South Industrial Zone

Environmental Statement

July 2020

Volume 2

Chapter G - Water Management and Flooding

Contents

G1.0 Introduction

G1.1 This Chapter of the Environmental Statement ('ES') has been prepared by JBA on behalf of the applicant, South Tees Development Corporation ('STDC'). It assesses the proposed development described in Chapter B and it considers the effects of the proposed development on Water Management and flooding surrounding the site.

G1.2 The chapter describes the existing environment in relation to hydrology and hydrogeology and assesses the potential impacts of the construction, operation and decommissioning of the proposed development on hydrology (surface water quality, levels and flows) and hydrogeology (groundwater quality and levels).

G1.3 The geological descriptions within this section provide context for the sensitivity of the hydrogeology assessment only. Existing potential contamination and its potential interrelationship with human health and groundwater quality is considered in Section G 4.51.

G1.4 The baseline situation is considered before the likely environmental effects of the development are identified, both during construction and operational phases of the development. Mitigation measures to reduce any negative environmental effects are identified as appropriate, before the residual environmental effects are assessed.

G1.5 This Chapter is supported by the following technical appendices: -

1 Appendix G1: Summary of Consultation with statutory consultees; and

2 Appendix G2: Flood Risk Assessment ('FRA')

About the Author

G1.6 The Water Management and Flooding Environmental Statement chapter has been prepared by JBA Consulting on behalf of STDC, following commission in May 2020. JBA Consulting is a member of the IEMA EIA Quality Mark.

Table G1.1 Core Staff Competencies

Team Member	Role and Qualifications
Alex Jones - 11 years' professional experience CGeol, FGS, BSc, MSc	Lead Hydrogeology Author
Susan Wagstaff - experience in EIA with regard to the water environment and hydrogeology since 2000 on a variety of EIA developments, also an external reviewer of EIAs CGeol, FGS, MSc, BA.	Lead Hydrogeology Reviewer
Alice Gent - 7 years' professional experience BSc CEnv MCIWEM C.WEM	Lead Flood Risk Author
René Dobson - over 20 years' experience in the engineering sector and over 16 years of specialist experience in water and environmental engineering in the UK and Ireland BEng CEng MICE David Bassett - over 25 years' experience in the water and environmental and engineering industry with experience in urban drainage, SuDS, Flood Protection Schemes, Flood Risk Assessment, Flood Risk Management, EIA and River Restoration. BSc MSc CEnv MCIWEM C.WEM	Lead Flood Risk Reviewers

G2.0 Policy Context

Overview

G2.1 This section provides an overview of the issues from the relevant planning policies guidance and policy guidance which have been considered in assessing potentially significant effects related to the water environment.

G2.2 A summary of policies and legislation is set out in the below tables. Further details are then provided, including on their relevance to this ES chapter.

Table G2.1 Policy issues considered in preparing the water environment assessment

Policy Reference	Policy Issues
NPPF (revised, 2019)	
Paragraph 17	Achieving Sustainable Development principles (para 8c) include contributing to protecting and enhancing the natural environment and minimising pollution.
Section 14, Paragraph 150a	New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change including flood risk and water supply. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure.
Section 14, Paragraphs 155-165	Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere. Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate.
Section 15, Paragraph 170e	New and existing development should not contribute to or be put at unacceptable risk from, or be adversely affected by, unacceptable levels of water pollution.
National Planning Practice Guidance (Environment Agency, 2019a)	Multiple benefits for people and the environment can be achievable through good design and mitigation. For example, flood risk can be reduced and biodiversity and amenity improved by designing development that includes permeable surfaces and other sustainable drainage systems, removing artificial physical modifications (for example, weirs and concrete channels) and recreating natural features. Water quality can be improved by protecting and enhancing green infrastructure and further information on this can be found in the planning practice guidance on the Natural Environment. Good design and mitigation measures can be secured through site specific policies for allocated sites and through non-site-specific policies on water infrastructure and protecting the water environment. For example, they can be used to ensure that new development and mains water and wastewater infrastructure provision is aligned and to ensure new development is phased and not occupied until the necessary works relating to water and wastewater have been carried out. Local planning authorities can use planning conditions and / or obligations to secure mitigation and compensatory measures where the relevant tests are met. Planning obligations can be used to set out requirements relating to monitoring water quality, habitat creation and maintenance and the transfer of assets where this

	mitigates an impact on water quality. The guidance supports the NPPF.
Redcar and Cleveland Borough Council (RCBC) Local Plan (May 2018)	
Policy SD1: Sustainable development	Protect the quality and availability of water resources and maximise the efficient use of water.
Policy SD7: Flood and water management	Flood risk will be taken into account at all stages in the planning process to avoid inappropriate development in areas at current or future risk.

G2.3 The legislation relevant to the assessment of effects of the proposed development on the water environment is summarised below.

Table G2.2 Legislation relevant to the assessment of the water environment

Legislation	Description
Water Environment (Water Framework Directive) (England and Wales) Regulations 2017	The Water Framework Directive (WFD) came into force in 2000 and is the most substantial piece of EU water legislation to date. All new activities in the water environment will need to take the Directive into account. The Directive imposes legal requirements to protect and improve the water environment The EU Water Framework Directive was transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The 2003 regulations were consolidated and replaced with the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. The Directive requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve Good Status (or Good Ecological Potential for Heavily Modified and Artificial Water Bodies)
Water Act 2003	This Act was a revision of the Water Resources Act (1991) which stated that it is an offence to cause or knowingly permit polluting, noxious, poisonous or any solid waste matter to enter controlled waters. The Act sets out regulatory controls for water abstraction, discharge to water bodies, water impoundment and protection of water resources. Elements of the Water Resources Act 1991 have now also been superseded by the Environmental Permitting (England and Wales) Regulations 2010.
Environmental Permitting (England and Wales) Regulations 2010	This provides a consolidated system for environmental permits and exemptions for activities which include discharges to surface waters. It also sets out the powers, functions and duties of the regulators.
Groundwater Regulations 1998	These require the prevention of List I substances (such as mercury, cadmium, polyaromatic hydrocarbons) entering groundwater and the control of List II substances (such as heavy metals, nutrients, phenols) to avoid pollution of groundwater. Within the context of the WFD, the groundwater daughter directive was brought into force in January 2009, which will seek to prevent deterioration in groundwater quality.
The Land Drainage Act 1991 & 1994	This places responsibility for maintaining flows in watercourses on landowners and gives Local Authorities powers to serve a notice on landowners to ensure works are carried out to maintain flow of watercourses.

Floods and Water Management Act 2010	This sets out the Government's proposals to improve flood risk management, water quality and ensure water supplies are more secure. In December 2009, the Flood Risk Regulations were published, which transpose the EU Floods Directive into UK law and these cover the flood issues from the Floods and Water Management Bill.

G2.4 Other policy, regulatory and best practice guidance of relevance to this assessment includes the following:

- Environment Agency ('EA') Principles and Practice for the Protection of Groundwater (GP3);
- EA Pollution Prevention Guidance (PPG) Notes[1]:
  - PPG 1 General guide to the prevention of water pollution;
  - PPG 2 Above Ground Oil Storage Tanks;
  - PPG 3 Use and design of oil separators in surface water drainage systems;
  - PPG 4 Disposal of sewage where no mains available;
  - PPG 5 Works in, near or liable to affect watercourses;
  - PPG 6 Working at construction and demolition sites;
  - PPG 7 The safe operation of refuelling facilities;
  - PPG 8 Safe storage and disposal of used oils; and
  - PPG 13 Vehicle washing and cleaning: prevent pollution;
  - PPG 21 Pollution incident response planning; and
  - PPG 22 Dealing with spills.
- Construction Industry Research and Information Association (CIRIA) Report C532: Control of Water Pollution from Construction Sites;
- CIRIA Report C502: Environmental Good Practice on Site;
- CIRIA Report 515: Groundwater Control – design and practice;
- CIRIA Report C697: The SuDS manual;
- BS6031: 2009 Code of Practice for Earth Works;
- Good Practice Guide for Handling Soils (MAFF, 2000);
- Local and Regional Land Drainage Bylaws;
- Redcar and Cleveland Strategic Flood Risk Assessment (RCBC, 2016); and
- River Tees Catchment Flood Management Plan (EA, 2009).

Requirements of Flood Risk Legislation, Policy and Guidance

G2.5 There are a number of pieces of legislation relating to flooding as shown in the flow diagram below. The EU Floods Directive 2007 was interpreted into the England and Wales legislation Flood Risk Regulations 2009 (Regulations) and the Flood and Water Management Act 2010 (Act).

[1] It is noted that the PPG notes are now withdrawn but are nonetheless applied in the absence of direct replacement guidance notes.

G2.6 The Regulations identify and take action in areas with the most significant flood risks and require the following to be produced:

1 A preliminary Flood Risk Assessment Report providing a high-level overview of flood risk from local flood risk sources and identifying the Flood Risk Areas.

2 Flood hazard maps and flood risk maps for Flood Risk Areas.

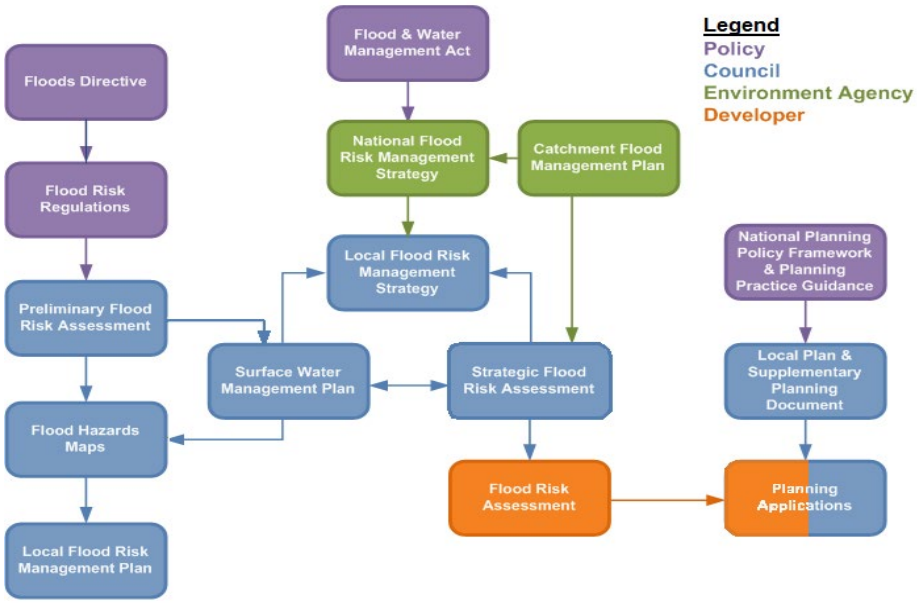
3 Flood risk management plans for Flood Risk Areas.

The purpose of the Act is to:

1 Introduce the concept of flood risk management and the framework for the delivery of flood and coastal erosion risk management through national and local strategies.

2 Provide definitions, for example "flood", "surface runoff", "Risk Management Authorities", "Lead Local Flood Authority."

Figure G2.1 Key documents and strategic planning links with flood risk



National Planning Policy

G2.7 The new National Planning Policy Framework ('NPPF') was published in July 2018 and updated was in June 2019. The NPPF sets tests to protect people and property from flooding which all local planning authorities are expected to follow. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions. Where these tests are not met, national policy is clear that new development should not be allowed. The main steps to be followed are set out below which, in summary, are designed to ensure that if there are better sites in terms of flood risk, or a proposed development cannot be made safe, it should not be permitted.

G2.8 The NPPF is accompanied by Planning Practice Guidance ('PPG') notes which are updated to reflect changes to NPPF.

G2.9 The key changes in the 2019 NPPF compared to the 2012 NPPF include:

1 Strategic policies should also now consider the 'cumulative impacts in, or affecting, local areas susceptible to flooding' (para 156), rather than just to or from individual development sites (see Section 6.5 of the main report).

2 Future risk from climate change. The 'sequential approach should be used in areas known to be at risk now or in the future from any form of flooding' (para 158) (see Sections 6.6 of the main report and Appendix B).

3 Natural Flood Management. 'Using opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques)' (para 157c) (see Section 5.7.4 of the main report and Appendix B).

4 Sustainable Drainage Systems (SuDS). 'Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate' (para 165) (see Section 6.7 of the main report) and;

5 Emergency planning. Emergency plans are required as part of an FRA that includes the inclusion of safe access and egress routes (para 163e) (see Section 7 of the main report).

6 As explained, the FRCC-PPG sits alongside the NPPF and sets out detailed guidance on how this policy should be implemented.

Flood Risk and Coastal Change Planning Practice Guidance (FRCC-PPG)

G2.10 At the time of writing, the current FRCC-PPG was published on 6 March 2014 (Gov.uk, 2014).

G2.11 Whilst the NPPF concentrates on high level national policy, the FRCC-PPG is more detailed. The practice guidance advises on how planning can take account of the risks associated with flooding and coastal change in plan making and the development management process. This is in respect of local plans, SFRAs, the sequential and exception tests, permitted development, site-specific flood risk, Neighbourhood Planning, flood resilience and resistance techniques and the vulnerability of development to make development safe from flooding.

Local Flood Risk Management Policy and Guidance

Strategic Flood Risk Assessment

G2.12 Redcar and Cleveland Borough Council published a Level 1 Strategic Flood Risk Assessment (SFRA) in 2010 and revised it in 2016 using up-to-date flood risk information together with the most current flood risk and planning policy available from the National Planning Policy Framework (NPPF) and Flood Risk and Coastal Change Planning Practice Guidance2 (FRCC-PPG). The purpose of the SFRA was to initiate the sequential risk-based approach to the allocation of land for development and inform the Adopted Local Plan and Detailed Policies.

G2.13 As part of the level 2 SFRA a detailed model was created to supersede the broad scale EA tidal flood risk mapping. The new model took into account natural and manmade restrictions to tidal flooding including the sand dune system at Coatham Sands and the disused railway embankment at Warrenby.

G2.14 When these natural and manmade barriers to flooding are modelled, this 'existing risk' scenario shows that only a small number of the proposed development sites are at risk. Flood depth and hazard results show that this site could be developed safely with straightforward mitigation measures. A conservative estimate of undefended flood risk (all barriers to tidal flooding removed) showed that the majority of the proposed development site is at risk of flooding to some degree. The results of which illustrate the important role natural and manmade defences play in effecting flood risk within the area. Flood risk can therefore be seen as more a 'residual risk' which can be managed through mitigation measures such as selected land raising and flood resilience techniques. In conclusion, the site as assessed in the Level 2 SFRA should be suitable for development subject to a detailed flood risk assessment (FRA).

Redcar and Cleveland Local Plan

G2.15 The Redcar and Cleveland Local Plan was adopted in May 2018 and the SFRA provides the evidence base to make decisions on where to direct new development to ensure development is located in sustainable locations. The adopted Local Plan sets out the long-term land allocations and other planning policies that will guide development proposals in the borough and against which planning applications are determined.

G2.16 Policy outlined in the Local Plan, in relation to flood risk and water management, aim to reduce flood risk, promote water efficiency measures, and protect and enhance water quality through mechanisms.

Local Plan Key Policies

G2.17 There are multiple policies within the Local Plan which are applicable to the site. A selection of the key policies are highlighted below:

1. All development proposals will be expected to be designed to mitigate and adapt to climate change, taking account of flood risk by ensuring opportunities to contribute to the mitigation of flooding elsewhere are taken.
2. For previously developed sites, the peak runoff rate from the development to any drain, sewer or surface water body for the 1-in-1 year rainfall event and the 1-in-100 year rainfall event, must be as close as reasonably practicable to the greenfield runoff rate from the site for the same rainfall event but should never exceed the rate of discharge from the development prior to redevelopment for that event.
3. Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g. the sea or River Tees) the peak flow control standards and volume control standards (attenuation requirement) need not apply. This may be the case for development in the SIZ1 site that where there is discharge into drainage channels which flow directly into the River Tees without any constraints.
4. The drainage system must be designed and constructed so surface water discharged does not adversely impact the water quality of receiving water bodies, both during construction and when operational. New development should seek to improve water quality where possible, as well maintaining and enhancing the biodiversity and habitat of watercourses.
5. The Council has a duty to have regard to the Northumbrian River Basin Management Plan to ensure the protection and improvement in quality of the water environment. This is also in accordance with the overall objective of the Water Framework Directive to achieve “good ecological status” in all waterbodies (including surface, ground and coastal waters) and not allow any deterioration from their current status.
6. Wherever possible, measures to deal with flood risk and drainage should identify opportunities to maintain and enhance the biodiversity and habitat of watercourses through protecting or restoring natural channel morphology. Actions should also be taken to remove modifications to restore a more natural watercourse and associated biodiversity. Where such removal is not possible or not in the public interest, mitigation measures must be taken to create a more natural watercourse, improve habitats and enhance biodiversity.

Tees Valley Sustainable Drainage Systems Design Guide and Local Standards

G2.18 To enable the practical implementation of the policies outlined in the local plan, a working group from the Local Authorities of Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton Borough Councils (Tees Valley Authorities) published the Tees Valley Authorities Local Standards for Sustainable Drainage (2017).

G2.19 The working group have recently updated the guide to provide an overview of SuDS techniques, policy requirements and produce Tees Valley specific local standards. The document is due to be formally published in 2020 and has been produced to strongly promote the use of sustainable drainage systems and help manage increased surface water runoff from new developments to help mitigate flood risk.

G2.20 The flood risk and surface water management strategy developed for the SIZ1 site needs to align with the requirements of the Tees Valley SuDS Design Guide and Local Standards.

Climate Change Resilience

G2.21 Addressing climate change is one of the core land use planning principles which the National Planning Policy Framework expects to underpin both plan-making and decision-taking. The NPPF states that planning should proactively help the mitigation of, and adaption to, climate change including the management of water and flood risk. These requirements are then filtered to a development level through the Local Plan and SFRA which outline the key factors developments must meet in order to gain planning permission.

Flood Risk and Water Management

G2.22 In terms of flood risk, the National Planning Policy Framework (NPPF) sets the current best practice for the application of allowance for climate change. The climate change allowances (prediction) of anticipated change are provided for:

1 Peak River Flow

2 Peak Rainfall Intensity

3 Sea level Rise

G2.23 Climate change allowances are used for flood risk assessments and design parameters.

Peak River Flows

G2.24 Peak river flow allowances show the anticipated changes to peak flow by river basin district. Redcar is located within the Northumbria river basin district. The application of allowance category is subject to the Flood Risk Vulnerability Classification and Flood Zone, now and in the future.

Table G2.3 EA Peak river flow allowances, Northumbrian River Basin District (use 1961 to 1990 baseline).

Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	20%	30%	50%
Higher central	15%	20%	25%
Central	10%	15%	20%

Rainfall Intensity

G2.25 With respect to surface water flood risk mapping and design of drainage systems (including blue-green networks and minor watercourses with a catchment of less than 5km2) the allowances outlined in Table G2.4 below shall be used. The development design life is to be taken as 50 years and is due to commence during 2020. Current climate change predictions extend to 2115 which is beyond the proposed life of the development. However, as a conservative approach, the default design parameters are to design for the 20% and sensitivity check for the 40% to consider the future impacts in relation to water management and drainage.

G2.26 As the development has a design life of:

Table G2.4 EA Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline).

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Drought Resistance

G2.27 Current climate predictions show an increased likelihood both in frequency and length, of periods of rainwater scarcity and potential drought conditions. The ability to harvest and reuse rainwater could help in adding resilience by maintaining business continuity during these periods. The rainwater harvesting must be designed using rainfall data and shall take into account the different potential requirements of rainwater by the different businesses which will operate on the site. Improved rainwater harvesting will produce resilience and reduce reliance on piped water infrastructure.

Sea Level Rise

G2.28 There are a range of allowances for each epoch for sea level rise in Northumbria derived from the EA table are shown in Table G2.5.

Table G2.5 EA Sea level allowance for each epoch for Northumbria.

Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Higher central	4.6 (161)	7.5 (225)	10.1 (303)	11.2 (236)	1.03
Upper end	5.8 (203)	10 (300)	14.3 (429)	16.5 (495)	1.43

G2.29 Since the original Tees tidal model was developed by the EA and the above table was published JBA have undertaken an update to the model on behalf of the EA. The update to the model was based on the UKCP18 uplift values utilising 2017 for a base year for extreme sea levels. The tables below summarise the results of the updated modelling on the uplift (mm) per epoch.

Table G2.6 Tees Tidal UKCP18 Tees Tidal Uplift Value

Uplift	Epoch	Updated uplift value (mm)
Present day uplift	2017-2019	0.011
UKCP18 2070 uplift	2019-2070	0.488
UKCP18 2100 uplift	2019-2100	0.947
UKCP18 2030 uplift	2019-2030	0.071
UKCP18 2050 uplift	2019-2050	0.249

Table G2.7 Tees Tidal UKCP18 Tees Tidal Climate Change Uplift Levels

Events	2017-2019 (present day)	2030	2070	2100
T2 (2 year)	3.45	3.52	3.94	4.40
T100 (100 year)	3.98	4.05	4.47	4.93
T200 (200 year)	4.08	4.15	4.57	5.03
T1000 (1000 year)	4.33	4.40	4.82	5.28

Roles and Responsibilities

G2.30 The responsibilities for the Risk Management Authorities (RMA) under the Flood and Water Management Act and the Flood Risk Regulations are summarised below

Environment Agency as an RMA

1 Has a strategic overview role for all forms of flooding at the national level;

2 Has the power to request information from any partner in connection with its risk management functions;

3 Must exercise its flood or coastal erosion risk management functions in a manner consistent with the National Strategy and Local Strategies;

4 Must be consulted on Local Strategies, if affected by the strategy, by the LLFA; and

5 Must help advise on sustainable development.

Redcar and Cleveland Borough Council Lead Local Flood Authority as an RMA

1 Must develop, maintain, apply and monitor a strategy for local flood risk management. This must be consulted on with all RMAs, the public and all other partners with an interest in local flood risk, and must comply with the national strategy;

2 Is required to coordinate and share information on local flood risk management between relevant authorities and partners;

3 Is empowered to request information from others when it is needed in relation to its flood risk management functions;

4 Must investigate flooding incidents in its area where it considers it necessary or appropriate;

5 Has a duty to establish and maintain a record of structures within its area that have a significant impact on local flood risk;

6 Is empowered to designate structures and features that affect flooding;

7 Has powers to undertake works to manage flood risk from surface runoff, groundwater and ordinary watercourses;

8 Must exercise its flood and coastal erosion risk management functions in a manner consistent with the National Strategy and the Local Strategy;

9 Must aim to contribute to sustainable development;

10 Is a statutory consultee on planning applications for major developments with surface water drainage considerations; and

11 Should consider flooding issues that require collaboration with neighbouring LLFAs and other RMAs.

Northumbrian Water as an RMA

1 Has a duty to act in a manner that is consistent with the National Strategy and have regard to Local Strategies;

2 Must be consulted on Local Strategies, if affected by the strategy, by the relevant LLFA;

3 Has a duty to be subject to scrutiny from LLFAs;

4 Has a duty to cooperate and share information with other RMAs;

5 Is responsible for managing the risks of flooding from surface water and foul or combined sewer systems providing drainage from buildings and yards.

Highways Service (RCBC) as an RMA

1 Has a duty to act consistently with the National Strategy and Local Strategies;

2 Has responsibility for ensuring effective drainage of local roads in so far as ensuring drains and gullies are maintained;

3 Must be consulted on Local Strategies, if affected by the Strategy, by the relevant LLFA;

The Local Community

1 Must be consulted on Local Strategies by the LLFA; and

2 Have a key role in ensuring local strategies are capable of being successfully delivered within the community. They should actively participate in this process and be engaged by the LLFA.

Riparian Owners

1 A riparian owner is someone who owns land or property alongside a river or other watercourses including a culvert.

2 Riparian owners have statutory responsibilities, including: maintaining riverbeds and banks; allowing the flow of water to pass without obstruction; and controlling Invasive Non-Native Species (INNS)

Developers

G2.31 Have a vital role in ensuring effective local flood risk management by avoiding development in areas at risk of flooding. Local Strategies should form a key element of local planning guidance.

G3.0 Assessment Methodology & Significance Criteria

Assessment Methodology

G3.1 This chapter will comprise an assessment of water management and flooding, incorporating the elements required for a Flood Risk Assessment ('FRA') (see Appendix G2 of the ES) as well as examining drainage and hydrogeology. It will therefore closely relate to and reference details included in the Ground Conditions and Remediation chapter for the EIA.

G3.2 The assessment will entail a review of existing baseline conditions, consideration of future baseline conditions and an assessment of the beneficial and adverse impacts which will result from the change in conditions. Since the preparation of this ES is for submission for outline planning application, the details of the proposed development have yet to be defined and so a number of assumptions have been made (detailed in Section G3.13).

G3.3 The study is necessary to meet the requirements of the National Planning Policy Framework (NPPF) and to support the outline planning application. It will therefore contain necessary details to be consistent with the reporting requirements detailed within the National Planning Policy Framework (NPPF). The aim of this document is to present relevant information in a clear format that can be reviewed by the Planning Authority and the EA, it does not guarantee that planning permission will be granted, or that proposed development will be acceptable to the EA.

Data Gathering Methodology

G3.4 The assessment undertaken for water management and flooding is desk-based. Data gathered for the assessment originate from three main sources:

1. The most up to date information available on publicly accessible websites and mapping has been used to determine the existing baseline conditions on the site, and in the immediate surrounding area. This has allowed identification of sensitive receptors in both the surface water and groundwater environment, which will need consideration during the design of the site.
2. The assessment is supported by the collection and interpretation of data and information requested from the EA (Environment Agency, 2020a) and the Environmental Health department at RCBC (Hill, 2020). They both provided hydrological information in January 2020 for a 2 km radius around the site for the neighbouring proposed development Grangetown Prairie, Energy from Waste Development. The request included groundwater abstractions, surface water abstractions, water quality data, discharges and private water supply records. Since the data is publicly available, the data have also been used for the SIZ1 South Bank site. The key data and sources of information collected are listed in Table G3.1.
3. The assessment also draws on information provided in previous reports and site investigations which have been completed for this site. Details of these are provided in the table below, referenced where noted in the text and listed in the References section at the end of this chapter.

Table G3.1 Sources of information used for the Hydrology, Hydrogeology and Geology

Source	Data
Ordnance Survey mapping at 1:50,000 and 1:25,000 scales (Microsoft, 2020).	Topography: elevation, relief.
Cranfield University's National Soils Resources Institute Soilscapes website (CSAI, 2020).	Soil type and land use.
Magic Map (2020) Natural England website (2020)	Nature Conservation Sites: Special Areas of Conservation (SACs). Special Protection Areas (SPAs). Sites of Special Scientific Interest (SSSI). EA groundwater vulnerability
The National River Flow Archive (CEH, 2020)	Climate: rainfall.
Environment Agency maps (2018) Environment Agency Catchment data explorer (2019b) The National River Flow Archive (CEH, 2020)	Surface Water. Surface water courses and flood risk Water quality. River flows.
British Geological Survey GeoIndex (2020) Wood (2019), Former Steelworks Land, South Tees - Outline Remediation Strategy Enviros (2004), Soil and Groundwater Baseline Characterisation Study Teesside Works - Interpretive Report	Solid and drift geology. Site geology and historic land use.
Wood (2019), Former Steelworks Land, South Tees - Outline Remediation Strategy Enviros (2004), Soil and Groundwater Baseline Characterisation Study Teesside Works - Interpretive Report Data requested from the Environment Agency (2020b, 2020c) EA Source Protection Zones and 2009 River Basin Management Plans (Groundwater), (EA, 2018)	Groundwater levels. Groundwater vulnerability. Groundwater quality. Abstractions and discharges.
Data requested from RCBC.	Private water supplies
Environment Agency Flood Risk and Coastal Change guidance	Peak flow allowances for the Northumbrian River Basin District., SLR, offshore wind speed and extreme wave height allowance tidal uplift and peak rainfall intensity allowances
British Hydrological Society, Chronology of British Hydrological Events Google Newspaper Archives SFRA reports for Redcar, 2010 and 2016 National Library of Scotland online mapping	Flood history and historical land use
Defra / Environment Agency Flood and Coastal Defence R&D Programme: R&D Outputs: Flood Risks to People, FD2321/TR2 Guidance Document, 2006	Emergency access and egress best practice guidance

Significance Criteria

G3.5 The methodology for the assessment of potential impacts follows the generic EIA methodology guided by IEMA (2016) and current government guidance (Gov.uk, 2020), and is based on the following principles:

1 Receptor sensitivity (very high, high, medium, low, very low) (see Table G3.2);

1 The magnitude (severity) of the effect (major, moderate, minor, no change) (Table G3.2)

2 The type of effect (long-term, short-term, or intermittent; positive, negative or neutral); and

3 The probability of effect occurring.

Table G3.2 Receptor sensitivity

Sensitivity	Criteria	Examples
Very High	Feature with a high quality and rarity at an international scale, with little potential for substitution. Medium to high flood risk.	Conditions supporting sites with international conservation designations (SAC, SPA, Ramsar sites), where the designation is based specifically on aquatic features. Land use types defined as essential civil infrastructure such as hospitals, fire stations, emergency depots etc.
High	Feature with a high yield and / or quality and rarity at a national scale, with a limited potential for substitution. Low to medium flood risk.	Highly productive aquifers and surface water resources typically used for public water supplies. Public water supplies. Conditions supporting a SSSI. Sites with freshwater fish protected areas. Water quality of receptor water body: Supporting WFD element type (e.g. Priority Substances) classified as 'High', ''Good' or Pass'. Land use types defined as schools, care homes, ground-based electrical and telecommunications equipment.
Medium	Feature with a medium yield and/or quality at a regional scale, or good quality at a local scale, with some potential for substitution.	Medium productivity aquifer and surface water resources typically used for smaller public water supplies or industrial water supplies. Industrial water supplies. Conditions supporting local nature conservation interest (e.g. Local Nature Reserve [LNR]), where the interest features are water-dependent. Water quality of receptor water body: Supporting WFD element classified as at least 'Good' in all cases.

	Low flood risk.	Other property types, including dwellings.
Low	Feature with variable yield and/or quality at a local scale, with potential for substitution. Negligible flood risk.	Low productivity aquifer and surface water resources typically used for private water supplies or not utilised. Livestock supplies; springs; ponds/lagoons; non-statutory groundwater-dependent conservation sites. Water quality of receptor water body: Supporting WFD element type classified as less than 'Good' in any situation (any supporting element). Undeveloped or agricultural land from a flood risk point of view.
Very Low	Feature with poor yield and / or quality at a local scale, with good potential for substitution.	Unproductive strata. Water quality of receptor water body: Supporting WFD element type classified as 'Poor' or 'Bad', with severely restricted ecosystems and pollution. Small surface water bodies such as drainage ditches and ephemeral ponds that are too small to be classified under WFD and have limited ecological potential due to being artificial or heavily-modified.

Table G3.3 Overview of magnitude of change

Magnitude	Criteria	Examples
Major	Results in complete loss of receptor or major impact on feature, of sufficient magnitude to affect its use / integrity, and which may be irrecoverable or slow to recover.	Major reduction in groundwater levels, flow or quality, reducing use and water body status. Major reduction in groundwater levels or water quality leading to a marked deterioration in conditions that support GWDTE features. Deterioration in river flow regime, morphology or water quality, leading to sustained, permanent or long-term breach of relevant SSSI conservation objectives (COs), or downgrading of WFD status (deterioration in current thresholds as defined by current WFD status, including supporting WFD elements). Complete loss of resource or severely reduced resource availability to other water users. Change in flood risk resulting in potential loss of life or damage to nationally critical infrastructure.
Moderate	Results in some loss of receptor, or noticeable impact on feature, of sufficient magnitude to affect its use / integrity in some circumstances. Has limited potential to recover.	Moderate reduction in groundwater levels, flow or quality, reducing use and water body status in some circumstances. Moderate reduction in groundwater levels or water quality leading to some deterioration in conditions that support GWDTE features. Deterioration in river flow regime, morphology or water quality, leading to periodic, short-term and reversible breaches of relevant SSSI conservation objectives, or downgrading of WFD status (deterioration in current thresholds as defined by current WFD status, including supporting WFD elements). Water quality status may impact upon potential future thresholds in relation to objective WFD status – potential for prevention of waterbody reaching its future WFD objectives. Minor reduction in resource availability for other water users. Change in flood risk resulting in potential for major damage to property and infrastructure.

Minor	Results in minor impact on feature, with insufficient magnitude to affect its use / integrity in most circumstances. May be fully recoverable.	Measurable reduction in groundwater levels, flow or quality, but with limited consequences in terms of use and water body status. Measurable reduction in groundwater levels or water quality, leading to a minimal change in conditions that support GWDTE features. Measurable deterioration in river flow regime, morphology or water quality, but remaining generally within SSSI COs, and with no change of WFD status (of overall status or supporting element status) or compromise of Environmental Quality Standards (EQSs). No change in resource availability for other water users. Increase in flood hazard in areas with no flood risk receptors e.g. increased flooding of agricultural land. Change in flood risk resulting in potential for minor damage to property and infrastructure.
No change	No perceptible change in the baseline situation.	N/A

G3.7 In terms of the EIA Regulations, it is only those impacts that are likely to have significant positive and/or negative environmental effects that require detailed assessment. As the EIA Regulations guide the assessor to focus on effects that are likely to be significant, the outcome of the assessment of a given effect on a particular receptor in its simplest form would be that it is significant or not significant. However, there may be instances where it is appropriate to further sub-divide the category of 'Not Significant', for example by use of the terms 'Negligible' in terms of the level of effect. The use of the category of 'may for example be used in acknowledgement that there are instances whereby there may be an effect, albeit that this is not likely to be significant - and this approach may better facilitate assessment of cumulative effects where cumulatively several slight effects could be significant. With this consideration in mind, Table G3.4 illustrates a matrix, which has been used for guidance in the assessment of significance. Where 'substantial', 'moderate' or 'minor' is referenced as a level of effect, this can be either beneficial or adverse.

G3.8 Having defined a level of effect, professional judgement, in combination with guidance and standards are then applied to identify which of those levels of effect are then considered to be equivalent to significant effects when discussed in terms of the EIA Regulations. Those levels of effect which are shaded in Table G3.4 equate to those considered significant under the EIA Regulations with the others constituting no effect or an insignificant effect.

Table G3.4 Derivation of the level of effect

Magnitude of change	Receptor Very High	Sensitivity High	Medium	Low	Very Low
Major	Substantial	Substantial	Substantial	Moderate	Minor
Moderate	Substantial	Substantial	Moderate	Minor	Neutral/ Negligible
Minor	Moderate	Moderate	Minor	Neutral/ Negligible	Neutral/ Negligible
No change	Neutral/ Negligible	Neutral/ Negligible	Neutral/ Negligible	Neutral/ Negligible	Neutral/ Negligible

G3.9 Key:

Shaded Cell = Significant in terms of EIA Regulations.

Unshaded cell = Not significant in terms of EIA Regulations.

G3.10 Effects that are predicted to be moderate or greater are considered to be significant for the purpose of this assessment.

G3.11 It should be noted that the type of categorisations illustrated in Table G3.1 to Table G3.4 provide a guide only and may be moderated based upon professional judgement and experience. In particular, the divisions between categories of receptor sensitivity, magnitude of change, and level of effect should not be interpreted as definitive, and the lines that represent the boundaries between categories should in many cases be considered as 'blurred'. Where the level of effect is considered to be minor or less, these are generally not deemed significant in terms of the EIA Regulations. However, depending on the receptor being considered, it is possible that some potentially minor effects could be judged as significant in terms of the EIA Regulations, and where this is judged to be the case, the rationale for this conclusion has been provided in this chapter.

Consultation

G3.12 Lichfields has informally scoped the proposed development at the site with Officers at RCBC and requested that chapter authors should contact relevant staff at RCBC and other regional and national statutory bodies where relevant, to discuss and agree the scope of the technical assessment.

G3.13 The following organisations have therefore been contacted, however since the water management strategy for the wider STDC site is being developed concurrently with this ES for the wider South Industrial Zone site, the consultation consists of high-level comments provided for the strategy and the confirmation that these comments can be applied to this site. These have also been referenced in the FRA (see Appendix G2 of the ES). It is anticipated that further consultation will be undertaken with these organisations during the development of the STDC water management strategy and the detailed design development of this site.

G3.14 Full details of the information provided in the scoping report and the responses received are provided in Appendix G1 to the ES.

Table G3.5 Summary of relevant consultee consultation

Consultee	Consultation
Redcar and Cleveland Borough Council	Drainage - proposals will be determined and included as part of the STDC strategy and further developed at design stage of the project. Noted to be acceptable in principle Flooding - The proposed finished floor level of 5.79mAOD is above the 1000 year plus climate change still water level and has a low probability of flood risk. A high-level site-specific FRA is being undertaken for the site. Noted to be acceptable in principle Local and National plans and policies - have been considered. Noted. Climate change – the ES will consider the impact of climate change on water levels (as per the baseline assessment using government guidance). Need confirmation that wave overtopping, and freeboard are not considered significant. Noted. Water quality - It is assumed that all surface water runoff will require SuDS treatment and attenuation prior to discharge into the Tees or local watercourses. Pollution control measures advised in the water strategy, such as bunding of potential sources of contamination, will be implemented in order to prevent potential contamination incidents to the Tees. Noted. Note that SuDS are a general aspiration for the whole STDC masterplan area, and the feasibility of SUDS will be commented on in the below sections of this ES chapter.
Northumbrian Water	Blue green strategies need to be discussed with the Lead Local Flood Authority for this area as they are responsible for the governance on the management of surface water. In terms of ascertaining available capacity available in Northumbrian Water's network to accommodate flows from the development, a request should be submitted to the Northumbrian Water Pre-Planning Enquiry Application should be made which will incur a fee. It is anticipated that this will be undertaken by the team developing the water management and drainage strategy for the STDC site (outwith this project scope for the SIZ1 site.
Natural England	A consultation telecon is due to be held with Natural England by the chapter author of the ecology and biodiversity assessment (Arup) for which we have requested that Natural England were asked about their aspirations for incorporating SuDS, management of discharge and blue green networks into proposed development, as well as water quality in relation to WFD waterbodies. Assessment scope and requirements for the chapter are therefore yet to be confirmed. However, it is anticipated that an assessment of cumulative effects will need to be considered as well as the impact of climate change on the water environment.
Environment Agency	Consultation has been sought with the EA and a reply was provided with the EA's 'Planning advice for developers - Frequently Asked Questions' document, noting that this document summarises the environmental issues for which the EA are responsible and forms free advice at the pre-application stage. The reply also noted that further guidance and site-specific advice can be provided for a fee chargeable per hour, but as the form for this requires details of the site layout and proposed works (details which are not yet available until the water strategy for the STDC is finalised), this has not been undertaken for this high-level assessment for the SIZ site. The key points in the guide are: that a FRA is required; LLFA consultation is required for surface water management; SuDS should be carefully considered; land contamination and pollution prevention needs to be considered; if a proposal affects surface waterbodies a WFD assessment is required demonstrating how the

	development will prevent deterioration and improve the waterbody's ecological status; the opposition of the EA to culverting. It is therefore anticipated that a WFD assessment will be requested once the water management strategy and design is developed, to assess the impact of discharges to the Tees and protected areas in and surrounding the site. Also, an environmental permit is required for any activity that may pollute the air, water or land; increase flood risk; or adversely affect land drainage and work on or near main rivers requires a permit. The River Tees is designated as a main river but as the other watercourses (open and culverted) across the site are not main rivers, the EA guidelines advise contacting the local council or internal drainage board to check if land drainage consent is required. Permits are generally required for: any activity within 8 metres of the bank of a main river (or 16 metres if it is a tidal main river) and any activity within 8 metres of any flood defence structure or culvert on a main river (or 16 metres on a tidal river).

Assumptions and Limitations

G3.15 The following assumptions and limitations have been made when considering the future baseline conditions as well as the design and construction of the proposed development: -

1 Strategy for water management and drainage - the water management strategy is currently being discussed and developed with STDC (due July 2020) and so at present there are no details available for the water management and drainage design. Due to the limited details available at this time, the chapter is therefore a high level assessment of water management and flooding and the water strategy will be considered at the detailed design stage of the scheme . The STDC strategy shall be prepared in advance of construction so that whilst the specific nature of the design is yet to be determined, regardless of the assets which form the detailed design, the design shall comply with the required industry standards, regulations and guidance, as detailed in the strategy and supply appropriate mitigation for the adverse impacts. In light of NPPF, RCBC Local Plan and the Regulations noted above in the Policy section of this chapter, the following details of the strategy can be noted:

a There is an aspiration for blue/ green networks across the site. (Note that this is an area wide aspiration and the feasibility of implementing these networks will be undertaken on a site by site basis). The aspirations for this are noted and where they are achievable and practical, they will be designed into development plots when they come forwards.

b When the detailed design is developed, it shall be prepared in line with the requirements of the following plus any other applicable documentation noted in the strategy that will be required to meet planning conditions:

i CIRIA The SuDS Manual C753

ii Sewers for Adoption (Northumbrian Water currently use version SfA6 but will likely migrate to SfA8 during the time of the development of the design for the site.

iii Local Authority SuDS Officer Organisation. Non statutory technical standards for sustainable drainage: Practice Guidance

iv Tees Valley Local Authorities Local Standards for Sustainable Drainage

2 Contaminated Land - management of the contaminated land shall be undertaken in line with the 2019 Wood Outline Remedial Strategy and the recommendations detailed in Chapter H (Ground Conditions and Contamination) of this ES

3 Design parameter assumptions: -

a The water management and drainage plan, with the exception of modified discharge infrastructure, will not change the physical nature of the Tees bank.

b Construction works are not anticipated to be undertaken within 16m of the tidal Tees (the minimum limit under which an Environmental Permit for construction works near a tidally influenced river is required) but will need to be confirmed by Royal Haskoning who are undertaking the EIA for marine works and the separate planning application that is coming forwards.

c Environmental Permits will likely be required for the proposed activities on site including for the drainage and discharge of surface water to the Tees and industrial activities on site.

d The Final Floor Levels (FFL) are proposed to be a minimum of 5.79mAOD and will not be lowered below the 1:200 year coastal and tidal flood risk level with an allowance for Sea Level Rise (SLR) that equates to 5.03mAOD. Further details on elevation are to be provided by Halls Construction.

e The water management strategy will not comprise soakaways due to the contaminated nature of the land.

f The design life of the development is 50 years.

g A Water Framework Directive (WFD) Assessment will be undertaken at a later stage once further details regarding water management for the proposed development are available. The WFD assessment will determine the effects of the proposed facility on ecological, hydromorphological and chemical quality and identify any potential impacts that could cause deterioration in the current status of the water body or could hinder the water body from meeting its WFD objectives in the future. At this stage, the water management strategy aims to improve water quality from existing run-off.

h Drainage proposals and a Drainage Impact Assessment will be included as part of the STDC water management strategy and further developed at design stage of the project.

i It is assumed that all surface water runoff will require SuDS treatment and attenuation prior to discharge into the Tees or local watercourses, however due the contaminated nature of the land on site, the water management strategy will not comprise soakaways. Note that this is a general aspiration for the whole STDC masterplan area and the feasibility of SUDS will be commented on in the below sections of this ES chapter.

j Northumbrian Water would need to confirm capacity is available in their network to accommodate flows from the development.

k Ground conditions will not have significantly changed from the latest contamination and ground investigation reports undertaken prior to 2019.

l Environmental mitigation measures are recommended in accordance with the EA's Pollution Prevention Guideline notes, CIRIA guidance and other current best practice in the industry. It is anticipated that these will be included in the Construction Environmental Management Plan (CEMP)

m Due to the historic industrial nature of the site and absence of natural surface soils, soils are not an agricultural resource and are not considered to be a sensitive receptor in this aspect. Therefore, a soils impact assessment has not been carried out.

n

G4.0 Baseline Conditions

Existing Conditions

Location and Topography

G4.1 As described in chapter B of this ES, the site is located in the STDC area is part of the South Industrial Zone 1 (SIZ1). The site is 174ha (1,740,000m2) in size and comprises brownfield land on the banks of River Tees estuary, 5km to the west of Redcar. The site area excludes four areas within the outer boundary, which relate to industries /businesses still present. The 1m Lidar DTM shows the elevations at the site are mostly between 6-12 mAOD. There is a large raised area in the centre of the site, to the east of the unnamed channel which rises to 27 mAOD.

Climate

G4.2 The Flood Estimation Handbook ('FEH') gives the Standard Percentage Runoff ('SPR') near the site as being circa 36%. The SPR is the percentage of rainfall responsible for the short-term increase in river flow during and/or following a rainfall event.

G4.3 The Baseflow Index ('BFI') for the area (excluding the Estuary) is circa 0.38. This is the proportion of total local streamflow which is mostly groundwater input.

G4.4 The FEH also includes long-term average rainfall data for catchments in the UK. For the catchment in which the site is located, the Standard Annual Average Rainfall ('SAAR') is 619-625 mm/yr.

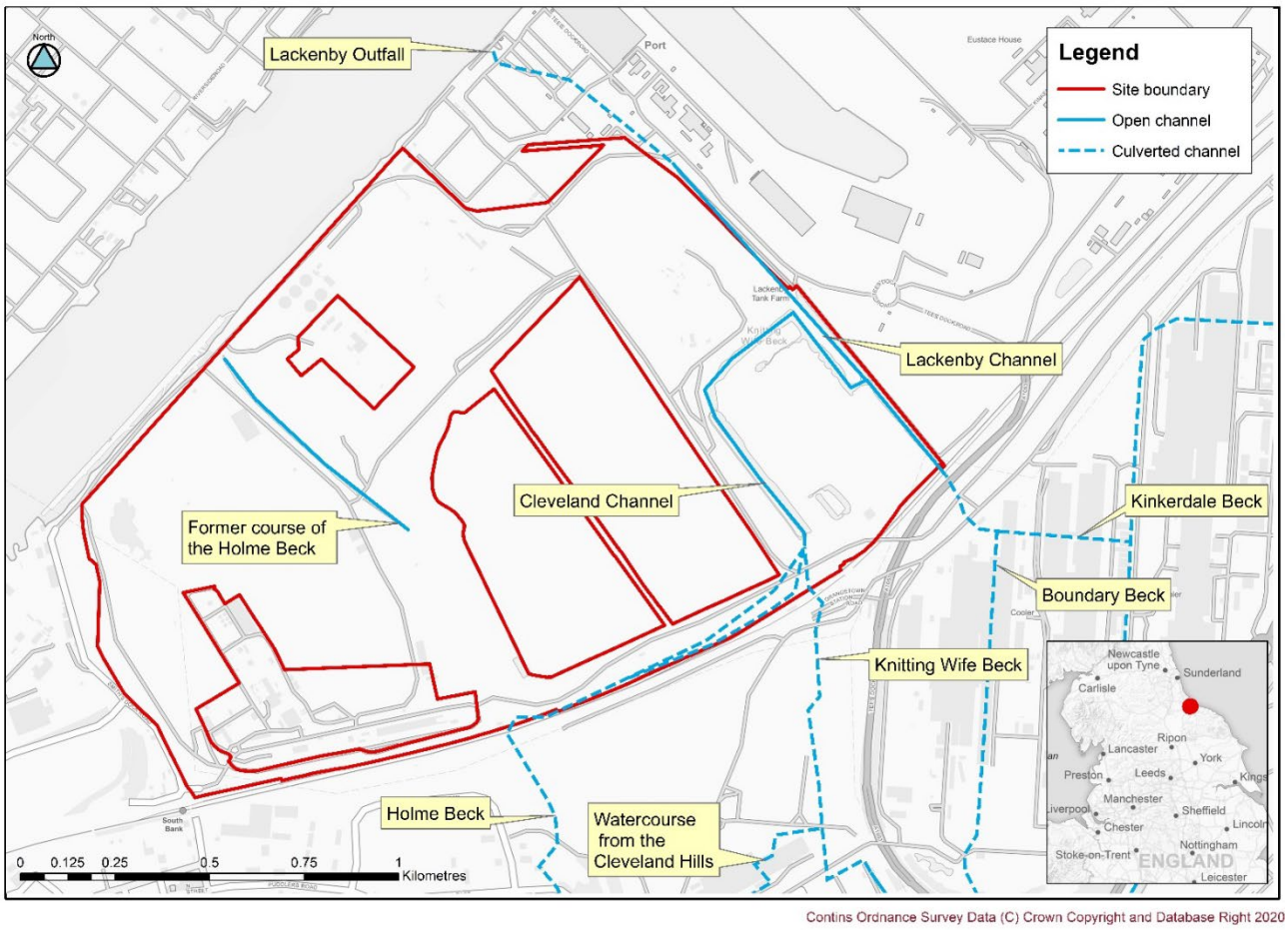
G4.5 In summary, the area experiences less rainfall than the national average (885 mm), with moderate runoff rates and a moderate proportion of groundwater input to river flow.

Surface Water Bodies

G4.6 The site is bounded to the north-west by River Tees, with a width of approximately 300 m. The site is located within the tidal range of the river, with the tidal limit defined by the Tees Barrage at Stockton, located approximately 8.5 km to the west, upstream of the site. The tidal water level in the Tees has been monitored at the Tees Dock gauging station 200m northeast of the site. The levels observed are between approximately -2.6 and 3.15 mAOD (with the 'normal level' in average weather conditions being -2.3 and 2.89 mAOD). As this reach of the Tees is tidal the water level fluctuates on a roughly 12-hour cycle. The gauge has been operational since January 1992 and has Environment Agency Station ID 8372.

G4.7 The site lies within the catchment of the River Tees that lies adjacent to the northern boundary of the site. It is also within the catchments of two waterbodies – the Lackenby channel, which drains along the eastern boundary of the site and into which the Cleveland channel drains, and an unnamed channel which drains through the southern section of the site that was historically part of the Holme Beck watercourse that discharged to the Tees (at present, the Holme Beck is culverted and flows are directed to the Cleveland channel). Both channels discharge to the River Tees. The 1m Lidar DTM shows the elevations at the site are mostly between 6-12 mAOD. There is a large raised area in the centre of the site, to the east of the unnamed channel which rises to 27 mAOD.

Figure G4.1 Open and culverted waterbodies at and surrounding the site



G4.8 The Cleveland channel is a large open channel which receives flows from the Holme Beck and Knitting Wife Beck culverts at the southern boundary of the development parcel. Flows in the Cleveland Channel are conveyed to Lackenby Channel around an area associated with iron and steel production recycling. The Lackenby Channel which flows along the eastern boundary of the development zone also receives flow from Boundary Beck and Kinkerdale culverts. In the Lackenby Channel downstream of the confluence with the Cleveland channel there is an in-channel structure assumed to act as a tidal weir. Beyond the weir the Lackenby channel is a deep large open channel that drains to a culvert of unknown dimension which conveys flows below Teesport to an outfall on the River Tees.

G4.9 The hydrological catchment of the Lackenby Channel, down to NZ 54600 22950, has an area of approximately 8.3km2. The catchment drains from the south-east to the north-west. It rises on Eston Moor to the south east of the site at elevations of 240mAOD and drains north west, declining to an elevation of approximately 50 mAOD at the site. The FARL value of 0.844 for the catchment indicates there is capacity for water storage within the catchment, this includes the reservoirs either side of the A174 and the wide-open Cleveland Channel that runs parallel to the Lackenby Channel within the development site.

G4.10 The catchment at the downstream extent of the former course of the Holme Back, at NZ 53400 22500 has an area of approximately 4.9km2. It is adjacent to the Lackenby Channel catchment and also originates on Eston Moor. Both catchments are highly urban.

Flood Risk

G4.11 There are a number of potential sources of flooding that could impact any site; these are fluvial (originating from a watercourse), coastal, groundwater, surface water (pluvial), sewers and blocked culverts and infrastructure failure.

G4.12 The Flood Risk Assessment undertaken for the site forms Appendix G2 of this chapter. The key findings from the assessment are summarised below.

Fluvial flooding

G4.13 The site is at low risk from fluvial flooding. The EA flood map for planning shows the combined flood extents from rivers and the sea at the site. The site is entirely in Flood zone 1, meaning it has a less than 1 in 1000-year annual probability of flooding from river or sea. The Tees Estuary channel and a small portion of land on the river bank adjacent to the site lies within Flood zones 2 and 3, which equates to a risk greater than a 1 in 100-year probability of river flooding. The EA flood extents for this mapping are created using coarse scale UK wide fluvial modelling and so this mapping does not include the small watercourses through the site.

Coastal and tidal flooding

G4.14 The site is at a moderate risk from coastal flooding. The EA flood map for planning shows the combined flood extents from rivers and the sea at the site. The site is entirely in Flood zone 1, meaning it has a less than 1 in 1000-year annual probability of flooding from river or sea. However, as part of the Level 2 Strategic Flood Risk Assessment (SFRA), a detailed model was created to supersede the broad scale EA tidal flood risk mapping. The modelling shows inundation in the south east corner at the former land fill and iron and steel recycling area. However, the existing coastal model is unlikely to account for the structure assumed to be a tidal weir in the Lackenby Channel which is likely to limit the tidal influence is this area. As previously mentioned, the coastal flood modelling does not take into account the presence of tidal limiting structures such as flap valves and weirs. As such there is a lower confidence in the flood mapping of the inland areas.

Surface water flooding

G4.15 The site is at a moderate risk from surface water flooding. The EA flood map shows the site is at some risk from surface water flooding. There is no clear area of flow path present, just many small areas of isolated extent in low spots. High level modelling of surface water undertaken as part of the Phase 1 study for the Water Management Strategy indicates that the areas at most risk are the localised depressions associated with the landfill in the centre of the site as well as the area associated with iron and steel recycling in the south east. There are no clear overland flow paths associated with surface water flooding. The surface water flooding across the remainder of the site is predominantly formed of a large number of shallow (0.3m-0.5m deep) localised depressions in which water can pond.

Climate change

G4.16 Tidal flood levels, fluvial flows, sea level and rainfall are all predicted to increase with climate change, in accordance with EA defined flood risk guidance. Climate change allowances have been considered. 5.03mAOD represents the 200-year Coastal Flood Risk + Sea Level Rise Allowance to 2100 design scenario, which is below the current ground elevations. As previously noted, the development design life is to be taken as 50 years but as a conservative approach these climate change projections to 2100 and beyond have been used to consider the future impacts in relation to water management and drainage.

G4.17 In accordance with National Planning Policy Framework (NPPF), the proposed development is considered to be essential infrastructure, therefore, development is appropriate in Flood Zone 1 (outside of 1000-year flood).

Water Framework Directive

G4.18 Any activity which has the potential to have an impact on the ecology of a water body will need consideration in terms of whether it could cause deterioration in its Ecological Status or Potential. For each water body, three different status objectives are identified within the River Basin Management Plan (RBMP). These are the overall status objective, the ecological status or potential objective and the chemical status objective. A default objective for all water bodies is to prevent the deterioration in the Ecological Status (or Ecological Potential for Heavily Modified and Artificial Water Bodies) of the water body.

G4.19 Any activity that has the potential to have an impact upon any of the Quality Elements will need consideration in terms of whether it could cause a deterioration in the status of a water body. The activity will also need to be considered in terms of whether it will compromise the ability of the water body to reach Good Ecological Status or Good Ecological Potential. Future Environmental Permits and full planning application for the site will likely require WFD Assessments to support them. Those assessments will determine the effects of the proposed facility on ecological, hydromorphological and chemical quality and identify any potential impacts that could cause deterioration in the current status of the water body or could hinder the water body from meeting its WFD objectives in the future.

G4.20 The three WFD water bodies relevant to the site are outlined in the table below.

Table G4.1 WFD Water Bodies

Water Body ID	Water Body Name	Hydromorphological designation	Current Overall Status	Overall Status Objective
GB510302509900	Tees	Heavily modified	Moderate	Moderate 2015
GB40302G701300	Tees Mercia Mudstone and Redcar Mudstone	N/A (Groundwater Body)	Poor	Poor 2015
GB650301500005	Tees Coastal	Heavily modified	Moderate	Good by 2027

G4.21 The site is located 0.2km south east of the Tees Transitional water body (GB510302509900), 5km south west of Tees Coastal Water (GB650301500005) and is within the Tees Mercia Mudstone and Redcar Mudstone Groundwater water body (GB40302G701300).

G4.22 Since the design of the proposed development and the water management strategy are yet to be developed, it is assumed that a WFD assessment will be undertaken at a later date.

Surface Water Quality

G4.23 Under the WFD, the EA has produced nine 'RBMP' for England to manage water quality targets and river basin planning, with the Northumbrian River Basin Management Plan being relevant to the site.

Geology and Soils

G4.24 Whilst the underlying geology is not considered to be a receptor, the geological environment controls the behaviour and quality of the groundwater and potential pathways to receptors and

is, therefore, described as part of the baseline conditions at the site. A more detailed description is found in chapter H which also considers existing contamination sources and their impacts on water body receptors.

G4.25 The site lies on ground reclaimed from the sea. The site is covered by a variable layer of made ground and reflects the historic development of the site (see chapter H for more details). There are no natural soil units on site.

2 Underlying the made ground are tidal flat deposits and underlying these are glaciolaustrine and glacial till deposits (see Figure G4.3). Underlying the superficial deposits is the Mercia Mudstone (see Figure G4.2). This lies circa 20m below ground level

G4.26 A summary of the geological units is presented in the table below.

Table G4.2 Geological Units of the Site (adapted from Wood, 2020)

Unit	Description	Average Thickness	Aquifer Type
Made Ground	Variable Light grey to dark grey slag with occasional ash and clinker Four landfills operated within the study area	3.3-10.2	N.A.
Tidal Flat Sand	Medium dense predominantly laminate black, dark grey, greyish brown or brown silty SAND with occasional shells and gravel	1.2-5.6	Undifferentiated Secondary Aquifer
Tidal Flat Clay	Firm laminated brown silty CLAY	0.6-2.0	
Glaciolaustrine Deposits	Firm brown or grey mottled silty CLAY	1.2-2.25	Unproductive
Glacial Till	Firm or stiff, locally soft to firm, locally hard, reddish brown, locally dark brown locally fissured silty sandy gravelly CLAY with rare sand layers.	1.8-11.2	Unproductive
Mercia Mudstone	Reddish brown occasionally green weathered MUDSTONE	To depth	Secondary B

G4.27 The site is not located within a Coal Mining Area.

Figure G4.2 Bedrock Geology

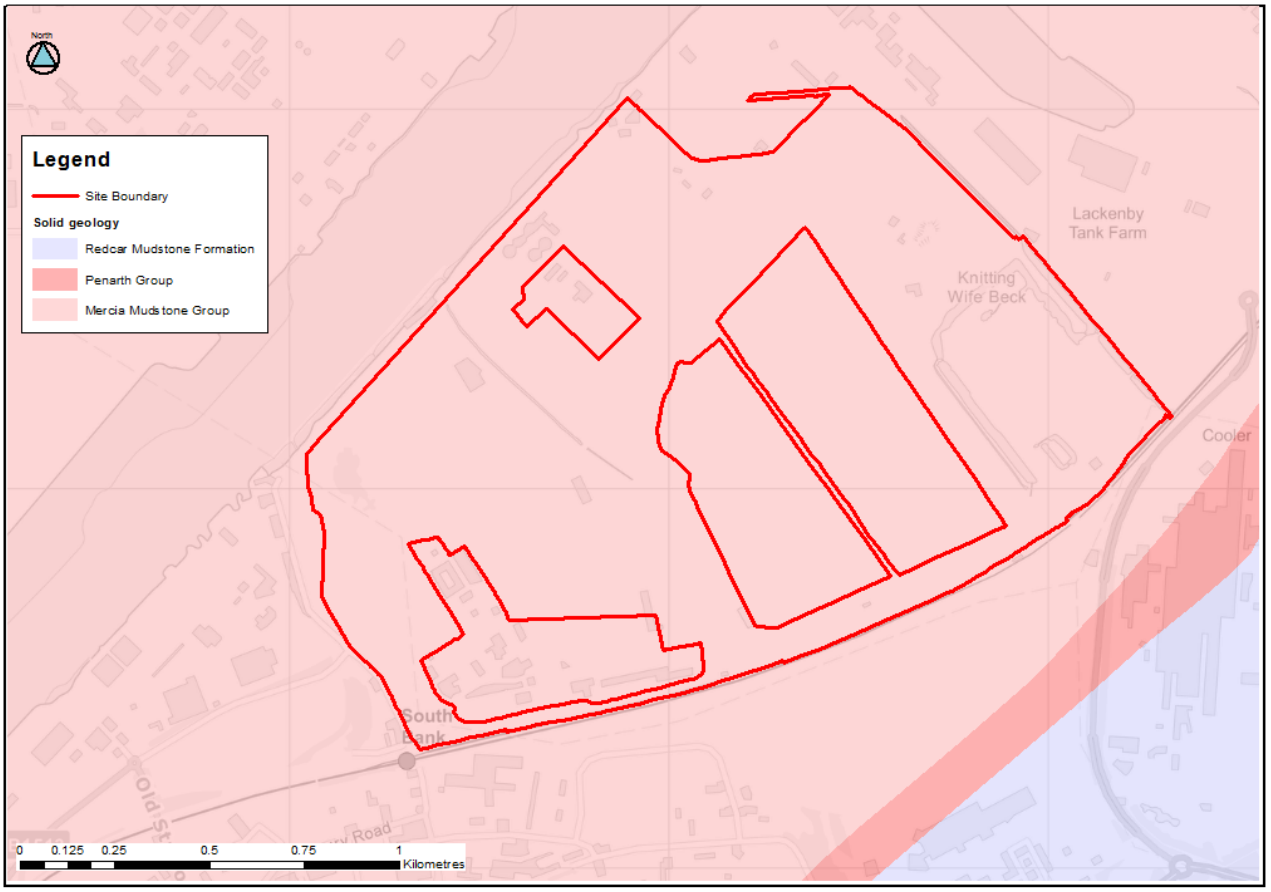
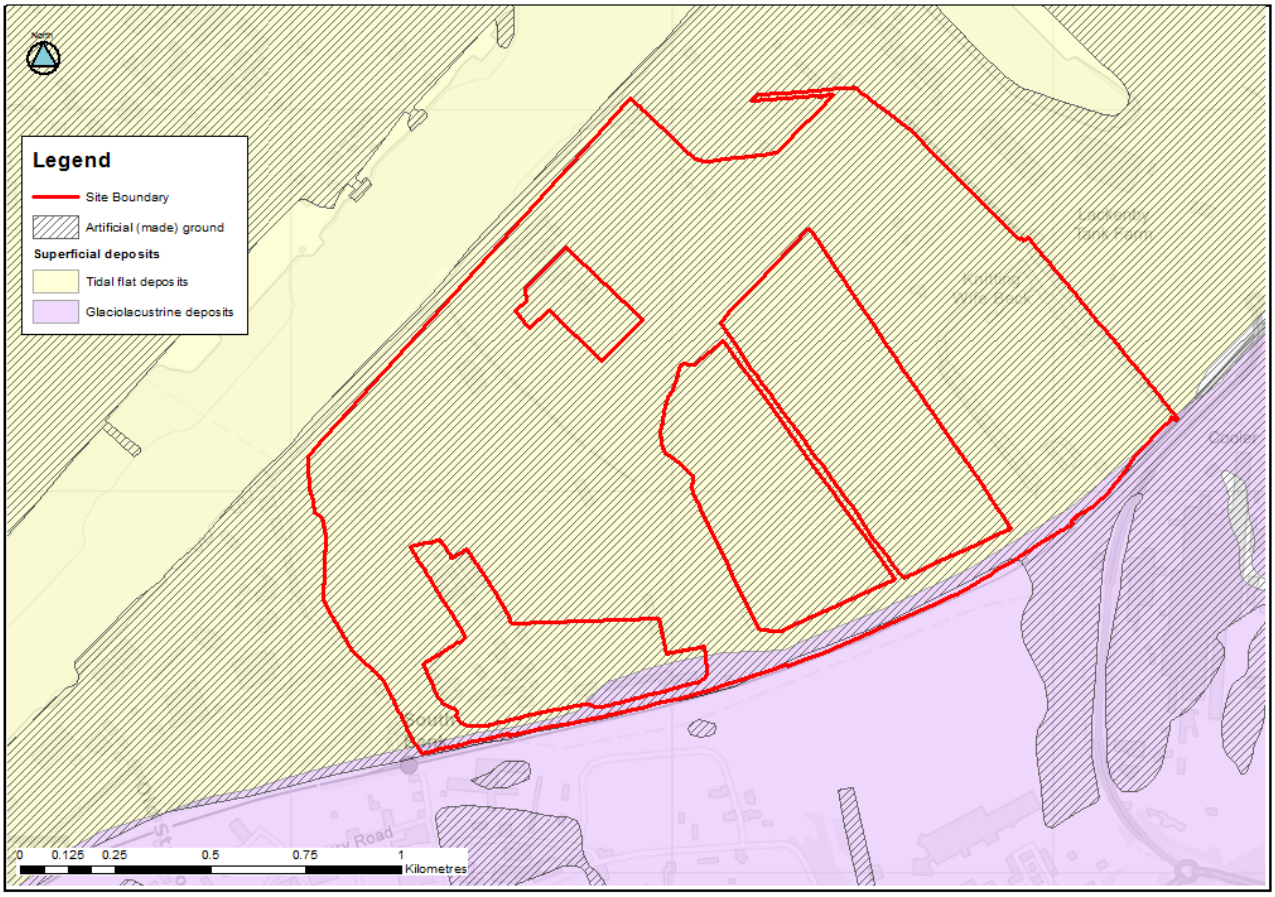


Figure G4.3 Superficial Geology



Land Quality

G4.28 Existing land quality and its potential impacts on receptors is considered in the ground conditions and remediation chapter (chapter H of this ES). The site is covered with made ground and contains a number of potential sources of contamination.

Hydrogeology and Groundwater Vulnerability

G4.29 The bedrock mudstone is classified as a Secondary B Aquifer, defined by the EA as predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers. The tidal flats deposits are classified as a Secondary (undifferentiated) Aquifer, which has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the lithology.

G4.30 The top of groundwater table lies within the made ground layer between 1.3-2.2mAOD (between 1-9mbgl) (Wood, 2020). This water is likely perched on the underlying deposits, with a limited gradient due to the flat topography.

G4.31 The conceptual understanding of the overall groundwater functioning of the site is for direct recharge through the Made Ground, which is of varying permeability. Below this, the ground is likely to be mainly saturated within the glacio-lacustrine/Tidal Flat deposits and underlying

Glacial Till and bedrock mudstone. Groundwater heads within the permeable units are likely to vary across the site and the more permeable horizons may not be laterally continuous across the site and may vary in elevation. Nonetheless parts of the site are likely to be in hydraulic connectivity with the River Tees, particularly through the tidal flat sands and a potential pollution linkage may lie between the two. There may also be some limited discharge of baseflow from the Mercia Mudstone secondary B aquifer to the River Tees as the River Tees is likely to form the most significant groundwater discharge boundary in this area for all permeable strata.

G4.32 Groundwater vulnerability beneath the site is medium-high. This relates to the vulnerability of the secondary undifferentiated tidal flat deposits aquifer.

Groundwater Quality

G4.33 The groundwater quality of the Tees Mercia Mudstone and Redcar Mudstone groundwater body (ID GB40302G701300) has been assessed in 2016 as having a WFD status of 'Poor' in the Northumbrian RBMP. This appears to be due to the general chemical status in relation to the ironstone mining history of the area and due to risk of nitrate contamination (Environment Agency, 2019c).

G4.34 Source Protection Zones ('SPZ') (inner, outer and total catchment) are defined around abstraction boreholes that are used for public water supply (see below), to help monitor the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk is likely to be. The zones are used in conjunction with the EA's Groundwater Protection Policy (GP3) to set up pollution prevention measures and monitor the activities of potential polluters near public water supply boreholes. The site does not lie within a defined SPZ, nor is within 5 km of one.

G4.35 Numerous investigations have been undertaken across the site (see Chapter H Ground Conditions and Remediation). For example, Enviros (2004) identified elevated concentrations of sulphates, cyanide, arsenic, copper, boron, PAHs (Poly-Aromatic Hydrocarbons), BTEXs (Benzene, Toluene, Ethylbenzene and Xylene), TPH (Total Petroleum Hydrocarbons), and free phase product was noted in some boreholes. Overall, the groundwater quality is poor, reflexing the complex historic of industrial activities on the site.

Abstractions and Discharges

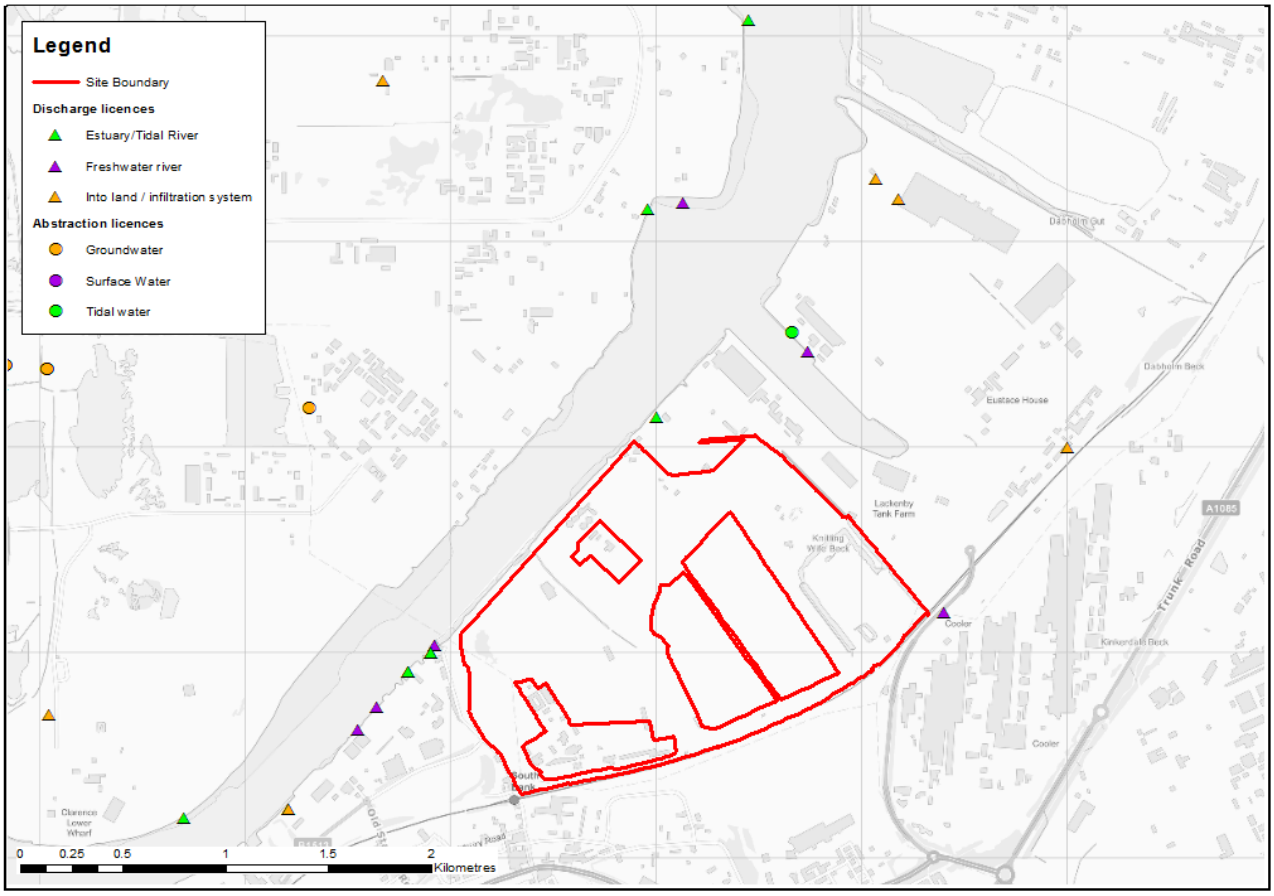
G4.36 Available information from the EA indicates that there are six abstractions within 5 km of the site (Environment Agency, 2020c) and are shown on Figure G4.4. Of these, the groundwater abstractions are all located on the north side of the River Tees and, due to the hydraulic barrier formed by the River Tees, it is unlikely that any of these abstractions have their catchment within the site of the proposed development.

G4.37 The nearest abstraction is tidal and lies on the south bank of the River Tees, downgradient of the site. The abstraction on the south bank of the River Tees is for dust suppression and power station cooling.

G4.38 Discharge data provided by the EA indicate that there are numerous active consented permits within the vicinity of the site which are shown on Figure G4.4. None of the discharges lie within the site although some lie close to the northern and south-west edge of the development. All the discharges are for sewage or trade effluent, issued to ground/infiltration, surface water or tidal water receiving water bodies.

G4.39 On the basis of the above information, none are deemed to be potentially impacted by the proposed development. None of the other discharge receiving waterbody locations are likely to have their flows or water quality altered by the proposed development.

Figure G4.4 Abstractions and Discharges



G4.40 RCBC confirmed that there are no abstractions for private water supply within 2 km of the site. Whilst every effort has been made to locate private water supplies, there is the potential for unrecorded private supplies to be present but this unlikely given the local hydrogeological conditions (e.g. historic contamination and poor aquifers).

Nature Conservation Sites

G4.41 There are no sites designated for geological importance within the footprint of the proposed development. Baseline ecology is presented in Chapter D.

Future Baseline

G4.42 Hydrological systems are in a state of constant flux. The two main influences on the future hydrological and hydrogeological regime of the site and surrounding area are climate change and local land use change, which have the potential to change the river flow regime (through changes in rainfall patterns and storm surges as a result of climate change and sea level rises) and ground permeability and runoff/infiltration (through changes in land use).

G4.43 The UK Climate Projections (UKCP18) indicate that as a result of climate change, it is projected that, in general, winters will become wetter and summers drier. The EA via the Gov.UK website provides recommended climate change sensitivities for peak river flow, peak rainfall intensity and sea level rise. Potential climate change sensitivities can be used to derive appropriate design levels above which the proposed development shall be constructed. The lifespan of the proposed development is 50 years, but as the design is yet to be finalised, a conservative approach has

been taken and the data examined up to 2100. Details of the estimated increases to peak river flow, peak rainfall intensity and sea level rise are provided from Section 2.25.

G4.44 The effect of these projections regarding decreased summer rainfall and increased winter rainfall is likely to be greater seasonality of flows and water levels, with greater susceptibility to both drought and extreme flood events. The increased frequency of floods, increases the likelihood of morphological changes in watercourses.

G4.45 In the absence of the proposed development proceeding, it is anticipated that the land use, management of the site and condition of the water bodies at the site and in the surrounding area would remain the same as the current baseline. as described in the FRA in Appendix G2).

Summary of Receptors and their Sensitivity

G4.46 From consideration of the baseline characterisation, a sensitivity classification has been allocated to each identified water environment receptor, and these are set out in Table G4.3. The receptor sensitivity allocated is based upon the definitions set out within Table G3.1 and utilising professional judgement.

Table G4.3 Sensitivity of water environment and human health receptors

Receptor	Rationale	Sensitivity
Surface water		
River Tees estuary	Under the EA's Catchment Explorer, as noted in Section G5, the Tees estuary is classified as being of 'Moderate' ecological potential and 'Failing' chemical status with an overall classification of 'Moderate in 2016. Reasons for the classifications include diffuse and point source pollution from contaminated water body bed sediments, trade / industrial activity and sewage discharge. In addition, the whole estuary area holds an international designation (Teesmouth and Cleveland Coast SSSI) and the site lies within a zone of interest for the SSSI. Therefore, the sensitivity of the Tees is considered to be very high.	Very high
Holme Beck Culvert and Knitting Wife Culvert	The course of the small surface water body, Holme Beck, has been altered historically such that it now flows into the Cleveland Channel. These watercourses/culverts are too small to be classified under WFD as they have limited ecological potential. As such, the sensitivity of these watercourses is considered to be very low.	Very low
Cleveland and Lackenby Channels	These channels are interconnected, and therefore taken together as one receptor. In effect, they are now part of the re-routed Holme Beck, with limited ecological potential. In addition, the Cleveland Channel is understood to be filled with highly contaminated water and sediments. As such, the sensitivity of these water bodies is considered to be very low.	Very low
Groundwater		
Mercia Mudstone	The site sits on a solid geology aquifer of low-moderate groundwater potential. Although the current overall status of the WFD groundwater body which dominates the site is 'Poor', the overall groundwater resource only yields limited amounts of groundwater, as a Secondary B aquifer, and is therefore regarded as of low sensitivity.	Low

Superficial aquifer (Made Ground, Glacio-lacustrine deposits, Tidal Flats and Glacial Till)	The site sits on superficial deposits classified as a Secondary (Undifferentiated) Aquifer. Due to the Poor aquifer status, lack of resource potential, and presence of known contaminants at the site, and lack of local use for abstraction, it is therefore regarded as being of low sensitivity.	Low

G5.0 Potential Effects

Embedded Mitigation

G5.1 The points below present a summary of the mitigation measures embedded into the design

G5.2 Construction Phase: -

1 Movement of material - it is assumed that the site is cut and fill natural.

2 Flooding and drainage - the proposed finished floor level will be a minimum of 5.79mAOD. The tidal flood level of 5.03mAOD represents the 200 year coastal flood risk + Sea Level Rise allowance to 2100 design scenario and so the proposed development would be outwith the elevations at risk of flooding.

G5.3 A Drainage and Water Management Strategy is being developed for the wider STDC area. This is being progressed and at the point of submitting this outline planning application, is yet to be finalised. The detailed design of the scheme will be designed in accordance with the industry standards, regulations and guidance for design of water management and drainage assets detailed in this water management strategy that will be required to meet planning conditions. Since this strategy is not yet finalised, it is not embedded into the design of the scheme and it is therefore considered as secondary mitigation. However, the STDC strategy shall be prepared in advance of construction so that the detailed design will comply with the industry standards, regulations and guidance for the design of water management and drainage assets and supply appropriate mitigation for the adverse impacts. Further details are included in the next section of this chapter.

During Construction

G5.4 This section outlines the potential effects that would be anticipated to occur (from the proposed activities) on the water environment during the construction phase of development, prior to the implementation of any secondary mitigation measures (i.e. those not included as embedded measures within the design of the scheme - as noted in paragraph G5.3 above, this is the drainage and water management strategy).

G5.5 The following types of potential effect (prior to secondary embedded mitigation) of the proposed development upon water environment interests have been identified:

Surface watercourses - flows

G5.6 Surface water flows could be impacted during the excavation and placement of site won material. Whilst the Cleveland Channel in particular is understood to have a very low quality and to be filled with contaminated sediments, the introduction of further material to this channel and the other water bodies on site could decrease capacity for flows. Also, without management of drainage and surface waterbodies, the potential for pockets of surface water flooding across the site and coastal / tidal flooding to the south east of the site (as detailed in the FRA), remains possible at high rainfall / high flow events since not all of the ground will be located at the proposed minimum finished floor level of 5.79mAOD. However, the receptor sensitivity of the Cleveland and Lackenby Channels and the Holme Beck and Knitting Wife Culvert is low and the magnitude of change minor and so the effect would be negligible and not be significant. The Tees estuary has a very high sensitivity and so whilst the magnitude of change is minor, there is the potential for moderately significant effects without further mitigation.

Surface watercourses – water quality

G5.7 The potential for pollution of surface water is principally when high levels of suspended solids and/or leachates from Made Ground have the potential to enter local watercourses during earthworks. A potential pollution pathway also exists from the site through the shallow groundwater system to the River Tees and other surface water bodies. This may arise from runoff associated with construction activities e.g. through generation of silt borne run-off during groundworks, accidental spills and leaks from construction plant. The FRA notes that the groundwater vulnerability map available via the Defra MAGIC Map indicates that the site is within an area of medium-high risk from groundwater (where 'high' equates to areas able to easily transmit pollution to groundwater with high leaching soils). During site preparation (where the construction compound will be developed with waste and fuel storage areas) and construction, there is the potential for spillages and leaks and so moderate magnitude of change. Areas adjacent to the Lackenby Channel and Cleveland Channel are shown in the FRA flood maps to be risk from high magnitude coastal flooding with an allowance for sea level rise. Whilst these areas are excluded from the site boundary, this shall be considered in terms of the eastern access point to be established for the site and also for the storage of vehicles and materials required for the construction phase. Since fuels, oils and chemicals would be stored on-site during certain phrases of works (e.g. for re-fuelling of plant and equipment), spillages and leakages could occur. The potential spillages and leakages are likely to be localised. However, depending on location, they may present a risk to surface water quality if in the area where flooding is anticipated, albeit at high magnitude events. This is likely to result a minor magnitude of change given the on-site management protocols that would be adopted to deal with such incidents during construction works. For the low sensitivity of the receptors of the Cleveland and Lackenby Channels and the Holme Beck and Knitting Wife Culvert, this would have a minor effect and so not significant.

G5.8 The proposed development avoids changes to the bank of the River Tees, which limits the potential for direct and thus significant impacts. Thus, whilst the Tees is a very high sensitivity receptor, the lack of change means there is a neutral / negligible effect and so not significant.

Groundwater aquifer - flows

G5.9 For the anticipated construction activities, as detailed Chapter B of this ES, the ground surface would largely be expected to remain above the groundwater table, and it is unlikely that groundwater would be encountered as part of these works. Reduced infiltration may be expected where areas of hardstanding across the site are increased and so potential adverse effects on aquifer recharge. Nonetheless, given the groundwater here is not used as a resource, the magnitude of the effect of excavation on groundwater flow is deemed to be minor. Alongside a receptor sensitivity category for the superficial aquifer of low, the level of effect is therefore negligible, and not significant.

Groundwater – water quality

G5.10 Effects on groundwater quality could results from the following:

- Excavations and earthworks,
- Piling
- Spillages and leaks of fuels, oils and chemicals.

G5.11 Potential pollution to underlying aquifers. This includes a potential pathway through the made ground to the River Tees. This may arise from runoff associated with construction activities e.g. through generation of silt borne run-off during groundworks, accidental spills and leaks from

construction plant as well as accidental spillage from operational site activities. Overall, due to the presence of Glacial Till underlying the tidal mudflats and Made Ground, the bedrock aquifer is considered to be in limited hydraulic continuity with the shallow groundwater system and the surface waters in the Tees estuary. Nonetheless, some continuity cannot be ruled out, and so potential impacts to the bedrock aquifer from pollution are deemed to be of moderate magnitude Alongside a receptor sensitivity category for the aquifer as low, the level of effect is therefore minor, and not significant.

Operation

Surface watercourses - flows

G5.12 During the operation of the site, there are potential adverse effects on drainage patterns and surface water, principally in relation to a change in runoff patterns and drainage associated with groundworks from site development since it is assumed that the post development site will comprise 90% of the ground surface. The water management and drainage strategy is currently being developed but without this there would likely be minor magnitude of change which for the very high sensitivity receptor of the Tees could have a moderately significant impact and for the receptors of the Cleveland and Lackenby Channels and the Holme Beck and Knitting Wife Culvert, this would have a neutral / negligible effect and so not significant.

Surface watercourses – water quality

G5.13 Without collection and discharge of surface water through a new drainage and water management system the magnitude of change for water quality could therefore be moderate and for the very high sensitivity River Tees, the level of effect could be substantial and therefore significant. For the low sensitivity receptors of the Cleveland and Lackenby Channels and the Holme Beck and Knitting Wife Culvert, this would have a minor effect and so not significant

Groundwater aquifer - flows

G5.14 The aquifer is not used as a resource for abstraction and is of limited potential but the change to the ground surface so that 90% is concrete potentially limits the volume of direct recharge to the aquifer as such, the potential magnitude of change for groundwater flows impacts during operation is moderate. The site is located adjacent to the River Tees, a very significant groundwater discharge boundary, any changes to recharge on site will only alter the path of the potential rainfall recharge on site from through the ground (which is known to be contaminated) to the Tees to through the drainage system to the Tees: both pathways are relatively short. Hence, for these low sensitivity groundwater receptors the level of effect is minor and not significant.

Groundwater – water quality

G5.15 The collection of surface water from the site using the new drainage system that is proposed minimises There is the potential for any contaminated surface runoff to reach the superficial or bedrock aquifer during the operational stage without a water management and drainage system. In addition, re-placement of material in the construction phase means that rainfall-infiltration through the Made Ground could introduce potential contaminants to groundwater. As such, the magnitude of change for groundwater quality impacts during operation is moderate, and the level of effect on the low sensitivity groundwater receptors is minor, and not significant.

G6.0 Mitigation and Monitoring

G6.1 The mitigation for impacts to surface water and groundwater impacts will be provided through secondary mitigation (i.e. that in addition to the embedded mitigation) from adoption of the STDC water management and drainage strategy for the whole STDC site that details the required regulations and industry standards required for water and drainage asset design and also through a Construction Environmental Management Plan. The CEMP shall also take of mitigation measures detailed in Chapter H (Ground Conditions and Remediation). The STDC strategy shall be prepared in advance of construction so regardless of the assets which form the detailed design, the design shall comply with the industry standards, regulations and guidance for the design of water management and drainage assets and supply appropriate mitigation for the adverse impacts.

G6.2 The CEMP shall embed best practice guidance to produce the water environment from among others the following:

1 Environment Agency (EA) Principles and Practice for the Protection of Groundwater (GP3);

2 A Pollution Prevention Guidance (PPG) Notes (as referenced in Section G2.4):

3 Construction Industry Research and Information Association (CIRIA) Report C532: Control of Water Pollution from Construction Sites;

4 CIRIA Report C502: Environmental Good Practice on Site;

5 CIRIA Report 515: Groundwater Control – design and practice; and

6 CIRIA Report C697: The SuDS manual.

G6.3 The STDC strategy is currently being discussed and developed with STDC (due July 2020) and so at present there are no details available. However, in light of NPPF, RCBC Local Plan and the Regulations noted above in the Policy section of this chapter, the following details of the strategy can be noted:

a the design shall be prepared in line with the requirements of:

i CIRIA The SuDS Manual C753

ii Sewers for Adoption (Northumbrian Water currently use version SfA6 but will likely migrate to SfA8 during the time of the development of the design for the site.

iii Local Authority SuDS Officer Organisation. Non statutory technical standards for sustainable drainage: Practice Guidance

iv Tees Valley Local Authorities Local Standards for Sustainable Drainage

b there is an aspiration for blue/ green networks across the site - the aspiration for a Water Sensitive Urban Design, which is a land planning and engineering design approach which integrates the urban water cycle including stormwater, groundwater and wastewater management and water supply, into urban design to minimise the cost of infrastructure and environmental degradation.

c where reasonably practicable the runoff rate from the site shall be reduced as far as possible in light of the large extent of low permeability surfaces.

d hydraulic modelling will be required as part of the site-specific design of drainage and overland and exceedance flow paths

e the design shall take account of climate change projections and comply with current best practice.

f drainage channels and/or networks will be lined with a geomembrane to prevent connection of surface water with contaminated ground material.

a any harvested rainwater will need to be protected for re-use so that it is not contaminated.

G6.4 As has been explained within this chapter, this STDC is currently being drafted and therefore the specific nature of the design is yet to be determined.. Where possible and achievable the detailed design of the scheme should take into account the aspirations for blue green networks. However, regardless of the assets which form the detailed design, the STDC strategy shall be prepared in advance of construction so that the detailed design will comply with the industry standards, regulations and guidance for the design of water management and drainage assets and supply appropriate mitigation for the adverse impacts.The below table sets out the proposed mitigation and monitoring measures for the construction and operational phase of development.

Table G6.1 Rationale for incorporation of environmental measures

Receptor	Potential Impact	Design Mitigation - Construction	Design Mitigation - Operation
River Tees estuary Holme Beck tributary, Knitting Wife Culvert and the Cleveland and Lackenby Channels (flooding)	Increased risk of flooding from increased surface runoff reaching watercourses.	No works are planned to the existing shore / bank of the Tees A plan for surface water management (as recommended in Chapter H for Land Management and Contamination) will be incorporated into site specific drainage design Consideration and appropriate measures shall be required to manage the pockets of pluvial flooding at high rainfall events until the ground surface is constructed.	The development will incorporate a Water Management and Drainage Strategy appropriate to the site to improve the management of water compared to the baseline conditions, whilst also taking into account potential changes in rainfall from climate change. This strategy will be signed off via the Environmental Permit process It is anticipated that in addition to the outfall to the Tees from the Lackenby Channel there would be additional discharges to the Tees from blue green networks. At present it is not yet known whether there is a flap on the outfall to control the tidal influences, however it is anticipated that discharges to the Tees will be regulated under an environmental permit.
River Tees estuary, Holme Beck tributary, Knitting Wife Culvert, Cleveland and Lackenby Channels, and discharges	Increased runoff to watercourses and drains due to increased roadways and areas of hardstanding could affect channel morphology.	The timing of excavation and re-placement of ground materials shall be sensitive to avoiding poor weather conditions.	The potential effects of the scheme will seek to be minimised by the water management and drainage strategy by reducing the runoff rate from the site as far as possible in light of the large extent of low permeability surfaces. The drainage design will take account of climate change.

(surface water flows)			Holme Beck is an Ordinary Watercourse, therefore, proposed discharge rates (if any) must be agreed with the LLFA and if required confirmation obtained for capacity of discharge to Northumbrian Water systems.
	Change in water quality from increased sediments in surface runoff.	It is assumed the site is cut and fill neutral. Any ground material would be retained within the site, or alternatively within the wider STDC site and activities for movement of material would be covered in the CEMP to account for the contaminated nature of ground material. The timing of excavation and re-placement of ground materials shall be sensitive to avoiding poor weather conditions.	The proposed drainage system will include consideration of design features to remove silt and other suspended solids, as well as capture any spills/oil and grease, prior to discharge. The large extent of low permeability surface proposed for the site will 'cap' underlying contaminated land. Once the site design and the water management and drainage strategy are available, a WFD Assessment shall be undertaken. The water management strategy will not include infiltration SuDS such as soakaways, in order to limit mobilisation of contamination. The suggested blue green networks for the water management and drainage strategy will be tested to see if they are achievable within the development site. Where Blue Green Networks are achievable conveyance and storage features will be lined with a geomembrane to prevent connection of surface water with contaminated ground material and consider the risk of contamination of local groundwater through increased percolation. In addition, any harvested rainwater would need to be protected for re-use so that it is not contaminated. Discharges to the Tees will require an environmental permit and should lead to an improvement in the water quality.
	Change in water quality from a change in land use or drainage patterns at consented discharge locations.	Placement of oil-water interceptors at outfalls from the site	The proposed drainage system within the site boundary means that no overall changes to local drainage patterns around discharge locations are anticipated. If additional discharge points are proposed from blue green networks, consultation will be required with the LLFA and the EA for direct discharges to the Tees.

	Potential pollution from silt and accidental spills or leaks.	A range of environmental measures will be implemented during construction to deliver adherence to the EA's PPG notes, CIRIA guidance into Construction Method Statements and other current best practice. These will be set out in a Construction Environmental Management Plan (CEMP) Measures to reduce the risk of silt pollution and contamination from chemicals/oils include: -Minimising the amount of exposed ground and soil stockpiles from which water drains and the period of time such water drains; -Storage of all chemicals and oils within areas of hard standing and installation of secondary containment, such as a bund wall. Storage areas shall be located at least 10m away from any surface watercourses and areas at risk of flooding; -Plant and machinery used during the construction phase would be well maintained to minimise the risks of oil leaks or similar. In these designated areas, contingency plans would be implemented so that the risks of spillages are minimised. Placing a drip tray beneath plant and machinery during re-fuelling and maintenance would contain small spillages; and -Locating plant and wheel washing facilities in a designated area of hard standing at least 10m from any watercourse or surface water drain. Groundwater and surface water monitoring shall be carried out associated with any site investigation	Effluent from welfare facilities on the site will either be taken off site for disposal and treatment or routed to the local sewer network.

		programme. This would continue throughout the construction phase and would include a contingency plan, detailing actions to be taken should a departure from the established baseline be identified. Relevant guidance and monitoring guidelines would be set out in the CEMP. An emergency response protocol will be developed by contractors and incorporated into the CEMP so that any accidental spillages are intercepted and that there are procedures for site staff to follow. Spill containment equipment (e.g. absorbent material) will be provided on site.	
	Potential failure of wastewater infrastructure to cope with additional flows from the development resulting in a deterioration in the quality of surface waters and groundwater (affecting WFD chemical status).		The proposed development provides the opportunity to replace/improve all existing surface water drainage infrastructure where reasonably practicable. This will be required for infrastructure that is part of the site that does not currently have the required capacity as identified in the strategy and site design. The feasibility of this will be tested as part of a detailed drainage strategy for the site and each development plot. New drainage will be designed to current standards with allowances for additional rainfall and surface water flows under a climate change scenario. Permits shall be obtained for works and signed off by the Environment Agency Water management and drainage strategy will need to ascertain whether there is a groundwater input to the culverts and if so how to accommodate this in the site drainage strategy and design. A WFD Assessment will need to be undertaken once the site design and the water management and drainage strategy is developed.

Secondary Aquifers (groundwater recharge)	Groundwater recharge to the Secondary Aquifers may be reduced as a result of the increase in roadways, and areas of hardstanding.		
Secondary Aquifers (groundwater quality)	Groundwater quality may be impacted by changes in pathways of soils during excavation and re-placement of materials.	It is assumed the site is cut and fill neutral. Any ground material would be retained within the site, or if not possible, with the wider STDC site and activities for movement of material would be covered in the CEMP to account for the contaminated nature of ground material. Such details are available in Chapter H.	As above, the risk of potential mobilisation of contaminants is likely, prior to excavation this would be managed through a contaminated land remediation strategy. The water management strategy will not include infiltration SuDS such as soakaways, in order to limit mobilisation of contamination.
	Beneficial changes to the groundwater system during the operation phase		The remediation strategy and the drainage strategy shall reduce the mobilisation of contaminant on site due to reduction in recharge.
Surface waters and groundwater	Potential for mobilisation (e.g. leaching) of contaminants from soils encountered during construction phase.	It is assumed the site is cut and fill neutral. Any ground material would be retained within the site, or where not possible, within the wider STDC site and activities for movement of material would be covered in the Construction Waste Management Plan to account for the contaminated nature of ground material. Disposal of any surplus materials shall be undertaken in accordance with the Waste Management Licensing Regulations 1994 and Duty of Care requirements in accordance with the Environmental Protection Act 1990. Potential effects from the interaction of contamination with utilities services including sewers and water supplies will be mitigated through the contaminated land strategy.	

	Beneficial changes to the groundwater -surface water system during the operation phase		If it is possible for the drainage strategy to incorporate blue green networks. The design of these features should consider the use of a liner to minimise the incorporation of contaminants into drainage water and protect the aquifer.
	Piling	Any piling work will be subject to a piling risk assessment	

G7.0 Residual Effects

G7.1 The STDC water management strategy shall be prepared in advance of construction. The residual impact assessment has been carried out on the assumption that the above mitigation principles detailed in the strategy and the CEMP shall be adopted through the construction and operation phases. Since the water management strategy and CEMP are to be considered as secondary mitigation, this secondary mitigation will change the effect of the development over and above that assessed in the embedded mitigation section.

G7.2 As previously noted, the water management and drainage strategy is yet to be completed but in light of the application of the appropriate mitigation following the mitigation hierarchy and the aspirations to establish blue-green networks and daylight culverts where possible, no significant residual impacts are predicted during construction, operation or decommissioning of the project. Residual effects to the water environment are summarised below.

During Construction

Surface watercourses - flows

G7.3 For the River Tees surface water body, which is of very high sensitivity, the minor magnitude of change which may be expected from the beneficial mitigation measures undertaken means that the level of effect would be moderate and, therefore, significantly beneficial. For other surface water receptors (the Holme Beck Culvert and channel and Knitting Wife culvert, Cleveland and Lackenby channels), a moderate magnitude of change would also be subject to a level of effect that would be minor, and not significant albeit positive.

Surface watercourses – water quality

G7.4 The water management strategy shall seek to incorporate mitigation measures to limit risk of contamination such as the placement of oil-water interceptors at outfalls from the site and locating construction vehicles and materials out with the areas shown to be at flood risk. In addition, surface water channels, associated with drainage and the blue green networks for which there is an aspiration, will be lined with a geomembrane that and harvested rainwater would need to be protected for re-use to avoid contaminated ground. There would therefore be a moderately beneficial impact which would result in a minor positive impact for the surface water bodies of the Holme Beck, Knitting wife culvert, Cleveland and Lackenby channels

Groundwater aquifer - flows

G7.5 Receptor sensitivity category for the superficial aquifer of very low, the magnitude of the effects will be minor, so the level of effect is therefore negligible, and not significant. Additional mitigation will not change the effect of the development over and above that assessed in the section above which includes consideration of the embedded mitigation.

Groundwater aquifer - water quality

G7.6 Excavations associated with the proposed development would be of a superficial nature, within the made ground and are not anticipated to extend downwards into the underlying tidal flat aquifer. Also, the use of site won and imported soil-based material used during construction would comply with the agreed re-use criteria, which would be set out in site construction documentation, such as the CEMP.

G7.7 During future piling activities associated with future site redevelopment, groundwater quality of the aquifer units may be affected where there is potential to generate viable pollutant linkage

between the potentially contaminated shallow soils (Made Ground) and groundwater. This may impact on the aquifer units below and any surface waters to which they are hydraulically connected. However, the work would be undertaken in accordance with EA guidance and a piling risk assessment for the site. Therefore, any effects on groundwater quality are likely to be of minor to moderate magnitude of change, which combined with a low sensitivity receptor gives an effect greater than minor or negligible, which is not significant.

G7.8 Given that fuels, oils and chemicals would be stored on-site during certain phrases of works (e.g. re-fuelling of machinery), spillages and leakages could occur. The potential spillages and leakages are likely to be localised. However, depending on location, they may present a risk to groundwater quality. This is likely to result a minor magnitude of change given the on-site management protocols that would be adopted under the CEMP. For the low sensitivity aquifer receptors, this would result in a negligible level of effect of pollution which would be deemed to be not significant.

During Operation

G7.9 Surface water - flows: - there would be a minor magnitude of change from the mitigation measures which would result in a moderate beneficial effect for the Tees receptor and a negligible beneficial effect for the other surface waterbodies (Holme Beck, Knitting wife, Cleveland and Lackenby Channel).

G7.10 Surface water - quality: - there would be a moderate magnitude of change from implementation of the mitigation measures and so a substantial beneficial effect for the Tees and negligible beneficial effect for the other surface waterbodies (Holme Beck, Knitting wife, Cleveland and Lackenby Channel).

Groundwater aquifer - flows

G7.11 Receptor sensitivity category for the superficial aquifer of very low, the magnitude of the effects will be minor, so the level of effect is therefore negligible, and not significant. Additional mitigation will not change the effect of the development over and above that assessed in the section above which includes consideration of the embedded mitigation.

Groundwater aquifer - water quality

G7.12 In the operation phase, the site will have been subject to the work undertaken in the remediation strategy. The drainage strategy should also not include for the provision of infiltration SuDS. Together this should reduce the overall risk from on-site contamination and its potential for mobilisation. This should result in a moderate magnitude of change from the implementation of the mitigation measures and result in minor beneficial effect

G8.0 Summary and Conclusions

G8.1 The table below summarises the: receptors, potential effect (including significance), mitigation measure, residual effect (including significance) in relation to water management and flooding.

Concluding comments

G8.2 The straightened and culverted watercourses through and surrounding the site present constraints to development, but they also provide significant opportunities. The aspirations of the forthcoming water management and drainage strategy seek to provide a plan for managing and improving the current baseline conditions on site with respect to the water environment. Works shall be done under an environmental permit and the STDC water management and drainage strategy shall be prepared in advance of construction so that there is a means to ensure commitment to delivering mitigation that adheres to the best practice, regulations and guidance noted in previous sections of this chapter.

G8.3 With regards to groundwater, the site has limited groundwater resources. The development should lead to an overall improvement of groundwater conditions through the remediation strategy, blue green infrastructure and other embedded mitigation. SuDS shall be used to protect and enhance the environment. As most of the site is made ground the proposed SuDS and any new drainage shall be lined or subject to local investigation to minimise infiltration into contaminated parts and translocation of the contaminants into wider environment. Any storage for rainwater shall be lined or in tanks that are suitably protected against ingress from contaminated soils. This will prevent contamination during storage.

G8.4 This assessment has been undertaken as a high-level analysis of flood risk to the site. Further mapping and modelling of flood risk will be undertaken as part of detailed planning applications that will further identify opportunities and constraints. Consultation with the Risk Management Authorities – Redcar and Cleveland Council LLFA, Northumbrian Water, Environment Agency, Highways Services is being undertaken as part of the development of the water management strategy and engagement with these organisations should continue throughout the design of the proposed development.

Table G8.1 receptors, potential effect (including significance), mitigation measure, residual effect

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
During Construction					
Surface water					
River Tees estuary	Increased runoff	Very high	Moderate adverse	Implementation of Drainage Strategy to reduce runoff rates whilst taking into account potential changes in rainfall from climate change through appropriate use of sustainable drainage during construction. The timing of excavation and re-placement of ground materials shall be sensitive to avoiding poor weather conditions. It is anticipated that in addition to the outfall to the Tees from the Lackenby Channel there may be additional discharges to the Tees from blue green networks. The developer will need to comply with the requirements of the FRA in order that no impacts arise from flooding due to increased surface runoff from the site to the surface water bodies.	No significant adverse effect from residual impacts. Minor magnitude of change so moderate beneficial impact.

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
	Mobilisation of contaminants and sediment Spillages and leakages causing pollution		Moderate adverse Moderate adverse	Implementation of the water management and drainage strategy to remove silt and other suspended solids, as well as capture any spills/oil and grease, prior to discharge. The timing of excavation and re-placement of ground materials should be sensitive to avoiding poor weather conditions. Placement of oil-water interceptors at drainage system outfall. Foul water to be directed to mains sewer. Implementation of appropriate pollution prevention measures e.g. CIRIA guidance: Control of water pollution from construction sites. Guidance for consultants and contractors (C532D).	No significant effect from residual impacts. Moderate magnitude of change and so minor significance.

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
Other surface water bodies (Holme Beck, Knitting Wife Culvert, Cleveland & Lackenby Channels)	Increased runoff	Low	Negligible adverse	Implementation of water management and drainage strategy to reduce runoff rates whilst taking into account potential changes in rainfall from climate change. Low permeability concrete surfaces are proposed for the majority of the ground across the site to 'cap' contaminated ground. Run off will be collected and passed through appropriate SuDS treatment that will be lined with a geomembrane to prevent connection of surface water with the contaminated ground. The timing of excavation and re-placement of ground materials shall be sensitive to avoiding poor weather conditions. The developer will need to comply with the requirements of the FRA in order that no impacts arise on flow volumes. Holme Beck is an Ordinary Watercourse, therefore, proposed discharge rates (if any) must be agreed with the LLFAs of the Environment Agency and Northumbrian Water.	No significant effect from residual impacts. Minor magnitude of change so negligible beneficial impact.

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
	Mobilisation of contaminants and sediment Spillages and leakages causing pollution		Minor adverse Minor adverse	Implementation of Drainage Strategy to remove silt and other suspended solids, as well as capture any spills/oil and grease, prior to discharge. The timing of excavation and re-placement of ground materials shall be sensitive to avoiding poor weather conditions. Placement of oil-water interceptors at drainage system outfall. Foul water directed to mains sewer. Implementation of appropriate pollution prevention measures e.g. CIRIA guidance: Control of water pollution from construction sites. Guidance for consultants and contractors (C532D).	No significant adverse effect from residual impacts. Moderate magnitude of change so minor beneficial effect.
Groundwater					
Mercia Mudstone	Reduced infiltration	Low	Negligible adverse	No further mitigation is proposed.	No significant effect from residual impacts.
	Pollution from spills Contaminant pathways activated		Minor adverse Minor adverse	Disposal of any surplus materials shall be undertaken in accordance with the Waste Management Licensing Regulations 1994 and Duty of Care requirements in accordance with the Environmental Protection Act 1990. Any proposed piling will require a piling risk assessment done in accordance with EA guidance. Groundwater monitoring would be ongoing, to determine whether the potential for mobilisation of contaminants is likely, prior to excavation. CEMP will be based on best practice guidance to limit the risks associated with fuels, oils and chemicals.	No significant effect from residual impacts.

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
Superficial aquifer	Reduced infiltration	Low	Negligible adverse	No further mitigation proposed.	No significant effect from residual impacts.
	Pollution from spills Contaminant pathways activated		Minor Adverse Minor adverse	Disposal of any surplus materials shall be undertaken in accordance with the Waste Management Licensing Regulations 1994 and Duty of Care requirements in accordance with the Environmental Protection Act 1990. Groundwater monitoring would be ongoing, to determine whether the potential for mobilisation of contaminants is likely, prior to excavation. CEMP will be based on best practice guidance to limit the risks associated with fuels, oils and chemicals.	No significant effect from residual impacts.
During Operation					
Surface Water Receptors					
River Tees estuary	Increased runoff	Very high	Moderately adverse	No additional mitigation measures are required other than those embedded into the design of the scheme.	No significant effect from residual impacts. Minor change so moderate beneficial effect.
	Spillages and leakages causing pollution		Substantial adverse	Additional mitigation measures will be included within the CEMP.	No significant effect from residual impacts. Moderate change so substantial beneficial effect.
Other surface water bodies (Holme Beck, Knitting Wife Culvert,	Increased runoff	Very low	Negligible adverse	No additional mitigation measures are required other than those embedded into the design of the scheme.	No significant effect from residual impacts. Minor magnitude of change so negligible beneficial effect.

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
Cleveland & Lackenby Channels,)	Spillages and leakages causing pollution		Minor adverse	The aspiration for blue green networks across the site and the daylighting of culverts where possible (dependent on travel and access routes) will seek to improve the quality of water bodies on site. Surface water channels in the blue green networks would be lined with a geomembrane. This will mitigate the potential pollution pathway to the surface water and so there would be no contact with contaminated ground. In addition, harvested rainwater would need to be protected. As most of the site is made ground the proposed SuDS and any new drainage shall be lined or subject to local investigation to minimise infiltration into contaminated parts and translocation of the contaminants into wider environment. Any storage for rainwater shall be lined or in tanks that are suitably protected against ingress from contaminated soils. This will prevent contamination during storage.	No significant effect from residual impacts. Moderate magnitude of change so minor beneficial change.
Groundwater					
Mercia Mudstone	Reduced infiltration resulting in lower flows	Low	Minor adverse	No additional mitigation measures are required other than those embedded into the design of the scheme.	No significant effect from residual impacts.
	Pollution from spills		Minor adverse	No additional mitigation measures are required other than those embedded into the design of the scheme.	No significant effect from residual impacts.
Superficial aquifer	Reduced infiltration	Low	Minor adverse	No additional mitigation measures are required other than those embedded into the design of the scheme.	No significant effect from residual impacts.
	Pollution from spills		Minor adverse	No additional mitigation measures are required.	No significant effect from residual impacts.

Water Environment Receptor	Impact	Receptor Sensitivity	Impact including embedded mitigation before additional Mitigation	Mitigation	Significance of Effects of Residual Impacts
	Reduced generation of contaminated groundwater from made ground	Low	Minor Beneficial	Remediation strategy and hardstanding will limit the regeneration of contaminated groundwater	No significant effect from residual impacts.

G9.0 Abbreviations & Definitions

1 AEP Annual Exceedance Probability
2 ALTBAR Mean catchment altitude (m above sea level)
3 ASCII American standard character set for information interchange
4 BFIHOST Base Flow Index estimated from soil type
5 BGS British Geological Survey
6 DEFRA Department of the Environment, Food and Rural Affairs (formerly MAFF)
7 DPLBAR Index describing catchment size and drainage path configuration
8 DPSBAR FEH index of mean drainage path slope
9 DTM Digital Terrain Model
10 EA Environment Agency
11 EIA Environmental Impact Assessment
12 FARL FEH index of flood attenuation due to reservoirs and lakes
13 FEH Flood Estimation Handbook
14 FRA Flood Risk Assessment
15 LiDAR Light Detection and Ranging
16 mAOD metres Above Ordnance Datum
17 NGR National Grid Reference
18 NPPF National Planning Policy Framework
19 OS Ordnance Survey
20 OS NGR Ordnance Survey National Grid Reference
21 PDF Portable Document Format
22 PPG Planning Policy Guidance
23 PROPWET FEH index of proportion of time that soil is wet
24 Ramsar The intergovernmental Convention on Wetlands, signed in Ramsar, Iran, in 1971
25 SAAR Standard Average Annual Rainfall (mm)
26 SFRA Strategic Flood Risk Assessment
27 SPRHOST Standard percentage runoff estimated from soil type
28 SSSI Site of Special Scientific Interest

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