very High	High	Medium	Low
Major	Very Substantial	Substantial	Moderate	Low
Moderate	Substantial	Moderate	Low	Negligible
Minor	Moderate	Low	Negligible	Negligible
Negligible	Low	Negligible	Negligible	Negligible

Standard terminology has been adopted to describe the significance of effects (see Table 2.5) for the purpose of this assessment.

Table 2.5: Terminology used to describe significance of effects

Significance of effect – standard terminology used in this Technical Appendix	Significance of effect – WebTAG terminology (from Table 2.4)
Major adverse	Substantial or Very Substantial
Moderate adverse	Moderate
Minor adverse	Low
No significant effect	Negligible adverse/beneficial
Minor beneficial	Low
Moderate beneficial	Moderate
Major beneficial	Substantial or Very Substantial

In applying this methodology, if a major adverse effect were to be identified then mitigation measures would be developed to reduce or mitigate this effect. If beneficial effects are identified, then opportunities for further environmental enhancement would be considered.

3 Baseline Conditions

3.1 Study Area

The study area for consideration of aquatic impacts comprises the surface water bodies that are hydrologically connected with the proposed development site, based on available data.

These include Drigg Stream, East-West Stream, the River Irt, the Ravenglass Estuary and the Cumbria Coastal Area. There are also a number of small ponds on site.

3.2 Site Description

The site is described in detail in Chapter 3 of the ES. The setting and location of the site are shown in Figure 14.1. The important features of relevance to this assessment within the LLWR include:

- the Vault 9A to 11 development area;
- ancillary construction area;
- the Vault 8 and 9 drainage and leachate management system;
- trench drainage and leachate management system;
- marine discharge pipeline;
- the LLWR surface water drainage system;
- Drigg Stream
- East-West Stream
- 22 Ponds; and
- Drigg Coast Site of Special Scientific Interest (SSSI)/Special Area of Conservation (SAC).

3.3 Current Drainage

The proposed development area is drained by the current LLWR drainage system consisting of numerous drains which cross the LLWR site and feed into the East-West Stream and Drigg Stream.

There are effectively two separate drainage systems that collect rainwater runoff and leachate from the LLWR Site.

Runoff from the current trench cap and other uncontaminated surface water is discharged to Drigg Stream through a series of surface drains. Silt traps (on the surface drain receiving runoff from the trench caps) to treat runoff from areas of spoil) are installed on the system to ensure that water is of sufficiently good quality before it is discharge to surface watercourses. There are also a number of land drains that discharge to various points in Drigg Stream.

All water flowing through the waste areas is deemed leachate and is addressed accordingly. The Leachate Collection System (LCS) collects leachate from the trenches (trench leachate) and all water that comes into contact with Vaults 8 and 9 (vault leachate). Trench and vault leachate is discharged via a passive and pumped drainage system to the marine holding tank, after which it is discharged via the Sea Discharge Pipeline approximately 1.2 km offshore into the Irish Sea.

The operational system supports flow from extreme rainfall events of up to approximately 1 in 50 year intensity for 2 ‘open’ (uncapped) vaults with ample additional capacity. During extreme high flows leachate collected from the vaults area can be diverted into the Drigg Stream.

The vault leachate drainage collection and extraction was designed in accordance with best practice, taking due note of the current legislation at the time of the works being carried out. However, it is understood that the older drainage system serving trench leachate was built to standards that would now be considered non-compliant.

3.4 Surface Water/ Hydrology

The location of the surrounding water bodies is shown in Figure 14.1.

The nearest and most important water feature is Drigg Stream, which runs almost the entire length of the south-west boundary of the LLWR, flowing in a southerly direction before joining the River Irt outside the site boundary. The stream is entirely man-made having been initially constructed to facilitate drainage of ROF Drigg. The stream is not managed, and is choked with aquatic and marginal vegetation.

Drigg Stream drains part of the north of the Drigg Coast SAC/SSSI near Carl Crag and enters the LLWR to the west of Vault 8 flowing in a culvert before entering an open channel near the junction between Vaults 8 and 9.

Drigg Stream is joined by a tributary, East-West Stream at SD 056 998, within the LLWR site. East-West Stream enters the site at SD 058 991 and is fed by land drains and surface water drainage.

The upper reach of the Drigg Stream, upstream from the confluence with the East-West Stream comprises a shallow, slow-flowing drainage ditch constrained within a deep channel with steep-sided banks (50-60°) up to 3 m high. Downstream of the confluence with the East-West Stream it is a more substantial watercourse.

Drigg Stream leaves the LLWR site in the south-east of the site at approximately SD 061 984 meandering through farmland before reaching the boundary of the Drigg Coast SAC/SSSI. It continues to meander before discharging into the River Irt at approximately SD 064 982.

The River Irt discharges to the Ravenglass Estuary and then the Irish Sea downstream of the confluence with the Drigg Stream.

There are also 22 other small ponds on the site (as shown on Figure 14.1) and various ditches (all of which were dry at the time of the walkovers between 2011 and 2015). Only ponds 14, 15, 19, 22, 24 and 25 are considered within this Technical Appendix. This is because all other ponds on the site are not likely to be impacted by the proposed development (i.e. not within the vicinity of works or not hydrologically connected) or, if within the scheme footprint, are permanently dry.

The site of the proposed development lies just inland of the coast area of Irish Sea which is referred to as ‘Cumbria Coastal Area’ in the North West River Basin Management Plan (RBMP). The Cumbria Coastal Area adjacent to the site consists of sand dunes, beach and an area of shingle known as ‘Barn Scar’.

Drigg Coast SAC/SSSI lies adjacent to the south-western boundary of the LLWR site for approximately 700 m. This area of the SAC/SSSI comprises dune heath habitat. The varied topography and poor drainage in this part of the SAC/SSSI has resulted in many ephemeral and permanent water bodies, some of which support populations of the European protected species natterjack toad and great crested newt.

3.5 Water Quality and WFD Status

The Environment Agency survey all main watercourses in England and Wales on a regular basis, in order to analyse, monitor and review the status of water bodies against the WFD (2000/20/EC) objectives set out for them. The WFD requires all water bodies to reach at least ‘Good Status or Potential’ by 2015. However, provided that certain conditions are satisfied, in some cases the achievement of good status may be delayed until 2021 or 2027.

For surface waters, good status is a statement of ‘overall status’ consisting of a chemical and ecological component. Chemical status measures priority substances which present a significant risk to the water environment and is classified as ‘good’ or ‘fail’. Ecological status is measured on a scale of ‘high’, ‘good’, ‘moderate’, ‘poor’ and ‘bad’. The ecological status takes into account physico-chemical elements, biological elements, specific pollutants and hydromorphology.

Some water bodies are designated as ‘artificial’ or ‘heavily modified’ and are not able to achieve near natural conditions. The classification of these water bodies and the biology they represent are measured against ‘ecological potential’ rather than status. For these water bodies to reach good potential their chemistry must be good and the structural nature of the waterbody, which harms the biology, must be essential for its valid use.

Drigg Stream (known as Drigg Drain, Waterbody ID GB112074070060 in the North West RBMP) is classified as a low lying, extra small, calcareous stream. It currently assessed as having of moderate ecological potential (its chemical status is not classified).

Drigg Stream is also monitored by LLWR downstream of the confluence with East-West Stream (data provided by LLWR). It is reported that the sediment within the stream at this location has radioactive contaminants present due to historical discharges prior to improvements in trench leachate drainage in 1991.

The East-West Stream is not currently classified by the Environment Agency but the quality is expected to be similar to that of Drigg Stream.

The reach of the River Irt considered in this investigation (known in the RBMP as 'River Irt D/S Bleng Confluence', Waterbody ID GB112074070070) is classified as a mid, medium siliceous watercourse and is currently of moderate ecological status. This stretch of the River Irt has an overall physico-chemical quality and specific pollutant quality of 'high' status, although the overall hydro-morphological quality is categorised as 'not high'.

The Ravenglass Estuary, into which the River Irt flows (known in the RBMP as 'Esk (W)', Waterbody ID GB531207408400), is classified as a transitional waterbody (estuary). It is currently of moderate ecological status and its chemical status does not require assessment. Good ecological status is expected to be met in 2027.

The coastal area of the Irish Sea considered in this investigation is macrotidal and is known in the North West RBMP as 'Cumbria Coastal Area', (Waterbody ID GB641211630002). It is currently of moderate ecological status and has good chemical quality. This stretch of the Irish Sea currently satisfies the requirements of the mandatory standards for the Bathing Water Directive with a good water quality in 2010.

Water quality data are not available for any of the ponds on site.

3.6 Fisheries

The River Irt is a principal salmon river and is designated under the Freshwater Fish Directive. It is regularly fished and contains other important protected species including eel, trout, sea trout and lamprey.

Drigg Stream and East-West Stream are not known to be of importance in terms of fisheries (not designated) and are not likely to be of significant importance given the potential for historic contamination and flow conditions.

3.7 Biodiversity

The biodiversity value of water bodies is considered in detail within the relevant chapters of the Environmental Statement. For the purpose of this Technical Appendix it is important to note:

- a number of the ponds on site are know to be used by great crested newt and natterjack toads (European protected species); and
- there is a SAC/SSSI (Drigg Coast SAC/SSSI) adjacent to the site of the proposed development.

The only ponds that are considered in terms of water quality or pollution impacts are the ponds that are understood to not have species of significant conservation importance (great crested newts and natterjack toads). This is because the two ponds that are known to be used by these species will not to be impacted by the proposed development (ponds 6 and 13) because they are not within the vicinity of works or not hydrologically connected. Water quality impacts on ponds of high conservation importance are therefore not considered within this Technical Appendix.

3.8 Abstractions

There are currently no abstraction licences in the vicinity of the site.

3.9 Discharges

There are 21 known permitted discharges in a 5 km radius of the site. Table 3.1 shows the details of these licensed discharges.

Table 3.1: Details of the permitted discharges within 5 km of the proposed scheme

Operator	Grid Reference	Type of Discharge	Receiving Watercourse
Sellafield Limited	NY0201001990	Nuclear fuel production and waste processing	Irish Sea
	NY0258002720	Industrial waste landfills	Newmill Beck
British Nuclear Fuels PLC	NY0252003280	Nuclear fuel production and waste processing	River Calder
Ehen Garth	NY0264003060	Sewage disposal works – other	River Calder
Drigg Waste Disposal Site	SD0340098700	Nuclear fuel production and waste processing	Irish Sea
The Croft	NY0396400491	Domestic property (shingle)	Unknown
D/S under railway bridge	NY0354001220	Sewage disposal works – water company	Unknown
BNFL	NY0316003850	Nuclear fuel production and waste processing	River Calder
	SD0559098820	Nuclear fuel production and waste processing	Drigg Stream
Seascale WWTW	NY0403000930	Sewage disposal works – water company	Whitriggs Beck
Drigg Moorside Farm	SD0553099730	Tourist/short stay accommodation	Drains to Drigg Stream
LLWR	SD0613698938	Nuclear fuel production and waste processing	Drigg Stream
Driggs Tanks STW	SD0677098520	Sewage disposal works – water company	River Irt
5 Cottages	SD0676099080	Domestic (Multiple)	Sinks that drain to River Irt
Meadowfield	NY0685003370	Sewage disposal works – water company	Hare Beck
Village Hall	SD0786099591	Sewage disposal works – water company	River Irt
Drigg RD	SD0786099590	Sewage disposal works – water company	River Irt
Holmacre	SD0728399389	Domestic (single)	Sinks that drain to River Irt
Greengarth & Holmrook STW	NY07830000290	Sewage disposal works – water company	Black Beck
Gosforth STW	NY0782002750	Sewage disposal works – water company	Hare Beck
Ravenglass STW	SD0853096020	Sewage disposal works – water company	River Esk Estuary

3.10 Pollution Incidents

The Environment Agency has no records of major or significant pollution incidents on watercourses within 5 km of the site or on the adjacent coastline.

3.11 Future Baseline

Drigg Stream and the stretch of the River Irt considered for this investigation are both expected to have moderate ecological status in 2015 and are expected to reach good ecological status and good overall status in 2027. However, given the functional nature of Drigg Stream, no significant improvements are expected throughout the duration of the

project. The Cumbria Coastal Area of the Irish Sea is considered to remain of the same chemical and ecological quality in 2015 but reach good ecological status, good chemical status and good overall status by 2027.

3.12 Importance of Water bodies

Table 3.2 describes the designated importance of each waterbody in the vicinity of the proposed scheme. These designations are based on the methodology described in this Technical Appendix and the categorisation described in Table 2.2.

Table 3.2: Designated importance of considered water bodies

Waterbody	Key Attributes	Current Importance Designation	Future Importance Designation
Drigg Stream	Water Quality/WFD Designation	Medium Importance	Medium Importance
	Dilution/removal of waste products/conveyance of flow		
	Biodiversity WFD Ecological Status		
East-West Stream	Water Quality	Medium importance	Medium Importance
	Dilution/removal of waste products/conveyance of flow		
River Irt/ Estuary	Water Quality/WFD Designation	High Importance	High Importance
	Dilution/Removal of waste products/conveyance of flow		
	Biodiversity WFD Ecological Status Designated Freshwater Fisheries Site		
Cumbria Coastal Area (Irish Sea)	Water Quality WFD Good Chemical Quality Good Bathing Water Status	High Importance	High importance
	Recreation (e.g. bathing/walking)		
	Biodiversity WFD Ecological Status		
Ponds 14 15, 19 and 24	Biodiversity (no species of high conservation value)	Medium Importance	Medium Importance
Drigg Coast SSSI/SAC	Biodiversity/ conservation value Recreation	Very High Importance	Very High Importance

4 Potential Environmental Impacts

4.1 General

An assessment of how the development will potentially impact aquatic features and their attributes is addressed in this section. Potential impacts include:

- change in flow regime;
- sedimentation;
- pollution of surface water; and
- land modification to aquatic features.

Given the timescales associated with the construction and operational elements of the proposed development, certain potential impacts would only affect specific phases of the development, while others will be common throughout the duration of the proposed development. Phase specific impacts and general impacts are highlighted throughout this section.

In addition, 'construction' and 'operation' phases will be effectively overlapping (with some areas being operational while other areas remain under construction or indeed where construction has not yet commenced). Thus construction and operational impacts cannot be considered independently.

Detailed descriptions of the proposed development programme and phasing are provided in Chapter 3 of the Environmental Statement.

4.2 Changes to Drainage

Currently, runoff from the trench cap is discharged via site drainage (a perimeter drain) to Drigg Stream, while leachate from Vaults 8 and 9 and the trenches is pumped via the LCS to the Irish Sea. Other areas of the development site within the catchment (including areas where Vaults 9A to 11 will be constructed) drain to the Drigg Stream (either via surface runoff, infiltration or formal/informal site drainage).

As the trenches and vaults are progressively constructed and/or capped the drainage system will be modified, which will alter the catchment dynamics and size of Drigg Stream downstream of the proposed development. In effect, as the trenches and each of the vaults are permanently capped, the volume of leachate drainage pumped to the Irish Sea will be significantly reduced although not eliminated by use of a composite cap of low permeability.

Indicative drainage throughout the different phases is illustrated in Drawings 47070159/SWM/01-06 in Appendix C to the ES. These illustrate that temporary drainage will be installed as capping progresses (see also Drawing 47070159/ENG/04 in Appendix C).

4.3 Potential Sources of Impacts

During the different construction phases of the proposed development, various activities and developments have the potential to impact surface water quality, quantity and flow. These include:

- preparation of site compound and stockpile areas;
- temporary changes to site drainage (runoff rates from impermeable surfaces, volume of runoff);
- relocation of Drigg Stream (construction impacts, including excavation of channel);
- construction of settlement/attenuation lagoon ;
- concrete pouring;
- construction of stockpile areas;

- runoff from stockpile areas;
- use of potentially polluting construction materials (fuels, oils, etc.);
- disturbance of contaminated sediment in the Drigg Stream downstream of its confluence with the East-West stream;
- disturbance of potentially contaminated ground;
- leakage or spillage of potential pollutants and contaminated runoff entering watercourses; and
- dewatering from construction activities.

As different areas of the site become operational, the following operational impacts are considered to have the potential to impact surface water:

- Changes to drainage (volume and rate of surface water runoff from hard surface area);
- Relocation of Drigg Stream; and
- Change in Drigg Stream Catchment.

5 Assessment of Impact Magnitude and Significance of Effects

This section considers the magnitude of potential impacts brought about by the proposed development and the significance of any resulting effects, following the methodology set out within this Technical Appendix.

Certain measures proposed (such as the installation of the settlement/attenuation lagoon, changes to the final perimeter drainage, etc) are likely alleviate many of the impacts and resulting effects described. However, for the purpose of the assessment, impacts are assessed initially without mitigation. The effectiveness of these measures in mitigating any effects is considered within the mitigation section of this Technical Appendix and residual impacts identified.

5.1 Relocation of Drigg Stream

That part of the course of the Drigg Stream adjacent to the proposed development will be permanently relocated approximately 50 metres to the south-west of the current channel for approximately 1 km along the south-western boundary of the site, to allow for construction of Vaults 9A to 11 and capping of Vaults 8 to 11. It is understood that there will be no change in the direction of flow and/or catchment drainage potential. The relocated watercourse will re-join the existing channel at SD 054 990. The geometry of the Drigg Stream diversion is shown on Figure 3.6 in Volume II of the ES

The relocation of 1 km of watercourse will have short term impacts before biological and physical elements are established in the new channel. This will involve the short term loss of aquatic and marginal fauna and flora and a temporary degradation of the physical/aesthetic quality of the stream. However, areas of Drigg Stream are managed to allow it to fulfil its functional role as a drainage ditch. The temporary impact of relocation needs to be considered against current and future baseline conditions.

In light of its current status and use, the relocation of Drigg Stream would therefore have a temporary impact of moderate magnitude (given the greater disturbance and longer duration of impact that would be experienced). Given the importance of Drigg Stream attributes (medium), this is assessed as having an effect of minor adverse significance. Long term impacts are considered to be neutral (of no significance).

Impacts associated with the construction phase of the stream relocation (such as increased suspended solids discharges) are considered separately, below.

Mitigation regarding the relocation of Drigg stream is also considered below.

5.2 Suspended Sediment Contamination

During the construction phases of the proposed development, pollution from mobilised suspended solids is the main concern, potentially causing increased sediment loads in the nearby surface watercourses. This may result from land clearance, movement and storage of materials to and from the site, and from other construction activities. The following activities pose the highest risk for suspended sediment contamination:

- Drigg Stream relocation;
- soil removal during construction;
- concrete pouring and associated materials substances;
- runoff from excavated materials and stockpiles;
- run-off from newly placed fill and capping; and
- erosion from increased flows as a result in (temporary and permanent) changes in drainage and increased permeability of surface area.

High sediment input can have direct adverse effects on adjacent surface watercourses by increasing turbidity and reducing dissolved oxygen concentrations, and indirect effects caused by suspended sediments that have associated inorganic and organic compounds (such as heavy metals and pesticides). Indirect effects include reducing light penetration and reducing plant growth, smothering vegetation and bed substrates, impacts on invertebrate and fish communities, and destruction of feeding areas, refuges and breeding/ spawning areas.

The potential impact would be greatest to the Drigg Stream, East-West Stream and any ponds, given the location of materials near to recently constructed vaults and stockpile areas. Downstream water bodies such as the River Irt and the coastal areas would not be significantly impacted. This is because most solids would settle out in the slowly flowing Drigg Stream and East-West Stream. In addition, impacts would be insignificant due to the high level of dilution provided in the River Irt and the coastal area of the Irish Sea.

This would therefore have an impact of moderate magnitude on Ponds 14 and 15, Drigg Stream and East-West Stream. Given the importance of these water bodies (medium), this is assessed as having an effect of minor adverse significance.

5.3 Accidental Discharge of Pollutants

During construction, there is an elevated risk of leakages or accidental spillage of building materials and potential pollutants used on site, migrating to nearby surface watercourses or infiltrating to the aquifer. Contaminated runoff could result from unstable exposed soils, excavated materials, stored aggregates and contaminated road surfaces. Washout facilities (washing of tools, plant and equipment), storage and use of various liquids and soluble solids, and fuel storage and handling all have the potential to result in pollution of watercourses. Inappropriate disposal of waste materials associated with the construction phase of the development has the potential to enter surface water.

A significant discharge of fuel, for example, would be detrimental to water quality and aquatic flora and fauna, such as fish and invertebrates.

Nearby watercourses, such as East-West Stream and Drigg Stream and any nearby ponds would suffer the greatest impact, potentially of major magnitude. Given the importance of these watercourses (medium), an effect of moderate adverse significance would be experienced.

Downstream, the River Irt would potentially be affected as the water would carry the pollutant some distance downstream. However, the River Irt would suffer a lesser impact, given the dilution in this watercourse and distance from the source. It would have an impact of minor magnitude. Given the importance of the River Irt (high), an effect of minor adverse significance would be experienced.

Given the distance downstream and very high level of dilution, there would be no significant impact on the estuary or Cumbria Coastal Area.

5.4 Disturbance of Contaminated Sediment

Site drainage using the Drigg Stream could have the potential to mobilise contaminated sediment in the watercourse south of the confluence with the East-West stream if unmitigated flows exceed those currently experienced.

The Drigg Stream would suffer the greatest impact, potentially of major magnitude. Given the importance of this watercourse (medium), an effect of moderate adverse significance would be experienced.

Downstream, the River Irt would potentially be affected as the water would carry the pollutant some distance downstream. However, the River Irt would suffer a lesser impact, given the dilution in this watercourse and distance from the source. It would have an impact of minor magnitude. Given the importance of the River Irt (high), an effect of minor adverse significance would be experienced.

5.5 Disturbance of Contaminated Ground

The area for future vault construction is located on a site formerly used for storage of explosives (TNT). However, LLW Repository Ltd has indicated that the area is not at risk of containing contaminated soil.

5.6 Drainage and Flow Alterations

The changes to the catchment during the different construction phases and after the development is fully complete and operational are likely to alter flow dynamics in receiving watercourses.

Construction associated activities, such as the temporary increase in hard-standing, temporary road surfaces, compaction of soils (site compounds, stockpiling areas, etc) is likely to reduce the infiltration capacity of the catchment and increase the rate of direct surface runoff.

Once the final capping of the LLWR structures is underway (following the completion of different construction phases) there will be a change in the infiltration and runoff rates from the capped area. This is because, even though the area will be grassed over, the underlying substrate will be different from 'natural ground' due to the presence of artificial highly permeable surface layers and an impermeable barrier that has the functional role of protecting the vaults and trench structures below. In addition, once Phase 5 is complete and all of the vaults and trenches have been capped, there will be a net increase in the catchment draining to Drigg Stream compared with the baseline scenario (i.e. leachate from open vaults, currently being discharged via the Leachate Drain will be minimised, thus increasing water in the surface water system).

The potential environmental impact of these alterations is to increase flow rates (particularly during storms), leading to increases in channel scouring, sediment loading in watercourses and marine/estuarine environments downstream and an increase in flood risk to the surrounding area. There is also a risk that polluted sediments present in downstream areas of Drigg Stream will be disturbed (sediment re-suspension) and affect downstream water bodies.

If unmitigated by suitable drainage (attenuation), the changes in flow would potentially have an impact of medium magnitude on Drigg Stream (throughout each of construction phases and when the proposed development is fully functional), and East-West Stream (during relevant construction phases only). Given the designated importance of these watercourses (medium), this would result in an effect of minor adverse significance.

There would also potentially be an impact from polluted sediments being carried into the River Irt. However, given the level of dilution, this would only have an impact of minor adverse significance on the River Irt (high importance), resulting in an effect on minor significance.

There would be no impact on other water bodies, including those further downstream (i.e. the estuary or coastal area), given the very high level of dilution and distance downstream.

5.7 Loss of Ponds

Due to the construction activities associated with the construction of vaults, the capping of trenches and vaults, site compounds and stockpiling areas, four existing ponds (Ponds 19, 22, 24 and 25) will be lost during the duration of the construction period.

These ponds are principally of interest in terms of their aquatic and marginal fauna (amphibians, invertebrates) and flora. Therefore, the loss of these habitats is considered within Appendix H – Ecology and Nature Conservation.

5.8 Potential Impacts on SAC/SSSI

Although not within the site boundary, changes on site have the potential to impact the adjacent SAC/SSSI. Potential sources of such impacts include:

- Impacts on Drigg Stream affecting downstream areas as it passes through the SAC/SSSI
- Impacts from the relocation of Drigg Stream adjacent to SAC/SSSI

Any impacts on Drigg Stream have the potential to impact the SAC/SSSI. Potential impacts include higher peak flows, changes to water quality and/or sediment loading. As most of these impacts would not have a significant impact on Drigg Stream, any change to the SAC/SSSI would be negligible. Indeed, Drigg Stream only passes through the SAC/SSSI for a short distance.

The only potentially significant impact would be a large spillage of potentially polluting material (such as cement, oil or chemicals used on site). Mitigation measures to minimise this risk are considered below.

As the above risks have been assessed in the LLWR management risk assessment, they are considered unlikely and are considered as having an impact of negligible magnitude on the SAC/SSSI (very high importance) resulting in an effect of minor adverse significance.

The relocation of Drigg Stream and the construction of the settlement/attenuation lagoon has the potential to create hydraulic drawdown at the boundary between the SAC/SSSI and the LLWR near to Drigg. However, a detailed study into the hydrogeological impacts of the proposed development on the SAC/SSSI (Appendix J) demonstrated that there would only be a small change in groundwater levels (a few centimetres within 50 m of the boundary between LLWR and the SAC/SSSI). Therefore, any impact to the SAC/SSSI would be of negligible magnitude. Given the importance of the SAC/SSSI (very high), this would result in an effect of minor adverse significance.

5.9 Potential Impacts on WFD Status

Potential impacts on water bodies have been discussed in the relevant sections of this Technical Appendix. A number of these impacts have regulatory implications regarding the WFD, notably when water bodies concerned are covered in the North West RBMP and have specific WFD objectives/status. The North West RBMP designates WFD status to three water bodies considered in this Technical Appendix:

- Drigg Stream;
- River Irt/Estuary; and
- Cumbria Coastal Area.

The majority of potential impacts discussed in this Technical Appendix would be caused by accidental discharges due to various construction activities or changes to drainage. These impacts would therefore have temporary, reversible and/or intermittent effects, while other impacts would only have minor effects and would therefore not affect WFD status.

The permanent modification to a short distance of Drigg Stream would not affect its WFD objectives. Drigg Stream is considered to be a Heavily Modified Waterbody (HMWB) in the RBMP, due its functional role as a drainage ditch. The Scheme will not affect its status as a HMWB and there would be no effect on Drigg Stream WFD current or future objectives and status.

6 Mitigation

6.1 Construction

As a general measure to protect ground and surface water from a range of potentially dangerous activities associated with construction of this type, the contractor will comply with relevant Environment Agency guidance during construction, including:

- PPG 1 General guide to the prevention of pollution;
- PPG 2 Above ground oil storage tanks;
- PPG 3 Use and design of oil separators in surface water drainage systems;
- PPG 4 Treatment and disposal of sewage where no foul sewer is available;
- PPG 5 Works and maintenance in or near water; and
- PPG 6 Working at construction and demolition sites.

6.2 Settlement/attenuation lagoon

A settlement/settlement/attenuation lagoon will be installed onto temporary drainage on the south of the development. It is important that this lagoon is suitably sized. It should be sized to cope with a 1 in 100 year return period rainfall event, with runoff rate set at Greenfield runoff rates.

In addition, where necessary, flocculants will be used to control suspended solids prior to discharge to the Drigg Stream.

The pond will also attenuate flows in the Drigg Stream downstream as described in Appendix L3.

6.3 Temporary Drainage

Given the duration of the proposed development construction, a detailed drainage strategy should be developed and agreed with the Environment Agency, covering each of the different construction phases. This report should also cover the design (sizing and discharge rate) of the settlement/attenuation lagoon.

Measures that should be considered for temporary drainage include:

- installation of measures such as catchpits, silt traps, swales and filter drains to reduce sediment load;
- a valve to isolate the settlement/attenuation lagoon in the event of a polluted discharge;
- oil interceptors to be installed (notably the outflow from the settlement/attenuation lagoon) to reduce the potential risk for contamination of ground and surface water; and
- all potentially polluted waters (including washdown areas, stockpiles and other area of risk for water pollution) to have separate drainage and to be tankered away from site, as described below.

6.4 Drigg Stream Relocation

A method statement for the diversion of the Drigg Stream is included as Annex L1-1. A flood risk assessment and sustainable drainage assessment which incorporate the relocation of the Drigg Stream form Appendices L2 and L3 respectively.

6.5 Storage of Materials

The contractor will site spoil and temporary stockpiles on areas of hardstanding with isolated drainage systems in order to prevent discharge to surface water.

Chemicals used and stored on site pose a risk of contamination of surface water.. Strict preventative measures will be implemented, including 110% bunding, Control of Substances Hazardous to Health (COSHH), and related restrictions for all fuels, chemicals and oil stored on site on or near to drains and soil areas. Security measures for storage of dangerous chemicals shall be adhered to, such as protecting valves and trigger guns and storing containers in locked compounds.

Exposed ground and stockpiles should be protected (e.g. covered) as appropriate and practicable.

6.6 Staff Awareness/ Training

The contractor will ensure that site personnel are fully aware of the potential impact to surfacewater associated with certain aspects of construction works and procedures in the event of any accidental pollution occurring (see below). This shall be included in the site induction and training, with an emphasis on procedures and guidance to reduce risk of surfacewater pollution.

6.7 Pollution Plans

Plans to deal with accidental pollution plans shall be drawn up and agreed with the Environment Agency prior to construction commencing and any necessary equipment (e.g. spillage kits) shall be held on site and made accessible to all site personnel. The Environment Agency shall be informed immediately in the unlikely event of a suspected pollution incident.

6.8 Discharge/ Disposal of Potentially Contaminated Site Runoff

Plans for the discharge and/or disposal of potentially contaminated water will need to be agreed in advance with the Environment Agency.

All foul water from the site compound (including toilets) shall be tankered away to an appropriate disposal facility. Any potentially contaminated water should be tested as described above. If the water is of acceptable quality, as agreed with the Environment Agency, it will be discharged to watercourse via the drainage system. If it is not, then it will not be discharged in this way, but treated appropriately (such as removal from site to treat at a sewage treatment works).

6.9 Upgrading of Infrastructure and Construction of Access Tracks

All access will be constructed at a suitable slope angle with drains or swales running alongside whereby all surface runoff will be captured. This runoff will be discharged to buffer zones or filtered through silt traps, if necessary, before being discharged to the local watercourse.

Buffer areas are proposed in areas at risk of soil erosion. The width of the buffer area will influence the likelihood of soil erosion and is dependent on vegetation type, soil type, gradient and catchment area. Guidance on the width of the proposed buffer zones for the site is provided in Table 6.1.

Measures will be taken to minimise potential soil erosion and exposed soil by re-vegetating bare soil where possible and limiting and or avoiding construction activities during periods of high rainfall.

Water crossings will be designed to allow the year-round safe passage of wildlife and will be suitably sized so as not to restrict flow movements during spate conditions. Appropriate erosion control measures will also be implemented around the water crossing points.

Table 6.1: Proposed Buffer Zones

Waterbody	Recommended Buffer Zone
Drigg Stream < 1 m wide	5 m on either side
Drigg Stream between 1 – 2 m wide	10 m on either side
Confluence of Streams	20 m on either side
East-West Stream	8 m on north side
Ponds and Pools	At least 20 m

* Width should be increased locally if soils are very prone to erosion.

6.10 Concrete Pouring

Concrete and bentonite enhanced soil to be used during construction will initially be transported on site to allow for the batching plant set up. It will then be batched on site within the compound.

A list of mitigation measures are proposed for the movement and placement of concrete:

- concrete pouring will take place within well shuttered pours to prevent leakage of concrete from the pour area;
- an appropriate offsite wash down facility will be provided for concrete transporting vehicle under the appropriate regulatory requirements;
- flocculants will be used to control suspended solid and bentonite concentrations; and
- an accident plan will be prepared to include a site spill response. Site staff including drivers of vehicles carrying concrete will be briefed on the potential impacts of concrete spillage and the procedures for the clean up of any accidental spillages.

6.11 Runoff from Exposed Soil/Capping

Banks on site will be suitably graded and revegetated to prevent soil erosion. Any surface runoff from exposed soil will be passed through a buffer zone or a silt trap prior to discharge to local watercourses. The proposed drainage system will also be designed so as to capacitate increased run-off quantities to the settlement/attenuation lagoon.

6.12 Water Quality Monitoring

Water quality monitoring will be undertaken for site construction discharges and operational discharges. Details of monitoring parameters and locations will be agreed with the Environment Agency.

7 Residual Effects

The measures proposed for the construction phase will significantly reduce the likelihood of pollution that would affect the water quality or use of surface waters.

A summary of the water bodies and attributes, magnitude of impact and significance of effects is shown in Table 7.1, below.

Table 7.1: Summary of Impacts, Effects and Mitigation Measures

Potential Impact	Nature of Impact (Permanent or Temporary)	Importance of Water Feature	Magnitude of Potential Impact	Significance	Mitigation Measures
Accidental leakage of pollutants or contaminated runoff	Temporary	Drigg Stream (Medium)	Major	Moderate adverse	Compliance with relevant Environment Agency guidance during construction. Suitable storage, management and use of potentially polluting liquids. Training of personnel with respect to water pollution issues. Correct procedures for storing potentially harmful substances. Isolated temporary drainage usage with the use of oil interceptors, catchpits, silt traps, swales and filter drains. Polluted waters to be tankered away from site. Development of emergency spill plan. Construction of settlement/attenuation lagoon. Use of flocculants to control suspended sediment and bentonite concentrations. Concrete pouring in shuttered pours with appropriate washdown facilities. Water quality monitoring.
		East-West Stream (Medium)	Major	Moderate adverse	
		Ponds 14 and 15 (Medium)	Major	Moderate adverse	
		River Irt (High)	Minor	Minor adverse	
Suspended sediments contamination in site runoff	Temporary	Drigg Stream (Medium)	Moderate	Minor adverse	Compliance with relevant Environment Agency guidance during construction. Suitable upgrading of infrastructure and construction access.
		East-West Stream (Medium)	Moderate	Minor adverse	

Potential Impact	Nature of Impact (Permanent or Temporary)	Importance of Water Feature	Magnitude of Potential Impact	Significance	Mitigation Measures
		Ponds 14 and 15 (Medium)	Moderate	Minor adverse	Training of personnel with respect to ground and surface water pollution issues. Isolated temporary drainage usage with the use of oil interceptors, catchpits, silt traps, swales and filter drains. Construction activities limited during high rainfall periods. Construction of settlement/attenuation lagoon. Appropriate regrading and revegetation of banks. Water quality monitoring.
Relocation of Drigg Stream	Temporary	Drigg Stream (Medium)	Moderate	Minor adverse	Undertake detailed assessment of the hydraulic capacity of the new channel to ensure no impact on flood risk during storm events.
Drainage/ flow alterations flood risk and	Variable	Drigg Stream (Medium)	Medium	Minor adverse	Undertake detailed assessment of the hydraulic capacity of the new channel to ensure no impact on flood risk during storm events.
		East-West Stream (Medium)	Medium	Minor adverse	
Drainage/ flow alterations flood risk and	Variable	River Irt (High)	Minor	Minor adverse	Attenuation measures installed onto new drainage, as agreed with Environment Agency
Impact on SSSI/SAC	Variable	SSSI/SAC (Very High)	Negligible	Minor adverse	Isolated temporary drainage usage with the use of oil interceptors, catchpits, silt traps, swales and filter drains. Training of personnel with respect to ground and surface water pollution issues. Construction of settlement/attenuation lagoon. Compliance with relevant Environment Agency guidance during construction. Water quality monitoring.

8 Summary

8.1 Relocation of Drigg Stream

The relocation of Drigg Stream would have a temporary impact of moderate magnitude (given the greater disturbance and longer duration of impact that would be experienced). Given the importance of Drigg Stream attributes (medium), this is assessed as having an effect of minor adverse significance. Long term impacts are considered to be neutral (of no significance).

8.2 Suspended Sediment Contamination

During the construction phases of the proposed development, pollution from mobilised suspended solids is the main concern, potentially causing increased sediment loads in the nearby surface watercourses. This may result from land clearance, movement and storage of materials to and from the site, and from other construction activities. The following activities pose the highest risk for suspended sediment contamination:

- Drigg Stream relocation;
- soil removal during construction;
- concrete pouring and associated materials substances;
- runoff from excavated materials and stockpiles;
- run-off from newly placed fill and capping; and
- erosion from increased flows as a result in (temporary and permanent) changes in drainage and increased permeability of surface area.

A settlement/attenuation lagoon will be installed on the south of the development. This lagoon will be suitably sized for each of the construction phases. In addition, where necessary, flocculants will be used to control suspended solids prior to discharge to the Drigg Stream.

8.3 Accidental Discharge of Pollutants

During construction, there is an elevated risk of leakages or accidental spillage of building materials and potential pollutants used on site, migrating to nearby surface watercourses or infiltrating to the aquifer. Contaminated runoff could result from unstable exposed soils, excavated materials, stored aggregates and contaminated road surfaces. Washout facilities (washing of tools, plant and equipment), storage and use of various liquids and soluble solids, and fuel storage and handling all have the potential to result in pollution of watercourses. Inappropriate disposal of waste materials associated with the construction phase of the development has the potential to enter surface water.

Plans to deal with accidental pollution plans shall be drawn up and agreed with the Environment Agency prior to construction commencing and any necessary equipment (e.g. spillage kits) shall be held on site and made accessible to all site personnel. The Environment Agency shall be informed immediately in the unlikely event of a suspected pollution incident.

Given the distance downstream and very high level of dilution, there would be no significant impact on the estuary or Cumbria Coastal Area.

8.4 Disturbance of Contaminated Material

The area for future vault construction is located on a site formerly used for storage of explosives (TNT). However, LLW Repository Ltd has indicated that the area is not at risk of containing contaminated soil.

8.5 Drainage and Flow Alterations

The changes to the catchment during the different construction phases and after the development is fully complete and operational are likely to alter flow dynamics in receiving watercourses.

The potential environmental impact of these alterations is to increase flow rates (particularly during storms), leading to increases in channel scouring, sediment loading in watercourses and marine/estuarine environments downstream and an increase in flood risk to the surrounding area. There is also a risk that polluted sediments present in downstream areas of Drigg Stream will be disturbed (sediment re-suspension) and affect downstream water bodies.

This would be mitigated by construction of an appropriately sized settlement/attenuation lagoon.

8.6 Potential Impacts on SAC/SSSI

The relocation of Drigg Stream and the construction of the settlement/attenuation lagoon has the potential to create hydraulic drawdown at the boundary between the SAC/SSSI and the LLWR near to Drigg. However, a detailed study into the hydrogeological impacts of the proposed development on the SAC/SSSI (Appendix J2) demonstrated that there would only be a small change in groundwater levels (a few centimetres within 50 m of the boundary between LLWR and the SAC/SSSI). Therefore, any impact to the SAC/SSSI would be of negligible magnitude. Given the importance of the SAC/SSSI (very high), this would result in an effect of minor adverse significance.

8.7 Potential Impacts on WFD Status

The North West RBMP designates WFD status to three water bodies considered in this Technical Appendix:

- Drigg Stream;
- River Irt/Estuary; and
- Cumbria Coastal Area.

The majority of potential impacts discussed in this Technical Appendix would be caused by accidental discharges due to various construction activities or changes to drainage. These impacts would therefore have temporary, reversible and/or intermittent effects, while other impacts would only have minor effects and would therefore not affect WFD status.

The permanent modification to a short distance of Drigg Stream would not affect its WFD objectives. Drigg Stream is considered to be a Heavily Modified Waterbody (HMWB) in the RBMP, due its functional role as a drainage ditch. The Scheme will not affect its status as a HMWB and there would be no effect on Drigg Stream WFD current or future objectives and status.

References

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Environment Agency (2009) River Basin Management Plan: North West River Basin District

Highways Agency (2009) - Design Manual for Roads and Bridges Volume 11, Section 3 Part 10 - Document Number HA 45/09

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Annex L1-1: Drigg Stream Diversion Method Statement

Introduction

As set out in the ES, the Drigg Stream will need to be diverted as part of Phase 1 and 2 of the proposed works. This is to allow sufficient area on site to complete the construction and subsequent capping of vaults in this area. The stream is to be diverted to a route approximately 50 m south-west of the current location, flowing in approximately the same direction.

The catchment and therefore flow of Drigg Stream will not be amended during the proposed diversion works, though the overall capping programme will ultimately result in a slightly increased catchment (as a result of capping of Vaults 8 and 9) and therefore flow, as set out and assessed in the ES.

The section of Drigg Stream to be diverted is currently very slow flowing, with a very small volume of flow for most of the year. The watercourse is choked with vegetation in a number of places.

Pre-construction surveys

The very low flow and dense vegetation, almost certainly prevents migratory fish from using the watercourse, and is likely to also limit the invertebrate community present. This is confirmed by observations on site during site walkovers and ecological surveys (where only small sticklebacks were observed in this section of watercourse).

For this reason we do not recommend an extensive suite of pre-construction ecological surveys. If it is anticipated that there may be fish present then a visual inspection by a fisheries expert prior to construction should be undertaken to confirm whether fish are likely to be present. Either way, a fisheries expert must be on hand during the reconnection works (see later section) with fish rescue equipment, to rescue any stranded fish in the unlikely event that they are present and manually move them to the new watercourse section once it is reconnected.

Methodology for creation of the channel

The existing channel is man-made and very regular in shape with very limited diversity, performing a function of land drainage. It is recognised as such in the River Basin Management Plan (RBMP), as the Drigg Stream (or Drigg Drain as it is known in the RBMP) as a heavily modified watercourse due to its use for land drainage. The vegetation within and surrounding the Stream is very overgrown in places, choking the channel and providing a high level of shading in parts.

The bottom of the new section of watercourse will be no lower than the existing feature (therefore no increased potential for impact on the water table, as assessed in the 3D hydrogeological model discussed above). The detailed design for the new channel will be completed prior to works commencing, and agreed with the Environment Agency and local authority in advance. There are a number of features that the channel design should adopt, however, to bring habitat improvements and these are set out below.

The new channel will be dug and shaped dry, before dams are created/ removed to connect it to the remainder of Drigg Stream up and downstream of the diversion, and the flow is stopped to the existing section of channel. Ecological mitigation required during this reconnection stage is set out below.

If possible, the channel must be dug, shaped and compacted using site-won low permeability materials (this will be confirmed through analysis of the soil substrate through either existing geotechnical information or testing to be carried out prior to detailed design). It is recommended that no lining is required, due to the uncontaminated nature of runoff entering the watercourse, and ideally the channel shape should be formed through compacted soil (assuming the soil has enough clay content).

Whilst significant improvement would be required to the entire length of watercourse to encourage more ecological diversity (and in particular to open the watercourse up to migratory fish species), there are certain small measures that can be taken to enhance the diversity of habitat in the watercourse. If space allows on site whilst maintaining the required volume in the watercourse (to be confirmed during detailed design), it is recommended that a berm is cut into one bank of the relocated watercourse to provide a diversity of flow and habitat available for fish, and in particular increase areas available for fish refuge. This berm (or ledge) would need to be relatively close to the base of the channel due to the low flows currently existing in the channel.

It is recommended that the channel is allowed to vegetate naturally rather than large scale planting or translocation of material from the existing stream. In order to 'seed' the stream and encourage vegetation, however, it is recommended a small number of clumps of vegetation are removed from the existing stream (limiting the amount of substrate transferred with it in case of any existing contamination of sediments) and placed in the new stream. In order to prevent erosion when the new stream section is reconnected, and to provide habitat variety in the stream over the long term, it is recommended that a range of substrate materials are placed in the stream (cobbles and pebbles, covering more than 25% of the stream bed) prior to reconnection.

During Phases 1 to 5 the diverted stream will discharge to in an engineered settlement/attenuation lagoon sized to allow a discharge to the Drigg Stream limited to a peak value that is comfortably less than the greenfield rate under the same storm conditions (see Drawings 47070159/SWM/01-06 in Appendix C to the ES). The settlement/attenuation lagoon will also act as a settlement pond during Phases 1 to 5 to allow pollution control in relation to suspended solids (see below). The outflow from the settlement/attenuation lagoon will discharge into the Drigg Stream. The settlement/attenuation lagoon will be retained post-restoration all drainage will be direct via the lagoon to the Drigg Stream. The effect of the construction of the settlement/attenuation lagoon on the trench leachate diverter valve will be examined.

Methodology for connection of the new diverted channel

The new channel (including settlement/attenuation lagoon) will not be connected until habitats have become established approximately 18 months after its creation. This will allow the channel and its bankside and aquatic vegetation to become established, although as with the terrestrial invertebrates it is acknowledged that there may be some short term changes in the species present as the channel habitats develop. After 18 months the new reach (outlet from the settlement/ attenuation lagoon) should be reconnected to the existing stream through careful damming of the old reach and opening of new links to the new channel.

This should be undertaken in a staged manner, opening a new connection from the new stream channel to the existing watercourse at the downstream end first, then opening the connection at the upstream end (and at the same time damming the upstream end of the existing channel). As the existing channel drains (the downstream end is left flowing until all water has discharged) a fish rescue expert should be on hand to move any small fish that are stranded, if any.

Mitigation for ecology prior to and during works

As noted above, a fish expert should be present during the phase of works involving disconnecting the existing reach of watercourse, to move any fish that happen to become stranded (though it is considered unlikely there are many fish present in the watercourse).

It is recommended that vegetation and invertebrate life be allowed to colonise naturally over time, as planting with vegetation risks immediate choking of the watercourse due to the low flows present.

The proposed construction of the watercourse will increase the habitat diversity within the watercourse, creating an improvement for ecology over and above the current situation. It is noted, however, that further improvements would need to be made to the whole watercourse to achieve any significant improvement in biodiversity. For this reason whilst the habitat will be an improvement on the existing situation (in particular in terms of hydromorphology of the reach affected), in terms of Water Framework Directive requirements for Good Ecological Status, it is not anticipated there will be any change in the status of Drigg Stream as a result of the proposed work.

Pollution Control Infrastructure

Queries have been raised by consultees process in relation to details of the proposed pollution control infrastructure. As set out in Section 6 of this Technical Appendix, the key aspects of the drainage design in relation to control of pollution are temporary drainage arrangements specific to each stage of the proposed works (including settlement lagoons as necessary to capture solids, swales and filter drains to reduce sediment load, silt traps and catchpits).

Pollution control of surface water run-off from Vault construction areas will be managed by the contractor within the construction site including use of on-site attenuation/sedimentation/ flocculation capacity (see below) by use of tanks. Clean surface water run-off from the vault construction area will be discharged into the disused section of the original channel of the Drigg Stream prior to discharge to the Drigg Stream proper downstream of the site.

Pollution control during cap construction will primarily be achieved via management of surface water drainage from working areas on the cap/profiling fill using a filter drain placed within the profiling fill at the edge of the landform. This will be connected to the north-eastern side of the existing trench cap drainage system and ultimately drain in to the settlement/attenuation lagoon.

The settlement/attenuation lagoon will take surface water run-off from the cap during construction which may contain suspended solids. This will be designed with isolation valves to prevent any discharge in the event of a contaminant entering the lagoon. Should large amounts of suspended solid be reported through the proposed on site monitoring, coagulants (flocculants) may be used as necessary to encourage settling of the solids prior to the discharge of clean water.

Clays (including bentonite) and similar solids are likely to be the most difficult to settle and, if the pond retention time is not sufficient, these will probably need some coagulant aid. There is a range of coagulants (flocculants) available depending upon the nature of the solids that require settlement and the chemical status of the water they are in. Such dosing requires expertise to ensure that the correct chemicals are added in appropriate quantities to ensure that no pollution of receiving watercourses is caused. Only sufficient coagulant should be added to form flocs which will settle and thus no significant excess will be discharged. The most likely flocculants will be polyelectrolytes and aluminium compounds, though for reasons of storage space, ferric for example may be used rather than aluminium which tends to form a rather voluminous floc. Polyelectrolytes are biodegradable and, once attached to solids, have low environmental impact. If aluminium compounds are used, it will be important to prevent discharge of unflocculated or dissolved material, since this can have adverse effects on aquatic life. Most flocculating chemicals either require some alteration of alkalinity or pH if the water is not in the right condition for optimum coagulation. Such changes may need to be readjusted before the clear water is discharged, to ensure pH in particular is within the normal range for the receiving watercourses.

The system will be designed to prevent discharges of both solids and the associated coagulant, preventing any environmental damage to the receiving watercourse downstream. The detailed design of the settlement/attenuation lagoon is not yet completed but measures such as staged discharge or overflow weirs to encourage full settlement will be incorporated, along with isolation valves as stated above. Any solids that may be contaminated will be removed from the settlement lagoons and taken to a suitable, licensed, treatment facility for appropriate disposal. It is anticipated that such a design will be agreed with the Environment Agency and the local authority in advance of construction works commencing.

Drainage of the vault caps during construction will also be a key issue, with the potential risk of pollution from bentonite being heightened during the construction of the vault caps. The temporary cap drainage will be designed to ensure runoff can be contained during stages of the cap construction where risk of bentonite entering the drainage system is heightened. This will allow prevention of any discharge to the Drigg Stream. Should contamination of the closed drainage system occur, the bentonite will be settled using an appropriate coagulant (as described above) or the water will be removed from site and taken to an appropriate facility for treatment.

The settlement/attenuation lagoon will be securely fenced with permanent amphibian exclusion fencing to prevent colonisation by amphibians.