

## APPENDIX 14.1 WSP GEOENVIRONMENTAL

Appendix A: Groundsure

Appendix B: Historical Maps

Appendix C: Site Information

Appendix D: Zetica UXO Bomb Risk Map

Appendix E: Preliminary Risk Assessment Methodology

Appendix F: Geotechnical Register

Appendix G: Preliminary Risk Assessment

Green Lithium Refining Limited

# Teesport Lithium Refinery

Phase 1 Geoenvironmental Desk Study

December 2022



## Document Control

Contract No.	Document Registration No.	Document Class
CPA-CON-EOI-2021-10000	852500-WSPE-RP-OC-00001_S0_P02	Technical Report

## Issue Status

No.	Date	Reason for Issue	Prepared by	Checked by	Approved by
01	November 2022	Draft for comment	Tom Middleton / Benjamin Amaira	Rachael Elliott / Graeme Smart	Mike Sheard
02	December 2022	Final	Benjamin Amaira	Rachael Elliott / Graeme Smart	Mike Sheard
03					

## Paragraphs Revised in this Issue

Para No.	Page No.	Reason for Change

## Paragraphs Hold in this Issue

Hold No.	Section / Para No.	Page No.	Reason for change

# Executive Summary

## Purpose of this Report

This report has been produced for the purpose of identifying potential sources of land contamination and potential geotechnical constraints associated with the proposed development and to provide a baseline assessment of the site prior to lease by Green Lithium. The report may also be used to support a planning application and inform the engineering design of the proposed development.

## Site Setting and History

The site is located on the southwest side of the River Tees at PD Ports Transport, off Kinkerdale Road, Middlesbrough at approximate central Ordnance Survey grid reference 455747, 523397. The site comprises a 24.7 hectare (ha) irregularly shaped plot of commercial industrial land situated on both the north and south of Kinkerdale Road. The northern portion of the site comprises a large hardstanding used for container storage and the southern portion is an area of undeveloped open ground. The site is relatively flat and is located at approximately 10m AOD. The site is bound to the east, west and south by industrial land uses including large distribution depots, chemical works and a port containing a bulk handling and container handling facility.

The earliest historical mapping indicates that the site was originally below the high water of the River Tees estuary until the 1890's when a sea wall or defence was constructed through the centre of the site and reclamation of the River Tees estuary commenced. The northern half of site remained below the high water mark until sometime in the late 1950's to mid-1960's when the River Tees estuary is reclaimed to its current limits. A railway line connecting the site to the adjacent Lackenby Slag Breaking Plant was added to the southern half of the site during the 1950's. By mid-1960's the southern half of the site had been developed with a marshalling yard, but the remainder of the site was disused until the late 1960's to early 1970's. By that time the Teesport Refinery was developed onsite including a rail oil loading yard that dominated the land use of the northern half through to the late 1980's. By the early 1990's the Teesport Refinery had been demolished and the northern half of the site becomes a car importation depot and container facility. Aerial imagery indicates vehicles were stored on the site and by 2015 the site changed to a container storage depot. The southern half of the site remains open disused land from around 1999 to the present day.

In the wider area industrialisation commenced from the 1890's with the addition of the Lackenby Iron Works, Tees Slag Wool Works and the formation of slag heaps to the south. The Lackenby Slag Breaking Plant is constructed to the southwest in the early 1900's and the slow development of earthworks is identified through to the 1960's. During the 1960's and early 1970's significant industrial development is identified to the south and west including the South Teesside Works Lackenby, Teesport Refinery, Lackenby Tank Farm, works (unspecified), warehouses, marshalling yards, electrical sub-stations and an oil supply terminal. By the early 1990's industry declines with the removal of the Teesport Refinery as well as the oil terminal and Lackenby Tank Farm to the south. The Teesport to the west of the site continues through to the present day and to the immediate northeast unannotated commercial/industrial buildings are added.

## Environmental Setting

British Geological Survey (BGS) mapping indicates that the site is entirely underlain by Made Ground that extends along the southern bank of the River Tees. Previous investigations of the site

encountered Made Ground to depths of between 0.40m and 5.40m that comprised clay, slag, ash and gravel. Made Ground is potentially deeper where tidal flat guts were present historically. BGS mapping indicates that Made Ground is underlain by Tidal Flat Deposits that previous investigation encountered and found to comprise soft organic sandy silt or silty sand. This is potentially underlain by Glaciolacustrine Deposits of laminated silty clay and silt as well as Glacial Till that has been described as silty clay. The underlying bedrock is recorded as Mercia Mudstone Group comprising very weak mudstone. The site is situated within the limits of the Boulby Halite and is therefore likely to be underlain by the halite (salt) at a significant depth.

BGS and Coal Authority records indicate that the site is not underlain by ironstone or coal workings. However, a brine extraction well is recorded approximately 770m south of the site. The inferred zone of settlement is approximately 600m south of the site.

The superficial deposits are classified by the Environment Agency (EA) as a Secondary Undifferentiated Aquifer and the underlying Mercia Mudstone Group has been classified Secondary B Aquifer. The Mercia Mudstone Group is part of the Tees Mercia Mudstone and Redcar Mudstone Water Framework Directive (WFD) waterbody that was classified by the EA as having an overall status of Poor and chemical status of Poor in 2019. The site is not located within a Source Protection Zone (SPZ) and there are no groundwater abstractions within 1km of site.

The nearest surface water feature is an unnamed ditch immediately adjacent to the northeast of the site and nearest WFD waterbody is the River Tees Estuary located approximately 730m to the northwest which is tidal up to the Tees Barrage at Stockton on Tees. The River Tees Estuary was classified by the EA as having an overall status of Moderate, a chemical status of Fail and an ecological status of Moderate in 2019. The Ordnance Survey mapping also identifies several unnamed ditches and drains as well as the Dabholm Beck and Dabholm Gut approximately 285m and 610m to the southeast and northeast of the site, respectively.

Statutory designated sites have been identified within 1km of the site including Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI) approximately 450m west and 665m north of the site that is also a Special Protection Area (SPA) and a proposed Ramsar site. The site is also situated within a SSSI Impact Zone for the Teesmouth and Cleveland Coast SSSI.

No regulated waste activities have been identified on the site, though exempt activities and landfills have been identified in the wider area. The site was historically a Notification of Installations Handling Hazardous Substances Regulations (NIHHS) installation that relates to activities by Tees and Hartlepool Port Authority. Other regulated activities in the near vicinity of the site include those by Kemira Chemicals (UK) Limited to the immediate east and BOC Limited approximately 55m southeast of the site.

## Geotechnical Constraints

Geotechnical constraints relating to the site have been identified through a review of the available information on the site geology, land use and UXO risk. Based on the available information the geotechnical constraints identified include the presence of variable and significant thicknesses of Made Ground underlain by soft or loose ground deposits, potential aggressive ground and groundwater conditions, potential for expansive slag, the presence of obstructions and relic foundations, groundwater at shallow depths and services.

## Preliminary Risk Assessment

The Conceptual Site Model (CSM) and preliminary risk assessment has identified potential sources of contamination associated with the historical land uses of the site. In total 21 potentially unacceptable pre-existing contaminant linkages representing Moderate or higher risks to current onsite receptors have been identified and a further 12 potentially unacceptable contaminant

linkages have been identified in association with potential offsite sources of contamination. These risks generally relate to contamination in Made Ground that is related to the site's historical use as a refinery and reclamation of the River Tees estuary. The Made Ground underlying the site has the potential to be a source of asbestos, heavy metals and hydrocarbons. Previous investigations of the site have identified areas of free phase hydrocarbon contamination and potential significant sources of ground gas.

The preliminary risk assessment identified three potentially unacceptable contaminant linkages to future receptors that relate to the presence of aggressive ground and ground gas sources. The risks to human health and controlled waters receptors are considered to be moderate/low due to the proposed development containing a significant proportion of buildings and hardstanding with associated drainage system. This is likely to break the pathway to human receptors and reduce the leaching of contamination from Made Ground into the underlying groundwater.

## Recommendations

An intrusive site investigation is recommended to characterise the potential sources of contamination (including ground gas and vapour) and the geotechnical ground & groundwater conditions. In addition, it is recommended that information on groundwater conditions is obtained during post works monitoring to characterise the groundwater levels (including tidal influences) and the groundwater quality. In addition, further investigation is also recommended to establish the presence of significant below ground structures and obstructions to excavation and construction that may require a combination of intrusive and non-intrusive investigations.

Prior to undertaking ground investigation works the presence of utilities on the site should be established through a review of desk-based information and site survey. A UXO desk study should also be performed by a specialist UXO consultant to confirm the potential UXO risks at the site prior to the ground investigation.

It should be noted that as lessee (with appropriate lease conditions) Green Lithium Refining Limited should not be liable for pre-existing contamination and unacceptable contaminant linkages present prior to their tenancy, the liability for these linkages lies with the landowner / polluter (given their continued existence). However, Green Lithium Refining Limited will be responsible for any further deterioration of the site and for ensuring that the site is suitable for use (i.e. there are no unacceptable contaminant linkages with future users) following the implementation of mitigation measures. It is anticipated that unacceptable linkages can be mitigated through appropriate design of the proposed development as well as environmental management plans, risk assessments, method statements and health & safety plans for the works, and subsequent compliance with environmental permits for the development's operation.

# Contents

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<b>1.</b>	<b>Introduction</b>	<b>8</b>
1.1	Purpose of the Report	8
1.2	Scope	8
1.3	Proposed Development	9
1.4	Regulatory Context	9
1.5	Sources of Information	9
1.6	Assumptions and Limitations	10
<b>2.</b>	<b>Site Setting</b>	<b>12</b>
2.1	Site Location	12
2.2	Site Description	12
2.3	Boundaries and Adjacent Land Uses	13
<b>3.</b>	<b>Site History</b>	<b>14</b>
3.1	Summary of site history	19
3.2	Shell Refinery Fire	20
<b>4.</b>	<b>Environmental Setting</b>	<b>21</b>
4.1	Artificial Ground	21
4.2	Superficial Deposits	21
4.3	Bedrock Geology	22
4.4	Previous Investigations	22
4.4.1	BGS Historical Boreholes	22
4.4.2	Previous Site Investigations	22
4.4.3	Summary of Site Geology	26
4.5	Previous Remediation	27
4.6	Mineral Extraction	28
4.6.1	BGS Recorded Sites	28
4.6.2	Non-Coal Mineral Extraction	28
4.6.3	Coal Authority	28
4.7	Ground Stability	29
4.8	Radon	29
4.9	Hydrogeology	29
4.10	Hydrology	30
4.11	Designated Sites	30
<b>5.</b>	<b>Regulated Activities</b>	<b>31</b>
5.1	Waste	31
5.1.1	Storage, Treatment, Transfer and Use (exemptions)	31
5.1.2	Landfills	31

5.2	Hazardous Substances	31
5.3	Licensed Industrial Activities	31
5.4	Discharge to Controlled Waters	32
5.5	Pollution Incidents	32
<b>6.</b>	<b>Geotechnical Constraints</b>	<b>33</b>
6.1	Unexploded Ordnance (UXO)	33
6.2	Geotechnical Risks and Hazards	33
6.3	Geotechnical Risk Assessment	35
<b>7.</b>	<b>Preliminary Risk Assessment</b>	<b>36</b>
7.1	Conceptual site model	36
7.2	Potential contamination (sources)	36
7.3	Potential receptors and exposure pathways	37
7.4	Exclusions from risk assessment	38
7.4.1	Current site users	38
7.4.2	Redevelopment workers	38
7.4.3	Invasive species	38
7.4.4	Trespassers	38
7.5	Preliminary risk assessment	39
<b>8.</b>	<b>Conclusions and Recommendations</b>	<b>40</b>
8.1	Conclusions	40
8.1.1	Land Contamination	40
8.1.2	Geotechnical	40
8.2	Recommendations	41

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Table 2.1	Summary of site boundaries and surrounding land uses	13
Table 3.1	Summary of site history	14
Table 4.1	Summary of underlying geology	26
Table 7.1	Current and historical contaminant sources	36
Table 7.2	Pathways and Receptors	37

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Figure 2.1	Site location map	12
Figure 4.1	Inferred location of previous site investigation exploratory holes.	23
Figure 6.1	Geotechnical hazard map.	35

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Appendix A	Groundsure Report
Appendix B	Historical Maps
Appendix C	Site Information
Appendix D	Zetica UXO Bomb Risk Map
Appendix E	Preliminary Risk Assessment Methodology
Appendix F	Geotechnical Risk Register
Appendix G	Preliminary Risk Assessment



# 1. Introduction

WSP Environment and Infrastructure Solutions UK Limited (WSP) was commissioned by Green Lithium Refining Limited (Green Lithium) to prepare a Phase 1 Geo-Environmental Desk Study including review of available existing information in relation to the proposed development of the Green Lithium Refinery in the Teesport area of Middlesborough ('the site').

## 1.1 Purpose of the Report

This report has been produced for the purpose of identifying potential sources of land contamination and potential geotechnical constraints associated with the proposed development and to provide a baseline assessment of the site prior to lease by Green Lithium. The report will also be used to support a variety of purposes including:

- A planning application for the site.
- Informing engineering design for the proposed development.
- Providing a baseline for the long-term site lease from PD Ports.
- Providing a baseline for the future environmental permit for the site.

## 1.2 Scope

The scope of works comprises:

- A review of geological, hydrogeological and hydrological information.
- A review of previous ground investigations relating to the site.
- Reviewing a range of contemporary environmental data including historical land use and environmental setting information.
- Development of a Conceptual Site Model (CSM) and Preliminary Environmental Risk Assessment, in line with LCRM<sup>1</sup> to provide an assessment of the site's potential contamination status and identify the presence of potentially significant contaminant linkages (source, pathways and receptors) that require further consideration.
- Identification of potential geotechnical constraints to the proposed development.
- Development of a geotechnical risk register for the site.

An assessment of the site has been performed in general accordance with Environment Agency guidance Land Contamination Risk Management (LCRM). This has been undertaken to provide an assessment of the site's potential contamination status and identify potentially significant contaminant linkages that are potential constraints to development that require further consideration prior to development of the land. LCRM comprises an iterative risk-based approach starting with a Phase 1 Desk Study followed by Phase 2 comprising a Site Investigation (including quantitative risk assessment), where considered necessary, to assess the risks to the environment and users of the land posed by contamination that may be present. This report presents the Phase 1 Desk Study stage of LCRM and also identifies geotechnical hazards associated with the Proposed Development.

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<sup>1</sup> Environment Agency, (2020). Land contamination risk management (LCRM). (online) Available at: <https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm> (Accessed November 2022).

## 1.3 Proposed Development

The proposed development of the site will comprise a refinery which will sustainably produce lithium for use in electric vehicles and storage batteries. It is understood that Green Lithium intend to lease the site on a long-term basis from the current landowner PD Ports.

## 1.4 Regulatory Context

Development of the site is controlled under the Planning Regime. Planning guidance relating to the development of land potentially affected by contamination is detailed in the National Planning Policy Framework (NPPF) February 2021 and constitutes guidance for Local Planning Authorities (LPA). In this case the LPA is Redcar and Cleveland Borough Council (RCBC).

The NPPF sets out the Government's planning policies for England and how these should be applied. The NPPF states that:

*Give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land.*

Therefore, planning policies and decision should ensure that:

*A site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation).*

*After remediation, as a minimum, land should be capable of not being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*

*Adequate site investigation information, prepared by a competent person, is available to inform these assessments.*

The statutory definition of contaminated land is given under Part 2A of the Environmental Protection Act (EPA) 1990 (Part 2A). This does not include land that is already regulated through other means, such as Waste Management Legislation or the Environmental Permitting Regulations 2010.

In addition, the NPPF states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.

## 1.5 Sources of Information

The following sources of information have been used in preparation of this report:

- Groundsure, Enviro+Geo Insight report, reference GS-8836186, obtained by Sol Environmental in June 2022.
- British Geological Survey (BGS) GeoIndex, <https://mapapps2.bgs.ac.uk/geoindex/home.html>, accessed in November 2022.
- British Geological Survey, 1987, Stockton, England and Wales Sheet 33, Solid and Drift Geology, 1:50,000, held on the BGS maps portal (<https://webapps.bgs.ac.uk/data/maps>), accessed in November 2022
- BGS Non-coal Mining Plans, held on the BGS GeoIndex, accessed in November 2022.

- Ordnance Survey Map of Middlesbrough and Hartlepool, OS Explorer Map 306, 2022.
- Zetica Limited Unexploded Bomb Risk Information Map, reference 455721-523418\_14112022.
- Defence of Britain Archive, access in Google Earth Pro in November 2022.
- Coal Authority Interactive Map, <http://mapapps2.bgs.ac.uk/coalauthority/home.html>, accessed in November 2022.
- Environment Agency website Flood Risk Map, <https://flood-map-for-planning.service.gov.uk/>, accessed in November 2022
- DEFRA Magic Map, <https://magic.defra.gov.uk/MagicMap.aspx>, accessed in November 2022.
- Sol Environmental, Planning and Permitting Due Diligence Risk Appraisal, PD Ports, Green Lithium Refining, July 2022.
- PD Ports, Teesport Hidden Structures, June 2021.
- Exploration Associates, Teesport Estate Distribution Warehouse, Report on Ground Investigation, reference 131109, October 2002.
- Exploration Associates, Teesport CATS Terminal, Volume 2, Report on Ground Investigation, reference 137080, July 1997.
- THPA Limited Engineering Department, Tees & Hartlepool Port Authority Limited, Clearance of Tees Port Refinery Site by Shell Oil UK Limited in 1985 – 1987, Borehole Logs and Groundwater Analyses, January 1993.
- Cementation Ground Engineering, Report on an investigation of ground conditions at Teesport Refinery for Shell (U.K) Limited, September 1972.
- Cementation Ground Engineering, Report on an investigation of ground conditions at Teesport Refinery for Shell (U.K) Limited, November 1973.

This report has been produced in general accordance with the following UK guidance on the assessment of land condition:

- LCRM, the Environment Agency (2020) which provides the technical framework for applying a risk management process when dealing with land affected by contamination.
- Guidance for the Safe Development of Housing on Land Affected by Contamination, NHBC et al. (2008) which provides guidance on defining the likelihood definitions used when assessing risks from land contamination.

An assessment of geotechnical risks has been performed in general accordance with the Institute of Civil Engineers guidance document Managing Geotechnical Risk: Improving Productivity in UK Building Construction, 2001.

## 1.6 Assumptions and Limitations

This report was prepared by WSP for use by Green Lithium for the purpose set out in Section 1.1 above. The report has been prepared on the assumption that the end use will be commercial/industrial. Any change of end use would necessitate a review of this report and its conclusions. Third party use or reliance on this report is not permitted without written agreement from WSP, and where this is given, will be subject to our terms and conditions.

This report is based on a desk-based assessment of publicly available information and information provided by the client only. No intrusive investigations have been undertaken by WSP at the site to establish the ground and groundwater conditions or to provide data for the assessment. Site reconnaissance was undertaken remotely using Google aerial mapping and other such sources.

The conclusions reached and advice given in this report are based in part upon information and/or documents that have been prepared by third parties. In view of this, WSP accepts no responsibility or liability of any kind in relation to such third-party information and no representation, warranty or undertaking of any kind, express or implied, is made with respect to the completeness, accuracy or adequacy of such third party information. In preparing this report WSP has assumed that all information provided by the Client is complete, accurate and not misleading.

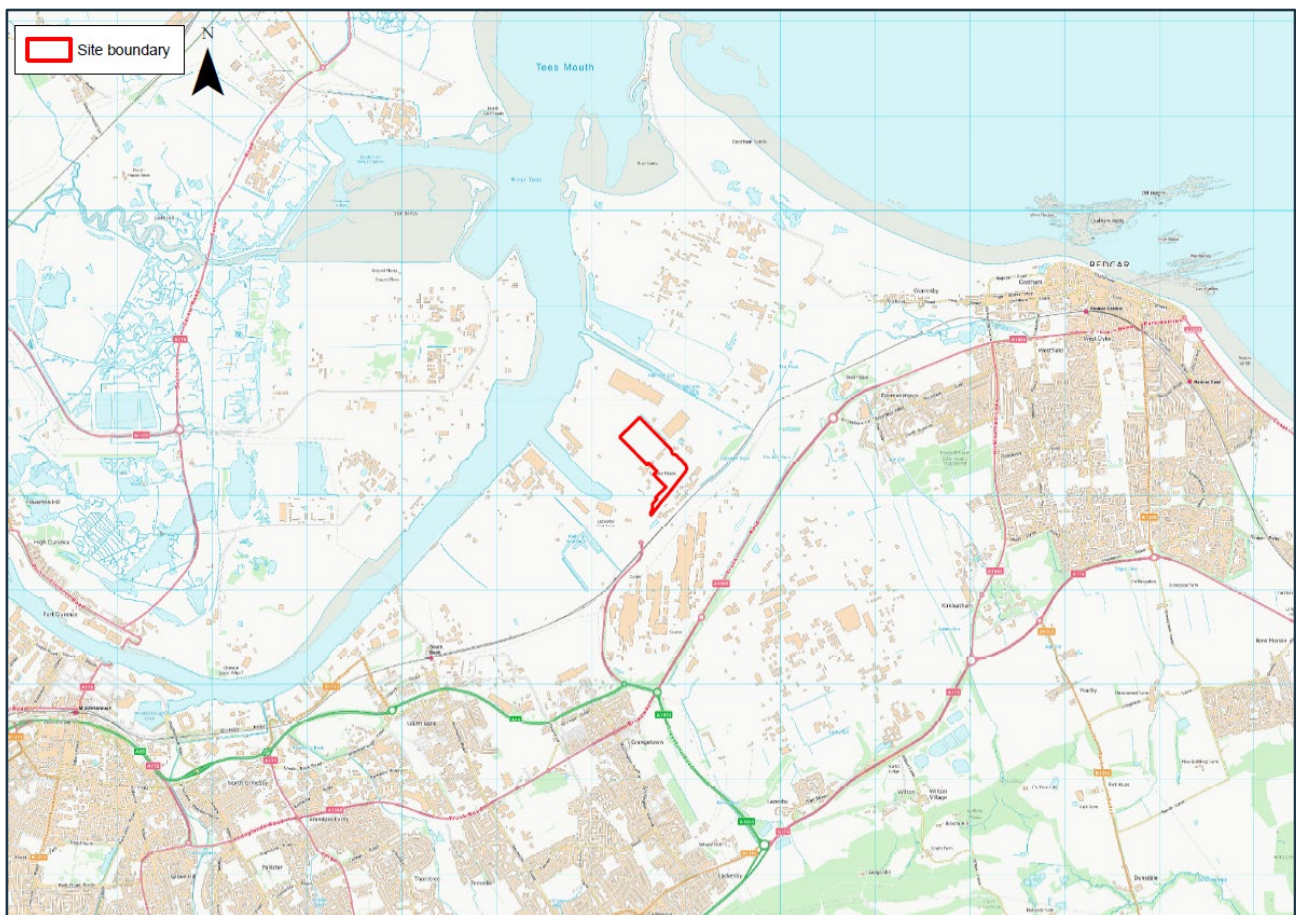
## 2. Site Setting

### 2.1 Site Location

The site is located on the southeast side of the River Tees at PD Ports Transport, Kinkerdale Road, Middlesbrough, TS6 6UD. The site is approximately 560m southeast of the River Tees estuary and adjacent to the northeast of the Tees Dock. The site is located at approximate central Ordnance Survey grid reference 455747, 523397.

A site location drawing is presented as **Figure 2.1** below.

Figure 2.1 Site location map



### 2.2 Site Description

The site comprises a 24.7 hectare (ha) irregularly shaped area of commercial/industrial land. The site is situated on both the north and south of Kinkerdale Road. The northern portion of the site comprises a large hardstanding that is understood to be permeable and is used for container storage by PD Ports. The southern portion of site is currently an area of undeveloped open ground which borders Kinkerdale Road to the north and Teesport Road to the south.

The site is relatively flat and is located at approximately 10m AOD.

## 2.3 Boundaries and Adjacent Land Uses

The site boundaries and adjacent land uses are summarised in Table 2.1 below.

Table 2.1 Summary of site boundaries and surrounding land uses

Direction	Boundaries (Land uses and relevant features)	Adjacent	Beyond (within 200m)
<b>North</b>	Site fencing directly borders undeveloped scrubland.	A Riverside roll on-roll off (Ro-Ro) terminal	Teesport Container Terminal 1
<b>East</b>	Site fencing borders Dabholm Road.	A Riverside Ro-Ro terminal building	Kemira a chemical manufacturing company.
<b>South</b>	Site borders Teesport Road.	BOC works, industrial gas supplier.	BOC works, industrial gas supplier.
<b>West</b>	Site borders a container storage area, PD Ports office and Tees Container Terminal 2	Container transport businesses, Seafarers Missions.	Container terminal Teesport and associated railway.

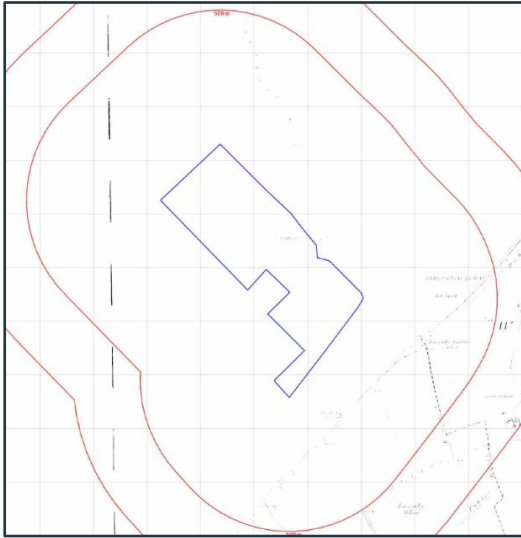
### 3. Site History

A summary of the historical development of the site, based on historical OS maps, is presented in Table 3.1 below. The historical maps can be found within **Appendix B**. Where relevant, interpretation of the maps is supported by further information and reports provided by PD Ports.

Table 3.1 Summary of site history

1855-57

Extract of the 1855-57 map from Groundsure

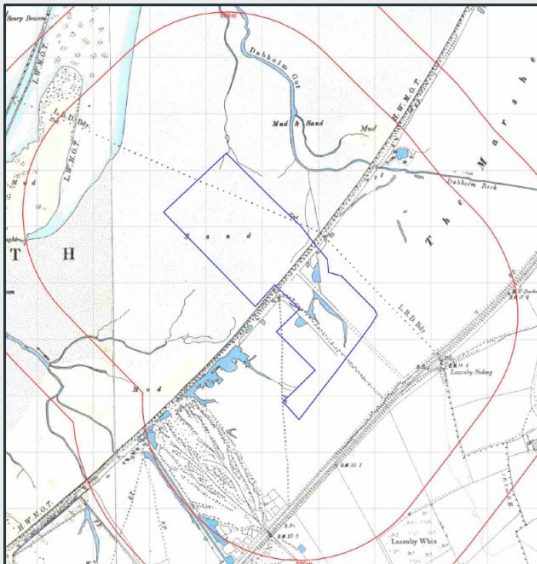


**Onsite:** The mapping (supplemented by better quality maps available on the National Library of Scotland map library<sup>2</sup>) indicates that the site is entirely below the mean high water mark. The site is shown to be within an area of mudflats and marshes.

**Offsite:** The Eastern Railway line to Redcar and the Lazenby Station are identified approximately 200m southeast of the site, beyond which is open agricultural land. Dabholm Gut is identified approximately 250m northeast of the site. The wider area to the north and west is dominated by the River Tees estuary.

1893

Extract of the 1893 map from Groundsure



**Onsite:** The northern half of site is shown to remain below the mean high water mark and is labelled sand. The southern portion of site has irregular shaped surface water features and a track running north to south that connects to the railway. In addition, an embankment is shown to pass through the central part of the site from southwest to northeast and earthworks are also shown centrally though the southern portion of the site. The high water mark of the River Tees estuary has been revised to central area of the site. The embankments are likely to represent sea defences that may have been constructed of slag that was tipped in an uncontrolled manner until settlement of the embankment ceased and the intended surface elevation of the embankment was reached.

**Offsite:** To the northwest of the embankment that passes through the site the land use is dominated by mud and sand of the River Tees estuary. To the east and southeast the land use remains dominated by open agricultural land.

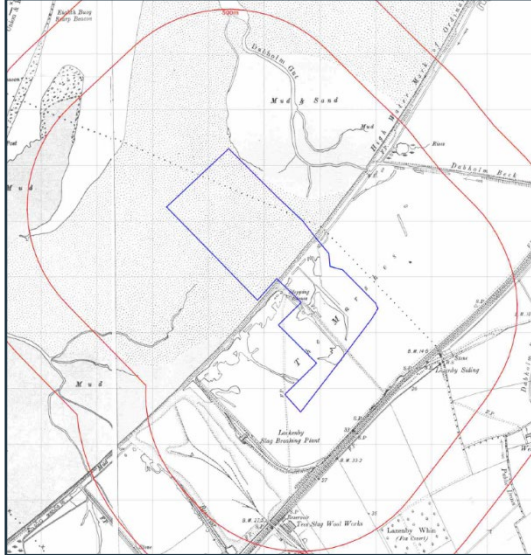
To the south an iron works is identified approximately 625m from the site that includes railways lines, marshalling yards and a possible refuse tip located approximately 250m to the southwest. The mapping

<sup>2</sup> <https://maps.nls.uk/view/102344170>

also identifies additional water bodies immediately adjacent to the west of the site and marsh guts approximately 50m west.

## 1914

### Extract of the 1914 map from Groundsure

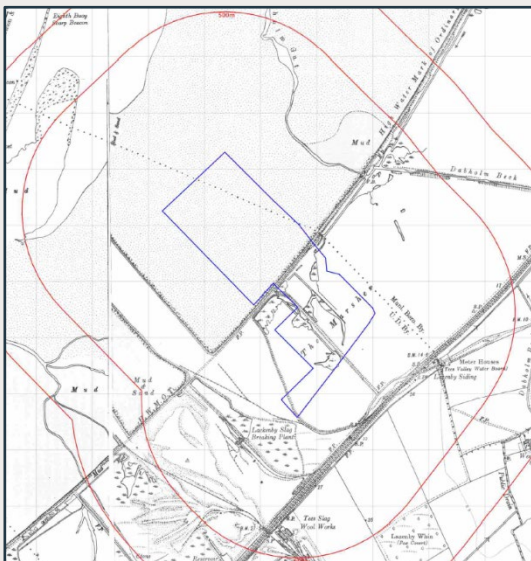


**Onsite:** The southern section of site is now labelled as the Marshes.

**Offsite:** The former iron works to the south is reannotated as the Lackenby Iron Works and the Tees Slag Wool Works is shown to have been developed immediately to the north of it approximately 450m south of the site. In addition, the Lackenby Slag Breaking Plant is identified approximately 250m southwest of the site that includes a railway line.

## 1923-27

### Extract of the 1823-27 map from Groundsure



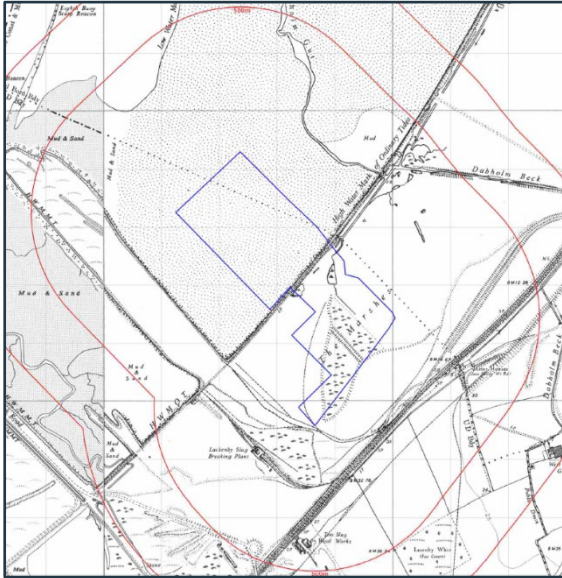
**Onsite:** There has been no significant changes to the site other than the additional earthworks in the far southwest of the site.

**Offsite:** The Lackenby Slag Breaking Plant is shown to have expanded to the southwest with the addition of possible tramways. In addition a railway line or tramway is identified immediately adjacent to the southwest of the site. To the west of the site a portion of the River Tees estuary is shown to have been reclaimed approximately 250m west of the site. There have been no obvious significant changes to the land uses to the north, northeast and east of the site.



## 1955

### Extract of the 1952-55 map from Groundsure

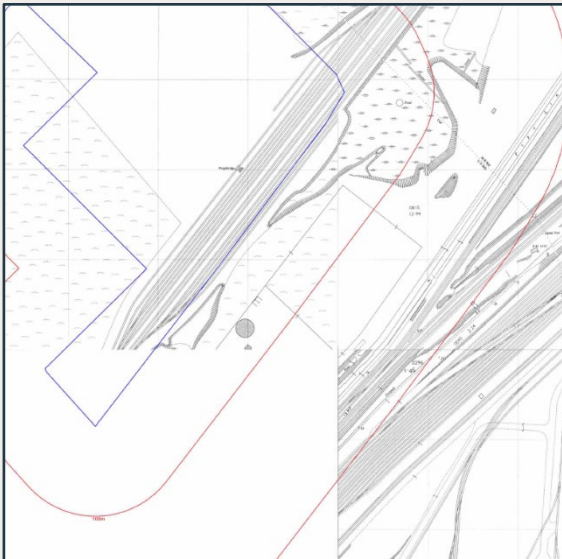


**Onsite:** In the southern half of the site the tracks identified in previous mapping have been removed. However, additional earthworks are identified that appear to have created raised bunds and banks through the central southern part of the site. In addition, the water bodies on site have been reduced in size and a railway line is shown entering site from the southwest. This may indicate that the site has been partially reclaimed from the River Tees estuary.

**Offsite:** To the immediate southwest of the site a marshalling yard has been developed with there has been the addition of railway lines between the site and the Lackeny Slag Breaking Plant. The former Lackeny Station has also been reannotated as meter houses for Tees Valley Water Board and an additional railway line has been developed beyond the meter houses. To the south of the site the Lackeny Iron works is no longer shown.

## 1965

### Extract of the 1965 1:2500 map from Groundsure

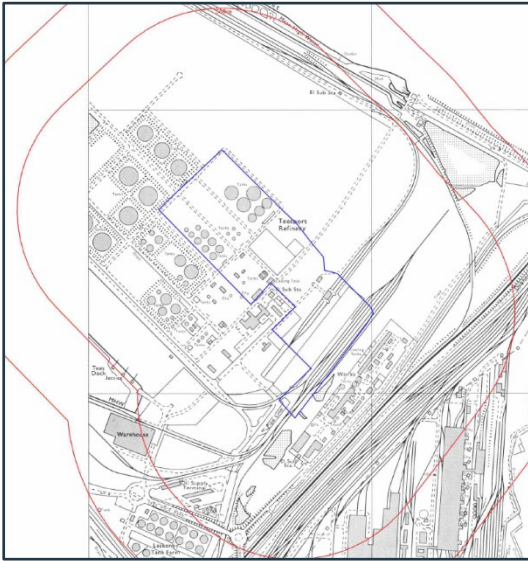


**Onsite:** The mapping indicates that by 1965 the site had been completely reclaimed from the River Tees estuary. In addition the far south of the site is shown to have been developed with a marshalling yard.

**Offsite:** There has been little obvious significant change the land uses immediately surrounding the site.

## 1974

### Extract of the 1974 map from Groundsure



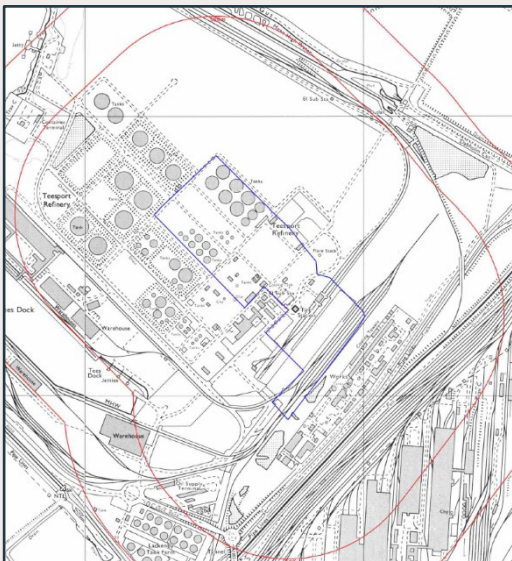
**Onsite:** The Teesport Refinery is shown to have been developed and covers the entire area of site. The refinery is shown to include tanks, chimneys, a substation and cooling tanks. In addition, extra railway lines are identified in the southern half of the site. Further information provided by PD Ports indicates that the structures on the railway were an oil loading gantry and locomotive shed. In the north, the tanks are arranged in groups (or tank farms). A pipeline crosses site east to west in the south.

**Offsite:** The site only covers a portion of Teesport Refinery with much of the refinery immediately adjacent to the northwest and west. The offsite portion of the refinery includes a significant number of tanks, roadways, earthworks, drains, an electrical sub-station, and possible refining buildings/structures. To the south of site are two ponds and a works (unspecified, possibly the BOC works) that contains tanks, buildings, a cooling tower, and an electrical sub-station. Also to the south, a large

marshalling yard has been developed beyond the works approximately 250m from the site and beyond that is the South Teesside Works Lackenby approximately 450m from the site. To the southwest an Oil Supply Terminal, the Lackenby Tank Farm and a warehouse are identified between approximately 400m and 750m from the site. The Tees Docks with jetties is approximately 200m west of site.

## 1983-88

### Extract of the 1983-88 map from Groundsure

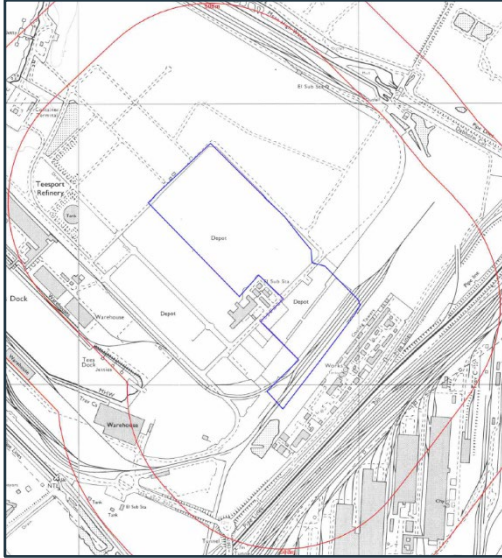


**Onsite:** Other than the addition of three additional tanks in the north and a fire station in the central south there has been little significant change to the site. There is then little obvious significant change to the site until the 1992 mapping.

**Offsite:** To the west of the site warehouses and a conveyor are shown on the Tees Dock between approximately 300m and 750m from the site. There is then little obvious significant change to the site until the 1992 mapping.

**1992**

**Extract of the 1992 map from Groundsure**



**Onsite:** All structures associated with the Teesport Refinery have been demolished. By this time the site is dominated by a depot that extends offsite to the west. The railway lines remain along the southern boundary of site.

**Offsite:** The land to the immediate west of the site is shown to be dominated by a depot. In the wider area, other than the removal of the oil terminal and Lackenby Tank Farm there has been no significant changed to the surrounding land use.

**1999**

**Extract of the 1999 aerial imagery from Groundsure**

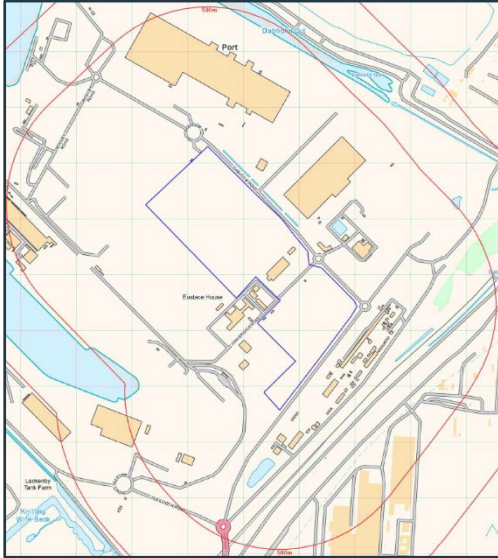


**Onsite:** Aerial imagery appears to indicate that the northern half of the site was used for vehicle storage. The southern half of the site is shown to be open disused ground. In the central area of the site is a rectangular building.

**Offsite:** In the immediate surroundings the imagery shows that land adjacent to the west was also used for vehicle storage and beyond that is what appears to be container storage at Tees Port. To the immediate north and east is open disused land with a number of stock piles. Also to the east is an industrial building that is identified on a plan provided PD Ports as the Kemira Chemicals (UK) Limited facility.

## 2001 – 2022

### Extract of the 2022 map from Groundsure



**Onsite:** The site is shown to remain in use as a vehicle storage depot until at least 2007. By the 2015 imagery (see the Groundsure report) the vehicles are shown to have been removed and container storage is shown to have commenced. This continues to the present day. In the centre of the site the imagery appears to show a road haulage depot/yard. The southern half of the site is shown to remain as open disused ground through to the present day.

**Offsite:** During the period between 2001 and 2022 the land use to the immediate west of the site is similar to that of the site (i.e. vehicle and container storage). By 2001 a railway line or marshalling yard is shown approximately 250m west of the site that remains to the present day. The land surrounding Tees Dock between 250m and 750m remains a port containing warehouses. To the immediate northeast of the site an unannotated building (annotated an ASDA depot in the PD Ports plan) is constructed sometime prior to 2007 and

remains to the present day. To the south of the site the Teeside Works Lackenby remains to the present day.

## 3.1 Summary of site history

The earliest historical mapping indicates that the site was initially entirely below the high water mark within an area of tidal mud flats and sand of the River Tees estuary. By the 1893 mapping a sea wall or defence is shown to have been constructed through the centre of the site and reclamation of the River Tees estuary commences. The northern half of site remains below the high water mark as shown in imagery from the Britain from Above<sup>3</sup> website until sometime between 1955 and 1965 when the River Tees estuary is reclaimed to its current limits. Following the construction of the sea wall/defence in the 1890's the southern part of the site is located above the high water mark and is shown to contain marshes, ponds and earthworks/embankments. A railway line connecting the site to the adjacent Lackenby Slag Breaking Plant was added to the southern half of the site during the 1950's.

By 1965 the entire site and land beyond the northwest and northeast had been reclaimed from the River Tees. By this time the southern half of the site had been developed with a marshalling yard, but the remainder of the site appears disused. During the late 1960's to early 1970's the Teesport Refinery was developed onsite and dominates the land use of the northern half through to the late 1980's. The refinery included tanks, chimneys, pipelines a fire station and other ancillary structures. The refinery covered an area larger than the site extending beyond the site to the west and north.

By the early 1990's the Teesport Refinery had been demolished and the northern half of the site is annotated as a depot. The historical aerial imagery indicates that the site was initially used to store vehicles but by 2015 the site changed to a container storage depot associated with the nearby Teesport. The southern half of the site remains open disused land from around 1999 to the present day.

In the wider area the earliest mapping indicates that industrialisation of the site surroundings commenced from around the 1890's. This starts with the construction of the Lackenby Iron Works and the Tees Slag Wool Works to the south and the formation of slag heaps to the southwest of

<sup>3</sup> <https://www.britainfromabove.org.uk/en/image/EAW050696>

the site. The Lackenby Slag Break Plant is constructed approximately 250m southwest of the site in the early 1900's and historical mapping identifies the slow development of earthworks to the south of the site through to the 1960's. During the 1960's and early 1970's significant industrial development is identified to the south and west and the River Tees estuary is reclaimed to its current limits. This includes the development of the South Teesside Works Lackenby, Teesport Refinery, Lackenby Tank Farm, works (unspecified), warehouses, marshalling yards, electrical sub-stations, and an oil supply terminal.

By the early 1990's industry in the areas starts to decline with the removal of the Teesport Refinery to the immediate west as well as the oil terminal and Lackenby Tank Farm to the south. The Teesport to the west of the site continues through the 2000's to the present day and to the immediate northeast unannotated commercial/industrial buildings are added.

### 3.2 Shell Refinery Fire

An internet search was performed to establish whether any further information is available on the historical land use of the site. The search revealed an article in the Quarterly Journal of the Association of Petroleum Acts Administration<sup>4</sup> that provides details of a fire that occurred at the former Shell Teesport Refinery in February 1971. The article indicates that the fire occurred within the process area of the refinery that formerly occupied the central portion of the site. The fire is noted to have damaged approximately 60% of the process area with approximately 10% of the structures and concrete base and approximately 30% of the process equipment severely damaged. In the process of fighting the fire the article notes that approximately 1,400 gallons (~5,300 litres) of firefighting foam was used and water was used at a rate of approximately 6,000 gallons (~22,715 litres) per minute.

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<sup>4</sup> <https://issuu.com/apeauk/docs/the-bulletin-april-1971>

## 4. Environmental Setting

The environmental setting of the site has been determined through review of information obtained from published geological mapping on the BGS website, including historical boreholes, as well as information provided in the Groundsure report presented in **Appendix A**.

### 4.1 Artificial Ground

British Geological Survey (BGS) mapping indicates that the site is entirely underlain by Made Ground (undivided) that extends along the southern bank of the River Tees estuary and inland approximately 700m to the southeast.

Previous investigations of the site reveal that Made Ground ranges in thickness between 0.40m and 6.10m but may be deeper where tidal flat guts and slag walls were present historically. The Made Ground was noted to comprise clay, slag, ash and gravel. Further information provided by previous investigations of the site is detailed in Section 4.4.

A documentary recording the construction of the former Shell Teesport Refinery<sup>5</sup> indicates that the land in the northern half of the site was reclaimed from Tees Estuary by pumping dredgings from estuary into an enclosed barrage. The water was drained and the silt and sand was left to consolidate and dry out. The dredgings were then covered with up to 15 feet (~4.5m) of blast furnace slag to form a firm construction platform from which to sink ballast columns to support the bulk storage tanks. On this basis, it is likely that the site is underlain by Made Ground obviously comprising slag underlain by reworked (or redeposited) estuarine silt and sand that does not appear to have been engineered.

In WSPs' experience of working in the area the underlying Made Ground has the potential to contain slag and fused slag ranging in size from cobbles to very large boulders much greater than 1.00m in diameter. It is also worth noting that reclamation of the River Tees estuary was achieved by creating sea defences constructed of slag that was tipped into place continually until settlement of the embankment ceased. As such, it is possible that Made Ground in the location of the former sea defences, trackways and embankments is much deeper and comprised of a higher proportion of slag than Made Ground across the remainder of the site.

### 4.2 Superficial Deposits

BGS mapping indicates that the site is underlain by recent Tidal Flat Deposits of sand, silt and clay that extend beyond the site in all directions.

In the wider area the superficial deposits approximately 330m southeast of the site are shown to comprise Glaciolacustrine Deposits comprising clay and silt and Glacial Till is shown approximately 1.9km southeast of the site. These deposits are likely to underlie the recent Tidal Flat Deposits.

BGS mapping indicates that there are no linear glacial landforms including buried channels, glaciofluvial outwash channels or infilled features within the site or its vicinity.

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<sup>5</sup> Landscape in Oils: The Building of Teesport Refinery By Press And Costain (J.V.) Limited, 1969, North East Film Archive, <https://www.yfanefa.com/record/24156>

## 4.3 Bedrock Geology

BGS mapping indicates that the site is underlain by the Mercia Mudstone Group comprising mudstone. In addition, to the immediate southeast and east of the site the Penarth Group comprising mudstone that dips away from the site to the southeast.

The BGS mapping indicates that site is situated within the limits of the Boulby Halite and is therefore likely to be underlain by the halite (salt) at a significant depth.

The mapping indicates that there are no geological faults underlying the site.

## 4.4 Previous Investigations

### 4.4.1 BGS Historical Boreholes

Although the BGS GeoIndex identifies several historical borehole logs within and adjacent to the site, only four are publicly accessible to view. The following BGS records are located within 50m northeast of the site and are presented in **Appendix C**:

- NZ52SE199
- NZ52SE200
- NZ52SE206
- NZ52SE209

The logs indicate that Made Ground extends to a depth of between 3.70m and 5.40m bgl. The shallow Made Ground is described as soil, clay, slag, brick fill and rubble overlying silty clay and sand. Made Ground near the interface with the underlying deposits are variable comprising either natural materials such sand, shells and vegetation or fill containing sand, ash, brick rubble and slag. In all except one location the depth of Made Ground was proven and found to be underlain by superficial deposits comprising red brown fissured Glacial Till (described as boulder clay). BGS record NZ52SE206 proved the thickness of Glacial Till to a depth of 9.80m bgl that was found to be underlain by laminated clay.

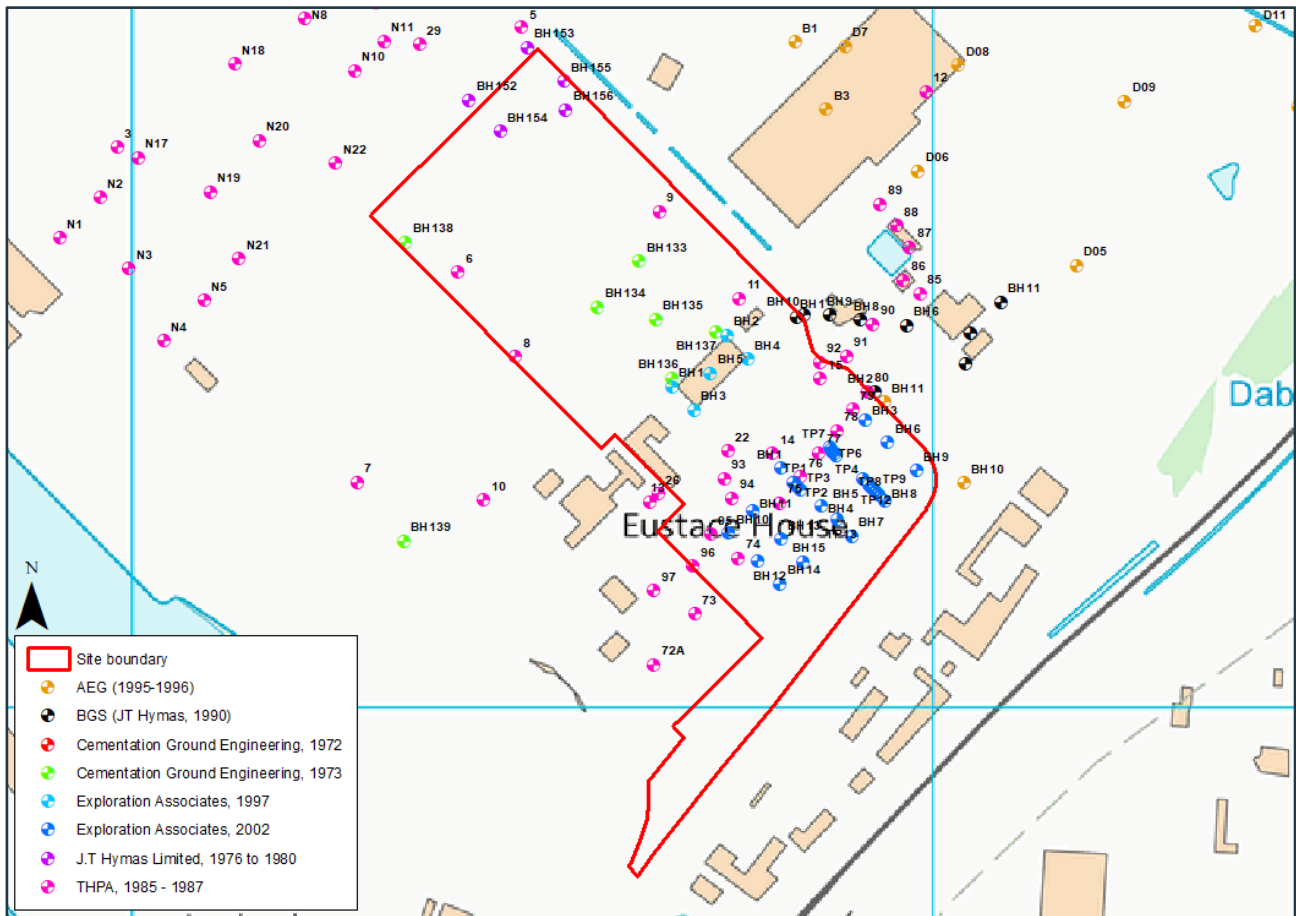
Groundwater strikes were recorded at depths between 0.70m and 3.30m bgl with standing levels recorded at between 1.42m and 2.90m bgl.

In BGS record NZ52SE209 the log notes that methane gas was struck at 3.50m bgl and the borehole was abandoned.

### 4.4.2 Previous Site Investigations

The following reports provide further information on the ground conditions underlying the site. The full report references are provided in Section 1.5.

Figure 4.1 Inferred location of previous site investigation exploratory holes.



### Cementation Ground Engineering, 1972

Cementation Ground Engineering were commissioned to undertake a ground investigation in the north of Teesport Refinery. The ground investigation comprised the drilling of eight boreholes approximately 400m northwest of the site. As such, the information on ground conditions provided by the boreholes is not relevant to the site, although the logs do indicate that blowing conditions were encountered in silty sand deposits from 7.00m bgl. However, the report provides information from a later investigation of the Teesport Refinery undertaken by J.T Hymas Limited between 1976 to 1980. Figure 4.1 above shows the inferred locations of these boreholes.

The J.T Hymas Limited borehole logs are inferred to be onsite in the far north based on the drawing provided in the report. The ground conditions encountered comprised Made Ground of hardcore, slag and topsoil extending to a depth of between 0.75m and 0.80m bgl. Made Ground is shown to be underlain by black silty clay with bands of silt to a maximum depth of between 5.70m and 7.40m bgl. This is shown to have been underlain by a thin stratum of brown laminated clay up to 0.5m in thickness below which is Glacial Till (described as boulder clay) comprising clay to a depth of 9.10m. In one location grey weathered shale was encountered to the end of the borehole at 10.00m bgl.

### Cementation Ground Engineering, 1973

Cementation Ground Engineering undertook a ground investigation comprising nine boreholes spread across the Teesport Refinery in October 1973. Of the nine boreholes excavated six were located onsite and are inferred to have been located with the centre and far northwest of the site as shown in Figure 4.1. No environmental soil or groundwater samples were obtained or analysed.



The boreholes encountered Made Ground comprising slag, ash, clay and gravel to a maximum depth of between 1.20m and 1.90m bgl. This was underlain by Tidal Flat Deposits of soft to very soft black organic sandy and occasionally laminated silt or silty sand to a maximum depth of 8.30m bgl. This was underlain in all locations by a stiff brown laminated silty clay to a depth of 9.00m bgl and below this was the Mercia Mudstone Group comprising stiff to very stiff red and grey marl to the end of the boreholes at 15.00m bgl.

The borehole logs indicate that chiselling was required within the Made Ground at locations 133, 136 and 138. The chiselling is recorded from ground level to a maximum depth of 1.80m bgl.

Groundwater was encountered at depths between 3.10m and 7.00m bgl generally within the organic sandy silt / silty sand perched above the laminated clay.

### Tees & Hartlepool Port Authority Limited, 1993

A total of 21 boreholes were excavated within the south, centre and north of site as shown in Figure 4.1 during 1985 and 1986 to investigate the ground conditions prior to clearance of the Teesport Refinery. The ground investigation also investigated the offsite portions of the Teesport Refinery as well as the Lackenby Oil Terminal to the south and a tank farm to the west of the site.

The boreholes encountered Made Ground to a maximum depth 5.10m bgl in the north. In the south Made Ground water encountered to slightly shallower depths of between 1.80m and >3.00m. In general Made Ground in both areas of the site comprised possible reworked silty clay and compacted slag over tidal deposits of clayey silt or silty sand. In the far north of the site tidal deposits were underlain by laminated clay and in central and south they were underlain by Glacial Till (boulder clay).

The report provides chiselling information relating to the boreholes within the site that indicates chiselling was required for most of the boreholes within the southern half of the site. The report indicates that obstructions were encountered at depths ranging between 1.20m and 3.50m bgl and was performed for thicknesses between 1.00m and 3.50m.

The report provides notes on 18 water samples taken on and offsite of which 8 were taken from within or immediately adjacent to the site and analysed for hydrocarbons. However, only basic information is presented in the report regarding the testing of these samples. Although the method of analysis is not provided the results indicate that samples of groundwater from boreholes 6, 8, 11 and 13 located in the centre and north of the site contained between 0.5% (11) and 99% (13) oil. The results describe the sample from borehole 6 as "*Thin brown oil, odour resembling gas oil*" and from the other locations as brown oil with an odour described as "*crude oil.*" In the wider refinery, oil terminal and tank farm of the remaining water samples 10 samples are noted to have been contaminated with hydrocarbons.

### Exploration Associates, July 1997

Exploration Associates were commissioned by Tees and Hartlepool Port Authority Limited to investigate the ground conditions at a proposed workshop building. This report describes the investigation site as being located within the centre of the site, either side of the Kinkerdale Road. The scope of the investigation comprised five cable percussion boreholes that were progressed to characterise the ground conditions in the footprint of a proposed workshop building. The boreholes were installed to allow for gas monitoring. Although borehole logs and laboratory testing are referenced, the report is incomplete and does not contain the logs.

A description of the ground investigation findings in the report indicates that Made Ground was found to a maximum depth of 4.35m bgl and comprised loose to medium dense grey to orange brown silty sand with gravels of sandstone, concrete and ash inclusions. In two locations strong hydrocarbon odours were noted. The shallow Made Ground was underlain by Made Ground comprising dark grey or black silty gravelly sand with strong hydrocarbon odour to 7.0m bgl. This

was underlain by estuarine alluvial deposits which were found to comprise of slightly sandy clays. Glacial deposits comprising fine to medium gravels and laminated clays underlie the alluvium which was in turn underlain by rockhead at 6.50m bgl that comprised weak to moderately weak highly weathered mudstone.

Groundwater was recorded between 3.26m and 3.65mbgl two weeks after drilling works.

During the investigation soil samples were taken and submitted for analysis. The results were compared with guideline values published by the International Committee on Redevelopment of Contaminated Land (ICRCL), Health and Safety Executive and the Dutch Intervention values. The assessment of results revealed only copper and zinc were reported at concentrations above the assessment criteria used.

Ground gas monitoring and sampling revealed the maximum methane concentration was 25%v/v. As such the report recommends ground gas protection measures and further monitoring.

### Exploration Associates, October 2002

Exploration Associates were commissioned by Tees and Hartlepool Port Authority Limited to investigate the ground conditions at a proposed distribution warehouse. The area of this investigation covers only the southern section of the site to the south of the Kinkerdale Road.

As shown in Figure 4.1 the investigation comprised 18 cable percussion boreholes excavated to a maximum depth of 15.00m bgl and 13 trial pits to a maximum depth of 3.30m bgl (not shown). Geotechnical and environmental sampling was undertaken on arisings from the boreholes and trial pits.

The investigation encountered Made Ground to a proven maximum depth of 6.10m bgl that comprised loose to medium dense red brown gravelly clay, gravels of slag, metal, brick and concrete. Made ground at depth was granular and contained slag, clinker, brick and concrete. The Made Ground was found to be underlain by alluvium deposits comprising a thin stratum of sand with thicknesses ranging between 0.1m and 1.70m. In a number of locations the Made Ground was noted to directly overlie very weak to weak red brown mudstone often with bands of gypsum noted.

The borehole logs note that chiselling for more than 1 hour was required in all locations, some of which were eventually abandoned. In BH1, BH1B and BH3 chiselling on gravels and cobbles of slag was required from 0.80m bgl and the holes were both abandoned at a maximum depth of 1.60m bgl. The remaining boreholes that progressed to depth all encountered obstructions in Made Ground, and all boreholes (excluding BH7, 13, 14) were excavated with a mechanical excavator prior to boring to remove near surface obstructions. Chiselling was required at least once in each hole (even after removal of the near surface obstruction) and in some locations was required multiple times at depths ranging between 0.8m and 5.25m bgl

Groundwater was encountered generally within Made Ground or the underlying alluvium at between 2.5mbgl and 8.1mbgl. No groundwater sampling or analysis was undertaken.

In total nine environmental samples were obtained and submitted for contamination analysis including metals and TPH. The results of analysis were compared against the ICRCL threshold trigger values (now withdrawn) which revealed exceedances of the trigger threshold for copper, zinc, boron and lead. The results of TPH analysis were compared with guideline values published by the Dutch Ministry of Housing (now withdrawn). The highest TPH concentration of 4,360mg/kg was below the guideline value, but the report does suggest precautions may be required should soils be moved from site or should workers come into contact with contaminated soils.

During drilling downhole gas monitoring recorded methane in boreholes 1B (5.5% v/v) and 10 (0.5% v/v). In addition, carbon dioxide was recorded in borehole 1B (0.5% v/v).

## Sol Environmental, July 2022

Sol Environmental were commissioned by Green Lithium Refining Limited to prepare a planning and permitting due diligence review of the site. The report considers geological, hydrogeological, hydrological sensitivity and receptors as well as permitting and planning history of the site.

The report notes several potentially contaminative land uses surrounding site, these include infilled land, pipelines and terminal infrastructure to the north, a sewage works to the north and northeast and an infilled lake to the northwest. To the east is Kemira Chemical Works is identified and to the south is BOC Industrial Gas supplies with railway infrastructure beyond. To the west and southwest are container port terminals including Cleveland Potash, the Tees REP Power Station a biomass Combined Heat and Power (CHP) plant which is yet to be commissioned.

The report states that the potential for land contamination is high given the historical land uses, which includes the oil refinery. The report notes that the state of remediation of site is unknown and that an evaluation of site conditions is recommended to establish a baseline.

The site is given a Medium risk for environmental sensitivity and also a Medium risk with respect to a planning application and early liaison with regulators is recommended.

Land contamination is given a medium risk. Ground assessment and remediation are expected to be required prior to Green Lithium leasing the site and investigation is recommended at the earliest possible opportunity.

Ecology is given a low risk and the report notes there are no ecological features on site but grassland in the southern portion should undergo a Phase 1 ecological assessment. The site is close to designated sites, however risk to these should be mitigated during site design stage.

### 4.4.3 Summary of Site Geology

The summary of the underlying geology in Table 4.1 has been compiled from published information and previous investigations of the site.

Table 4.1 Summary of underlying geology

Strata	Description/Constituents	Range of depths to top (range of thickness)
<b>Made Ground</b>	Generally comprises a heterogenic mix of clay, sand, ash, slag, concrete, brick, marl and sandstone. Previous investigations encountered indications of cobble and boulder sized obstructions of fused slag. Chiselling records indicate the presence of multiple obstructions, possibly associated with fused slag and other obstructions that were encountered from shallow depth. Previous investigations also encountered signs of contamination including hydrocarbons and ground gas.	Ground level (0.40m to 6.10m) <sup>1</sup>
<b>Tidal Flat Deposits</b>	Sometimes not present but where present it generally comprises upper layers of black organic sandy silt underlain by silty sand or sand.	0.40m to 6.10m bgl (0.1m to 6.80m)
<b>Laminated Clay</b>	Sometimes not present but where present it generally comprises stiff brown laminated silty clay.	5.75 – 9.80m bgl (0.4-1.70m)
<b>Glacial Till</b>	Sometimes not present but where present comprises reddish brown boulder clay or stiff to very stiff brown silty clay	0.50m – 10.50m bgl (1.60m – 2.30m)
<b>Mercia Mudstone</b>	Grey weathered shale, grey shale or stiff to very stiff marl becoming rock marl from between 9.50-13.00m bgl. Also	4.90m – 9.30m bgl (not proven)

Strata	Description/Constituents	Range of depths to top (range of thickness)
	described as very weak mudstone with gypsum nodules below 12.00m bgl	

#### Notes

1 - note that Made Ground may be deeper along historical (buried) sea defences, trackways and embankments. It is also worth noting that the deposits immediately underlying Made Ground in the northern half of the site are likely to be reworked estuary dredgings.

## 4.5 Previous Remediation

When the Shell Teesport Refinery ceased operation records provided by PD Ports indicate that Tees and Hartlepool Port Authority (THPA) entered negotiations with Shell on the specification for handing the land back to THPA. The communications state that the document represented the negotiating position of THPA and not the practical solutions to address the requirements. The specification settled on between THPA and Shell in March 1986 (the last available communication reviewed) required the following in relation to the ground at the site:

- All concrete across the site was to be broken out and completely removed. No concrete was allowed to be used as fill unless agreed with THPA. No refractory brick was to be used as infill material, but normal brickwork was acceptable.
- In the process area in the centre of the site all concrete paving and supporting beams were to be broken out and completely removed. The remaining piles up to the pile caps were to remain pending further negotiation between Shell and THPA.
- All drains in the process area were to be left clean and gas free and the remaining pit from PP12 was to be filled with suitable material. It is unclear what PP12 is referring to.
- Underground water mains within the process area were to be 'partially' filled with granular material and capped.
- All pits within the process area were to be broken out and concrete removed with the void filled with a suitable material.
- At the rail loading area in the south of the site the rail loading gantry, paving below the gantry, and associated piping was to be removed and all buildings demolished. In addition, the oil catchers were to be broken out, removed, filled and graded. The railway tracks were to remain pending further discussion, it is therefore unclear whether these were removed.
- At the rail loading area all underground tanks were to be removed, filled and graded. It is unclear where these were.
- In the northern tank plot areas in the north of the site all tanks and pipe work were to be removed including all foundation upstands and drainage ring bungs. In addition, all pump slabs were to be broken out as well as any precast sleepers, cast insitu pipe sleepers and anchors prior to regrading.
- In regard to the administration and workshop area located in the centre of the site the correspondence references a petrol filling facility that was to be removed, broken up and backfilled with suitable material.
- A tank referenced as P6503 and an underground foam tank were to be removed and broken up with the remaining void filled with suitable material.

- In regard to contaminated ground THPA initially requested that all contaminated ground is removed and this appears to have been initially accepted by Shell, pending further discussion. However, the final correspondence states that in Shells opinion leaving it insitu was the 'best solution' and they suggested a technical exchange which may have included some additional sampling.

Although the above indicates the THPA requested that action be taken to address below ground obstructions and contamination no documents verifying that the above actions were completed to the acceptance of THPA have been provided by PD Ports for review. As such, it is possible that a significant number of below ground obstructions relating to the former refinery and hydrocarbon contamination remain at the site.

## 4.6 Mineral Extraction

### 4.6.1 BGS Recorded Sites

The Groundsure report reveals that there are no mineral extraction sites recorded within or near the site on the British Pits database held by the BGS.

The Groundsure report identifies numerous ponds and heaps that may represent worked or infilled ground generally located within the centre and south of the site.

### 4.6.2 Non-Coal Mineral Extraction

A search of the non-coal mine abandonment plans held on the BGS GeoIndex has been performed to establish whether the site is likely to be underlain by non-coal workings. Although plans are available for workings of ironstone these are indicated to be more than 3.5km southeast of the site.

A report prepared by the Morris C.H (1994) Report on Abandoned Mineral Workings and Possible Surface Instability Problems, Cleveland County Council has also been reviewed for information on the presence of non-coal mineral workings within the vicinity of the site. The report includes information on ironstone, anhydrite and halite (brine) extraction in Teesside. The report indicates that the site is not underlain by ironstone workings, the nearest of which are located more than 5km south of the site. The site is also not underlain by any know anhydrite mines, the nearest of which is identified at Billingham more than 7km west.

In relation to brine extraction the nearest brine extraction well is recorded approximately 770m south of the site beyond the former Lackenby Tank Farm. The well is recorded as operational from 1889 and extracted salt from a seam with a thickness of 40m at a depth of 510m bgl. In the Tees region, brine extraction ceased in the 1950's therefore settlement is likely to have ceased. The report indicates that the zone of influence for settlement at the surface caused by the extraction is 50% of the extraction depth, the limit of which is approximately 600m south of the site. As such, the site is not located within the inferred zone of settlement. It should be noted that due to the uncertainties in relation to the extent of the extraction laterally from the well the report has only measured the zone of settlement from the well, not the edge limit of the brine extraction. However, even considering the absolute limit of settlement reported in Morris C.H (1994), that is taken to be 70% of the extraction depth the site is still approximately 500m from the zone of settlement. This together with the fact that extraction ceased in the 1950's indicates that further settlement due to brine extraction is considered unlikely.

### 4.6.3 Coal Authority

The Coal Authority Interactive Map indicates that the site is situated outside of the Coal Mining Report Area where a coal mining report would be required. The underlying geology of the site is not conducive to the extraction of coal.

## 4.7 Ground Stability

The Groundsure report identifies the following ground stability hazards and associated ratings at the Site:

- Collapsible Ground – Negligible hazard rating
- Compressible Ground – Very low hazard rating
- Ground Dissolution – Negligible hazard rating
- Landslide – Very low hazard rating
- Running Sand – Very low hazard rating
- Shrinking or Swelling Clay – Very low hazard rating

## 4.8 Radon

The UK Radon Map published by Public Health England<sup>6</sup> indicates that the far southeast of the site is within a Radon Affected Area where between 1% and 3% of properties are above the Action Level. In these areas existing properties should have radon measurements taken and where measurements reveal concentrations above the Action Level (200 Bq/m<sup>3</sup>) measures should be taken to reduce the concentration to as low as reasonably practicable.

The remainder of the site is shown to be within an area where less than 1% of properties are above the Action Level.

## 4.9 Hydrogeology

The Groundsure report reveals that the superficial deposits underlying the site are classified by the Environment Agency (EA) as a Secondary Undifferentiated aquifer. These are deposits where it was not possible to apply either a Secondary A or B classification due to the variable nature of the deposits. These aquifers only have a minor value and negligible significance for water supply to rivers lakes or wetlands. The site is within the tidal limits of the River Tees estuary therefore saline intrusion into the underlying groundwater is considered likely.

The Mercia Mudstone Group underlying site is classified by the EA as a Secondary B Aquifer. These are bedrocks with mainly lower permeability layers that may store and yield limited amounts of groundwater through faults, fissure, openings or eroded layers. They support water supplies at local rather than strategic scale.

The site is underlain by the Tees Mercia Mudstone and Redcar Mudstone Water Framework Directive (WFD) waterbody that was classified by the EA as having an overall status of Poor and chemical status of Poor in 2019.

The Groundsure report reveals that site is not located within a Source Protection Zone (SPZ) and there are no groundwater abstractions within 1km of the site.

The groundwater vulnerability for the site is classed as High Vulnerability, meaning the area may be able to transmit pollution to groundwater easily. Soils transmit leachate easily and superficial deposits are likely to be more permeable.

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<sup>6</sup> <https://www.ukhsa-protectionservices.org.uk/radon/information/ukmaps>

Based on the information above and the method for assessing the sensitivity of water environment receptors in NHBC guidance document R&D 66<sup>7</sup> the sensitivity of the underlying groundwater has been assessed as Moderate.

The Groundsure report reveals that site is within an area where the risk of groundwater flooding has been assessed as low risk in the report.

## 4.10 Hydrology

The nearest surface water feature identified by the Groundsure report is an unnamed ditch immediately adjacent to the northeast of the site. The direction of flow and receiving water of the ditch is unknown but is likely to be ultimately the River Tees estuary. The nearest WFD waterbody is the River Tees Estuary located approximately 730m to the northwest of the site which is tidal up to the Tees Barrage at Stockton on Tees 10km to the southwest. The River Tees flows in a general northern direction past the site to the North Sea approximately 4.0km north of the site.

The River Tees Estuary was classified by the EA as having an overall status of Moderate, a chemical status of Fail and an ecological status of Moderate in 2019.

In addition to the River Tees, Ordnance Survey mapping also identifies a number of unnamed ditches and drains as well as the Dabholm Beck and Dabholm Gut approximately 285m and 610m to the southeast and northeast of the site, respectively.

Based on the information above, as well as the statutory designations of the River Tees Estuary detailed in Section 4.10 below, the sensitivity of surface water environment has been assessed as Moderately High based on the guidance in NHBC guidance document R&D 66.

The Groundsure report indicates that the site is not within an area at risk of flooding by rivers or the sea. There are no active surface water abstractions recorded within 1km of the site.

## 4.11 Designated Sites

The Groundsure report identifies the following statutory designated sites within 1km of the site:

- Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI) approximately 450m west and 665m north.
- Teesmouth and Cleveland Coast Special Protection Areas (SPAs) between approximately 450m and 750m to the southwest, west, north and northeast.
- Teesmouth and Cleveland Coast proposed Ramsar site between approximately 460m and 1km to the northwest, north and northeast.

In addition to the above, the site is situated within a SSSI Impact Zone for the Teesmouth and Cleveland Coast SSSI.

The site is not located within a Nitrate Vulnerable Zone.

Based on the information above the ecological sensitivity has been assessed as high based on the guidance in NHBC guidance document R&D 66.

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<sup>7</sup> NHBC/ CIEH / Environment Agency, Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008

## 5. Regulated Activities

The following information on regulated activities within 500m of the site has been obtained from the Groundsure report presented in **Appendix A**.

### 5.1 Waste

#### 5.1.1 Storage, Treatment, Transfer and Use (exemptions)

There are no recorded waste activities on the site.

In the wider area there are 14 exempt activities between approximately 35m and 465m to the southwest, south and northeast of the site. The nearest of these are located approximately 35m southwest of the site at the Teesdock and the Potash Terminal that relate to crushing fluorescent tubes, recovery of scrap metal and the storage of wastes.

#### 5.1.2 Landfills

There are no active or recently closed landfills registered with the EA within 500m of the site. There are also no historical landfills identified within the site.

In the wider area there are four EA historical landfills and two historical Local Authority landfill sites. The closest is a historical Local Authority landfill site located approximately 290m to the northeast that was recorded as a refuse tip. The nearest EA historical landfill site is located approximately 300m northwest of the site and was operated by Bells Containers. The landfill was operational from 1987 and was permitted to accept liquid sludge.

There are five historical waste sites within 500m of site, the closest is approximately 445m east of site and is described as a refuse pit dated to 1952.

There is one record of a licensed waste site approximately 470m northeast of site. This relates to Teesport Landfill operated by Hall Construction that are permitted to use waste in construction.

### 5.2 Hazardous Substances

A historical Notification of Installations Handling Hazardous Substances Regulations (NIHHS) record relating to activities by the Tees and Hartlepool Port Authority is identified on the site.

In the wider area three Control of Major Accident Hazards (COMAH) sites are identified, the closest of which relates to operations by BOC Limited approximately 55m southeast of the site. The BOC Limited facility is also a Planning (Hazardous Substance) Regulations 2015 site authorised to store hydrogen, liquid oxygen and Liquefied Petroleum Gas (LPG).

### 5.3 Licenced Industrial Activities

The Kemira Chemicals (UK) Limited Kemira Teesport installation is identified in the south of the site (though is actually located to the northeast) and is regulated under the Environmental Permitting Regulations 2016. The environmental permit for the installation is current as of 01/01/2022 and relates to a chemical works with organic chemicals and oxygen containing compounds.

In the wider area the MGT Teesside Renewable Energy Plant has a permit in place approximately 240m west of site for combustion of fuels that is noted as current on 01/01/2022.



## 5.4 Discharge to Controlled Waters

There are four discharge to controlled waters records relating to the site. The records relate to discharges of unspecified trade discharges to the tidal waters of the River Tees. However, all licences have now lapsed or were revoked as of October 1996.

In the wider area there are a further five discharge to controlled water licences. The nearest active discharge is recorded approximately 160m southeast of the site at the BOC Limited facility that was licenced to discharge cooling water to land (e.g. a soak away).

Two discharges of substances regulated under the Environmental Damage (Prevention and Remediation) Regulations 2015 are identified within 500m of the site. The nearest of these is located approximately 210m southwest of the site that relates to discharges of a range of compounds including metals, pesticides, herbicides and semi-volatile organic compounds. A record relating to the discharge of benzene, toluene and xylene to an unknown receiving water is also identified approximately 310m southeast of the site.

## 5.5 Pollution Incidents

There have been no records of substantiated pollution incidents in relation to the site. In the wider area a pollution incident is recorded approximately 255m southwest of the site that relates to the release of diesel that caused a minor impact to the land.

## 6. Geotechnical Constraints

### 6.1 Unexploded Ordnance (UXO)

An Unexploded Bomb Risk map for the site has been obtained from Zetica Limited in November 2022 and is presented in **Appendix D**. The map indicates that the site is on the boundary between an area of Moderate and Low bomb risk. An area of Low bomb risk is defined by Zetica as having 15 bombs or less dropped per 1000 acres while an area of Moderate bomb risk is defined as having 15 to 49 bombs per 1000 acres. The Zetica Unexploded Bomb Risk map indicates that a bombing decoy was present adjacent to the northeast of the site.

The Defence of Britain Archive indicates that there were no known defence infrastructure targets within the site that may have been a target of enemy bombing during World War 2. However, numerous potential bombing targets are identified between approximately 750m and 3km northeast of the site along the coastline including trenches, pillboxes and gun emplacements.

The North East Diary 1939-1945<sup>8</sup> website was searched for records of bombing in the vicinity of the site. However, no bombing records relating to the site were identified.

On the basis of the available information and due to the presence of a nearby decoy and industrial targets including steel works and railways the likelihood of encountering UXO is considered to be a Moderate.

### 6.2 Geotechnical Risks and Hazards

A review of the potential geotechnical constraints has been undertaken for the site using the available information sources listed in Section 1.5. The available information has been used to develop the Geotechnical Risk Register (presented as **Appendix F**) and the Geotechnical Constraints map presented as **Figure 6.1** below. Although full details of the proposed structures are not known at this stage, the following potential geotechnical constraints have been identified:

- There is limited information and data on the ground and groundwater conditions. The information presented in Section 4.4 is more than 20 years old. A ground investigation is recommended to characterise the ground and groundwater conditions underlying the site to enable a safe and economic design of the proposed development, temporary works and foundations.
- Significant thicknesses of Made Ground are anticipated in association with reclamation of the River Tees estuary, infilling of ponds and previous developments of the site. The BGS has recorded Made Ground across the entire site and previous investigations have identified Made Ground to thicknesses of up to more than 6m bgl. Made Ground is unlikely to be a suitable founding stratum given its inherent low bearing capacity, heterogenic nature and potential for unacceptable differential settlement.
- Made Ground underlying the site is noted to contain significant proportions of slag which may be fused in places and has the potential to be expansive. This may result in obstructions and unacceptable movement of foundations. The previous investigations of the site also encountered obstructions in Made Ground containing slag that may result in overbreak in excavations and obstructions to piling.
- Historical mapping indicates that the site is likely to contain relic embankments and earthworkings. These may result in unacceptable differential settlement of

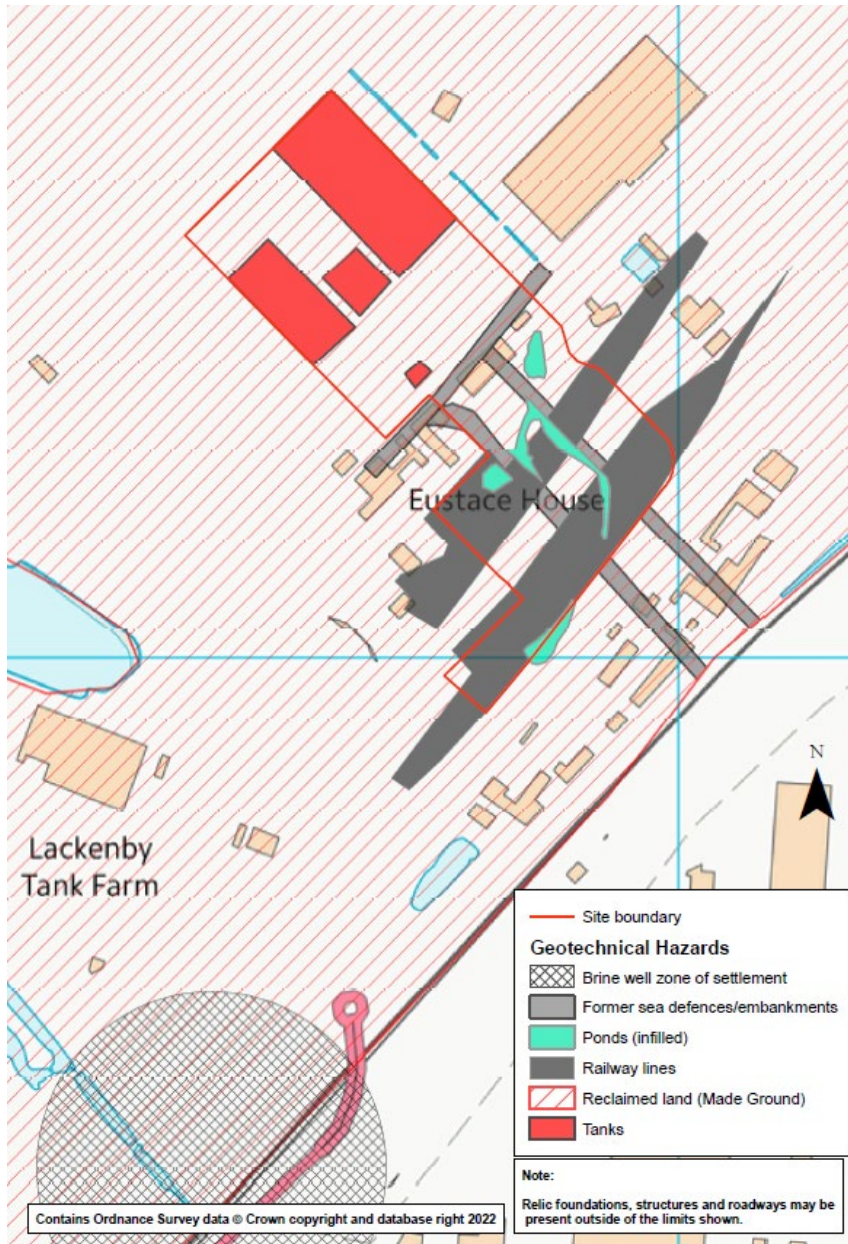
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<sup>8</sup> <https://ne-diary.genuki.uk/index.html>

foundations. Where these features are present the proportion of slag is likely to be greater and Made Ground may extend to a greater depth.

- Historical mapping indicates that the site was a refinery containing numerous tanks, chimneys, roadways, railway lines and buildings. While there is information indicating that THPA requested the complete removal of structures there is no information on the level to which these features were demolished and removed from the site. As such, there is the potential for relic foundations to be present underlying the site.
- Deep excavations into the Made Ground and underlying deposits are likely to require support and groundwater control may also be required where access is required.
- There is limited groundwater monitoring information available for the site. Groundwater is likely to be present at shallow depths in Made Ground. This may result in unstable excavations and formation boiling during construction and deep excavations. The groundwater regime should be determined during the ground investigation and a period of post ground investigation monitoring considered to establish the regime within the site. The groundwater regime with respect to tidal influences should also be established.
- Made Ground is underlain by soft organic sandy silt or loose to medium dense sands that extend to a significant depth. The ground conditions are also noted to be significantly different in the northern half of the site compared to the southern half. Where deep Made Ground and or soft/loose deposits are encountered and depending on the type of structures proposed for the site a piled foundation solution is likely to be required.
- There is limited information on the ground and groundwater aggressivity with regard to concrete, particularly of the Made Ground which contains slag and is likely to be aggressive to concrete.
- Utilities are present within the site. Prior to redevelopment of the site they should be identified and may need to be diverted or impact assessments undertaken to determine level of risk from the redevelopment.

Figure 6.1 Geotechnical hazard map.



### 6.3 Geotechnical Risk Assessment

A preliminary Geotechnical Risk Register (GRR) has been prepared and is included in **Appendix F**. The GRR summarises the geotechnical risks and hazards identified to date as part of the Desk Study and provides proposed mitigation measures, including further investigation and assessment, to control and/or manage these risks to an acceptable level as the development progresses to the next phases. The preliminary GRR is considered a live document that must be reviewed and updated during the subsequent development of the Site. The GRR has been developed in general accordance with the guidance presented in the ICE/DETR Document Managing Geotechnical Risk<sup>9</sup> (2001).

<sup>9</sup> Institute of Civil Engineers (2001) Managing Geotechnical Risk: Improving Productivity in UK Building Construction.

# 7. Preliminary Risk Assessment

## 7.1 Conceptual site model

The Conceptual Site Model (CSM) and plausible contaminant linkages are defined below based on the desk study review of available information collated in the previous sections. The CSM is carried out in line with LCRM and is based on the proposed commercial end use as a lithium refinery. The CSM provides an assessment of the site's potential contamination status and identifies the presence of potentially unacceptable contaminant linkages that require further consideration.

## 7.2 Potential contamination (sources)

A review of the site's history and environmental setting has identified potential contaminant sources on the site and the surrounding area, as summarised below in Table 7.1. The list of contaminants has been established through a review of Annex 3 in the Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008 Volume 2.

Table 7.1 Current and historical contaminant sources

No.	Source	Likely Contaminants	Location	Source to be considered further?
1	General Made Ground (reclaimed land including slag and rubble)	Inorganics (metals, abnormal pH, sulphate and cyanide). Organics (PAH, TPH, VOCs and SVOCs) <sup>1</sup> . Asbestos. Ground gases (carbon dioxide, methane, hydrogen sulphide)	Onsite across the whole site	Yes
2	Teesport Oil Refinery (including the oil loading gantry and substation, excluding railway land)	Inorganics (metals, abnormal pH, sulphate and cyanide). Organics (PAH, TPH, VOCs and SVOCs). PCBs. Asbestos. Ground gases (carbon dioxide, methane, VOCs)	Onsite across the whole site	Yes
3	Fire station, refinery fire and foam tank	PFAS	Onsite across the whole site	Yes
4	Railway land (marshalling yards)	Inorganics (metals and sulphate). Organics (PAH, TPH, VOCs and SVOCs). PCBs. Asbestos. Ground gases (carbon dioxide, methane)	Onsite across the central and southern part of the site.	Yes
5	Depot (including vehicle and container storage and workshops)	Inorganics (metals and sulphate). Organics (PAH, TPH, VOCs and SVOCs). PCBs.	Onsite across the central and northern part of the site.	Yes
6	BOC Limited works	Inorganics (metals, abnormal pH, sulphate and cyanide). Organics (PAH and SVOCs). Asbestos. Ground gases (carbon dioxide, methane).	Offsite adjacent to the south.	Yes

No.	Source	Likely Contaminants	Location	Source to be considered further?
7	Kimera Ltd chemical works	Inorganics (metals, abnormal pH, sulphate and cyanide). Organics (PAH, TPH, VOCs and SVOCs).	Offsite adjacent to the east.	Yes
8	Historical industrial land uses including slag breaking and Tees Works Lackenby	Inorganics (metals, abnormal pH, sulphate and cyanide). Organics (PAH, TPH, VOCs and SVOCs). PCBs. Asbestos. Ground gases (carbon dioxide, methane, hydrogen sulphide)	Offsite between 250m and 500m to the south and southeast	Yes
9	Offsite Landfills	Inorganics (metals and sulphate). Organics (PAH, TPH, VOCs and SVOCs). PCBs. Asbestos. Ground gases (carbon dioxide, methane)	Offsite 120m northeast. All other landfills are down gradient of the site.	Yes
10	Teesport Docks including container and potash terminal.	Inorganics (metals, abnormal pH and sulphate). Organics (PAH, TPH, VOCs and SVOCs). PCBs, Asbestos.	Offsite approximately 300m west.	No – activities are down the hydraulic gradient therefore significant migration to the site is unlikely.
11	Historical land uses including Bransands Sewage Works, Lackenby Tank Farm and Oil Terminal	Inorganics (metals, abnormal pH and sulphate). Organics (PAH, TPH, VOCs and SVOCs). Asbestos.	Offsite approximately 500m to >750m south and northeast.	No – these activities are down the hydraulic gradient therefore migration to the site is unlikely.

#### Notes

1 - PAHs – Polycyclic Aromatic Hydrocarbons, TPH – Total Petroleum Hydrocarbons, VOC – Volatile Organic Compounds, SVOC – Sem-volatile organic compounds, PCBs – Polychlorinated biphenyl, PFAS – Per- and Polyfluoroalkyl Substances (includes PFAAs, PFAS and PFOA).

## 7.3 Potential receptors and exposure pathways

The potential receptors and associated pathways that have been identified are shown in Table 7.2.

Table 7.2 Pathways and Receptors

Receptors	Potential Pathways
<b>Site users:</b> commercial/industrial	Dermal contact, ingestion and/or inhalation of soil, soil dusts and fibres.  Permeation of drinking water pipes and ingestion  Inhalation of vapours and accumulated gases
<b>Offsite users:</b> commercial/industrial sites.	Dermal contact, ingestion and/or inhalation of soil dusts and fibres.  Permeation of drinking water pipes and ingestion  Inhalation of vapours and accumulated gases

Receptors	Potential Pathways
<b>Controlled Waters:</b> Tees Estuary (including SSSI Impact Zone, River Tees SSSI and SPA)	Leaching from soils and lateral migration of contamination (including non-aqueous phase liquids (NAPL)) in groundwater  Surface water run-off, flooding and drainage
<b>Controlled Waters:</b> Secondary Aquifers (Tidal Flat Deposits and Mercia Mudstone)	Leaching of soils and NAPL and vertical migration in the unsaturated zone.  Vertical migration of groundwater in the saturated zone  Lateral migration from offsite
<b>Onsite buildings and services</b>	Direct contact with soil and groundwater  Ground gas migration and indoor accumulation
<b>Offsite buildings and services</b>	Direct contact with groundwater  Ground gas migration and indoor accumulation

## 7.4 Exclusions from risk assessment

### 7.4.1 Current site users

Users of the site in its current configuration are not considered as part of this assessment.

### 7.4.2 Redevelopment workers

The CSM does not consider risks to construction/ site maintenance workers on the basis that risks to workers will be dealt with under the Health and Safety at Work Act (1974) and regulations made under the act. site-specific contamination data obtained from all site investigations should be included in the pre-construction information (requirement of Construction Design and Management (CDM) Regulations 2015) for the proposed works, to enable any contractors to address potential risk from contamination as necessary in their risk assessments and method statements. Moreover, as the exact details of the method adopted are not currently known, it is not considered appropriate to provide a wide ranging and speculative risk assessment for redevelopment workers.

### 7.4.3 Invasive species

Invasive species (such as Japanese knotweed and giant hogweed) are not considered within the risk assessment for contamination. However, invasive species are considered to be a constraint to remediation/redevelopment rather than a contaminated land risk issue and would be anticipated to be assessed/addressed further in appropriate documentation relating to the remediation or contractor's method statements for ground preparation.

### 7.4.4 Trespassers

The northern half of the site appears to be secured by a security fence and controlled access routes therefore trespass in the northern half is considered unlikely. The southern part of the site does not appear to be secured by fencing therefore trespass is considered possible. However, the site is situated in a heavily industrialised area and has not been landscape or maintained. As such, regular trespass by sensitive receptors (e.g. children) is considered unlikely.

## 7.5 Preliminary risk assessment

In order for land contamination risk to be realised, a 'contaminant linkage' must exist. A contaminant linkage requires the presence of a:

- Source of contamination;
- Receptor capable of being harmed; and
- Pathway capable of exposing a receptor to the contaminant.

A preliminary risk assessment has been undertaken for these potential contaminant linkages to identify potentially unacceptable risks on a qualitative basis. Risk is therefore based on a consideration of both:

- The likelihood of an event (probability – takes into account both the presence of the hazard and receptor and the integrity of the pathway); and
- The severity of the potential consequence (takes into account both the potential severity of the hazard and the sensitivity of the receptor).

Further information on the risk assessment methodology used is given in **Appendix E**. The method of dealing with identified risks and the level of significance of those risks will be a function of site use. The risk assessment is based on the future proposed land use and assumes no control measures to manage the risk (e.g. source removal or capping) have been incorporated in the development.

The preliminary risk assessment presented in **Appendix G** has identified 24 potentially significant pre-existing contaminant linkages representing Moderate or higher risks to receptors that are related to the onsite historical land use. In addition, 12 potentially significant contaminant linkages have been identified in association with potential offsite sources of contamination.



## 8. Conclusions and Recommendations

### 8.1 Conclusions

#### 8.1.1 Land Contamination

The Conceptual Site Model and preliminary risk assessment has identified potential sources of contamination associated with the historical land use and the presence of Made Ground within the site. The preliminary risk assessment has identified 21 potentially unacceptable pre-existing contaminant linkages representing Moderate or higher risks to current receptors that are related to the onsite historical land use. In addition, 12 potentially unacceptable contaminant linkages have been identified in association with potential offsite sources of contamination and current receptors.

The preliminary risk assessment identifies risks associated with onsite sources that are currently classified as Moderate and are associated with site users, onsite buildings, controlled waters and ecologically designated sites. These risks relate to contamination in Made Ground that is related to the site historical use as a refinery and reclamation of the River Tees estuary. The Made Ground underlying the site has the potential to be a source of asbestos, heavy metals and hydrocarbon. In addition, previous investigations of the site have identified areas of free phase hydrocarbon contamination. There is also the potential for the Made Ground to be significant source of ground gas, which was identified in previous investigations of the site.

The preliminary risk assessment has also assessed the risk to future receptors including employees and visitors of the proposed development, buildings and controlled waters. The risk assessment has identified three potentially unacceptable contaminant linkages that relate to the presence of aggressive ground and ground gas sources. The risks to human health and controlled waters receptors are considered to be moderate/low due to the proposed development containing a significant proportion of buildings and hardstanding with associated drainage system. This is likely to break the pathway to human receptors and reduce the leaching of contamination from Made Ground into the underlying groundwater.

The CSM does not consider risks to construction /site maintenance workers on the basis that risks to workers will be dealt with under the Health and Safety at Work Act (1974) and regulations made under the act. Site-specific contamination data obtained through subsequent assessments of the site should be included in the health and safety file for the proposed works, to enable any contractors to address as necessary in their risk assessments and method statements.

#### 8.1.2 Geotechnical

Geotechnical constraints relating to the site have been identified through a review of the available information on the site geology, land use and UXO risk.

Details of the form of the proposed development are not known but based on the available information geotechnical constraints to the development have been identified. These include the following:

- The presence of significant thicknesses of Made Ground underlain by soft or loose ground deposits, therefore, piled foundations are considered likely.
- Contamination and the potential for aggressive ground and groundwater conditions.
- Made Ground is likely to contain slag that may extend to significant depths in places and may be fused and expansive. Where slag is fused this may present large obstructions that may cause difficulty during excavation and piling works.

- Made Ground thicknesses and composition are likely to be variable across the site associated with historical reclamation of the River Tees estuary.
- Made Ground may contain obstructions and relic foundations.
- Groundwater may be present at shallow depths.
- Utilities are likely to be present on the site.

## 8.2 Recommendations

An intrusive site investigation is recommended to characterise the potential contamination (including ground gas and vapour) and the geotechnical ground & groundwater conditions. It is recommended that information on groundwater conditions is obtained during post works monitoring to characterise the groundwater levels (including tidal influences) and the groundwater quality. In addition, further investigation is also recommended to establish the presence of significant below ground structures and obstructions to excavation and construction that may require a combination of intrusive and non-intrusive investigations.

The objectives of the ground investigation should be to:

- Inform baseline condition of the site prior to lease by Green Lithium Refining Limited.
- Characterise the key onsite potential sources of contamination and contaminant linkages that are considered to pose unacceptable risks to receptors (i.e. those that pose a moderate or higher risk).
- Investigate and geotechnically characterise the depth, nature and extent of any Made Ground as well as the underlying superficial deposits and bedrock.
- Establish groundwater conditions (elevations and quality) including the influence of tides on groundwater.
- Establish the ground gas regime and assess gas risks future users / the development.
- Establish suitable geotechnical and geo-environmental design parameters for the strata underlying the Site.
- Inform human health and controlled waters Generic Quantitative Risk Assessment (GQRA).
- Enable an appropriate foundation design solution to be developed.

Prior to undertaking ground investigation works the presence of utilities on the site should be established through a review of desk based information and site survey. A PAS 128 survey was being undertaken at the time of writing, the results of the PAS survey should be considered during design of the investigation and proposed development. A UXO desk study should also be performed by a specialist UXO consultant to confirm the potential UXO risks at the site prior to the ground investigation.

Once the site has been characterised following the ground investigation, further assessment such as Detailed Quantitative Risk Assessment (DQRA), and remedial/mitigation measures may be recommended.

It should be noted that as lessee (with appropriate lease conditions) Green Lithium Refining Limited should not be liable for pre-existing contamination and unacceptable contaminant linkages present prior to their tenancy, the liability for these linkages lies with the landowner / polluter (given their continued existence). However, Green Lithium Refining Limited will be responsible for any

further deterioration of the site and for ensuring that the site is suitable for use (i.e. there are no unacceptable contaminant linkages with future users) following the implementation of mitigation measures. It is anticipated that unacceptable linkages can be mitigated through appropriate design of the proposed development as well as environmental management plans, risk assessments, method statements and health & safety plans for the works, and subsequent compliance with environmental permits for the development's operation.