CHAPTER 9 FLOOD RISK, HYDROLOGY AND DRAINAGE

9. FLOOD RISK AND DRAINAGE

INTRODUCTION

9.1. This Chapter assesses the likely significant effects of the Proposed Development on the environment with regard to water quality, water resources and flood risk. In particular, it considers the likely significant effects of the construction and operational phases of external flood risk from fluvial, surface water and groundwater impacting the Site and surrounding area, the increase in surface water runoff rates from the development, the potential for groundwater interruption and the increase in water demand and foul drainage demand. As well as this, this chapter will cover off the impacts on surface water and groundwater quality.

9.2. This Chapter (and its associated figures and appendices) is not intended to be read as a standalone assessment and reference should be made to the front end of this ES (Chapters 1 – 6), as well as the final chapter, 'Summary and Conclusions' (Chapter 14).

9.3. This Water Quality, Water Resources and Flood Risk chapter has been prepared by Melissa Seymour who has over 5 years' experience in water quality and hydrological impact assessment.

POLICY AND LEGISLATIVE CONTEXT

National Planning Policy

9.4. The National Planning Policy Framework (Ref 9.1) sets out the Government's planning policies for England and how these are expected to be applied. The principles of policy relevant to water quality, water resources and flood risk are provided in Section 14 '*Meeting the challenge of climate change, flooding and coastal change*' and Section 15 *'Conserving and enhancing the natural environment'* and, combined with the associated Planning Practice Guidance (Ref 9.2), from the current policy at the national level.

Local Planning Policy

9.5. The Redcar & Cleveland Local Plan (Adopted 2018) (Ref 9.3) provides the following policies that are considered relevant to water quality, water resources and flood risk for this development:

- "*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. All development proposals will be expected to be designed to mitigate and adapt to climate change.*

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 need not apply. Major developments will be required to submit a drainage plan which should incorporate SuDS and must be designed and constructed so surface water discharge does not adversely impact the water quality of receiving water bodies, both during construction and when operational. Development in areas at risk of flooding, as identified by the Environment Agency flood risk maps, will only be granted where all of the following criteria are met:

a) The proposal meets the sequential and exception tests (where required) in relation to the National Planning Policy Framework;
b) A site specific flood risk assessment demonstrates the development will be safe, including access and egress, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall;
c) New site drainage systems are well designed, taking account of events that exceed the normal design standard (e.g. consideration of flood flow routing and utilising temporary storage areas).

Legislation

9.6. A summary of key relevant UK water legislation is provided below:

- Environmental Protection Act (1990)(Ref 9.4): sets out a range of provisions for environmental protection, including integrated pollution control for dangerous substances;
- Water Resources Act (1991)(Ref 9.5): consolidated previous water legislation with regard to both the quality and quantity of water resources;
- Environment Act (1995)(Ref 9.6): established a new body (the Environment Agency (EA) with responsibility for environmental protection and enforcement of legislation. This Act introduced measures to enhance protection of the environment including further powers for the prevention of water pollution;
- Water Industry Act (1999)(Ref 9.7): consolidated previous legislation relating to water supply and the provision of sewerage services;
- Water Act (2003)Ref 9.8) extends the provisions of the Water Resources Act (1991) and the Environment Act (1995) with regard to abstractions and discharges, water conservation and pollution control;
- Anti-Pollution Works Regulations (1999)Ref 9.9): provides powers to the EA to stop any activity (e.g., construction) that is giving or is likely to give rise to environmental pollution or to adequately enforce pollution control measures;

- Control of Pollution (Oil Storage) (England) Regulations (2001)(Ref 9.10): Imposes general requirements for preventing pollution of controlled waters from oil storage, particularly fixed tanks or mobile bowsers. Makes contravention a criminal offence;
- Water Environment (Water Framework Directive) (WFD) (England and Wales) Regulations (2003)(Ref 9.11): requires the development and implementation of a new strategic framework for the management of the water environment and establishes a common approach to protecting and settling environmental objectives for groundwater and surface waters; and
- Flood and Water Management Act (2010)(Ref 9.12): makes provisions about the management of risks in connection with flooding and coastal erosion.

ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

Scope of Assessment

9.7. The ES chapter will identify and assess the effects of the Proposed Development on surface water quantity and quality, groundwater quantity and quality, flood risk and wastewater drainage as a result of the change in land use during both the construction and operational development phases.

9.8. The ES chapter will draw on the findings of the FRA and the surface water strategy and foul drainage approach which will include specific design measure to ensure the development does not have an adverse impact on flood risk from all sources. Similarly, the drainage strategy will be the primary means to control the quality and quantity of surface water runoff from the new development.

Effects Not Considered within the Scope

9.9. The potential impact of the Proposed Development on any surface water or groundwater abstractions is scoped out of this assessment. This is due to the lack of active surface water and groundwater abstractions within a 2 km radius of the Site. This is detailed further in the baseline section of this chapter.

Baseline Data

9.10. The study area is defined as that generally within a 2km radius of the site, although a number of issues are considered at a greater distance or at the river catchment level, where necessary. The assessment of effects encompasses surface water and groundwater quality and quantity, drainage and flood risk.

9.11. This assessment has been undertaken in accordance with national Planning Practice Guidance (PPG) on EIA (Ref 9.13) and has involved review of the following sources of baseline data:

- Review of the Groundsure EnviroInsight and Mapping data (June 2022) for the site and up to a 2 km radius. This Envirocheck data provides data on surface water and groundwater abstractions, baseline hydrogeology and groundwater (refer to Appendix 14.1.A in Volume 2 of the ES);
- Review of Environment Agency (EA) data records on the location of indicative floodplains and the risk of flooding from all sources;
- Review of the planning frameworks to identify specific plans and policies relating to the protection of the aquatic environment;
- Review of the Redcar & Cleveland Borough Council Level 1 Strategic Flood Risk Assessment (SFRA) Update (Ref 9.14), Redcar and Cleveland Borough Council Level 2 SFRA (Ref 9.15) and accompanying reports; and
- Review of the accompanying Flood Risk Assessment (FRA) and Surface Water Drainage Strategy prepared by Advisian for the Proposed Development (refer to Appendix 9.1 in Volume 2 of the ES).
- Foul Drainage Consultation (refer to Appendix 9.4 and 9.5 of Volume 2).

Assessment and Evaluation of Effects

9.12. The assessment of effects has involved the following general approach:

- The sensitivity or importance of aquatic receptors has been established on the basis of their use, proximity to the site and existing resource value (refer to Table 9.1);
- Evaluation of the magnitude of the potential changes in water quality and assessment of the sensitivity of the resource to the predicted changes (refer to Table 9.2);
- The potential effects have been given a significance of Negligible or Minor, Moderate or Major Adverse or Beneficial based on the matrix in Table 9.3; and
- Where any predicted effects are Minor, Moderate or Major Adverse, these are considered significant and, therefore, mitigation measures have been incorporated to eliminate or reduce the impacts to an acceptable level. The residual effects (post mitigation) are discussed in the final subsection of this chapter.

Table 9.1: Definition of Receptor Sensitivity

Receptor Sensitivity	Receptor Type	Sensitivity Detail
High	Surface Water	WFD catchment classification of 'High' or 'Good' No pathway constraints to this receptor
	Groundwater	Principal Aquifer Groundwater Source Protection Zone (SPZ) Zone I

Table 9.1: Definition of Receptor Sensitivity		
Receptor Sensitivity	Receptor Type	Sensitivity Detail
	Flood Risk	Flood Zone 3a or b
	Surface Water Drainage	Critical Drainage Area
	Water Supply and Infrastructure	Area of major known water stress
	Water Resources	Abstractions located within ≤ 250 m of the site
Medium	Surface Water	WFD catchment classification of 'Moderate'
	Groundwater	Secondary A or B Aquifer Groundwater SPZs Zone II or III Areas of potential historic contamination
	Flood Risk	Flood Zone 2
	Surface Water Drainage	Medium to High surface water flood risk
	Water Supply and Infrastructure	Area of known water stress
	Water Resources	Abstractions located within 1 km of the site
Low	Surface Water	WFD catchment classification of 'Poor' or 'Bad'
	Groundwater	Unproductive Strata, i.e. Non-Aquifer Not located on groundwater SPZ
	Flood Risk	Flood Zone 1
	Surface Water Drainage	Low or no surface water flood risk
	Water Supply and Infrastructure	Area of no known water stress
	Water Resources	No Abstractions located within ≥ 1 km of the site

Table 9.2: Methodology for Assessing Magnitude	
Magnitude of Impact	Criteria for Assessing Impact
Major	Total loss or major/substantial alteration to key elements/features of the baseline (pre-Development) conditions such that the post-development character/composition/attributes will be fundamentally changed.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post-development character/composition/attributes of the baseline will be materially changed.
Minor	A minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but not material. The underlying character/composition/attributes of the baseline condition will be similar to the pre-development circumstances/situation.
Negligible	Very little change from baseline conditions. Change barely distinguishable, approximating to a 'no change' situation.

Table 9.3: Effect Significance Matrix			
Magnitude	Sensitivity		
	High	Medium	Low
Major	Major	Moderate to Major	Minor to Moderate
Moderate	Moderate to Major	Minor to Moderate	Minor

Table 9.3: Effect Significance Matrix			
Magnitude	Sensitivity		
	High	Medium	Low
Minor	Minor to Moderate	Minor	Negligible to Minor
Negligible	Negligible	Negligible	Negligible

Limitations and Assumptions

9.13. When referring to data from web-based data searches and the Groundsure EnviroInsight within this ES Chapter, the distances and directions are quoted directly. It is possible that some of the data locations are at a different distance and/or direction from the closest part of the Site boundary.

9.14. The Proposed Development is assumed to have an operational lifetime of 25 years.

9.15. The assessment of construction phase effects is based on the indicative construction methodology and development phasing. The construction phase of the Proposed Development has an expected duration of approximately 18-24 months from commencement, including commissioning, which may last three months at the end of the construction works.

9.16. The assessment of operational phase effects is based on the maximum parameters of the detailed elements of the Proposed Development as described in Chapter 5: The Proposed Development and Alternatives.

BASELINE CONDITIONS

Surface Water

Hydrological Features

9.17. From a review of EA and Ordnance survey mapping, the closest 'main river'[2] is the River Tees which is located approximately 800 m north of the Site and this flows in an northerly direction.

9.18. The Tees Dock is located 500 m west of the Site and the Dabholm Gut is located 500 m north-east of the Site. A number of minor surface water drains are present on Site located mainly within the north-western extent and various other drainage features are located in close proximity to the Site which connect to the downstream River Tees.

[2] Main rivers are defined as any watercourses that contribute significantly to the hydrology of a catchment

Surface Water Quality

9.19. Since the introduction of the Water Framework Directive (WFD), the EA assigns a classification for rivers (and their catchments) on the basis of their *'ecological status'*, which encompasses chemical, biological and ecological assessment parameters.

9.20. The development lies within the '*Tees Estuary (S Bank)'* water body which has an overall ecological water body classification of *'moderate'*. The catchment has an ecological objective of *'good'* for 2027.

Sensitivity

9.21. In accordance with Table 9.1, the hydrology of the Site is considered to be of High Sensitivity. The Site falls within the *'Tees Estuary (S Bank)'* which has a 'good' ecological status objective for 2027.

Groundwater

Hydrogeological Features

9.22. When reviewing the British Geological Survey (BGS) online viewer, it indicates that the Site is underlain by Made Ground across the site mostly associated with the site's current land use and historical land uses (historical industrial use and current concrete hard standing housing office buildings). The Site is further underlain by the natural superficial geology of Tidal Flat Deposits (comprising sand, silt and clay). Beneath this, lies the bedrock geology of the Mercia Mudstone Group (comprising Mudstone) with nearby deposits of Penarth Group (comprising mudstone) to the east.

9.23. Online EA data sources provide the following hydrogeological information:

Table 9.4: Hydrogeological Information

Aspect	Designation	Description
Superficial Aquifer Designation: Tidal Flat Deposits	Secondary Undifferentiated Aquifer	These are rock types that have 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 rock type
Bedrock Aquifer Designation: Mercia Mudstone Group	Secondary B Aquifer	These are 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.

9.24. A review of the four borehole records on site show groundwater strikes at depths of 0.7 and 3.3 mbgl with standing levels recorded between 1.42 and 2.9 mbgl.

9.25. A site Investigation was undertaken by Exploration Associates in October 2002 which covered a southern section of the site (refer to Appendix 14.1 of Volume 2); this included excavation of trial pits, drilling of cable percussion boreholes. The site investigation encountered Made Ground to a proven depth of 6.1 mbgl which was underlain by alluvium deposits. Groundwater was generally encountered within the Made Ground or alluvium at 2.5 to 8.1 mbgl.

Groundwater Quality

9.26. When reviewing the EA catchment data, the Site is shown to be located within the WFD *'Tees Mercia Mudstone & Redcar Mudstone'* groundwater body which has a current overall water body status of *'poor'* (2019) and does not have a current objective. The Site does not lie within a groundwater Source Protection Zone (SPZ).

9.27. The site investigation detailed above by Exploration Associates (2002) which encompassed part of the site undertook environmental samples from the trial pits for contamination analysis. The investigation identified exceedances in copper, zinc, boron and lead.

Sensitivity

9.28. The Site is located on a Secondary B Aquifer; therefore, the hydrogeology is considered to be of Medium Sensitivity.

Water Resources

Surface Water Resources

9.29. When reviewing the Groundsure report (Appendix 14.1.A of Volume 2), there are no active surface water abstractions located within a 2 km radius of the Site.

Groundwater Resources

9.30. When reviewing the Groundsure Report, there are no active groundwater abstractions located within a 2 km radius of the Site.

Sensitivity

9.31. In accordance with Table 9.1, as there are no active abstractions located within a 2 km radius of the Site, water resources is not considered to be a receptor therefore has been scoped out of this assessment.

Flood Risk

9.32. A Flood Risk Assessment has been undertaken by Advisian and is included within Appendix 9.1 of Volume 2.

9.33. When reviewing the EA's flood map for planning, the Site is located entirely within Flood Zone 1 (low risk). Land within Flood Zones 2 and 3 (medium and high risk, respectively) is located approximately 0.5 km north-east and south-west of the Site. Therefore, the risk of flooding from fluvial sources at the Site is considered to be low.

9.34. According to the SFRA Level 1, tidal flood risk associated from the River Tees is confined to the Docklands area. The Redcar and Cleveland Borough Council Level 2 SFRA (Ref 9.15) shows extreme tide level mapping which indicates that the Site would not be affected by the undefended 1 in 200 or 1 in 1000 year tidal flood event. However, as stated in the FRA (Appendix 9.1 of Volume 2), the southernmost point of the Site could be affected in the undefended 1 in 200 year plus climate change tidal flood event with predicted depths of up to 1 m. Considering the small extent of the Site effected which will be mostly left undeveloped and that Site would be free from flooding in the 1 in 1000 year undefended tidal flood event, it is considered that the overall flood risk from tidal flooding is low.

9.35. The SFRA (2016) refers to groundwater flood risk mapping which identifies that the Site is located within an area 50-75% susceptible to groundwater flooding. The FRA states that groundwater is anticipated to be several meters below the Site, in hydraulic continuity with the River Tees. It is considered that the risk of groundwater flooding at the Site is of medium risk.

9.36. A review of the EA's surface water flood maps shows that the Site is mostly classified as 'very low risk' which is defined where *"each year, this area has a chance of flooding of less than 1 in 1000 (0.1%)".* There are some areas of the Site at 'low' *("each year, the area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)")* and 'medium' risk *("each year, this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%")* located within the surface water drains on Site. It is therefore considered that the risk of surface water flooding is medium.

9.37. The SFRA mapping refers to the Northumbrian Water (NW) DG5 Register which is used to record flood risk attributable to controlled sewer networks and has a 100 m accuracy and identifies that the Site is not within an area that has experienced sewer flooding. As such, the risk of flooding to the development from sewer flooding is therefore considered to be low.

9.38. The Site is not located within an area at risk of reservoir flooding according to the EA flood maps. Therefore, the risk of flooding from reservoirs is considered low.

9.39. The EA's historic flood map indicates that there are no historical incidents of flooding at the Site. The nearest historic flood event is approximately 0.5 km north-east and south-west of the Site.

Sensitivity

9.40. In accordance with Table 9.1, overall flood risk is considered to be of Medium Sensitivity associated with surface water and groundwater flood risk.

Surface Water Drainage

9.41. A Critical Drainage Area (CDA) is defined as "areas identified from historical flood events and/or modelled data as having significant risk from surface water flooding or subject to potential large changes in runoff due to development".

9.42. From reviewing the SFRA for the Site, it is confirmed that the site is not located within a CDA.

9.43. The site currently comprises of concrete hard standing housing office buildings, undeveloped former industrial land and a small area of grassland and therefore is considered to be brownfield. The existing topography is relatively flat, and there are a number of minor surface water drains located on the developed portion of the Site.

Sensitivity

9.44. The Application Site is not located within a CDA and, therefore, surface water drainage is considered to be of Low Sensitivity.

Water Supply and Infrastructure

Water Supply

9.45. When reviewing the EA's water stressed areas final classification report (Ref 9.16), identifies that the Site is not located within an area which is reported to suffer from 'water stress', i.e., where the availability of mains drinking water supply is limited. Whilst Northumbrian Water ensure sufficient water supply is provided for new developments, sustainable design measures would need to be adopted to minimise the water demand of the Proposed Development.

9.46. The Proposed Development would introduce the need for additional water supply at the Site when compared to the existing site due to an increase in workforce and water dependent industrial processes.

Network Infrastructure

9.47. According to the Northumbrian Water Asset Plan, there is a combined sewer which runs adjacent to the south-eastern boundary of the Site and is approximately 160 m away. This combined sewer flows into

an overflow pipe approximately 420 m east of the site which discharges into Dabholm Gut. The asset plans show that there are no existing foul water public sewers or surface water sewers located within the site curtilage.

9.48. The Proposed Development would introduce the need for additional water and foul drainage supply at the Site, due to an increase in the number of occupants when compared to the existing land use.

Sensitivity

9.49. In accordance with Table 9.1, water supply and infrastructure are classified as Low Sensitivity.

Without Development Baseline Scenario

9.50. It is necessary to assess the baseline conditions for the site should the development not come forward. The principal factor with regard to the evolution or change to the current baseline conditions in relation to water quality, water resources and flood risk is climate change. Should the Proposed Development not come forward, an increase in rainfall intensity (based on UK Climate Change predictions) as a result of climate change is likely to alter the quality of controlled waters by increasing/altering pollutant pathways within groundwater and soil. This assessment has considered the existing baseline with regard to surface water and groundwater quality and the predicted water quality status or objectives for future years as defined by the Environment Agency (EA) for the relevant river or groundwater catchment.

9.51. In terms of flood risk and drainage, the current baseline has been assessed with regard to existing conditions (i.e., current flood zones, existing rainfall intensity) and with the predicted impacts of climate change taken into account. The latest guidance on climate change effects is provided in '*Flood risk assessments: climate change allowances*' (Ref 9.17)

9.52. This assessment has also considered the existing baseline with regard to surface water and groundwater resources and the predicted water resource status in future years as defined by the EA for the relevant river and/or groundwater catchment.

ASSESSMENT OF EFFECTS

Design Solutions and Assumptions

9.53. The potential impact of the Proposed Development on any surface water or groundwater abstractions is scoped out of this assessment. This is due to the lack of active surface water and groundwater abstractions within a 2 km radius of the Site.

9.54. The assessment of effects section of this chapter assesses the impacts on water quality and flood risk associated with the Proposed Development. The 'pre-mitigation scenario' includes the measures that have been incorporated into the design and layout of the development, such as the inclusion of Sustainable Drainage Systems (SuDS). Any additional mitigation measures that are not shown within the design code and layout will not be included in the pre-mitigation scenario and will be recommended as additional measures.

CONSTRUCTION PHASE EFFECTS AND MITIGATION MEASURES

9.55. There are five potentially significant effects on water quality and flood risk during the construction phase of the Proposed Development, these are as follows:

- Increase in surface water runoff rates during the construction phase;
- Potential interruption of groundwater flows, giving rise to an elevated risk of groundwater flooding;
- Potential surface water and/or groundwater contamination from general construction related activities;
- External flood risk during construction (all sources); and
- Potential remobilisation of existing contamination to surface water and/or groundwater.

Increase in surface water runoff rates during the construction phase

9.56. During the construction phase of the Proposed Development, various areas of hardstanding (such as construction compounds and other associated infrastructure) will be constructed on the Site. and as a result, there will also be a potential increase in surface water runoff from these areas which could lead to increased flooding elsewhere, if not managed appropriately.

9.57. The effect magnitude of the increase in surface water runoff during the construction phase of the Proposed Development is considered to be **Minor**. Prior to mitigation, the effect significance is considered to be **Negligible to Minor Adverse** for surface water drainage (low sensitivity receptor).

Mitigation

9.58. During each phase of the Proposed Development, a construction compound will implement a drainage system designed and managed to comply with BS6031:2009 *'The British Standard Code of Practice for Earthworks'*, which details methods that should be considered for the general control of drainage on construction sites (Ref 9.18). Further advice is contained within the British Standard Code of Practice for Foundations (Ref 9.19).

9.59. All necessary drainage works would be installed to ensure that the increase in surface water runoff as a result of the areas of hardstanding is controlled and discharged at the rates set out in the accompanying FRA (Appendix 9.1 of Volume 2).

9.60. As each element of the Proposed Development is constructed, surface water attenuation measures will be implemented at the same time to ensure that there will be no uncontrolled increase in surface water discharge during construction.

9.61. With these mitigation measures in place, it is considered that the residual effect would be **Negligible.**

Potential interruption of groundwater flows, giving rise to an elevated risk of groundwater flooding

9.62. A review of the Redcar & Cleveland Borough Council Level 1 SFRA (Ref 9.14) confirms that the Site is located within an area of that has a 50-75% susceptibility to groundwater flooding. The FRA states that groundwater is anticipated to be several meters below the site, in hydraulic continuity with the River Tees. There are no active ground water abstractions within a 2 km radius of the Site.

9.63. A review of the borehole records undertaken in the Phase 1 Land Contamination Assessment (2022, Wood) identified four historical borehole records on site which show groundwater strikes at depths of 0.7 and 3.3 mbgl with standing levels recorded between 1.42 and 2.9 mbgl. A site Investigation was undertaken by Exploration Associates in October 2002 which covered a southern section of the Site (refer to Appendix 14.1 of Volume 2) found that groundwater was generally encountered at 2.5 to 8.1 mbgl. This suggests that the Site is within an area with a high water table.

9.64. There is the potential that deep foundations/piling of the Proposed Development to interrupt and extend below anticipated groundwater levels. The footprint of these foundations/piling would be relatively small, and the volume of displaced groundwater would result in a rise in groundwater locally; however, it is considered very unlikely that groundwater would emerge at the surface due to the low permeability of the soils.

9.65. Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. If winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers. This is less likely to cause a significant change to flood risk than from other sources since groundwater flow is not as confined.

9.66. Based on the above, it can be considered that the impact magnitude of potential interruption of groundwater giving rise to groundwater flooding during the construction phase is considered to be

Minor. Prior to mitigation, the effect significance is considered to be to be **Minor Adverse** on groundwater (medium sensitivity receptor) and mitigation measures are required.

Mitigation

9.67. Best construction practice should be utilised to minimise risk, which could possibly include localised dewatering in areas of cut. Assuming appropriate construction techniques are employed, the resulting long-term risk of groundwater flooding affecting the development is considered to be low. However, groundwater monitoring should be completed before construction to confirm groundwater levels and their proximity to the proposed ground levels.

9.68. With these mitigation measures in place, it is considered that the residual effect would be **Negligible.**

Potential surface water and/or groundwater contamination from general construction related activities

9.69. The operation of construction vehicles and general construction activities could give rise to the potential for surface water and/or groundwater to become contaminated with hydrocarbons, silt and other construction materials.

9.70. The Site is recorded to have a high groundwater table and it is anticipated that foundation/piling depths could potentially encounter and interrupt the groundwater. Therefore, there is the potential that contamination as a result of piling activities could migrate vertically and enter into the groundwater.

9.71. As well as this, should the Site drainage be allowed to enter existing drainage infrastructure or the ground untreated, this may lead to a contamination event.

9.72. Referring to Table 9.2, the effect magnitude of contamination arising from general construction activities is considered to be **Minor** on both groundwater (medium sensitivity) and surface water (high sensitivity). Prior to mitigation, the effect significance of contamination arising from general construction activities is considered to be **Minor to Moderate Adverse** for groundwater and surface water.

Mitigation

9.73. Construction vehicles will be properly maintained to reduce the risk of hydrocarbon contamination and will only be active when required. Construction materials will be stored, handled and managed with regard to the sensitivity of the local aquatic environment and thus the risk of accidental spillage or release will be minimised.

9.74. The construction drainage system will be designed and managed to comply with BS6031:2009 *'The British Standard Code of Practice for Earthworks'*, which details methods that should be considered for

the general control of drainage on construction sites (Ref 9.18). Further advice is contained within the British Standard Code of Practice for Foundations (Ref 9.19).

9.75. These mitigation measures have been incorporated into a Construction Environmental Management Plan (CEMP) as set out in Chapter 4: Development Programme and Construction, which sets out measures for the control of the Site drainage, reducing the risk of accidental spillages and the storage and handling of materials.

9.76. An appropriate foundation works risk assessment including a piling method statement would be prepared to inform the foundation design for the various elements of the Proposed Development and an appropriate quality assurance and control regime would be implemented. This would ensure that the contamination source or pathway (or both) would be removed. The piling method statement will ensure that all infrastructure, including below ground utility services, are considered within the piling method statement.

9.77. With these mitigation measures in place, it is considered that the residual effect would be **Negligible.**

External flood risk during construction (all sources)

9.78. As stated in the baseline assessment of this chapter, the Site would not be affected by the undefended 1 in 200 or 1 in 1000 year tidal flood event and therefore, it is considered that the overall flood risk from tidal and fluvial flooding is low during construction phase.

9.79. As reported in the baseline section of this chapter and within the FRA included as Appendix 9.1 of Volume 2, the impact of flood risk on the development is medium. This is because the Site has up to a medium surface water flood risk and the geology of the site is located on a Secondary B Aquifer.

9.80. Furthermore, as reported in the FRA, the low to medium surface water flood risk areas of the site are primarily located within areas of lowest topography associated with the surface water drains on Site. During each phase of the Proposed Development, a construction compound will implement a drainage system designed and managed to comply with BS6031:2009 'The British Standard Code of Practice for Earthworks'. As each element of the Proposed Development is constructed, surface water attenuation measures will be implemented at the same time to ensure that there will be no uncontrolled increase in surface water discharge during construction and as such will not pose a significant flood risk to the development. The potential impact of increase in surface water runoff at the site as a result of the construction phase has been considered within the section above within this chapter.

9.81. The Site is within an area identified within the SFRA as at risk of groundwater flooding by 50-75%. As reported above, groundwater levels are expected to be high and therefore there is the potential for groundwater to be encountered during construction.

9.82. Given the potential risk of surface water and groundwater flooding during construction in relation to surface water drainage and the foundation/piling works, the effect magnitude of flood risk during the construction phase is considered to be **Minor** on flooding (medium sensitivity). Prior to mitigation, the effect significance is considered to be **Minor Adverse** for flood risk.

Mitigation

9.83. Depending on meteorological conditions and groundwater depths, excavations may require dewatering (of accumulated rainfall or runoff) during construction. In such circumstances, care will need to be taken to ensure that the quality of this water is sufficiently high to allow discharge.

9.84. Ponded water from excavations will be pumped into temporary (baffled) holding tanks within the site to remove suspended sediment before discharge to surface water or to ground. If oil is observed in the water from the excavation sites, it will be diverted through temporary oil interceptors prior to being discharged. Dewatering activities may require a temporary abstraction licence, and this would need to be discussed with the EA prior to commencement of construction works.

9.85. Groundwater monitoring should be completed before construction to confirm groundwater levels and their proximity to the proposed ground levels.

9.86. With these mitigation measures in place, it is considered that the residual effects would be **Negligible.**

Potential remobilisation of existing contamination to surface water and/or groundwater

9.87. Construction works would disturb the ground at the Site from activities such as site levelling, excavations for foundation/piling and services and construction drainage routes, which could cause the remobilisation of any existing contaminants present in the shallow soils.

9.88. The site investigation detailed above by Exploration Associates (2002) which encompassed part of the site identified exceedances in copper, zinc, boron and lead. The results of TPH analysis were below the guideline value of published by the Dutch Ministry of Housing.

9.89. The River Tees is located 800 m north of the and is classified as being highly sensitive as a result of its WFD status. However, as reported above, surface water runoff will be controlled by suitable construction methods which would ensure that there is no adverse impact of contamination on the receptor.

9.90. The groundwater table on site is high and the evidence from previous ground investigations around the site, it is likely that the magnitude of remobilising of existing contamination via activities such as piling into groundwater and surface water is considered **Minor.** Prior to mitigation, the effect significance of the remobilising of contaminants to surface and/or groundwater during construction-related activities is considered to be **Minor to Moderate Adverse** for groundwater and surface water.

Mitigation

9.91. The Exploration Associates (2002) report suggests precautions may be required should soils be moved from site or should workers come into contact with contaminated soil

9.92. It is recommended that an intrusive site investigation is undertaken at the Site and appropriate remediation carried out where required prior to construction works beginning in order to eliminate any remobilisation of any possible existing contamination.

9.93. An appropriate foundation works risk assessment including a piling method statement would be prepared to inform the foundation design for the various elements of the Proposed Development and an appropriate quality assurance and control regime would be implemented. This would ensure that the contamination source or pathway (or both) would be removed. The piling method statement will ensure that all infrastructure, including below ground utility services, are considered within the piling method statement.

9.94. With the results of a ground investigation and appropriate remediation, it is considered that the residual effect would be **Negligible.**

OPERATIONAL PHASE EFFECTS AND MITIGATION MEASURES

9.95. There are five potentially significant effects on water quality and flood risk during the operational phase of the Proposed Development, these are as follows:

- External flood risk during the operational phase;
- The control of surface water runoff taking climate change predictions into account;
- Potential contamination of local surface waters and/or groundwater from the routine Site drainage or accidental spills;
- Water demand and the effect on the availability of local water resources; and
- Increase in foul drainage demand.

External flood risk during the operational phase

9.96. As reported in the baseline section of this chapter and within the FRA (included as Appendix 9.1 of Volume 2), the Site is located entirely within Flood Zone 1 (low risk). Considering its distance from land in Flood Zones 2 and 3, it is considered that the risk of flooding at the site is low.

9.97. The Redcar and Cleveland Borough Council Level 2 SFRA (Ref 9.15) shows extreme tide level mapping which indicates that the southernmost point of the site would be affected by the undefended 1 in 200 year plus climate change tidal flood event with predicted depths of up to 1 m. However, considering the small extent of the Site effected and that the Site would be free from flooding in the 1 in 1000 year undefended tidal flood event, it is considered that the overall flood risk from tidal flooding is low.

9.98. The Site is within an area identified within the SFRA as at risk of groundwater flooding by 50-75% and groundwater levels are expected to be high. Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. If winter rainfall becomes more frequent and heavier, groundwater levels may increase.

9.99. A review of the EA's surface water flood maps shows that the site is mostly classified as 'very low risk', however there are some areas of the Site at 'low' and 'medium' risk located within the surface water drains on Site (lowest areas on site). Surface water flood risk during the operational phase of the development is discussed in the subsection on the control of surface runoff below.

9.100. There is a risk of groundwater flooding however this is unlikely to be at surface levels given the small footprint of the foundations and the exclusion of a basement.

9.101. As the site is located in an areas at risk of groundwater, the effect magnitude of flood risk during the operational phase is considered to be **Minor** on flooding (medium sensitivity). Prior to mitigation, the effect significance is considered to be **Minor Adverse** for flood risk

Mitigation

9.102. An intrusive ground investigation will be undertaken on site prior to construction and will involve groundwater monitoring which will confirm groundwater levels and their proximity to the proposed ground levels. The investigation will inform the design of the Proposed Development to avoid potential groundwater flooding during the operational phase.

9.103. With these mitigation measures in place, it is considered that the residual effects would be **Negligible.**

The control of surface water runoff taking climate change predictions into account

9.104. The existing Site comprises of concrete hard standing housing office buildings, undeveloped former industrial land and a small area of grassland and therefore is considered to be brownfield. The Proposed Development will involve developing the existing hardstanding areas and the majority of the current grassland area and due to the added effects of climate change, there will likely be an increase in surface water runoff as a result of the development that, if not managed appropriately, would give rise to a significant increase in surface water runoff rates and volumes.

9.105. A surface water drainage strategy for the proposal is included within Appendix 9.1 of Volume 2 and has been included within the design of the scheme. This strategy confirms that the development will mitigate against this risk by incorporating a range of SuDS features on Site which will in turn discharge to an existing off-site surface water drainage system which discharges into the Tees Estuary. The drainage system and attenuation storage will be designed to ensure flows off-site are limited to 99 l/s/ha which mimics the existing greenfield (QBar) runoff rates which will provide a betterment compared to the existing brownfield scenario.

9.106. Attenuation will be provided on Site in order to limit surface water runoff to the greenfield runoff rate. In addition, rainwater harvesting, pervious paving, filter drains and gravel cover are all recommended SuDS for the Site. Infiltration based SuDS have not been considered due to low infiltration capacity, high groundwater levels and potentially contamination on site.

9.107. A climate change factor of 30% is deemed appropriate for this development and has a design life of 25 years. The preliminary drainage strategy drawing, and hydraulic calculations are within the FRA included as Appendix 9.1 of Volume 2 .

9.108. With the surface water drainage strategy in place, it is considered that the residual effect on surface water drainage would be **Negligible to Minor Beneficial** when compared to the existing scenario.

Potential contamination of local surface waters and/or groundwater from the routine site drainage or accidental spills

9.109. The Proposed Development could have the potential to contaminate surface water and/or groundwater from a number of sources. The Site will be utilised as a LHM Refining and Production Plant and, as such, a range of potential contaminants would be present on site (i.e., hydrocarbons and vehicle-related oils and lubricants, as well as hazardous materials).

9.110. The Proposed Development has been designed with a zero liquid discharge (ZLD) process, therefore removing the need for effluent treatment and offsite disposal of liquid wastes. Therefore, only clean

surface water runoff from buildings and associated hard standing and small amount of domestic sewage releases to foul sewer will take place and route via the internal Site drainage system.

9.111. All raw materials, by-products and wastes associated with the Lithium facility will be delivered, stored and processed within dedicated and appropriately designed storage and containment structures such that the risk of offsite pollution is considered minimal.

9.112. With the drainage strategy in place (refer to Appendix 9.1 and 9.3 of Volume 2), the Proposed Development has a very limited potential to impact nearby controlled waters. As infiltration is not a suitable means of discharge of runoff, the drainage strategy includes an attenuation-based strategy in the form of an attenuation tank. Runoff from roofs is generally considered to be clean and will be harnessed via rainwater harvesting and used for domestic and process needs. Pervious paving will allow for infiltration, adsorption, biodegradation and sedimentation within the sub-base and reduce peak runoff. Runoff from the Site roads will be treated via a filter drain. Other areas of hardstanding will use a gravel cover which provide attenuation storage and reduce peak runoff rates.

9.113. The proposed attenuation tank proposed would have a conservative storage volume of 20,100 m^3 and will be utilised in line with the CIRIA 753 guidance with the aim to minimise the developments impact on runoff quality and quantity.

9.114. All external hardstanding will be designed to be impermeable, provided with dedicated sealed drainage systems and will be fitted with interceptors to contain and prevent pollution. No discharge of water potentially in contact with any potentially polluting materials will occur to groundwater, and provisions will be made to retain any water used in the event of fire on Site for disposal at an appropriate facility.

9.115. With the implementation of the surface water drainage strategy, the residual effect of contamination risk from routine site drainage would be **Negligible** when compared to the existing Site use.

Water demand and the effect on the availability of local water resources

9.116. Parts of the current Site are undeveloped former industrial land where there is no current water demand. During operation, there would be an increase in water demand as a result of the inclusion of the Proposed Development. Consultation with Northumbrian Water has confirmed that a new water supply can be made available for the development from the 450 mm DICL distribution network located on Tees Dock Road. Northumbrian Water guarantee a minimum pressure of 15m in respect to potable water for both domestic and non-domestic use (refer to Appendix 9.4 and Appendix 9.5 of Volume 2).

9.117. It should be noted that, where possible, any increase in water demand will be reduced as far as possible by the incorporation of appropriate water-saving devices. The buildings will be designed to maximise water efficiency through measures such as rainwater harvesting.

9.118. Based on the above, the effect magnitude of the increase in water demand as a result of the Proposed Development is considered to be Negligible. Prior to mitigation, the effect significance is considered to be **Negligible** for water supply and infrastructure and no mitigation measures are required.

Increase in foul drainage demand

9.119. Wastewater flows are expected to increase as a result of the new development on site when compared to existing site use.

9.120. Since the publication of the new connections and development charging rules in April 2018, drainage authorities in England are obligated to provide a point of connection and undertake any mitigation or improvement works and network reinforcements, where necessary. These will be programmed once planning consents are granted.

9.121. Foul water will be kept separate from the surface water system and directed to an existing public sewer. A pre-planning enquiry has been undertaken with Northumbrian Water and this details a proposed foul water discharge rate of 0.14 l/s (refer to Appendix 9.4 and 9.5 of Volume 2). Confirmation that there is sufficient capacity within the foul sewer network to serve the Proposed Development will be obtained before construction works begin.

9.122. Therefore, the impact magnitude of increased wastewater flows from the Proposed Development is considered to be negligible on infrastructure. Prior to mitigation, the effect significance is considered to be **Negligible,** and no mitigation measures are therefore required.

CLIMATE CHANGE

9.123. It is necessary to consider whether the effects of the Proposed Development on water quality and flood risk will alter due to the effects of climate change, most notably due to an increase in rainfall intensity and increased river flows and sea levels.

9.124. From reviewing the Met Offices UKCP18 future climate change projections for the 30% probability level for the 2070s, it is estimated that the winter average precipitation will increase by 21.46% and the summer average precipitation will decrease by -35.57 % when compared to the baseline period (climatic

trends from 1981 to 2000). The predicted change for the 90% probability level from 1990s to the 2080s, the winter average precipitation will increase by 52.25% and the summer average will increase by 3.62%.

9.125. The receptors that have been identified within this assessment need to be considered in terms of their vulnerability (i.e., susceptibility or resilience to change) to the changes in the future climate. Table 9.5 below, gives a summary of the receptors, including their sensitivity classification and their vulnerability under these future climate conditions.

9.126. The vulnerability of a receptor is defined by the following classifications:

- High Vulnerability – the receptors directly dependent on existing and/or prevailing climatic factors, and reliant on these specific existing climate conditions continuing in the future; or only able to tolerate a very limited variation in climate conditions;
- Moderate Vulnerability – the receptor is dependent on some climatic factors, but able to tolerate a range of conditions; and
- Low Vulnerability – Climatic factors have little influence in receptors.

Table 9.5: Summary of Receptor Sensitivity and Vulnerability for Assessment

Receptor	Sensitivity	Vulnerability
Surface Water	High	High
Groundwater	Medium	High
Surface Water Drainage	Low	Moderate
Flood Risk	Medium	High
Water Supply and Infrastructure	Low	Moderate

9.127. During operation of the Proposed Development, it is considered that surface water, ground water and flood risk receptors identified within the assessment are considered to be highly vulnerable to climate change. Surface water drainage and water supply and infrastructure receptors are considered to have a moderate risk. However, current and future baseline conditions and the impacts identified within this assessment have already considered the predicted impacts of climate change.

9.128. The proposed mitigation measures include the future effects of climate change and, therefore, once these measures are implemented, the Proposed Development will be considered safe in terms of future climate effects. The climate change resilient measures include the following:

- The flood zones and tidal flooding have been considered with the added effect of climate change; and

- When assessing the control of surface water runoff during operation of the Proposed Development, storage calculations have included climate change as reported in the Drainage Strategy.

9.129. Overall, with the proposed mitigation measures in place, there will be no change in the significance ratings of the assessment and the resulting residual effects would remain **Negligible to Minor Beneficial**.

CUMULATIVE EFFECTS

9.130. All committed major developments in the area surrounding the Proposed Development will have to satisfy the requirements for the control of surface runoff within the NPPF PPG, i.e., discharge at the current greenfield runoff rate or the provision of a betterment in runoff rates post-development. Therefore, the cumulative effect of other local developments should result in a net positive effect through reducing overall flood risk in the area.

9.131. In terms of water quality, new or committed developments will also have to incorporate appropriate pollution control measures to protect the underlying groundwater and/or local surface waters through planning conditions enforced by the Local Authority and/or discharge consents enforced by the EA.

9.132. The cumulative effects of new development on water supply and foul drainage infrastructure are managed at the regional level by the appropriate water companies in consultation with statutory bodies such as the Local Planning Authorities and the EA. The cumulative effect of increases in mains water and foul drainage demand have to be offset by sustainable design and water efficiency measures and infrastructure contributions for sewage treatment works, where necessary. These measures should collectively ensure that the cumulative effects on regional water resources and treatment performance are controlled to an acceptable level during the construction and the operation of the Proposed Development. This is in relation to both inter-relationship and intra-relationships on cumulative effects. These measures ensure that any inter or intra cumulative effects will not have an adverse impact on the receptors.

SUMMARY AND RESIDUAL EFFECTS

9.133. The potential effects of the Proposed Development on water resources are scoped out of this assessment due to the lack of active surface water and groundwater abstractions within a 2 km radius of the Site.

9.134. This assessment has therefore considered the potential effects of the Proposed Development on Water Quality and Flood Risk. The key considerations are the potential effects on water quality, water supply, infrastructure, flood risk and surface water drainage.

9.135. Table 9.6 gives an overview of the assessment and summarises the potential effects that have been identified for the construction and operational phases of the development as well as the associated classification, mitigation measures and residual effects.

9.136. In conclusion, given the location and nature of the receptors, the overall residual effects of the Proposed Development with regard to water quality, water resources and flood risk is considered to be **Negligible.**

Table 9.6: Summary and Residual Effects					
Effect	Sensitivity of Receptor (receptor)	Magnitude of Effect	Effect Significance (pre-mitigation)	Mitigation Measure	Residual Significance (post mitigation)
Construction Phase					
Increase in surface water runoff	Low (surface water drainage)	Minor	Negligible to Minor Adverse	- Compliance with BS6031:2009; and - Installation of drainage works and attenuation measures	Negligible
Interruption of groundwater flows	Medium (Groundwater)	Minor	Minor Adverse	- Best construction practices will be used Groundwater monitoring will be undertaken prior to construction	Negligible
Contamination from general construction related activities	High (groundwater and surface water)	Minor	Minor to Moderate Adverse	- Construction vehicles properly maintained and appropriate storage/handing/management on construction material - Construction drainage system will be designed and managed to comply with BS6031:2009 - Implementation of CEMP - Piling method statement	Negligible
External flood risk	Medium (flood risk)	Minor (surface water and groundwater flooding)	Minor Adverse	- Dewatering of excavations and pumping into temporary (holding tanks). - Groundwater monitoring to be undertaken prior to construction	Negligible
Remobilisation of contamination to controlled waters	High (groundwater and surface water)	Minor	Minor to Moderate Adverse	- Intrusive site investigation and appropriate remediation carried out prior to construction - Foundation works risk assessment including piling method statement	Negligible
Operational Phase					
External flood risk	Medium (flood risk)	Minor	Minor Adverse	Groundwater monitoring to be undertaken prior to construction	Negligible
Control of surface water runoff	Low (surface water drainage)	Negligible	Negligible to Minor Beneficial	- Compliance with the Surface Water Drainage Strategy	Negligible to Minor Beneficial
Contamination of controlled waters from routine site drainage	High (groundwater and surface water)	Negligible	Negligible	- None required	Negligible
Water demand	Low	Negligible	Negligible	- None required	Negligible
Foul drainage demand	Low	Negligible	Negligible	- None required	Negligible

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