6 HYDROLOGY, HYDROGEOLOGY AND LAND QUALITY

6.1 Introduction

6.1.1 This section of the ES describes the existing environment in relation to hydrology, hydrogeology and land quality. It assesses the potential impacts of the proposed scheme on hydrology (surface water quality, levels, flows and land drainage) and hydrogeology (groundwater quality and levels), as well as the potential interrelationship with land quality and how this could affect the health of construction site workers, future site users and off-site workers/residents during the construction, operation and decommissioning phases.

6.1.2 Land quality in terms of an agricultural resource is not considered within this section owing to the industrial nature of the site. The focus of this section is on the baseline condition of soils and groundwater, particularly the potential for contamination to be present and the potential interactions between the soil and groundwater and sensitive receptors (as above).

6.1.3 The geology or geodiversity descriptions within this section provide context for the sensitivity of the hydrogeology and land quality assessment only. Geology is not considered to be a sensitive receptor in its own right, as environmental designations and protected status do not apply to the site.

6.1.4 It should be noted that the findings of this section have the potential to influence other sections within the ES, namely:

- **Section 18** - Infrastructure and Land Drainage.
- **Appendix 3.1** – Waste Management
- **Appendix 4.3** – Water Framework Directive Compliance Assessment.

6.1.5 Information regarding the general approach taken to the impact assessment is discussed in **Section 4**. Consistent with this approach, topic-specific receptor sensitivity and magnitude of effect definitions are provided within **Section 6.3**.

6.2 Guidance and consultation

Policy and guidance

6.2.1 The assessment within this section has been guided and informed by relevant policy, legislation, standards, guidance documents and consultation relevant to geology, hydrogeology and land quality.

6.2.2 The assessment has been undertaken with due consideration to the following legislation (and amendments, where appropriate), summarised in **Table 6-1** and **Table 6-2**.

Table 6-1 European legislation

European Legislation	Purpose and Effects
Water Framework Directive (2000/60/EC)	The Water Framework Directive (WFD) requires that all EU Member States must prevent deterioration and protect and enhance the status of aquatic ecosystems. This means that Member States must ensure that new schemes do not adversely impact upon the status of aquatic ecosystems, and that historical modifications that are already impacting need to be addressed.
Groundwater Daughter Directive (2006/118/EC, replacing 1980/68/EC)	This Directive establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The Directive establishes quality criteria that takes account of local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge. The Directive thus represents a proportionate and scientifically sound response to the requirements of the WFD as it relates to assessments of the chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations. Member States have to establish the standards at the most appropriate level and take into account local or regional conditions.
Directive on Environmental Quality Standards (Directive 2008/105/EC)	Repealed five older directives and amended 2000/60/EC to establish the list of and limits for 33 priority substances and eight other pollutants (as defined by the WFD) in the surface water environment.

Table 6-2 National legislation

National Legislation	Purpose and Effects
The Environmental Permitting (England and Wales) Regulations 2010	This national legislation replaced The Groundwater Regulations (1999, 2009). These regulations enact the European Directives (the WFD and the Groundwater Daughter Directive) and include controls on how to protect groundwater quality by preventing inputs of hazardous substances and limiting pollution from non-hazardous pollutants. It replaces those parts of the Water Resources Act 1991 that relate to the regulation of discharges to controlled waters (including groundwater).
Water Resources Act 1991, as amended by the Water Act 2003	This regulates water resources, water quality and pollution, and flood defence. It is regulated by the Environment Agency, and sets out provisions for the control of pollution of water abstracted for supply purposes.
Environmental Protection Act 1990, Part 2A	Delivers a system of integrated pollution control for the disposal of wastes to land, water and air. It requires local authorities to inspect land within their jurisdiction in order to identify contaminated land and cause the remediation of historical contamination at the expense of the polluter, or currently liable person. The Contaminated Land (England) (Amendment) Regulations 2012 are contained within these regulations. They deal with the designation of contaminated land through a risk based approach.
Environment Act 1995	Sets out provisions for the control of pollution of the environment, including land and water resources

National Legislation	Purpose and Effects
Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 (the WFD Regulations)	Implements the WFD through the designation of all surface waters (rivers, lakes, transitional (estuarine) and coastal waters) and groundwaters as 'water bodies' with certain quality and quantity targets; which mean that the requirements of the WFD need to be considered at all stages of the planning and development process.
Environmental Damage (Prevention and Remediation) Regulations 2009	Implements Directive 2004/35/EC by providing additional support to existing legislation to prevent serious environmental damage and ensure that remediation costs are met by the polluter.
Construction (Design and Management) Regulations 2007	Set out measures to control the health and safety of construction workers.

6.2.3 The assessment has also been undertaken with reference to the following statutory and general guidance:

- Environment Agency – Pollution Prevention Guidance (PPG) - 1 Understanding your environmental responsibilities – good environmental practices.
- Environment Agency PPG2 – Above ground oil storage tanks (August 2011, updated April 2014).
- Environment Agency PPG3 – Choosing and using oil separators: prevent pollution (April 2006).
- Environment Agency PPG5 – Works in, near, or liable to affect watercourses (November 2007, updated April 2014).
- Environment Agency PPG6 – Construction and demolition sites: prevent pollution (April 2012, updated April 2014).
- Environment Agency PPG7 – The safe operation of refuelling facilities (August 2011).
- Environment Agency PPG13 – Vehicle washing and cleaning: prevent pollution (July 2007).
- Environment Agency PPG21 – Pollution incident response planning (March 2009).
- Environment Agency PPG22 – Dealing with spills (April 2011).
- Environment Agency – Preventing industrial and commercial pollution: pollution prevention pays (January 2013).
- Environment Agency Groundwater Protection: Principles and Practice, Version 1.1 (2013).
- Environment Agency Model Procedures for the Management of Land Contamination (Contaminated Land Report (CLR) 11) (2004).
- Environment Agency – Remedial target methodology: Hydrogeological risk assessment for land contamination (2006).
- Environment Agency – Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, NC/99/73 (May 2001)
- Construction Industry Research and Information Association (CIRIA) publication C532 – Control of water pollution from construction sites (2001).
- Construction Industry Research and Information Association publication C650 – Environmental good practice on site (2005).
- Construction Industry Research and Information Association publication C515 – Groundwater Control – design and practice (2000).

- Construction Industry Research and Information Association publication C503 – Environmental good practices – working on site (2000).
- Construction Industry Research and Information Association publication C502 – Environmental good practices on site (2000).BS5930:1999 + A2:2010, The Code of Practice for Site Investigations (August 2010).
- BS10175:2011, Investigation of Potentially Contaminated Sites (March 2011).

Consultation

6.2.4 A summary of comments provided in the PINS Scoping Opinion and through consultation under Section 42 of the Planning Act 2008 that are of relevance to hydrology, hydrogeology and land quality is presented in **Table 6-3.**

Table 6-3 Summary of comments in the PINS Scoping Opinion and received during consultation under Section 42 of the Planning Act 2008 regarding hydrology, hydrogeology and land quality

Consultation Comment	Response / Section of the ES in which the comment has been addressed
Scoping Opinion (January 2014)	
Secretary of State	
The Secretary of State does not agree that the risk to soils, groundwater and surface water as a result of the construction of the new port terminal can be scoped out.	Due to the industrial nature of the site, the soils are not deemed to be an agricultural resource. They are, however, discussed within this section to define the baseline condition and to aid the assessment of potential impacts on sensitive receptors, including groundwater and surface water; **Sections 6.4 and 6.5**.
The baseline should explain in detail the extent of the study area and justify reasons for this.	**Section 6.3**
The Secretary of State is pleased that the approach to the assessment and need for a Phase 2 site investigation will be agreed with RCBC and the Environment Agency.	The approach to the Phase 2 site investigation was discussed with RCBC during a meeting on 13 May 2014. This is documented in a post meeting note (**Appendix 6-1**). An initial Phase 2 site investigation (Factual Report on Site Investigation for Bran Sands Quayside Investigation, Dunelm, 2014) and assessment (Site Characterisation and Generic Assessment, Royal HaskoningDHV, 2014) has been carried out. These reports are contained within **Appendix 6-2** and **Appendix 6-3**.
The Secretary of State is pleased to note that a piling risk assessment will be carried out.	**Section 6.5** discusses the proposed piling technique and associated potential risks. A foundation works risk assessment will be developed along with other health, safety and environmental documentation at the detailed design stage
The ES should include an assessment of the risk of contaminated material leaching into the ground during construction and operation and potential impacts on soil and land resources due to this.	**Section 6.5** and **Section 6.6**

Consultation Comment	Response / Section of the ES in which the comment has been addressed
Potential impacts associated with contamination risks should be addressed throughout the ES. Attention is drawn to Section 4 of the scoping opinion in relation to the potential need for a Health Impact Assessment.	**Section 6.5** and **Section 6.6**
Environment Agency	
The Environment Agency stated that an examination of landfill gas records from Bran Sands landfill identified that there is no previous evidence of landfill gas migration from the site that could affect the proposed development. This environmental monitoring data is available on the Environment Agency public register. The Environment Agency stated that the developer should be aware of the potential risk from landfill gas and the developer may wish to undertake a risk assessment to ensure the risk is adequately addressed.	**Section 6.5** and **Section 6.6**
Section 42 consultation	
Environment Agency	
The Environment Agency noted that the most recently submitted environmental monitoring (for 2013) for Bran Sands landfill shows some significant landfill gas migration issues, and this needs to be assessed, with any potential migration incorporated into the scheme. Monitoring infrastructure must not be damaged and access to them must be maintained. Careful consideration must be given to the use of some landfill areas for permanent car parking.	**Sections 6.4, 6.5, 6.6 and 6.7** Use of the landfill as a construction compound does not form part of the proposed scheme any longer.
Redcar and Cleveland Borough Council	
The proposed methodology for the Contaminated Land Assessment has been agreed with the Council.	See above notes under Scoping Opinion.

6.3 Methodology

Study area

6.3.1 For the purpose of this assessment, and to aid the baseline description, two study areas have been defined to assess the impacts associated with the project:

6.3.2 The development footprint – this encompasses the entire onshore area of the construction works, which includes the locations for the proposed port terminal, surge bins and overland conveyor, that have the potential to result in a direct impact.

6.3.3 A buffer zone – this constitutes a 1km buffer around the development footprint where environmental receptors may be present but no physical works would take place and, therefore, only indirect impacts could occur within this zone.

6.3.4 Although potential contaminative sources and receptors within 1km of the development footprint have been reviewed, based on current and historical land uses, sources within 250m of the development footprint are considered to be of greater potential risk to human health and the environment as a result of the construction and operation of the Harbour facilities. This rationale is used to assess the potential impacts on receptors herein; i.e. those within 250m of the development footprint are at greater potential risk. As such, the risks associated with sources within 250m of the development footprint are considered in greater detail than those beyond this distance.

Existing environment

6.3.5 This section sets out the environmental baseline and, where appropriate, defines the existing sensitivity of the receptors (specifically hydrology, hydrogeology and human health) in the study area. Land quality is not considered to be a receptor and is not assigned a sensitivity, but is discussed in the context of the potential for contamination to be present in the soils and groundwater.

6.3.6 The environmental baseline has been informed by data collated for a desk-based Preliminary Risk Assessment (PRA), third party reports and data collected during an initial Phase 2 intrusive site investigation undertaken by Dunelm (Dunelm, 2014). The PRA is provided in **Appendix 6-3**. It should be noted that the study area for the PRA is different to that presented on the current scheme drawings as the scheme has evolved since the drafting of the PRA in May 2014. The main difference between the two study areas is the exclusion of the Bran Sands Landfill (waste mass area) from the current scheme. Receptor sensitivity has been defined based on the criteria presented in **Table 6-4**.

6.3.7 The following data sources were reviewed and informed the preparation of the PRA and this section of the ES:

- An environmental sensitivity (Envirocheck™) report containing historical and current Ordnance Survey maps, records from Environment Agency and Local Authority databases and contemporary trade directory entries.
- Observations from a site walkover conducted on 2 December 2013 by Royal HaskoningDHV.
- Anecdotal evidence from site operatives.
- Environment Agency groundwater and river quality data (www.environment-agency.go.uk).
- Borehole logs accessed from the British Geological Survey (BGS) online viewer.
- BGS 1:50,000 Scale Geology Map – Solid and Drift edition (Sheet 34, Stockton).
- DEFRA (Department of the Environment and Rural Affairs) Industry Profiles.
- Phase 1 Liability Assessment of Bran Sands (Amec, November 2012).
- Bran Sands Landfill Stability Assessment (Carl Bro Group Ltd, December 2003).
- Breagh Pipeline Ground Investigation (Solmek, February 2011).
- Breagh Pipeline Ground Investigation (Solmek. August 2011).
- Bran Sands Landfill Monitoring Reports (Grontmij, 2007 – 2012).
- Bran Sands Landfill Site Hydrogeological Risk Assessment Review (Grontmij, February 2014).
- Factual Report on Site Investigation for Bran Sands Quayside Investigation (Dunelm, September 2014).
- Harbour Facility Site Characterisation and Generic Risk Assessment (Royal HaskoningDHV. October 2014).

Methodology for the assessment of potential impact

6.3.8 The methodology adopted for the assessment of potential impacts follows the generic EIA methodology set out in **Section 4** and is based on the following principles:

- the type of effect (long-term, short-term or intermittent; positive, negative or neutral);
- the probability of effect occurring;
- the sensitivity of the receptor (examples are provided in **Table 6-4**); and,
- the magnitude (severity) of the effect (examples are provided in **Table 6-5**).

Table 6-4 Examples of receptor sensitivity

Criteria	Hydrology	Hydrogeology	Human Health
Very high	Site assessed under the WFD as having high ecological quality and / or good chemical quality. Site protected under European or international habitats or species legislation (e.g. SPA, Ramsar site). Surface water abstraction licence (large volume) and / or discharge consent within close proximity of the site.	Licensed public water supply or major industrial abstractions (e.g. designated Source Protection Zone (SPZ) 1 / 2). Licensed / unlicensed abstractions and springs providing potable water supply, for which there is no alternative source (e.g. mains water). Site protected under European or international habitats or species legislation (e.g. SPA, Ramsar site).	Children present with a risk of long term constant exposure.
High	Site assessed under the WFD as having good ecological quality and / or good chemical quality. Site protected under UK nature conservation legislation (e.g. SSSI, NNR). Surface water abstraction licence (low volume, but no alternative source) and / or discharge consent proximity of the site.	Designated 'Principal Aquifer'. Licensed / unlicensed abstractions and springs providing potable water supply, for which an alternative source (e.g. mains water) is available. Nationally important nature conservation sites (SSSI, NNR).	Children present with a risk of long term exposure.
Medium	Site assessed under the WFD as having moderate ecological quality and / or good chemical quality. Supplies water to sensitive sites of local importance (e.g. LNR, SNCI, RIGS).	Designated 'Secondary-A (or Undifferentiated) Aquifer'. Regionally important wildlife or geological sites (LNR, SNCI, RIGS). Non-potable licensed abstractions.	Children present with a risk of medium term exposure, or adults present with a risk of long term exposure.
Low	Site assessed under the WFD as having moderate ecological quality and / or a failure in chemical quality. Surface water does not supply water to sensitive site.	Non-potable unlicensed abstractions. Local wildlife or geological sites, country parks.	Only adults present with a risk of short term exposure.

Criteria	Hydrology	Hydrogeology	Human Health
Very Low	Site assessed under the WFD as having bad ecological quality and / or a failure in chemical quality. Watercourse is a heavily modified drain of no ecological value.	Designated 'Secondary-B Aquifer' or 'Unproductive Strata'.	No human receptors present or very transient exposure (adults only).

Table 6-5 Examples of magnitude of impact

Criteria	Receptor		
	Hydrology	Hydrogeology	Human Health
Very High	Permanent change to surface water quality, levels or flows over a distance of >500m. Permanent derogation of abstraction. Permanent loss or creation of surface water dependent habitat. Permanent change in the WFD status of the surface water body or, in its ability to achieve WFD status objectives.	Permanent change to baseline groundwater quality, level, flow pattern or available yield over a wide area. Permanent loss of a water supply source. Permanent loss or creation of habitat. Permanent change in the WFD status of the groundwater body or any supported surface water body or, in its ability to achieve WFD status objectives.	Widespread contamination. High risk of exposure over a prolonged period. Multiple sources of pollution identified and multiple linkages to receptors.
High	Temporary change to surface water quality, levels or flows over a distance of >500m. Permanent change to surface water quality, levels or flows over a distance of <500m. Temporary derogation of abstraction. Temporary loss or creation of surface water dependent habitat. Change in the ability of a WFD surface water body to meet one or more objectives, but not affecting its WFD status.	Temporary change to baseline groundwater quality, level, flow pattern or available yield over a wide area. Permanent change to baseline groundwater quality, level, flow pattern or available yield locally. Temporary loss of a water supply source Temporary loss or creation of groundwater dependent habitat. Change in the ability of a WFD groundwater body or dependent surface water body to meet one or more objectives, but not affecting its WFD status.	Widespread contamination. High risk of exposure over a short time scale. Multiple sources of pollution identified and multiple linkages to receptors.

Criteria	Receptor		
	Hydrology	Hydrogeology	Human Health
Medium	Temporary change to surface water quality, levels or flows over a distance of <500m. Temporary derogation of abstraction that affects supply but does not render it unusable. Temporary change to surface water dependent habitat that does not affect the species it supports.	Temporary change to baseline groundwater quality, level, flow pattern or available yield locally. Temporary derogation of a water supply source that affects supply but does not render it unusable. Temporary change to existing groundwater dependent habitat size or quality that is not terminal for supported species.	Localised contamination. Unlikely to affect end users but may affect construction workers in close proximity.
Low	Permanent or temporary change to baseline surface water quality, levels or flows over a distance of <500m, with no measurable effects on ecological receptors or abstractions.	Permanent or temporary change to baseline groundwater quality, level, flow pattern locally, with no measureable effects on secondary receptors or available yield.	Very localised contamination. No perceptible effect (no pollutant linkages).
Very Low	Very slight change to baseline surface water quality, levels or flows over a distance of <500 m, with no measurable effects on ecological receptors or abstractions.	Very slight change to baseline groundwater quality, level, flow pattern locally, with no measureable effects on receptors or available yield.	No contamination. No effect on receptors.

6.3.9 Following identification of receptor sensitivity and magnitude of the effect, it is possible to determine the significance of the impact. The significance is determined by considering magnitude in relation to sensitivity as demonstrated in **Table 14.5** below.

Table 6-6 Significance of impact

Receptor Sensitivity (inclusive of value)	Magnitude of Effect				
	Very High	High	Medium	Low	Very Low
Very High	Major	Major	Moderate	Moderate	Minor
High	Major	Moderate	Moderate	Minor	Negligible
Medium	Moderate	Moderate	Minor	Minor	Negligible
Low	Minor	Minor	Minor	Negligible	Negligible
Very Low	Minor	Negligible	Negligible	Negligible	Negligible

6.4 Existing environment

Site setting

6.4.1 The site is located adjacent to the Bran Sands landfill and associated lagoon, and also includes a conveyor envelope to the north or south of the landfill (final route to be confirmed) which terminates at the MHF to the south-east. The site is predominantly flat and comprises a utilities corridor south of the landfill and orientated south-east to north-west, and an embankment west of the lagoon and orientated north to south, and open space/commercial property/infrastructure to the south-east of the landfill within the conveyor envelope. Access tracks are present adjacent to the utilities corridor and along the embankment, and comprise crushed stone (Dunelm, 2014). Beyond the access tracks, the majority of the site is vegetated with grass.

Geology

6.4.2 During the scoping phase of the EIA it was agreed with RCBC that geodiversity did not require assessment due to the absence of sensitive features. However, while not considered to be a receptor, the geological environment controls the behaviour and quality of groundwater and potential pollutant linkages and is, therefore, described as part of the baseline conditions of the site.

Superficial geology

6.4.3 The BGS published mapping (Sheet 34, Stockton) and the Geology of Britain Viewer and borehole logs (available from the BGS GeoIndex tool) indicate that the majority of the site is underlain by Made Ground deposits, beneath which are superficial deposits. Information taken from the BGS GeoIndex website describes Made Ground in the area as ‘slag’, with a maximum recorded thickness of 6.5m below ground level (bgl).

6.4.4 The superficial deposits underlying the landside footprint of the proposed port terminal and the majority of the overland conveyor route are Tidal Flat deposits, comprising sand, silt and clay.

6.4.5 To the south-east of the proposed port terminal footprint, prior to the overland conveyor entering the (off-site) MHF, the superficial deposits consist of Glaciolacustrine Deposits which are formed of clay and silt.

6.4.6 There is a small area of land within the western section of the proposed scheme footprint (near to the Tees estuary, traversing the Dabholm Gut) which is reported to contain no superficial deposits. The BGS reports that Made Ground deposits are present directly above the solid geology at this location.

Bedrock geology

6.4.7 The bedrock geology within the site comprises mudstone of various ages. The mudstone comprises (west to east) Mercia Mudstone, a narrow band of Penarth Mudstone and the Redcar Mudstone Formation.

Intrusive investigations

6.4.8 Several intrusive investigations have been undertaken at the site as described in **Section 6.4.45** onwards. A recent investigation was progressed by Dunelm in September 2014 along the existing embankment between the Bran Sands lagoon and the Tees estuary to investigate the superficial and bedrock geology. A summary of the ground conditions encountered is presented in **Table 6-7**.

Table 6-7 Summary of ground conditions

Unit	Depth mbgl (from – to)	Description
Made Ground	0 – 10.3	Brown/black/grey silty, sandy gravel and cobble, gravels and cobbles are fine to coarse slag with occasional brick, sandstone and concrete.
Tidal Flat Deposits	7.10 – 23.20	Brown/grey fine to medium sand comprising horizons of clay and occasionally gravelly (fine to medium sandstone) and frequent shell fragments.
Mercia Mudstone	14.25 - 44.50	Weak reddish brown Mudstone.

6.4.9 The ground conditions encountered during the Dunelm investigation generally concur with the ground conditions encountered during the Solmek (August 2011) investigation, which focused on the western extent of the utilities corridor and southern extent of the embankment. The Solmek (February 2011) investigation, which focused on the eastern extent of the utilities corridor south of the Waste Water Treatment Works (WWTWs), encountered a significantly greater thickness of clay deposits. Made Ground and mudstone was also encountered. The ground conditions identified concur with the published data.

Designated sites

6.4.10 There are no sites designated for geological importance within the footprint of the proposed scheme.

6.4.11 The Redcar Rocks SSSI is designated for its geological interest; however, the proposed scheme is located more than 6km from this SSSI.

Hydrology (surface waters)

6.4.12 In addition to the Tees estuary, the proposed scheme footprint is located adjacent to a number of smaller surface water bodies including ponds, lagoons and drainage channels (as identified on **Figure 6-1** and discussed below).

6.4.13 According to the Environment Agency, under the WFD, the chemical status of the estuary for all contaminants is deemed to be 'good' with the exception of tributyltin (TBT) compounds and, as a result of this failing element, the overall assessment for chemical elements is classified as 'failing'. TBT was used as a biocide in antifouling coatings on marine vessels and the main source of these compounds in marine sediments is considered to be as a result of leaching from these coatings. However, the landside works associated with the proposed scheme would not result in the disturbance of marine sediments.

6.4.14 The ecological status of the Tees estuary under the WFD has been defined as 'moderate', based on its overall biological quality and physico-chemical quality. **Section 7** contains a description of the quality of marine sediments and an assessment of the potential impacts associated with disturbance of contaminated sediments.

6.4.15 The local area is drained by Dabholm Gut, which is a locally important, tidally influenced drainage channel. Historically this channel received untreated domestic sewage and industrial effluents which were discharged directly into the Tees estuary. The area surrounding this straight tidal channel is heavily industrialised. A watercourse named The Fleet drains the area to the north-east of the proposed scheme footprint.

6.4.16 Under the WFD, the Environment Agency has classified non-tidal Dabholm Gut (part of the Tees Estuary (S Bank) water body) as being of 'moderate' ecological status; however, its chemical quality fails under the WFD due to priority hazardous substances. The tidal part of Dabholm Gut is identified under the Tees transitional water body. Bran Sands lagoon is not classified as a WFD water body. A WFD compliance assessment has been undertaken which includes all WFD water bodies relevant to the Harbour facilities and is included as **Appendix 4.3**.

6.4.17 With the exception of the Tees estuary, the largest surface water feature in the vicinity of the site is the Bran Sands lagoon, which is the sole remaining area left unreclaimed from a series of lagoons that were created using slag material in this area. It is approximately 700m x 500m in size, surrounded on all sides by bunds formed from locally derived slag fill and is constructed on the tidal flat deposits. The water level in the lagoon varies due to the presence of a concrete pipe which links the lagoon to the Tees estuary. The pipe allows limited tidal exchange between the estuary and the lagoon. The lagoon is fed by two swales which discharge into the lagoon along the eastern boundary adjacent to the landfill. The swales drain surface water from the landfill cap (Amec, November 2012).

6.4.18 The Bran Sands lagoon is within the boundary of the Bran Sands landfill site. Although no waste disposal has been reported within the lagoon area, the lagoon is regulated by the Environment Agency under the Environmental Permitting (England and Wales) Regulations (EPR) (Environmental Permit Reference: EA/EPR/MP3790ZW/V002). There is potential for a range of contaminants to be present within the Bran Sands lagoon, including leachate from the Bran Sands landfill or runoff from the adjacent industrial areas. The lagoon is monitored in accordance with a Closure and Aftercare Plan (Grontmij, November 2007).

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528000 526000 524000 522000

N

TEES ESTUARY

BRAN SANDS LAGOON

DABHOLM GUT

LEACHATE LAGOONS

ICI ECOLOGY POND

DRAINS

MILL RACE

DABHOLM BECK

DRAINAGE CUT

SETTLING POND

0 0.5 1 Kilometres

Source: Waterbodies derived from the Environment Agency

Legend:

- DCO Order Limits
- Surface Water Features

DCO Order Limits as of 24/02/15

Client:	Project:
York Potash Limited	York Potash Project Harbour Facilities

Title: Environmental Statement: Surface Water Features near Harbour Facilities

Part:	Figure:	Drawing No:
HF	6.1	9Y0989-HF-6-001

Rev:	Date:	Drawn:	Checked:	Size:	Scale:
1	04/03/2015	GC	SR	A3	1:30,000
0	09/12/2014	GC	SR	A3	1:30,000

Co-ordinate system: British National Grid

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Surface water quality

6.4.19 Surface water quality data is available for Bran Sands lagoon and Dabholm Gut as shown in **Table 6-8**. Samples from SW1 (**Figure 6-2**) have been tested for metals, ions and physical parameters monthly until the end of 2009 and then quarterly thereafter. Tests for hydrocarbons have been undertaken annually.

Table 6-8 Surface water quality data (Grontmij, February 2007 - 2012)

Borehole	Location	Monitoring period	Scheduled tests
SW1	Bran Sands lagoon	2007-2012	pH, ammonium (NH4-N), electrical conductivity (EC), dissolved oxygen (DO), chemical oxygen demand (COD), chlorides (Cl) monthly and metals ions and hydrocarbons annually (quarterly in 2008) until end of 2009, quarterly thereafter.
SW3	Dabholm Gut (exact position unknown)	2008	As above for 2008 only

6.4.20 WFD standards for estuarine and transitional waters are available for four of the parameters for which data are available: copper, zinc, toluene and xylene. A single exceedance for toluene and xylene was recorded in 2007 from a total of four samples.

6.4.21 Chloride concentrations at SW1 were typical of brackish waters, generally in the range 10,000 to 18,000mg/l, confirming that there is hydraulic continuity between the lagoon and both the Tees estuary (via the pipe through the embankment) and groundwater in the Made Ground adjacent to the river (see Table 6-8). Concentrations at SW3 were generally much lower, in the range 188 to 586 mg/l, with a single high value of 12,600 mg/l. This suggests that either the sample collection point is located upstream of the outfall to the Tees and is occasionally inundated by tidal waters or, that it is on the tidal reach and all but one sample were collected at low tide.

6.4.22 Total ammoniacal nitrogen (ammonia plus ammonium) concentrations at SW1 were found to be generally in the order of 5.0mg/l, but at SW3 during 2008 were significantly higher (15 to 30mg/l) on several occasions; matching the groundwater concentrations at BH09A at the eastern (up-gradient) end of the landfill (Grontmij, February 2007 – 2012).

6.4.23 Measurements of pH for SW1 were generally within the range 6 to 8 pH units but were consistently higher at SW3 in 2008, ranging from 7 to 9 pH units.

Water abstractions

6.4.24 There are no surface water abstractions within the proposed scheme footprint. However, there is one surface water abstraction licence (held by SSI), located approximately 500m to the north of the site boundary. The water is reported to be abstracted from the Tees estuary and is used for cooling purposes.

Discharge consents

6.4.25 There are a number of reported discharge consents within the proposed scheme footprint. The majority of these consents have been revoked, with the exception of two licences associated with the off-site WWTWs which discharge treated effluent to Dabholm Gut.

Sensitivity - hydrology

6.4.26 The landside section of the proposed scheme footprint is bordered by the Tees estuary and Dabholm Gut. Treated effluent and site drainage discharges to the Tees estuary. There are no surface water abstractions within the footprint of the proposed scheme.

6.4.27 Bran Sands lagoon is linked to the Tees estuary via a pipe which allows unregulated tidal exchange with the estuary and, although the footprint of the proposed scheme does not lie within the boundary of a conservation designation, there is significant waterbird use of both the Bran Sands Lagoon and Dabholm Gut by a variety of bird species associated with the nearby Teesmouth and Cleveland Coast SPA and Ramsar site. Consequently, on this basis, and given the sensitivity definitions included in **Table 6.4**, hydrological sensitivity in terms of surface water quality and level is assessed as high. It should be noted that Dabholm Gut is a reclaimed drain fed by a heavily industrialised area with fairly poor water quality; however, due to the waterbird use a high sensitivity has been assumed.

Hydrogeology

Aquifer classification

6.4.28 The Environment Agency has classified the superficial Tidal Flat Deposits within the western section of the landside part of the proposed scheme footprint (the quay and overland conveyor corridors) as a Secondary Aquifer (Undifferentiated). The remainder of the conveyor corridor to the east is underlain by superficial Glaciolacustrine Deposits and Glacial Till, which are both classified as Unproductive Strata (i.e. non-aquifers).

6.4.29 The underlying (Mudstone) bedrock has been classified by the Environment Agency as a Secondary B Aquifer, with the exception of the Penarth Group Mudstone, which is defined as a Secondary Aquifer (Undifferentiated).

Groundwater vulnerability

6.4.30 The majority of the site is situated on a Secondary (undifferenatiated) aquifer: the Tidal Flat Deposits. Environment Agency groundwater vulnerability mapping indicates this area to be of high vulnerability to pollution from spillages at the surface, due to the absence of overlying clayey soils that could otherwise attenuate the progress of any pollutants as they infiltrate to the aquifer. The secondary aquifer also provides a potential pollution pathway to surface waters and the underlying (Secondary B) bedrock aquifer.

6.4.31 The conveyor route south-east of the Redcar to Middlesbrough railway line is situated on low permeability Glacio-lacustrine Deposits, which are a non-aquifer and will prevent downward migration of any pollutants into the underlying bedrock mudstone aquifer.

Groundwater abstractions

6.4.32 There are no groundwater abstractions within, or in the vicinity of, the development footprint.

6.4.33 There are no groundwater Source Protection Zones (SPZ) within the development footprint or within the buffer zone around the proposed scheme footprint.

6.4.34 The site is located within the Tees Mercia Mudstone and Redcar Mudstone groundwater body (GB40302G701300) and has been designated by the Environment Agency as being at good quantitative status.

Groundwater quality

6.4.35 The WFD groundwater quality status for the Tees Mercia Mudstone and Redcar Mudstone groundwater body has been defined by the Environment Agency as poor, due the presence of priority hazardous substances from mines and urbanisation, which are causing an adverse impact on surface waters at a catchment scale.

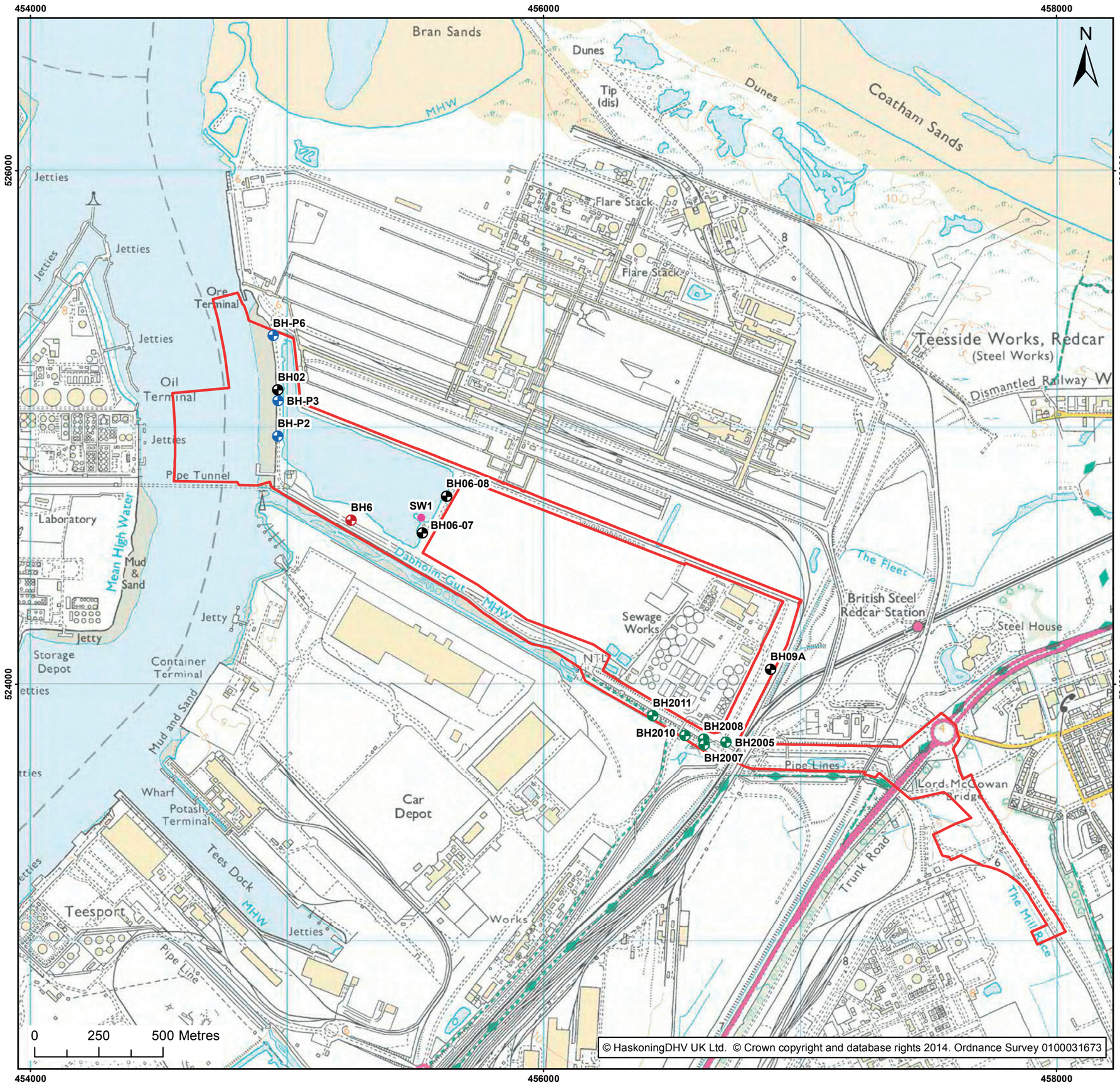
6.4.36 There is potential for superficial and bedrock aquifers to have been impacted by leachable contaminants within the Made Ground (slag) or by mobile contaminants from the Bran Sands landfill.

6.4.37 A number of groundwater monitoring boreholes are present at and in the vicinity of the site. These monitoring boreholes have been installed during several phases of investigation and monitoring is ongoing at selected boreholes. Monitoring boreholes are identified on **Figure 6-2**. The data indicate that compared to environmental quality standards (EQS) the groundwater quality is poor. A summary of the groundwater quality data is provided in **Table 6-9**.

Table 6-9 Summary of groundwater quality data obtained from previous site investigations and annual reports

Reference	Number of monitoring boreholes and groundwater samples	Summary results
Dunelm, 2014	Two samples were recovered from BHP2 and BHP3 which were installed in the Made Ground at the location of the proposed quay.	pH values were 7.8. High chloride concentrations were recorded reflecting the high degree of interaction between groundwater and estuarine water. WFD Estuarine EQS were exceeded for copper and zinc. Exceedances against other EQS values (where Estuarine EQS are not available) were also noted for boron and chromium.
Grontmij, 2012	Four boreholes were installed to support the Hydrogeological Risk Assessment of the Bran Sands landfill. Borehole BH09A, located up gradient of the landfill site, and BH02, located down gradient of the site, were each installed in 2003 and have been monitored regularly from	pH values ranged from 5.24 to 9.1. Total ammoniacal nitrogen (ammonia plus ammonium) concentrations are generally above the UK drinking water standard of 0.5 mg/l for ammonium at boreholes located on the up and down gradient landfill boundaries. Lower concentrations are recorded in surface water in Bran Sands lagoon and in groundwater adjacent to the Tees. High chloride concentrations were recorded in boreholes adjacent to

Reference	Number of monitoring boreholes and groundwater samples	Summary results
	2004 to present. Two further monitoring boreholes (BH06-07 and BH06-08) were installed down gradient of the landfill in 2008/ 2009 and monitoring data is available for the period 2009-2012. The monitoring programme is quarterly for metals and physical parameters and annually for hydrocarbons.	the Tees estuary, reflecting the high degree of interaction between groundwater and estuarine water. WFD Estuarine EQS were exceeded for copper (29/59 samples); zinc (11/59); iron (17/59); mercury (27/27); toluene (3/15) and xylene (4/15). Exceedances against other EQS values (where Estuarine EQS are not available) were also noted for cadmium, chromium, nickel, lead, vanadium, manganese, benzene and ethylbenzene. Exceedances were noted in both up and downgradient boreholes.
Solmek, August 2011	One borehole was converted to a monitoring well. Two groundwater samples were obtained and analysed.	pH values ranged from 7.8 to 8.50. Ammoniacal nitrogen concentrations exceeded the UK drinking water standard of 0.5 mg/l in both samples. The Estuarine EQS values were not exceeded. Exceedances were not recorded against other EQS values.
Solmek, February 2011	Four boreholes were converted to gas and groundwater monitoring wells. Four groundwater samples were obtained and analysed.	pH values ranged from 7.1 to 11.70. Ammoniacal nitrogen concentrations exceeded the UK drinking water standard of 0.5 mg/l in all samples. WFD Estuarine EQS were exceeded for toluene(1) and xylene(1). Exceedances against other EQS values (where Estuarine EQS are not available) were also noted for nickel(2), boron(4), PAHs(1), TPH(2), benzene(1), and ethylbenzene(1).



Legend:

- DCO Order Limits
- Groundwater Monitoring Boreholes (Grontmig)
- Groundwater Monitoring Boreholes (Dunelm)
- Groundwater Monitoring Boreholes (Solmek Aug)
- Groundwater Monitoring Boreholes (Solmek Feb)
- Surface Water Monitoring Point (Grontmig)

DCO Order Limits as of 24/02/15

Client:	Project:
York Potash Limited	York Potash Project Harbour Facilities

Title: Environmental Statement: Groundwater Monitoring Boreholes

Part:	Figure:	Drawing No:
HF	6.2	9Y0989-HF-6-002

Rev:	Date:	Drawn:	Checked:	Size:	Scale:
1	04/03/2015	GC	SR	A3	1:15,000
0	09/12/2014	GC	SR	A3	1:15,000

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Groundwater levels

6.4.38 Groundwater level data is available for boreholes drilled during 2014 by Dunelm (Dunelm, September 2014) and for monitoring wells associated with Bran Sands Landfill, reported by Grontmij.

Table 6-10 Summary of groundwater level monitoring locations

Borehole	Location	Monitoring strata/water body	Reference
BHP2	Adjacent to Tees estuary, down gradient of landfill	Made Ground	Dunelm, 2014
BHP3			
Jetty	NWL Jetty	River Tees	
BH02	Adjacent to Tees estuary, down gradient of landfill	Made ground and superficial deposits	Grontmij, 2014
BH06-07	Between landfill and lagoon, down-gradient of landfill	Unconfirmed - Made ground / superficial deposits	Grontmij, 2007-2012
BH09A	Adjacent to eastern, up gradient boundary of landfill	Superficial deposits	Grontmij, 2014

6.4.39 During the 2014 investigation (Dunelm, 2014), groundwater was struck at depths ranging from 3.1 to 5.1mbgl (1.6 to -0.6m AOD). Groundwater levels measured over a tidal cycle reached a maximum of 2.8mbgl (1.8m AOD) on each flood tide and displayed a strong tidal influence, with fluctuations in the order of 1.0 to 2.0m. This is approximately 60% of the range observed in the adjacent estuary and indicates that there is hydraulic continuity between perched water and the Tees transitional water body. As a result it is expected that groundwater quality within the embankment is very similar to that of surface water within the estuary and lagoon.

6.4.40 In the Bran Sands Landfill monitoring well BH02 (located down gradient, adjacent to Tees estuary), groundwater levels in the Made Ground/superficial deposits (measured monthly since 2007) varied between 4.8 to 1.7mbgl (0 to 3.1mAOD). In BH06-07 (located down gradient, between the landfill and the lagoon) groundwater levels (measured monthly since 2009) varied between 0.13 to 0.76mAOD). It is not clear whether this well is installed in the Made Ground, superficial deposits, or both. In BH09 (located upgradient of the landfill) groundwater levels in the superficial deposits (measured monthly since 2007) varied between 0.9 to 4.0mbgl (1.6 to 4.7mAOD).

6.4.41 No groundwater level data is available for the mudstones in the Bran Sands area and no water strikes were recorded during the 2014 Dunelm investigation. Ground investigations at the YPP Materials Handling Facility site indicate that groundwater within the Redcar Mudstone Formation is confined by the overlying low permeability superficial deposits and the upper part of the Redcar mudstone is permeable due to fracturing. Groundwater within the mudstone aquifer beneath the harbour development site is likely to be confined by the overlying Glacio-lacustrine deposits in the east and in hydraulic continuity with the overlying Tidal Flat Deposits in the west. Groundwater levels are likely to be tidally influenced.

6.4.42 Because the bedrock mudstone aquifer is known to be under pressure to the south east of the site, where it is confined by the overlying low permeability superficial clays it is possible that, should the mudstone be sufficiently permeable, there could be upward groundwater flow from the mudstone,

resulting in groundwater discharge, via the Tidal Flat deposits, to the Tees Estuary. As a result, there is potentially a small flow of groundwater into Bran Sands lagoon, but it is likely this would be insignificant in comparison with tidal exchange flows.

Sensitivity – hydrogeology

6.4.43 The majority of the site is underlain by Tidal Flat deposits, classified as a Secondary Aquifer (Undifferentiated) and there are no abstractions within 1km of the development footprint boundary. Groundwater quality within both the made ground and superficial deposits is poor and has likely been influenced by contaminants originating from the landfill and industrial activities in the local area. The criteria in **Table 6-4** suggest that due to the aquifer classification, groundwater within the Tidal Flat Deposits should be considered as being of medium sensitivity. However, due to its poor quality (due to saline influence and pollutant concentrations) and lack of use locally for abstraction, this aquifer is considered to be of low sensitivity.

6.4.44 The bedrock aquifer has been designated as a Secondary B Aquifer and there are no groundwater abstractions or SPZs within the buffer zone. Consequently the bedrock aquifer sensitivity is considered to be very low.

Land quality – soils

6.4.45 Potential contaminants of concern (either occurring naturally or as a result of anthropogenic activities) present within the soil can have detrimental effects on sensitive receptors, and such effects can be exacerbated where contaminants become mobilised as a result of construction activities. As previously noted, a desk-based PRA was undertaken which identified a number of potential contamination sources. Intrusive investigations have also been undertaken and included the collection of soil and groundwater samples for subsequent laboratory analysis.

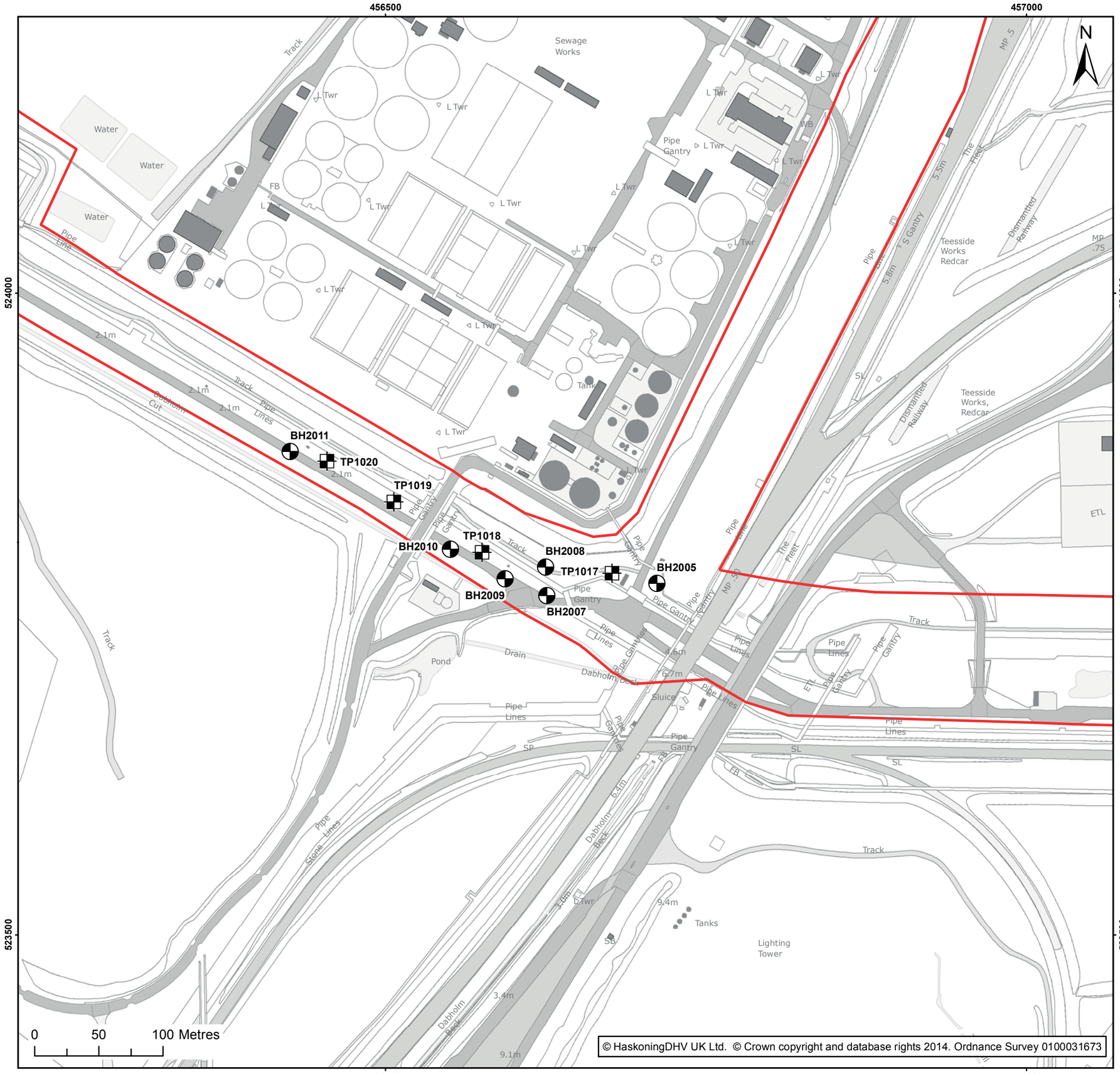
Potential contamination sources

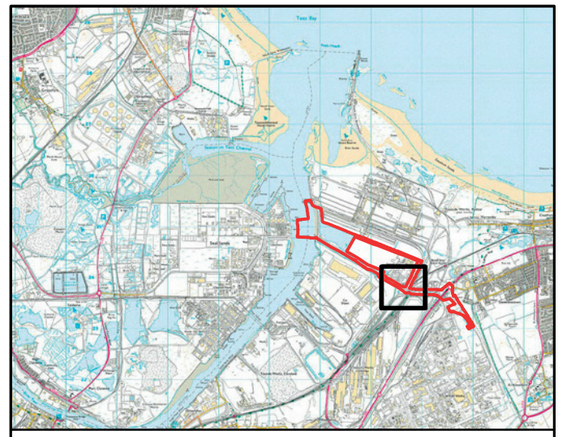
Made Ground

6.4.46 Given the history of the area, it is likely that Made Ground deposits would be encountered across the entire development footprint and extends to a significant depth. The Made Ground has been described as 'slag' and may represent a source of contamination. However, given the industrial nature of the area, there may also be residual contamination associated with other historical activities, particularly the presence of a number of landfills.

Solmek intrusive ground investigation (February 2011)

6.4.47 An intrusive ground investigation was undertaken by Solmek (Solmek, February 2011) in November and December 2010 in relation to a proposed onshore gas pipeline from the Breagh Field. Exploratory hole locations are shown on **Figure 6-3**. The investigation was undertaken within the utilities corridor located south of the landfill and in the vicinity of the WWTW, and comprised the 'drilling' of seven shell and auger boreholes and four machine excavated trial pits. Four of the boreholes were installed with combined groundwater and gas monitoring instruments. Eighteen soil samples were collected for the laboratory analysis of a range of potential contaminants of concern; a selection of these samples was scheduled for leachability testing and Waste Acceptance Criteria testing.





Legend:

- DCO Order Limits
- Borehole (BH)
- Trial Pit (TP)

DCO Order Limits as of 24/02/15

Client:	Project:
York Potash Limited	York Potash Project Harbour Facilities

Title:

Environmental Statement: Exploratory Hole Locations (Solmek Feburary 2011)

Part:	Figure:	Drawing No:
HF	6.3	9Y0989-HF-6-003

Rev:	Date:	Drawn:	Checked:	Size:	Scale:
1	04/03/2015	GC	SR	A3	1:3,000
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6.4.48 Four groundwater samples were also scheduled for laboratory analysis; these results are summarised in **Table 6-8**.

6.4.49 To determine the baseline condition of the soils and potential detrimental effects on human health as a result of the ground conditions, the results of the soil analysis were compared with Generic Assessment Criteria (GAC) for a commercial end use, assuming a soil organic matter content of 1%. The GAC were derived by Royal HaskoningDHV using the Contaminated Land Exposure Assessment model (CLEA) v1.06. The majority of samples did not exceed the GAC. Exceedances of the GAC are summarised in **Table 6-11**.

Table 6-11 Summary of soil exceedances

Potential Contaminants of Concern	Number of samples analysed	Number of exceedances against GAC/>LOD	GAC	Maximum concentration	Summary of exceedances
Asbestos	18	4	presence	presence	Chrysotile or amosite fibres were detected in: TP1020/0.3mbgl TP1017/0.6mbgl and 1.5mbgl BH2008/0.8mbgl
Lead	18	5	82-210	93-451	BH2007/2.0mbgl BH2009/1.2mbgl TP1017/1.5mbg TP1019/0.9mbgl TP1020/0.3mbgl
Benzo(a)pyrene	18	2	14	25.7	BH2010/0.3mbgl BH2011/0.4mbgl
Naphthalene	18	1	204	313.9	TP1017/1.5mbgl
1,3,5-trimethybenzene	7	1	0.08	1.68	TP10107/1.5mbgl
Dibenzofuran	7	2	ND	3.6	BH2010/0.3mbgl BH2011/0.4mbgl
Azobenzene	7	1	ND	13.8	TP1017/1.5mbgl

GAC – Generic Assessment Criteria
LOD – Limit of Detection
ND – Not Derived
mbgl – metres below ground level
Where there are several samples in the last column, bold text indicates the sample exhibiting the highest concentration

6.4.50 All exceedances were detected in samples recovered from the Made Ground generally comprising ash and slag. TP1017/0.6mbgl also exhibited a hydrocarbon odour, and TP1017/1.5mbgl also contained clinker.

6.4.51 Leachability testing was undertaken on seven soil samples to provide an indication of the potential mobility of contaminants. The laboratory results were compared to Environmental Quality Standards and the exceedances are summarised in **Table 6-12**.

Table 6-12 Summary of leachate exceedances

Potential Contaminants of Concern	Number of samples analysed	Number of exceedances against GAC/>LOD	EQS	Maximum concentration	Summary of exceedances
Copper	7	2	0.006	0.017	TP1017/0.6mbgl and 1.5mbgl
Naphthalene	7	2	0.0001	8.7314	TP1017/0.6mbgl and 1.5mbgl
Phenanthrene	7	2	0.0001	0.0005	BH2010/0.3mbgl BH2011/0.4mbgl
Fluoranthene	7	2	0.0001	0.0005	BH2010/0.3mbgl BH2011/0.4mbgl
Pyrene	7	2	0.0001	0.0006	BH2010/0.3mbgl BH2011/0.4mbgl
Benzo(a)anthracene	7	1	0.0001	0.0002	BH2011/0.4mbgl
Chrysene	7	1	0.0001	0.0002	BH2011/0.4mbgl
Benzo(b)fluranthene	7	1	0.0001	0.0002	BH2011/0.4mbgl
Benzo(a)pyrene	7	1	0.0001	0.0002	BH2011/0.4mbgl
TPH aromatic 5-7	7	1	0.001	0.003	TP1017/1.5mbgl
TPH aromatic 7-8	7	1	0.001	0.014	TP1017/1.5mbgl
TPH aromatic 8-10	7	2	0.001	0.102	TP1017/0.6mbgl and 1.5mbgl
TPH aromatic 10-12	7	2	0.001	8.773	TP1017/0.6mbgl and 1.5mbgl
TPH aliphatic 5-6	7	1	0.001	0.006	TP1017/1.5mbgl
TPH aliphatic 6-8	7	1	0.001	0.002	TP1017/1.5mbgl

Potential Contaminants of Concern	Number of samples analysed	Number of exceedances against GAC/>LOD	EQS	Maximum concentration	Summary of exceedances
TPH aliphatic 8-10	7	4	0.001	0.229	BH2008/0.8mbgl BH2010/0.3mbgl TP1017/0.6mbgl and 1.5mbgl
TPH aliphatic 10-12	7	4	0.001	0.168	BH2010/0.3mbgl BH2011/0.4mbgl TP1017/0.6mbgl 1.5mbgl
TPH aliphatic 12-16	7	5	0.001	0.196	BH2005/1.2mbgl BH2010/0.3mbgl BH2011/0.4mbgl TP1017/0.6mbgl 1.5mbgl
TPH aliphatic 16-21	7	5	0.001	0.183	BH2005/1.2mbgl BH2010/0.3mbgl BH2011/0.4mbgl TP1017/0.6mbgl 1.5mbgl
TPH aliphatic 21-35	7	5	0.001	0.248	BH2005/1.2mbgl BH2010/0.3mbgl BH2011/0.4mbgl TP1017/0.6mbgl and 1.5mbgl
TPH aliphatic 35-44	7	1	0.001	0.004	BH2010/0.3mbgl

GAC – Generic Assessment Criteria

LOD – Limit of Detection

mbgl – metres below ground level

Where there are several samples in the last column bold text indicates the sample exhibiting the highest concentration

Solmek intrusive investigation (August 2011)

6.4.52 An additional intrusive ground investigation was undertaken by Solmek (Solmek, August 2011) in June 2011 in relation to the proposed onshore gas pipeline from the Breagh Field. Exploratory hole locations are shown on **Figure 6-4.** The investigation was undertaken south-west of Bran Sands lagoon in the vicinity of the jetty (within the utilities corridor), west of the Solmek 2011 investigation, and comprised the 'drilling' of four shell and auger boreholes. One of the boreholes was installed with a combined groundwater and gas monitoring well.

6.4.53 Eight soil samples were scheduled for laboratory analysis of a range of potential contaminants of concern; a selection of samples was also scheduled for Waste Acceptance Criteria testing. Two groundwater samples were scheduled for laboratory analysis; these results are summarised in **Table 6-8**. Leachability testing does not appear to have been undertaken.

6.4.54 To determine the baseline condition of the soils and potential detrimental effects on human health as a result of the ground conditions, the results of the soil analysis were compared with GAC for a commercial end use, assuming a soil organic matter content of 1%. The GAC were derived by Royal HaskoningDHV using CLEA v1.06. The results are summarised below:

- The majority of samples did not record concentrations above the GAC.
- Asbestos (Amosite) was detected in one sample recovered from a depth of 2.0mbgl at BH6 at the base of the Made Ground.
- Royal HaskoningDHV has not derived a GAC for free cyanide; however, concentrations did not exceed the LOD in any of the samples analysed.

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Beacon
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Mud
Mean High Water
Bran Sands
BH3
BH4
Water
Teesside Works, Redcar
Pipe Tunnel
River Tees
Boro Const and UA Bdy
Mast
Pipe Gantry
BH6
BH7
Pipe Lines
Dabholm Gut
Bollard
Mud and Sand
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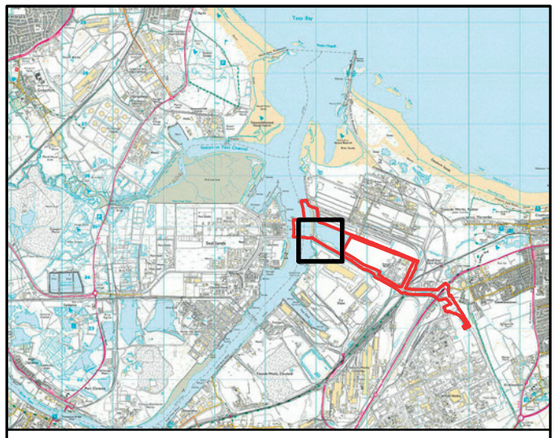

Legend:

- DCO Order Limits
- Borehole (BH)

DCO Order Limits as of 24/02/15

Client:	Project:
York Potash Limited	York Potash Project Harbour Facilities

Title:

Environmental Statement:Exploratory Hole Locations (Solmek August 2011)

Part:	Figure:	Drawing No:
HF	6.4	9Y0989-HF-6-004

Rev:	Date:	Drawn:	Checked:	Size:	Scale:
1	04/03/2015	GC	SR	A3	1:3,000
0	10/12/2014	GC	SR	A3	1:3,000

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Dunelm intrusive investigation (September 2014)

6.4.55 An intrusive ground investigation was undertaken by Dunelm in July and August 2014 (Dunelm, 2014) and is presented in **Appendix 6-2**. The objectives of the investigation were as follows:

- To investigate the superficial and bedrock geology and to obtain soil samples and rock cores of specific strata.
- To install standpipes at specific horizons for long term monitoring of groundwater levels and groundwater quality.
- To determine the chemical and geotechnical properties of the near surface soils and of the rock.

6.4.56 The investigation was undertaken within the embankment between Bran Sands lagoon and the Tees estuary, and comprised the 'drilling' of five cable percussive boreholes to a maximum depth of 27.20mbgl. The boreholes were continued using rotary core drilling to a maximum depth of 44.5mbgl. Three of the boreholes were installed with combined groundwater and gas monitoring instruments. Nine soil samples were scheduled for laboratory analysis of a range of potential contaminants of concern; the samples were also scheduled for leachability testing. Two groundwater samples were scheduled for laboratory analysis; these results are summarised in **Table 6-8**.

6.4.57 To determine the baseline condition of the soils and potential detrimental effects on human health as a result of the ground conditions, the results of the soil analysis have been compared with GAC for a commercial end use, assuming a soil organic matter content of 2.5%. The GAC were derived by Royal HaskoningDHV using CLEA v1.06. The results are summarised below:

- The majority of samples did not record concentrations above the GAC.
- Asbestos (Amosite and Chrysotile) was detected in one sample recovered from a depth of 1.5mbgl at BHP5B within Made Ground.
- Royal HaskoningDHV have not derived a GAC for free cyanide; however, concentrations did not exceed the LOD.

6.4.58 Leachability testing was undertaken on nine soil samples to provide an indication of the potential mobility of contaminants. The laboratory results have been compared against the Environmental Quality Standards and results are summarised below:

- The majority of samples did not record concentrations above the GAC.
- Copper was recorded in five out of twelve samples at concentrations exceeding the GAC; the concentrations ranged from 1.3µg/l to 2.7µg/l at BHP5B, against a GAC of 1.0µg/l. All samples were recovered from the Made Ground.

BGS Soil Geochemistry Maps

6.4.59 The BGS Estimated Soil Geochemistry maps for the site and environs indicate concentrations of arsenic within soils ranging from <15mg/kg to 25mg/kg, cadmium at concentrations <1.8mg/kg, chromium at concentrations ranging from 60mg/kg to 90mg/kg, lead concentrations ranging from <150mg/kg to 300mg/kg and nickel concentrations ranging from 15mg/kg to 30mg/kg. These concentrations are considered to represent baseline conditions at this site. However, the intrusive

investigations indicated that concentrations of cadmium, chromium, lead and nickel at some exploratory holes were greater than the BGS Soil Geochemistry maps indicate.

Landfills

6.4.60 The locations of historic and current landfills in relation to the site boundary are presented in **Figure 6-5** and discussed below.

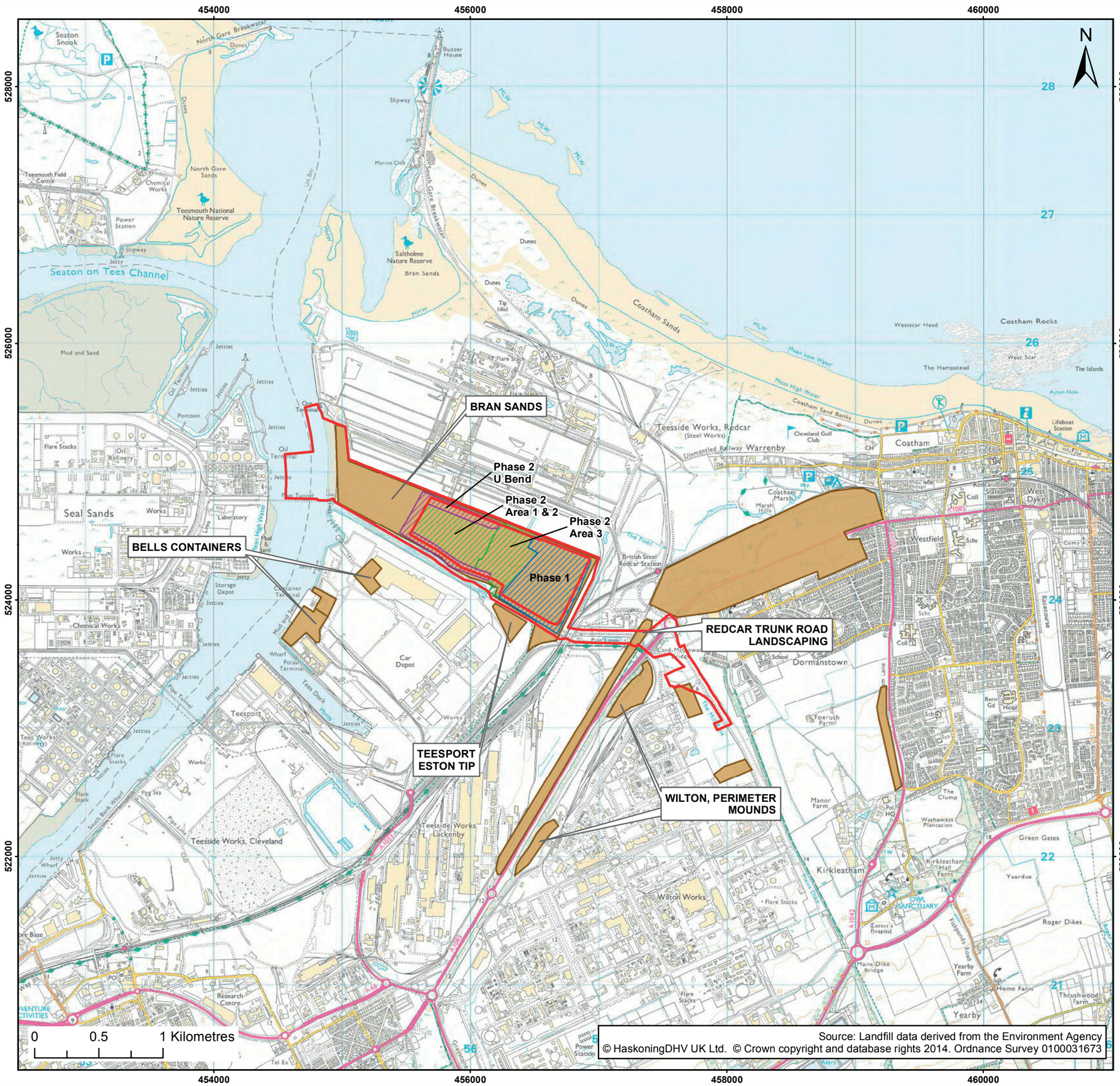
Bran Sands Landfill

6.4.61 Environment Agency mapping indicates that the proposed scheme is to be located partially within the boundary of the currently permitted Bran Sands landfill. Construction and operation of the proposed development would be outside of the landfilled area, away from the capped waste mass. The landfill itself was capped in two phases, as shown on **Figure 6.5**: Phase 1 comprises the eastern area upon which the NWL sludge treatment plant is situated; Phase 2 is the vacant land lying between Phase 1 and Bran Sands lagoon.

6.4.62 The Waste Management Licence (reference EAWML60092) permitted the Bran Sands Landfill site to accept controlled waste as defined by Section 75 of the Environmental Protection Act 1990 (as amended), including inert waste, general and biodegradable waste, metals, contaminated general wastes, asbestos and mineral wastes from thermal processes.

6.4.63 Available information indicates that wastes have been deposited at the site since at least the 1970s, although anecdotally landfilling is known to have been undertaken from the 1940/50s. It is understood that the landfill has been a co-disposal landfill, initially being used by ICI for disposal of process waste from the chemical industry. Records indicate waste deposits included drums, tar actactic, terepthalic acid, slag, dry factory refuse, oil, ash, mercury contaminated spoil, phenol contaminated wastes and oily liquids (ranging from 2% to 100% oil). More recent deposits include metals and discarded scrap composite equipment, contaminated general wastes, asbestos waste, mineral wastes and residues from thermal processes. It is reported that the lower waste deposits were covered with slag and dry factory refuse and that oil lagoons/ cells were dewatered in the 1990s and stabilised with fly ash. The thickness of the waste deposits is reported to be more than 10m in some locations. It is understood that the most of the landfill is not lined and that the base of the waste deposits may sit directly on the underlying estuarine deposits. Some later cells (including cells 15 and 17) were built with clay liners, although these pre-date modern landfill engineering standards and construction quality assurance provision so the efficacy of the liners is uncertain (Grontmij, 2014).

6.4.64 Historical plans of the landfill layout show the contents of each cell. Cells 15 and 17 located in the east of Phase 2 contain tars and tar-atactic (refer to **Figure 6-5**). The quadrant and the area immediately to the north contained dry factory refuse filled to a level of 30ft (9m) AOD. The remainder of Phase 2 comprises numerous disposal cells containing atactic, drums reported to contain polymer or surfactant type wastes, teraphthalic acid, mercury contaminated scrap and phenol contaminated wastes (only Cell 159). The cells were generally filled to 18ft (5.4m) AOD with these wastes and covered with slag and dry factory refuse to 30ft (9m) AOD to produce the current site profile.



Legend:

- DCO Order Limits
- Landfill Sites

Bran Sands Landfill Site

- Phase 1
- Phase 2
- Phase 2 (U Bend Area)

DCO Order Limits as of 24/02/15

Client:	Project:
York Potash Limited	York Potash Project Harbour Facilities

Title: Environmental Statement: Landfill Sites

Part:	Figure:	Drawing No:
HF	6.5	9Y0989-HF-6-005

Rev:	Date:	Drawn:	Checked:	Size:	Scale:
1	04/03/2015	GC	SR	A3	1:30,000
0	09/12/2014	GC	SR	A3	1:1,000,000

Co-ordinate system: British National Grid

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6.4.65 Cells 63, 64 and 65 were used to dispose of tar with water, clean oil and oil respectively. Oil and oily water wastes were generated from ICI's three manufacturing sites on Teesside. These wastes were disposed of in different lagoons at the site depending upon their oil content which ranged from approximately 2% to 100% oil. No agro-chemicals or pharmaceutical industry wastes were deposited at the site. Liquid wastes were not disposed of after 1988 and in the 1990s the oil lagoons/ cells were dewatered and stabilised with fly ash.

6.4.66 Waste is no longer deposited within the Bran Sands Landfill and the landfill has been capped with a composite capping system and is the subject of a Closure Plan agreed with the Environment Agency. Capping was completed in April 2007, with restoration completed in 2008. Data suggests that the side slopes of the Phase 2 area comprises a 1.0m thick clay cap. The remainder of the Phase 2 area was capped with a 300mm thick clay layer, overlain by a high-density polythene geomembrane, overlain by a protection geotextile which was then overlain by 1.0m of subsoil and topsoil. A surface water drainage system is in place to prevent excessive infiltration and damage to the capping system.

6.4.67 A sewage sludge treatment centre, operated by NWL, is located on the eastern side of the landfill site.

6.4.68 Leachate from the landfill site is collected from leachate extraction chambers located within the waste mass. It is then pumped to one of three leachate holding lagoons prior to being pumped to the sewer system under a discharge consent. Leachate is reported to meet discharge consent parameters.

6.4.69 Surface water is currently collected via two swales to prevent ponding and control surface water run-off. Surface water is ultimately discharged to the Bran Sands lagoon to the west.

6.4.70 Landfill gas is managed via a landfill gas utilisation scheme. Gas is extracted from a number of wells and gas fields and used to produce electricity.

6.4.71 A review of the annual monitoring reports for the Bran Sands Landfill was carried out by Amec on behalf of YPL (Amec, 2012). Environmental monitoring (groundwater, ground gas and leachate monitoring) is being carried out in accordance with the Closure Plan for the site. It was reported that monitoring parameters, locations and frequency are in compliance with the Environmental Permit and Closure, Restoration and Aftercare Plan (Amec, 2012).

Teesport Eston Tip Landfill

6.4.72 To the south of Bran Sands Landfill there is a historic landfill known as Teesport Eston Tip, which was operational from December 1977 to September 1993. According to the Environment Agency, waste deposited in this landfill comprised industrial wastewater, sewage sludge and chemical wastes mixed with municipal solid waste.

Redcar Trunk Road Landfill and Wilton Perimeter Mounds Landfill

6.4.73 There are landfill sites located to the south-east of the Bran Sands landfill site, namely Redcar Trunk Road and Wilton Perimeter Mounds. Waste was received at the Redcar Trunk Road landfill site from September 1977 to August 1979 and the site was licensed to receive inert and industrial waste.

Ground gas

6.4.74 Gas monitoring is undertaken within the development footprint at the Bran Sands Landfill site as required by the Environmental Permit and subsequent Closure, Restoration and Aftercare Plan. Gas monitoring is undertaken monthly within the waste mass and external to the waste mass. For the purpose of understanding the baseline conditions, only the data associated with the external monitoring has been reviewed.

6.4.75 Monitoring is undertaken at 29 monitoring wells primarily located adjacent to and around the perimeter of the landfill, with the exception of one monitoring well located adjacent to and west of Bran Sands lagoon. This monitoring well is located within the footprint of the proposed scheme. The parameters monitored at all the monitoring wells include methane, carbon dioxide, oxygen and atmospheric pressure.

6.4.76 The results for 2013 indicate fluctuating methane concentrations at a number of monitoring wells. However, methane was not detected at fourteen monitoring wells. The maximum range and concentration was recorded at BH06/05 (0.1%volume/volume (v/v) - 81.2%v/v), with an average methane concentration over the monitoring period of 21.1%v/v. Although this monitoring well exhibited the greatest range in methane concentration, a number of other monitoring wells recorded higher average concentrations. A maximum average methane concentration of 68.3%v/v was recorded at BH06/06. BH06/05 and BH06/06 are located along the south-western boundary of the landfill. Methane exceeded the trigger value on several monitoring visits.

6.4.77 The results for 2013 indicate fluctuating carbon dioxide concentrations at a number of monitoring wells. The maximum range and concentration was recorded at BH06/21 (0.1%v/v – 68.3%v/v), with an average carbon dioxide concentration over the monitoring period of 5.7%v/v. Although this monitoring well exhibited the greatest range of carbon dioxide concentrations a number of other monitoring wells recorded higher average concentrations. A maximum average carbon dioxide concentration of 26.9%v/v was recorded at BH06/06. BH06/21 and BH06/06 are located along the north-eastern and south-western boundary of the landfill respectively. Carbon dioxide exceeded the trigger value on several monitoring visits.

6.4.78 A summary of the average methane and carbon dioxide concentrations is presented in **Table 6-13**.

Table 6-13 Summary of average methane and carbon dioxide concentrations

Methane		Carbon Dioxide	
Number of wells	**Concentration range (%v/v)**	**Number of wells**	**Concentration range (%v/v)**
14	0	5	0
5	<5	17	<5
1	<10	3	<10
2	10-20	2	10-20

Methane		Carbon Dioxide	
Number of wells	Concentration range (%v/v)	Number of wells	Concentration range (%v/v)
1	20-30	2	20-30
3	30-40		
1	40-50		
2	60-70		

6.4.79 As noted above, a monitoring well is located within the footprint of the proposed scheme (BH06-29); the next nearest monitoring wells are located west of the landfill adjacent to the eastern boundary of Bran Sands lagoon (BH06-07, BH06-08). The results from these monitoring wells are summarised below.

- BH06-07: methane concentrations ranged from 0%v/v to 65%v/v with an average concentration of 34.8%v/v; carbon dioxide concentrations ranged from 0%v/v to 12.2%v/v with an average concentration of 5.2%v/v; methane and carbon dioxide exceeded their respective triggers during the majority of the monitoring visits.
- BH06-08: methane concentrations ranged from 47.5%v/v to 70.5%v/v with an average concentration of 66.67%v/v; carbon dioxide concentrations ranged from 19.5%v/v to 29.5%v/v with an average concentration of 24%v/v; methane and carbon dioxide exceeded their respective triggers during each monitoring visit.
- BH06-29: methane was not detected during the monitoring period; carbon dioxide concentrations ranged from 0%v/v to 0.3%v/v with an average concentration of 0.1%v/v; methane and carbon dioxide did not exceed their respective triggers during 2013, and the concentrations are consistent over the long term.

6.4.80 When assessing the risk to human health / structures from ground gas, it is current practice to undertake a gas risk assessment in accordance with current guidance (CIRIA 665). A gas screening value is derived based on the maximum gas concentration and maximum flow rate. This value is then compared to a range of gas characteristic situations to determine what mitigation measures would be required.

6.4.81 In this case the monitoring reports do not present gas flows or a gas risk assessment, only the results of the monitoring and any non-compliance against the trigger values; and therefore a gas screening value cannot be generated.

6.4.82 Although significantly elevated gas concentrations have been recorded adjacent to the landfill, the monitoring well adjacent to the proposed quay does not exhibit elevated gas concentrations, and has not over the long term.

Human health

6.4.83 The footprint of the proposed development incorporates an embankment (located between the Tees estuary and the Bran Sands lagoon), a utilities corridor / access track located adjacent to and south of the Bran Sands lagoon and landfill and a corridor of land located north of Bran Sands lagoon and

landfill. With the exception of the corridor to the north of the Bran Sands lagoon and landfill, the footprint falls within the boundary of the Environmental Permit for the landfill, although it is understood that the footprint is located outside of the boundary of the former landfilling operations. Although the lagoon was originally excavated to form another waste cell, waste has not been deposited in this area.

6.4.84 The topography of the site is generally flat and can be accessed on foot and by vehicle. Well defined access tracks are present to the south and west of the landfill and lagoon. Significant utility infrastructure is present along the southern conveyor envelope and may also be present in other areas of the site. As discussed within **Section 21**, there is a public right of way that enters the DCO application boundary and terminates adjacent to Dabholm Gut, as well as the Teesdale Way National Trail and a combined footpath and traffic free-cycle route which passes through the site along the A1085 road. The ground conditions comprise Made Ground with some concrete hard standing and, based on the data from third party reports and the conservative assessment of the data presented in this ES, potential contaminants of concern are present at the site at concentrations that could have detrimental impacts on human health if exposure were to occur.

6.4.85 Given the commercial nature of the site, the critical human health receptor would be adults involved in construction, maintenance and monitoring activities. Off-site human health receptors include adults involved in other commercial/industrial operations adjacent to the site, and residents of Dormanstown who are located approximately 3km from the port terminal and approximately 100m from the conveyor at it the nearest point. The critical receptor associated with adjacent residential developments would be young children (females).

6.4.86 On-site receptors could be exposed to contaminants of concern through dermal contact, ingestion and inhalation. Exposure to off-site receptors would be confined to ingestion and inhalation of fugitive dusts and gases.

Sensitivity – human health

6.4.87 Due to historical activity, contaminants are present within the embankment and access track south of the landfill that could have detrimental impacts on human health based on the conservative assessments undertaken. However, access to the site is secure and only operatives involved in construction, maintenance and monitoring activities are likely to access the site. Whilst public access is possible via the public right of way and Teesdale Way National Trail, any exposure would be short term. Any works undertaken in this area would be strictly controlled by the site operators and would be undertaken in compliance with current health and safety regulations and site rules, and any exposure would be short term.

6.4.88 The sensitivity of on-site and off-site commercial workers who will adopt appropriate working practices and PPE is considered to be low and for off-site residents (children) medium.

6.5 Assessment of potential impacts during construction

6.5.1 As outlined in **Section 3**, the proposed scheme incorporates the creation of a berth pocket, either an open or closed quay structure, ship loading facilities, product storage surge bins, conveyors for product transfer from the MHF to the port terminal (either routed to the north or south of the landfill), access infrastructure and welfare facilities.

6.5.2 Full details on the activities proposed during the construction phase of the proposed scheme are provided in **Section 3** and summarised below in the context of this section of the ES:

- Open quay structure:
  - installation of the piles using floating plant
  - construction of the concrete deck
  - revetment of the river embankment
  - installation of mechanical and electrical services
  - installation of materials handling plant on the quay

- Solid quay structure:
  - installation of the combi-pile wall using floating plant
  - partial reclamation
  - installation of anchor wall and crane beam using landside plant
  - installation of materials handling plant on the quay
  - installation of mechanical and electrical services
  - construction of the concrete deck.

- Storage surge bins and conveyor system:
  - installation of reinforced concrete pad foundations or piled foundations for the storage surge bins and transfer towers
  - installation of piled foundations for conveyor support towers.

- Office facilities:
  - construction of foundations
  - construction of steel framed structure with pitched roof or portacabin type structure
  - positioning of containers for storage
  - car park.

- Habitat enhancement scheme:
  - Deposition of capital and maintenance dredged material within Bran Sands lagoon to create a new shallow water area, islands and intertidal fringes.

6.5.3 The key activities associated with the construction of these facilities that potentially could result in impacts to hydrology, hydrogeology and human health would be earthworks and construction of piled foundations.

Environmental risk mitigation

6.5.4 All construction work has the potential to impact on land and water quality and human health, through spillages, mobilisation of sediment and contaminants by surface run-off or disturbance of contaminated ground. To minimise the risk of such impacts, all construction phase activities would be carried out in accordance with the following:

- Best practice guidance outlined in **Section 6.2** including the Environment Agency's Pollution Prevention Guidance (PPG) notes and guidance from the Construction Industry Research and Information Association (CIRIA).

- Adherence to Construction Design and Management (CDM) Regulations 2007 where applicable.
- Adherence to the Construction and Environmental Management Plan (CEMP) and an Incident / Emergency Response Plan.
- All works to be carried out by appropriately trained personnel.
- Appropriate PPE and working practices to be adopted by construction workers, including subcontractors, and health and safety measures would be undertaken to mitigate any short term risk during construction.

6.5.5 Groundwater and surface water monitoring has been undertaken over a number of years as part of the aftercare monitoring associated with the Bran Sands Landfill. Groundwater and surface water monitoring would continue throughout the construction phase with the objective of detecting any departure from the established baseline. This would include a contingency plan, detailing actions to be taken should a departure from the baseline be identified. Relevant guidance and monitoring requirements would be set out in the CEMP (an outline version of which is presented in **Appendix 6.4**).

6.5.6 The following impact assessment has been developed assuming the above principles would be adopted throughout the construction, operation and decommissioning phases. Where additional mitigation measures are considered necessary for a particular potential impact, these are highlighted.

Soils

6.5.7 Intrusive investigations have confirmed that, generally, the site of the proposed scheme is devoid of a natural surface soil resource and significant deposits of Made Ground are present. Laboratory testing of soil samples and subsequent data assessment has indicated that the soils contain potential contaminants of concern at isolated locations that could impact hydrology, hydrogeology and human health; these impacts are discussed in the following sections.

6.5.8 Due to the industrial nature of the site, and the absence of natural surface soils, soils are not an agricultural resource and are not considered to be a sensitive receptor in this respect. Therefore, as set out above, an agricultural soils impact assessment on the soil has not been undertaken.

6.5.9 Construction activities within the development footprint would involve the excavation of soils and is likely to involve the movement of soil around the site for stockpiling, potential re-use or disposal. These activities could result in the relocation and disturbance of potentially contaminated soils. The potential for cross contamination as a result of soil movements would be mitigated following the principles of the CL:AIRE Code of Practice incorporating the development of a materials management plan. Excavated soils would be chemically tested and screened against Regulatory approved assessment criteria to demonstrate the soils are suitable for use prior to re-placement on-site.

Potential impacts to hydrology (surface waters and land drainage)

6.5.10 There is potential for the proposed scheme to impact nearby surface water bodies in a number of ways, including:

- Increase of suspended solids.
- Deterioration in surface water quality (via contaminated run off).

- Deterioration of surface water quality due to impacts on groundwater quality (where these are in hydraulic continuity).
- Smaller tidal water level range due to reduced seepage through estuary embankment.

6.5.11 The potential for pollution of surface water is principally limited to the construction phase when high levels of suspended solids and/ or leachates from Made Ground have the potential to enter local watercourses during earthworks. Due to the low lying coastal location of the site, there is the potential that soils could wash away during extreme weather events directly into the adjacent surface water features.

6.5.12 Groundwater within the Made Ground and superficial deposits is considered to be in hydraulic continuity with surface waters in the Tees estuary, Bran Sands lagoon and Dabholm Gut. Surface water quality is therefore susceptible to impacts on groundwater but these are assessed as negligible (see below).

6.5.13 Given that fuels, oils and chemicals would be stored on-site during certain phases of works (for example, for the re-fuelling of machinery) spillages and leakages could occur. These potential spillages and leakages are likely to be localised; however, depending on location, they may present a risk to surface water quality. This is unlikely to result in significant pollution given the on-site management protocols that would be adopted.

6.5.14 The proposed solid quay option would involve a combination steel pile and sheet pile wall constructed on the estuary side of the tidal embankment, extending down into the Mercia Mudstone bedrock. This could prevent any seepage of estuarine or lagoon water through the embankment. Groundwater level data suggests there is currently good connectivity between these two water bodies therefore without mitigation, this option could result in a reduced tidal range within the lagoon and potentially also, an increase in water level. To ensure that water levels within the lagoon are not significantly affected by this option, seepage flow through the embankment, and groundwater flow within the superficial deposits would be accounted for during the design of the proposed habitat enhancement proposals. No further mitigation for this impact would therefore be required.

6.5.15 The open quay structure would involve placement of a rock revetment on the estuary side of the embankment but this would have a negligible impact on embankment permeability, therefore water levels within the lagoon would be unaffected.

6.5.16 The placement of dredged material within Bran Sands lagoon as part of the habitat creation scheme has the potential to impact on water quality. This is discussed separately within **Section 7.5**.

6.5.17 As set out in the baseline section above, based on the use of the Tees estuary, Bran Sands lagoon and Dabholm Gut by waterbird populations, the sensitivity of the surface water receptors is considered to be high. However, given the mitigation that would be adopted during the construction phase, it is considered that potential effects on water quality would be of a very low magnitude. Consequently, the potential impact to surface water is predicted to be of **negligible** significance.

Impacts to hydrogeology (groundwater)

6.5.18 There is potential for the proposed scheme to impact hydrogeology in a number of ways, including:

- levelling and raising of site levels;
- alteration of groundwater flow around piled foundations;
- alteration of groundwater discharge through the base of Bran Sands lagoon; and,
- deterioration in groundwater quality (via contaminated run off, infiltration and leaching).

6.5.19 The piling for the port terminal, surge bin foundations and conveyor support foundations may extend into the underlying bedrock aquifer. However, any excavations would be superficial and would not extend into the aquifer. As a consequence of the construction works, the ground level across the proposed construction area may require a degree of levelling and, for the solid quay structure, there would be the need for reclamation materials; however, this would be sourced from off-site and would comply with agreed re-use criteria.

6.5.20 Both quay options would require circular steel piles extending into the Mercia Mudstone. The solid quay would also involve intervening steel sheet piles, extending to a shallower depth, likely to be approximately level with the base of the superficial deposits. The solid quay option would therefore obstruct groundwater flow within the superficial deposits and has the potential to cause a local increase in groundwater and surface water level on the up-gradient side. Possible consequences for Bran Sands landfill are that the integrity of lined waste cells may be compromised or they may become flooded, leading to mobilisation of pollutants. Whilst excess leachate should be collected by the leachate drainage system the response of the landfill to a significant change in groundwater level conditions is difficult to predict.

6.5.21 However, Dabholm Gut, located immediately to the south of the site, is in hydraulic continuity with the superficial aquifer and provides an unobstructed discharge zone for groundwater within the Tidal Flat deposits, that would allow any increase in groundwater head behind the sheet piles to dissipate over a short distance. In addition the design of the proposed habitat enhancement proposals within Bran Sands lagoon would allow for effects on groundwater flow and flow due to the presence of the solid quay structure (if progressed). Any increase in groundwater level is therefore likely to be marginal and far below that which could result in the adverse effects described above.

6.5.22 The ground level would remain above the groundwater table and it is unlikely that groundwater would be encountered as part of these works (with the exception of piling). With regard to the piling, the bedrock aquifer is described as an aquifer with limited groundwater and / or limited flow via fissures or fractures and, consequently, the aquifer is not used as a resource. The effect of piling on flow is likely to be localised in terms of the Tees Mercia Mudstone and Redcar Mudstone groundwater body. The magnitude of the effect on the groundwater flow from both excavation and piling is considered to be low.

6.5.23 Intrusive investigations have indicated that a significant depth of Made Ground is present at the site and potential contaminants of concern are present in the Made Ground and adjacent landfill, which could impact the groundwater through leaching and lateral migration.

6.5.24 Dependent on the piling method employed, groundwater quality of the aquifer units may be affected by piling foundations. There is the potential to generate a viable pollutant linkage between the potentially contaminated shallow soils (Made Ground) and groundwater (perched or otherwise), which may impact upon the aquifer units below and, any surface waters to which they are hydraulically connected.

However, due to other site constraints it is proposed that reinforced concrete piles will be installed by bored piling methods. Due to the nature of the Made Ground the holes will be cased during the boring operation and the hole filled with concrete on completion of the boring operation. The piling works would be undertaken in accordance with Environment Agency guidance (Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, NC/99/73 (May 2001). During the boring operation soil is removed from the hole minimising the potential for dragging down contamination through the hole. The casing also minimises the potential for creating preferential pathways, therefore any effects on groundwater or surface water quality are likely to be of a very low magnitude.

6.5.25 Given that fuels, oils and chemicals would be stored on-site during certain phases of works (for example, for the re-fuelling of machinery), spillages and leakages could also occur. These potential spillages and leakages are likely to be localised; although they may present a risk to groundwater quality. However, this is unlikely to result in significant pollution given the on-site management protocols that would be adopted.

6.5.26 The habitat enhancement proposals detailed in **Section 3.1** and shown in **Drawing PB1586-SK466** and **PB1586-SK467**, involve placing a relatively thin layer of dredged material over a small proportion of the lagoon basal area. This would be placed away from the existing landfill cap so as not to impact on leachate heads within the landfill. It is therefore considered that any effects on groundwater discharge flow and quality would be of a very low magnitude.

6.5.27 The sensitivity of the groundwater in the superficial deposits is considered to be low, and in the bedrock aquifer, very low, as the water is of poor quality and not used as a resource (i.e. there are no known groundwater abstractions in the area). However, groundwater is considered to be in hydraulic continuity with surface waters, which are considered to be of high sensitivity.

6.5.28 The overall effects on groundwater flow, level and quality are likely to be very low magnitude. As a result the potential impact on groundwater, has been assessed as being of **negligible** significance.

Potential impact to human health associated with exposure to contaminants of concern during earthworks

6.5.29 During the construction phase, excavation within the Made Ground could disturb potential contaminants of concern and impact human health via dermal contact, ingestion or inhalation of soil, dust and any associated ground gases which may be present.

6.5.30 The soil quality has been shown to exhibit a range of potential contaminants of concern at concentrations exceeding the human health assessment criteria for a commercial / industrial land use. The potential contaminants of concern include asbestos, benzo(a)pyrene, naphthalene and 1,3,5-trimethylbenzene. Elevated concentrations of dibenzofuran were recorded in BH2010 and 2011 and azobenzene was recorded at a significant concentration in TP1017.

6.5.31 Key potential receptors include construction workers, off-site personnel and off-site residents. The sensitivity of construction workers and off-site personnel is considered to be low but the magnitude of the effect is considered to be high due to the presence of asbestos. The potential impact is, therefore, predicted to be of **minor adverse** significance.

6.5.32 The sensitivity of off-site residents is considered to be medium and the magnitude of the effect is considered to be high. The potential impact is, therefore, predicted to be of **moderate adverse** significance in this instance.

Mitigation and residual impact

6.5.33 In addition to the environmental risk mitigation measures described above, an asbestos management strategy will be developed to address potential impacts associated with asbestos. The implementation of this additional mitigation would reduce the magnitude of this effect to very low for all receptors (on the basis that there would be no effect); and the residual impact would be of negligible significance (for all receptors).

Potential impact to human health associated with potential exposure to ground gas

6.5.34 Significant gas concentrations have been recorded in boreholes adjacent to the landfill within the footprint of the conveyor route envelopes. Key potential receptors include construction workers, off-site personnel and off-site residents who could be exposed to elevated ground gas within confined spaces such as excavations for foundations / utilities, and as a result of off-site migration through preferential pathways associated with foundations and utility infrastructure.

6.5.35 The sensitivity of construction workers and off-site personnel is considered to be low but the magnitude of the effect is considered to be high. The potential impact is, therefore, predicted to be of **minor adverse** significance.

6.5.36 The sensitivity of off-site residents is considered to be medium and the magnitude of the effect is considered to be high; therefore, the potential impact is predicted to be of **moderate adverse** significance.

Mitigation and residual impact

6.5.37 In addition to the environmental risk mitigation measures described above, further monitoring of the gas regime will be undertaken so that mitigation measures can be implemented. These measures would reduce the magnitude of the predicted effect to very low for all receptors (on the basis that there would be no effect). The residual impact is, therefore predicted to be of **negligible** significance (for all receptors).

Introduction of new contaminants through leaks and spillages

6.5.38 The introduction of new contaminants, such as hydrocarbon based compounds, as a result of leaks and spillages is possible given that mechanised machinery would be used during the construction phase. Leaks and spillages could occur through poor maintenance of machinery, failure of components (e.g. hydraulic hoses) or poor site practices (e.g. poor storage facilities, refuelling protocols), although any such event is likely to be very localised.

6.5.39 The key potential receptor is considered to be construction site workers. The sensitivity of construction workers is assessed as low and the magnitude of the effect is considered to be low. The significance of the impact is, therefore, predicted to be of **negligible** significance.

Introduction of new contaminants through imported fill materials

6.5.40 There are currently two options under consideration for the construction of the quay, one of which is a solid quay structure. If this option is progressed, the quay wall would be backfilled; this is likely to require the use of imported fill materials if insufficient suitable capital dredged material arises.

6.5.41 Imported materials would only be used on-site where their provenance can be confirmed (e.g. quarry documentation / laboratory analysis and subsequent assessment to confirm the material is suitable for use). Receptors, therefore, would not be exposed to potential contaminants of concern associated with imported material. The magnitude of the effect is considered to be very low for all receptors and the significance of the impact is predicted to be **negligible**.

6.6 Assessment of potential impacts during operation

6.6.1 On completion of the construction works the principle activities undertaken within the footprint of the scheme would be the transfer of polyhalite from the MHF to the storage surge bins, bulk storage of polyhalite within the surge bins, subsequent periodic loading of ships at the quay, and associated maintenance activities.

6.6.2 There would be a number of potential contamination sources present on site during the operational phase of the proposed scheme. Polyhalite, which contains potassium, calcium and magnesium sulphate (K_2SO_4 $MgSO_4$ $2CaSO_4$ $2H_2O$), would be handled and stored on-site and limited quantities of fuels and oils may be stored on-site.

6.6.3 Made Ground has been shown to contain a limited number of potential contaminants of concern at concentrations exceeding the assessment criteria for a commercial / industrial end use, including asbestos. Elevated gas concentrations have also been recorded adjacent to the landfill.

6.6.4 The potential impacts arising from operational activities could include the contamination of soil and potential impacts to surface water quality via contaminated run off, as well as potential impacts to groundwater quality via infiltration. There is also the potential for operational activities to impact human health as a result of exposure to potential contamination sources as discussed in the following sections.

Potential impact on hydrology, hydrogeology and human health

6.6.5 The volumes of potentially polluting substances stored and handled on-site during the operational phase would be limited. Furthermore, physical controls would be in place in the form of enclosed storage areas for these materials, which would only be handled by trained personnel, in accordance with standard operating procedures, developed based on Materials Safety Data Sheets. The polyhalite granules are not immediately soluble and will be also be wax-coated.

6.6.6 Surface water from the port terminal would be collected, transferred and discharged through existing drainage systems during its operational phase. This will enable water to drain from the surface area of the proposed scheme without impacting upon the water quality within the Tees estuary.

6.6.7 Any impact to hydrology and hydrogeology during operation would be local, given the measures discussed above. Therefore, the potential effects associated with the on-site storage of polyhalite and

hydrocarbons during operation are considered to be of a low magnitude for surface waters and very low magnitude for groundwater. Given the high sensitivity of the surface waters, an impact of **minor adverse** significance is anticipated. Impacts on low and very low sensitivity groundwaters would be **negligible**. The sensitivity of site operatives is assessed to be low and the magnitude of the effect is also considered to be low; therefore, the significance of the impact is predicted to be **negligible**.

6.6.8 Site operatives and off-site personnel/residents could be exposed to ground gas as a result of the build-up of gas in enclosed spaces, such as on-site structures, and as result of migration through preferential pathways associated with foundations and utility infrastructure. However, although elevated ground gas concentrations have been recorded around the landfill, elevated gas concentrations have not been recorded in the area of the proposed structures. Furthermore, ongoing monitoring would be undertaken and if deemed necessary gas protection measures would be incorporated within the building to sever the pathway, and to prevent migration through preferential pathways such as utility ducts.

6.6.9 Site operatives and off-site personnel could also be exposed to potential contaminants of concern within the Made Ground as a result of wind-generated dust. However, the potential for wind-generated dusts within the site during normal operation is considered unlikely as the site comprises crushed stone tracks and vegetated areas.

6.6.10 Although asbestos has been identified at the site, an asbestos management strategy would be developed prior to the construction works to address potential impacts associated with asbestos; this would also address potential impacts during operation.

6.6.11 The sensitivity of site operatives and off-site personnel is assessed as low and the magnitude of the effect is considered to be very low. The significance of the impact is predicted to be of **negligible** significance.

6.6.12 The sensitivity of off-site residents is considered to be medium and the magnitude of the effect is considered to be very low. The potential impact is, therefore, predicted to be of **negligible** significance.

Assessment of potential impacts during decommissioning

6.6.13 The proposed port terminal would be a long term infrastructure proposal, with no plans to decommission it. However, there is a decommissioning plan for the proposed conveyor system from the MHF to the port terminal.

6.6.14 The decommissioning of the conveyor system would comprise the complete removal of site infrastructure (including site wide utilities, concrete / steel structures, platforms, foundations (or cutting them off at ground level) and drainage systems) and remedial works in order to allow the site surfaces to blend into the surrounding environment. Where possible, materials would be kept on site and used within the restoration works. Any materials not suitable for re-use would be removed from site and recycled if suitable. Further details are provided in **Section 3.**

6.6.15 The key activities associated with the decommissioning phase that potentially could result in impacts to human health would be earthworks associated with the excavation of the ground to expose foundations and the removal of utilities, draining down of fuels/oils from equipment and the backfilling of voids.

Potential impacts to hydrology and hydrogeology

6.6.16 There is potential for the decommissioning phase of the proposed scheme to impact nearby surface water bodies and groundwater primarily as a result of disturbance of soils, and the subsequent increase in suspended solids, and as a result of leaks/spillages from machinery. However, the decommissioning works would incorporate the risk mitigation principles referred to in **Section 6.5**; therefore any impacts would be localised and unlikely to result in significant pollution incidents.

6.6.17 Although, the sensitivity of the surface water receptors is considered to be high, any effects on water quality during decommissioning are likely to be of a low magnitude. Consequently, the significance of the impact to surface water is assessed as **minor adverse** and for groundwater (low / very low sensitivity), to be **negligible.** .

Potential impact to human health

6.6.18 There is potential for the decommissioning phase of the scheme to impact human health (including on and off-site receptors) primarily as a result of excavations in soils that have been shown to exhibit potential contaminants of concern, including asbestos, exposure to ground gases, exposure to dust as a result of crushing operations, backfilling excavations and exposure to leaks/spillages from machinery.

6.6.19 The decommissioning works for the conveyor would incorporate the risk mitigation principles referred to in **Section 6.5**. Furthermore additional mitigation measures are proposed as part of the construction phase, including an asbestos management strategy and further assessment of the ground gas regime to determine the need for additional mitigation measures. These mitigation measures would also be applied to the decommissioning phase. Potential impacts are assessed below.

In-situ soil quality

6.6.20 The sensitivity of construction workers and off-site personnel in 100 years' time is assessed to be low and the magnitude of the effect associated with soil quality is considered to be very low. The potential impact is, therefore, predicted to be of **negligible** significance.

6.6.21 The sensitivity of off-site residents is assessed as medium and the magnitude of the effect is considered to be very low. Therefore, the significance of the impact is predicted to be **negligible**.

Ground gas

6.6.22 The sensitivity of construction workers and off-site personnel is assessed as low and the magnitude of the effect is considered to be very low. The potential impact is, therefore, predicted to be of **negligible** significance.

6.6.23 The sensitivity of off-site residents is assessed as medium and the magnitude of the effect is considered to be very low; therefore, the significance of the impact is considered to be **negligible**.

Crushing operations

6.6.24 Crushing operations would be associated with the crushing of uncontaminated demolition material, primarily concrete. The sensitivity of construction workers and off-site personnel is assessed as low and the magnitude of the effect is considered to be very low. The potential impact is, therefore, predicted to be of **negligible** significance.

6.6.25 The sensitivity of off-site residents is assessed medium and the magnitude of the effect is considered to be very low; therefore, the significance of the impact is predicted to be **negligible**.

Backfilling operations

6.6.26 Foundation and earthwork voids will be backfilled using appropriate material recovered from the crushing operation or imported from off-site. Regardless of the source voids would only be filled with material where their provenance can be confirmed (e.g. quarry documentation / laboratory analysis and subsequent assessment to confirm the material is suitable for use). Consequently, the magnitude of impact is considered to be very low for all receptors and the significance of the impact is considered to be of **negligible** significance.

Leaks and spillages

6.6.27 On-site construction workers would be the only human health receptor. The sensitivity of construction workers is considered to be low and the magnitude of the effect is also considered to be low. Consequently, the significance of the potential impact is predicted to be of **negligible** significance.

6.7 Summary

6.7.1 The site is predominantly flat and comprises a utilities corridor south of the landfill and an embankment west of the lagoon. A conveyor envelope is also located to the north and south of the landfill, and terminates at the MHF. Access to the utilities corridor and embankment is controlled by the Wilton International Complex. Public access to the site is currently permitted by a public right of way that enters the DCO boundary and terminates adjacent to Dabholm Gut. There is also a combined footpath and immediate neighbours include other commercial / industrial operators as well as residential developments. A number of landfills are also located in the vicinity of the site, including the Bran Sands Landfill.

6.7.2 The BGS published mapping and the Geology of Britain Viewer indicates that the majority of the site is underlain by Made Ground deposits, beneath which are superficial deposits comprising Tidal Flat deposits (sand, silt and clay) and Glaciolacustrine Deposits (clay and silt). The bedrock geology comprises mudstone of various ages. Intrusive investigations at the site generally concur with the published geology and indicate that the Made Ground comprises ‘slag’ to a considerable depth (approximately 10m). There are no sites designated for geological importance within the footprint of the proposed scheme.

6.7.3 Soil samples recovered from the site exhibited a limited range of potential contaminants of concern at concentrations exceeding human health assessment criteria for a commercial end use. Leachability testing also indicated that a number of potential contaminants of concern were potentially mobile at

concentrations exceeding Environmental Quality Standards. Exceedances were detected in samples recovered from the Made Ground generally comprising ash and slag.

6.7.4 Significant ground gas concentrations have been recorded around the perimeter of the Bran Sands landfill, although a monitoring well located on the embankment west of the lagoon (adjacent to the proposed quay) did not detect elevated gas concentrations.

6.7.5 There are a number of surface watercourses in the vicinity of the site, including the Tees Estuary, Dabholm Gut and Bran Sands lagoon. There is hydraulic continuity between Bran Sands lagoon and the River Tees (via a pipe through the embankment) and with the groundwater in the Made Ground. There are no surface water abstractions within the proposed scheme footprint. However, there is one surface water abstraction from the Tees approximately 500m to the north of the site boundary which is utilised for cooling purposes.

6.7.6 The majority of the site is covered by alluvial deposits which are defined as a Secondary Aquifer (Undifferentiated). The bedrock aquifer has been designated as a Secondary B Aquifer. There are no groundwater abstractions or SPZs within the buffer zone. The WFD groundwater quality status for the Tees Mercia Mudstone and Redcar Mudstone groundwater body has been defined as poor. Groundwater monitoring has indicated exceedances of the WFD estuarine EQSs for chromium, copper, zinc, iron, mercury, toluene and xylene.

6.7.7 The findings of the impact assessment are summarised in **Table 6-14**. The assessment assumed that a range of environmental risk mitigation measures would be embedded within the project; in addition, further mitigation measures would be adopted, including the development of an asbestos management strategy, further monitoring of the ground gas regime, and adoption of the principles of the CL:AIRE Code of Practice.

Table 6-14 Impact assessment summary

Receptor	Sensitivity of receptor	Magnitude of effect	Significance of impact	Mitigation	Residual impact
Construction					
Surface water	High	Very Low	Negligible	Detailed design would take account of seepage flow through the embankment to ensure water levels in the lagoon are not significantly affected as result of the solid quay option (if selected). Testing of dredged material would ensure suitability for re-use within the lagoon as part of the habitat enhancement scheme. Construction work would be carried out in accordance with best practice etc.	Negligible
Groundwater	Very low – low	Very Low - Low	Negligible	Construction work including piling would be carried out in accordance with best practice etc.	Negligible
Human Health	Low - Medium	Very Low - High	Negligible – Moderate Adverse	Implementation of an asbestos management strategy. Further monitoring of the ground gas regime would be undertaken so that mitigation measures can be implemented. Construction work would be carried out in accordance with best practice etc.	Negligible
Operation					
Surface water	High	Low	Minor Adverse	Physical controls would be in place in the form of enclosed storage areas for materials used on-site. The site would be operated by appropriately trained staff.	Minor Adverse
Groundwater	Very Low - Low	Very Low	Negligible	Physical controls would be in place in the form of enclosed storage areas for materials used on-site. The site would be operated by appropriately trained staff.	Negligible
Human Health	Low - Medium	Very Low - Low	Negligible	Implementation of an asbestos management strategy. Implementation of gas mitigation measures. Construction work would be carried out in accordance with best practice etc.	Negligible

Receptor	Sensitivity of receptor	Magnitude of effect	Significance of impact	Mitigation	Residual impact
Decommissioning					
Surface water	High	Low	Minor Adverse	Construction work would be carried out in accordance with best practice etc.	Minor Adverse
Groundwater	Very Low - Low	Low	Negligible	Construction work would be carried out in accordance with best practice etc.	Negligible
Human Health	Low - Medium	Very Low - Low	Negligible	Implementation of an asbestos management strategy. Further monitoring of the ground gas regime would be undertaken so that mitigation measures can be implemented. Construction work would be carried out in accordance with best practice etc.	Negligible

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