DATA REVIEW

SSI1 Redcar Works – Phase 1 Geo-Environmental Desk Study

Prepared for

Homes and Communities Agency

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Acronyms and Abbreviations

'The Site'	SSI 1 area, as designated under the Redcar DVA project
BGS	British Geological Survey
BOF	Basic Oxygen Furnace (the same process as BOS)
BOS	Basic Oxygen Steelmaking (the plant is located on Lackenby Works)
BRE	Building Research Establishment
CATS	Central Area Transmission System
COMAH	Control of Major Accident Hazards
DOE	Department of the Environment
EA	Environment Agency
EPA16	16 priority PAHs as identified by the USA's Environmental Protection Agency
GIS	Geographic Information System
IPPC	Integrated Pollution Prevention and Control
LAAPC	Local Authority Air Pollution Control
LAPPC	Local Authority Pollution Prevention Control
LAIPPC	Local Authority Integrated Pollution Prevention and Control
Ha	Hectare
MAGIC	Multi-Agency Geographic Information for the Countryside
PAH	Poly Aromatic Hydrocarbons
PCB	Polychlorinated Biphenols
RCBC	Redcar and Cleveland Borough Council
RBT	Redcar Bulk Terminal
SSI-UK IL	Sahaviriya Steel Industries UK (In-Liquidation)
COMAH	Control of Major Accident Hazards
STSC	South Tees Site Company
TPH	Total Petroleum Hydrocarbons
UXB/UXO	Unexploded Bomb/Ordnance

Executive Summary

SSI 1 is part of the former Redcar Iron Works site and occupies approximately 137 hectares. The Ordnance Survey (OS) National Grid Reference for the centre of the site is 456469E 525055N (ref. Figure 1). The Redcar Iron Works continue north and west of the site to the coast. South of the site lies a Northumbrian Water Sewage Treatment Works and an area of old landfill.

With the exception of a small area of land currently occupied by D Jones Haulage and Construction (formerly Tube City), the majority of the site was reclaimed from tidal mudflat and marshland during the 1970s to facilitate the large-scale expansion of the Iron Works. Following reclamation, the Sinter Plant, former Pellet Plant and numerous blending/stocking yards were constructed across the site in an east/west aligned grid. Covered conveyor belts on stilts transported materials north from the stocking yards, to feed the blast furnace and coke ovens located within the adjacent SSI2 site.

The main site layout, as developed in the 1970s, remains broadly unchanged except for the Pellet Plant, which was demolished in the mid-1980s. The site, and all the buildings within it, were fully-functioning up until the closure of the plant in November 2015. Three buildings on site remain in daily use: The Teesside Management Offices (TMO); D Jones Haulage and Construction (formerly Tube City) and the Redcar Bulk Terminal (RBT) offices (ref. Figure 2). Also in use are the railway lines, operated by RBT (ref. Figure 4).

During WWI and WWII the manufacturing and industrial sites in Middlesbrough and around Teesside Port made the area a strategic target. The Zetica Regional Unexploded Bomb (UXB) Risk map which covers this area classifies the UXB risk to be ‘moderate’; based on a “bomb density of 11 to 50 bombs per 1000 acres” and potential WWII targets. Further investigation is required to determine the site risk.

Made ground is expected to cover the entire site with variable thickness up to 10m. This is predominantly described by historic investigations as comprising sand, gravel, cobbles and boulders of slag, clinker, brick, concrete and ash as well as other materials, including relic foundations. The slag is sometimes referred to as pellite or granulated blast furnace, with fused slag also recorded. Historic plans suggest a large portion of the site was reclaimed using Hydraulic Fill. Although its exact composition is unknown it is likely to closely resemble natural sand with rounded gravels and cobbles.

Geological mapping shows much of the site to be underlain by Tidal Flat deposits, with a small area on the eastern boundary shown as Blown Sand. Historical information indicates variable superficial deposits; comprising unconsolidated alluvium, estuarine clay and sand. Deeper boreholes sunk within the western portion of SSI1 encountered glacial till at between 18m and 20mbgl, described as stiff brown and grey silty clay. Bedrock is predominantly of the Redcar Mudstone Formation, with a smaller area of Mercia Mudstone Group. The succession dips towards the northwest, exposing a thin band of Penarth Group – Ironstone. Limited historic boreholes show a broad trend of increasing depth to bedrock from south to north, ranging from 20m to 9mbgl, respectively.

The SSI site holds a COMAH Upper Tier Establishment classification associated with the large quantities of PAH contained within the Coke Oven Gas Main which also applies to SSI1.

The features of concern include Made Ground, chimneys, electrical substations, transformers and oil filled cables, the Sinter Plant, Pellet Plant, conveyor belts, junction houses, garages and workshops, general buildings, stocking grounds and the highway and rail infrastructure. These are potential sources of contamination, which may include; asbestos, heavy metals, PCBs, hydrocarbons, sulphates, organic and inorganic compounds and materials capable of generating soil gases.

Asbestos should be presumed to be within all Made Ground deposits, and therefore will need to be included in piling risk assessment should piles be proposed. Heavy metals, sulphates, hydrocarbons and coal tar are also present throughout the Made Ground. However, a variety of proven and established

technologies are available to deal with these contaminants. Potential options include the use of clean cover systems, bioremediation and thermal desorption. The type of remediation will depend on the type, concentration and extent of contamination, and risk to potential receptors.

Certain types of slag may pose a risk to future buildings and structures due to their potential to exhibit volumetric instability. It can also weather resulting creating tufa (calcium hydroxide and calcium carbonate precipitates), which can be mobilised in surface and groundwater leading to damage to drainage infrastructure and unsightly deposits in watercourses. Slags are also characterised by elevated sulphate content, which will need to be considered when specifying concrete. Characterising the slag will enable the most problematic materials to be identified and if necessary removed; with the remaining material, mainly free of expansive slag. This slag can then be processed by crushing and blending to homogenise it, creating a usable fill. Processing the slag in this way will allow any discrete pockets of expansive materials to become disseminated with the fill. The processed slag is then allowed to hydrate over a period of months to promote any expansive reactions, before being placed in layers to distribute any remaining problem materials laterally.

By the nature of their deposition the underlying superficial Tidal Flat deposits are highly susceptible to compression resulting in excessive settlement, whilst their high organic content would also likely lead to long term secondary compression. This will need to be considered within the design of any future developments on site.

Introduction

CH2M was commissioned in May 2016 by the Homes and Communities Agency to undertake a Development Viability Assessment, largely comprising desk top technical studies, on the former Redcar (Sahaviriya Steel Industry (SSI)) Steelworks, following the site closure in October 2015. The SSI assets are currently in the hands of the Official Receiver, and permission to access the land and the information database held on site was granted in November 2016. The scope of the DVA was subsequently widened to include land in the ownership of TATA Steel, which is situated within the proposed South Tees Development Corporation (STDC) area, to inform the emerging Masterplan.

This document reports on a Phase 1 geo-environmental desk study, including site walkover surveys undertaken in March 2017, which aimed to review all information available pertaining to ground conditions and contaminated industry indicators, giving an overview of the existing ground conditions, including consideration of asbestos, and making recommendations for further studies and physical ground investigation works to inform future development of the wider STDC area.

1.1 Terms of reference

This report is based on the information that has been acquired and/or made available to us via the various searches and consultations undertaken as part of the Desk Study exercise. In some cases anecdotal information has been relied upon, where documented evidence has been lacking.

The conclusions drawn in the report are considered correct although any subsequent additional information may allow refinement of the conclusions. It should be noted that:

- The report has been prepared in accordance with the instructions of our client, the Homes and Communities Agency, for their sole and specific use, or, by prior agreement, any party to whom the client is permitted to assign or transfer its rights under its contract with CH2M. Any other persons who use any information contained herein do so at their own risk.
- All work carried out in preparing this report has utilised and is based upon CH2M's current professional knowledge and understanding of current relevant UK standards and codes, technology and legislation. Changes in this legislation and guidance may occur at any time in the future and cause any conclusions to become inappropriate or incorrect. CH2M does not accept responsibility for advising the Homes and Communities Agency or other interested parties of the facts or implications of any such changes.
- This report has been prepared using factual information contained in maps and documents prepared by others. CH2M can accept no responsibility for the accuracy of such information.

This site forms part of the wider South Tees Development Corporation area, covering some 4,500 acres, and this report refers only to the area designated as SSI1, referred to from now on as "the site".

1.2 Site location and description

SSI1 is approximately 137 hectares (Ha) of mixed-use industrial land in the south-eastern quadrant of the Redcar Iron Works site (ref. Figure 1). When operational, the site was primarily used for the production, processing and stockpiling of materials associated with the blast furnace. Most notably, the site contained the Sinter and Pellet Plants.

There are a number of structures remaining on site. The Sinter Plant is the largest, with the Pellet Plant of similar size being demolished in the 1980s. Smaller buildings include canteens and offices. The site is intersected with a number of stilted conveyor belts

There are three units on site currently in active use – the Teesside Management Offices (TMO), the D Jones Haulage and Construction (formerly Tube City) warehouse and the Redcar Bulk Terminal (RBT) Offices (ref. Figure 2). Roadways on site are still in use. Railways are operated by RBT and are in regular use.

As the primary site use was for the stockpiling of material and industrial processes, the site is generally flat and level throughout. The main topographic feature is an embankment running broadly east-west across the site, upon which a road and railway line run.

During the extensive expansion of the ironworks in the 1970s, approximately 75% of SSI1 was reclaimed from tidal mudflat and marshland area.

Sources of Information

The following sources of information have been consulted in the preparation of this report.

2.1 Landmark

Environmental data from government agencies was provided by Landmark Group Ltd in GIS format order ref 90671997.

2.2 Environment Agency

Information on flood risk, hydrology and hydrogeology and landfills was obtained from the Environment Agency (EA) at: http://apps.environment-agency.gov.uk/wiyby/default.aspx.

2.3 British Geological Survey

Geological mapping and published exploratory hole logs have been reviewed via the British Geological Survey (BGS), both in paper form and via the online Geoindex database. The data is listed in the following table:

Table 2.1 – List of Geological Sources

Title	Information
BGS Geological Map Sheet 34: Guisborough	Geological information, solid and drift at 1:50000 scale
BGS 1:50,000 scale GeoIndex Onshore (online)	Solid and superficial geology, faults and other linear features of the area
Historical boreholes Note: A large portion of the historic boreholes in SSI 1 are either confidential or not available through BGS GeoIndex.	Boreholes accessed through BGS Geoindex or through historical Ground Investigation reports supplied by the client. See Table 3.2 for summary.

2.4 Redcar and Cleveland Borough Council

GIS data was provided by Redcar and Cleveland Borough Council (RCBC). This included high resolution aerial photography and historical mapping.

2.5 SSI (UK) IL

The site was originally run by Dorman Long, becoming British Steel Corporation in 1967. The site was later privatised, becoming British Steel Plc in 1988, before merging with a Dutch firm to create Corus Group in 1999. Corus was bought by Tata Steel in 2007 who mothballed the plant in 2009. In 2011, SSI bought the plant and operated, with a pause in 2012, until the full closure and liquidation of SSI (UK) in 2015.

The repository of historical plans and As Built drawings, known as ‘Cabinet’, contains digital copies of all the drawings produced by successive owners dating back to the 1970s. These have been reviewed for the purposes of this project.

Scans of low quality/illegible and those considered irrelevant have not been considered. Drawings referred to for this desk study are listed in the following table:

Table 2.2 – List of Drawings and Documents accessed through 'Cabinet'

Drawing name	Drawing Ref.	Author/Company	Data
General			
Hazardous Substances 2016	A124449	SSI UK	Plan showing storage location and quantities of hazardous substances across the site.
Layout of Teesside Works Showing Location of COMAH Substances Jul 2003	A199673	Corus	Plan showing location and quantities of COMAH substances.
General Works and Layouts Apr 2003	A-119525	Corus	Layout of Redcar works showing location of enclosed coal conveyors and junction houses
Works Plans & Layouts Apr 1978	A-56682B	British Steel Corporation	Layout of Redcar Stage 2 B from 1400E to Warrenby Halt Bridge
General Layout Plan Aug 1976	R/GEN1641F	British Steel Corporation	Shows the 1976 layout of Redcar Works
Site Layout: Sheet 2 Mar 1973	R/GEN156	British Steel Corporation	Detailed plans of proposed works
Services and Substations			
Ownership of HV substations on Teesside Works Sep 2016	5002-E7221	British Steel Limited	Location, ownership and activity at HV substations
COMAH Coke Oven Gas Sections Nov 2008	A122859	Corus	Plan showing the Coke Oven Gas Main with a series of exclusion zones ranging from 15m to 145m.
Buildings			
Coke Crushing Plant Jun 1975	RCO-5444 RCO-5446 RCO-5459 RCO-3798 RCO-5471 RCO-4672 RCO-4142 RCO-2761 RCO-4140 RCO-3933	British Steel Corporation	Arrangement and details including conveyor layouts
Conveyor Layout Nov 1991	A-114064	British Steel General Steel	Drawing showing arrangement of conveyor belts and junction houses
Pellet Plant Arrangement and Elevation Jun 1973 Oct 1974	A-50350 A-50351 A-50352 A-52003	British Steel Corporation	Plans showing the general layout and vertical elevations of the pellet plant building.

Sinter Plant Feb – Nov 1973	A-49418 A-49417 A-49420	British Steel Corporation	Plans and elevations of the Sinter Plant
	A-50353 A-50354 A-50355		Elevations and Arrangement of the Sinter Plant
	A-51629		Arrangement of Sinter Plant
May 1975	A-52004		Plan on Sinter Plant
	RSP-365 RSP-366 RSP-435		Sinter Plant Foundations
Piling Layout -1990	RGEN8670	RTJ Construction	Piling layout to 66Kv Corridor Substation. Pile design has made an allowance for the potential for slag volumetric change by including a slip coating and installing a precast concrete pile through an oversized borehole into a concrete plug below the slag horizon and into the underlying clays and mudstone

2.6 Zetica

An indicative Unexploded Bomb (UXB) risk map has been obtained from Zetica. This report is a preliminary assessment of risk based on historical site uses. No further information is available at this time pertaining to UXO risk at the site.

2.7 Previous Studies

The following table outlines the previous studies which have been made available for the site.

Table 2.2 – List of Previous Studies

Document title and date	Author (Client)	Information summary	Document reference in this report.
Soil and Groundwater baseline characterisation study Teesside Works – 25th June 2004.	Enviros (Corus UK Ltd)	Baseline soil and groundwater assessment carried out prior to the sale of Corus' landholding to a 'Joint Venture Company'. 3 volumes: Volume 1: Factual Volume 2: Interpretive Volume 3: Executive Summary	2004 Enviros Report
Design of Site Protection and Monitoring Programme for Redcar Works	Corus UK Ltd	Site Protection and Monitoring Plan (SPMP) submitted to the Environment Agency in order to fulfil a permit condition.	Corus SPMP

The Enviros 2004 report followed an intrusive environmental investigation covering Redcar, Cleveland and Lackenby works. The investigation was undertaken prior to a transfer of the majority landholding at Teesside to a new joint venture company.

A review of desktop information was carried out to inform the investigation strategy, the purpose of which was to provide a broad characterisation of soil and groundwater conditions.

Across the three areas, works comprised 264 trial pits and 42 boreholes using shell and auger (cable percussive) techniques. Of these, 31 trial pits and two boreholes were undertaken within SSI 1 – see table 3.2 for a summary of historic boreholes on site.

Sampling of soils, groundwater and surface water was undertaken. Chemical screening was carried out against a set of 'Tier 1 Screening' criteria based on Contaminated Land Exposure Assessment (CLEA), Dutch Intervention Values (DIV) and, in the absence of CLEA or DIV, Enviros Screening Values (ESV). Programme requirements only allowed for one round of groundwater sampling.

The interpretive report and executive summary includes a conceptual site model as well as an assessment of risks to potential development.

Site Information

3.1 Introduction

The following information has been obtained from the data sources listed in Section 2.

3.2 Historical Development

Table 3.1. - Historical Development at SSI 1

Mapping Date	Map Scale	Site Use
1894	1:2,500	The majority of the site (Approx. 80%) is tidal mudflat and marshland area with large areas marked as 'Sand'. The northeast corner of the site extends on to Coatham Iron Works. A Tramway and some residential buildings are shown along the South Gare Breakwater which intersects the site.
1915	1:2,500	As 1894, now with railway lines crossing the northeast corner. Brick Kilns and Slag Wool works noted approximately 100m off eastern site boundary.
1929	1:2,500	Tidal mudflat and marshland area unchanged. Residential area behind South Gare Breakwater has been removed. Area now labelled 'Redcar Iron & Steel Works'. Extensive railway lines and signalling crossing the site. Multiple industrial buildings, one labelled 'Meter House'.
1953-1954	1:1,250	Marshland now intersected with a grid-sequence of drains. Railway and industrial area unchanged from 1929.
1970s		Main period of development on Redcar site. 1973: 1st phase completed. Wharf and ore unloading facilities completed. (not within SSI 1) 1978: 2nd phase completed. Stockyard's, blending facilities, sinter plant, pellet plant and coke ovens completed. (partially within SSI 1) 1979: 3rd phase completed. Blast furnace and power plant opened. Facilities shown in current layout (not within SSI 1).
1973-1979	1:1,250	Site coverage incomplete. Marshland area has been developed, railway lines recorded crossing the site and western edge of site has been developed with conveyors and multiple industrial buildings.
1973	1:1,250	Drawing no R/GEN156 – Site Layout Sheet 2 dated 1973. Detailed site plan showing proposals for expansion: Sinter Plant and Pellet Plant areas designated. Southern area of SSI1, where raw coal stockyards were located. Two areas of 'Existing Tars' recorded, with a note '*These areas to be filled with slag to cover tar deposits'.* Adjacent area noted as '*Existing Chemical Waste solidified*'. Area south of the railway/road embankment, what are now raw and blended coal stockyards, shows notes for '*Hydraulic sand fill Type 1 with 500mm slag topping'.*
1981-1988	1:1,250	Site has been extensively developed both on marshland and tidal flat area. Sinter plant, stockyards and coke crushing plant are shown in similar layout to present day.

		The 1986 map area shows a Pellet Plant to the east of the Sinter Plant. The Pellet Plant has been demolished during the period between 1973 and 1981-1988.
2012	1:2,500	Site plan produced by SSI. Drawing Number A124449 titled Hazardous Substances. 3 tanks recorded on site: Sinter plant diesel tank, 200 tonnes of diesel in a concrete bund, located to the rear of current TMO building. Sinter Plant Coke Oven Gas, 1 tonne in pipeline, located east of main Sinter Plant building. Redcar Ore Terminal Diesel, 25 tonnes in a bund.
2015		September 2015: Site permanently closed and SSI UK put in to liquidation.
2016	1:5,500	Site plans dated September 2016 shows the current site layout.

3.3 Utility Apparatus

Figure 5 shows the location of existing utility apparatus within SSI 1 and adjacent to the boundary. This does not include the location of local services for which further investigation is required. The following utilities are recorded:

- BT Openreach Underground cables
- BOC Oxygen Pipeline
- BOC Nitrogen Pipeline
- BOC Hydrogen Pipeline
- Northern Gas Network – Medium Pressure
- Northern Gas Network – Low Pressure
- National Grid Overhead Electricity
- Northumbria Water Limited - Clean water
- Northumbria Water Limited - Sewer
- Northern Power Grid – underground electricity
- Coke Oven Gas Main – Above ground
- Coke Oven Gas Main – Underground
- Industrial Water
- Fuel Oil Pipeline

Figure 5 shows the location of these utilities, but does not include details regarding local distributions and local supplies to and within the buildings on site. Furthermore, there is a possibility that temporary utilities routes may also exist on site which may or may not be redundant. These are associated with temporary contractor compounds which were established as and when required. Although not included within the list above pipework transporting gas from the SBCO to the By-Products Plant will also exist, and may be above ground as well as below ground level.

3.4 Site Inspection

A site walkover was conducted by CH2M in February 2017.

The topography of the site is largely artificial. Large sections containing buildings, stockpiles and roadways, are broadly flat and level with a number of topographical features across the site, those of note are:

- Roadway running between sinter/pellet stocks and the railway sits atop an approx. 5m high embankment.
- Roadway along eastern boundary of site sits atop an approx. 5m high embankment.
- Area formally housing the Pellet Plant is surrounded by approx. 3m high shallow-sided embankment.
- The square plot of land north of the Sinter Plant is a lower level than surrounding land, with a steep cutting 3-5m high on all four sides.
- The railway and coal yards in the south of the site are at a reduced level to the rest of SSI1.

There are numerous buildings across the site ranging in size from electrical substation houses to the Sinter Plant in the centre of SSI1, which has a large chimney stack on its eastern end. Other key buildings are the Teesside Management Offices (TMO) and the D Jones Haulage and Construction warehouse (formerly Tube City), which are both in daily use.
Roads are broadly arranged across the site in a grid; traffic flows vary but the most heavily used is the road running along the northern boundary of the site, connecting the main Redcar Gate entrance with the TMO and Area Workshops elsewhere on site.
A set of railway lines crosses the site between the Blended Coal yards and the Sinter/Ore yards. Entering the site through the southeast corner and running east, connecting the Redcar Bulk Terminal to the main railway line in the south.
There are several above ground services, mounted on stilted platforms, running parallel to the roadways on site. There are also a few service reservations, demarcated by two sections of Armco with 'SERVICES' warning signs along their length.

3.5 Geology & Ground Conditions

Historic boreholes at the site are largely confidential or unavailable to view through BGS GeoIndex. (ref. Figure 3)

Table 3.2 - Summary of Historical Boreholes

Geoindex Borehole Ref.	Borehole ref from GI	Details of GI	Location on site
NZ52NE60	BH 3651	Excavated by Soil Mechanics on behalf of W.S.Atkins. 26-28/9/1972	West, within Ore Blending & Handling Plant NGR 455905, 525053
NZ52NE50	BH 3501		Southwest corner, between Raw Coal Stocks and Ore Blending & Handling. NGR 455919,525410
NZ52NE51	BH 3504	Excavated by Soil Mechanics on behalf of W.S.Atkins. 18-28/9/1972	West, within Coke Crushing Plant NGR 456023,525506
NZ52SE51	BH 3001	Excavated by Soil Mechanics on behalf of W.S.Atkins. 3-11/8/1972	Just outside the southeast corner of the site, within the railway lines. NGR 456991, 524582
N/A	13-A-B2	Excavated by Enviros. Client: Corus. 16/04/2004	Southeastern corner of Sinter Stocks

N/A	13-C-B1	Excavated by Enviros. Client: Corus. 14/04/2004	Northeastern corner of SSI 1 area. Within Tube City IMS area.

3.5.1 Topsoil

Areas not used for stocking material or buildings are likely to have grass cover and a thin (<0.2m) layer of topsoil.

3.5.2 Made Ground

A large area of the site was reclaimed from mudflat and marshland. The reclamation material is likely to vary in both thickness and composition across the site.

Areas used for stocking material typically will have a thin covering (<0.5m) of residual material. This may have been disregarded in historic logs.

Enviros (2004) describes Made Ground as generally comprising reworked natural materials with a mixture of brick, slag and ash, reaching thicknesses of up to 10m. Made Ground appears to be thicker in the south and east and thinnest in central and northern areas. Made Ground layers vary between loose and very dense.

Site plans from around the date of reclamation and plant expansion record some areas as 'Hydraulic Fill'. This is expected to be material borrowed from sand banks in the estuary mouth and will likely appear very similar to natural ground, containing shells and rounded pebbles.

3.5.3 Superficial Geology

BGS geological maps at 1:50,000 scale record two areas of superficial deposits on the site. The main unit comprises Tidal Flat Deposits, described as sand and silt with soft silty clay, gravel and peat. A small portion (≈20%) on the eastern boundary of the site is covered by Blown Sand with a general description of pale brown, fine grained, uncemented sand.

The 2004 Enviros Report on Redcar describes superficial deposits of variable thickness, comprising unconsolidated alluvial deposits and estuarine clay. At depth, glacial till underlies these deposits.

Boreholes sunk during the Soil Mechanics/W S Atkins site investigation of 1972 describe a layer of Estuarine Deposits. These range in thickness from 0.70m to 1.90m and are found both above and below the layer of unconfirmed natural/hydraulic fill sand.

Boreholes from the 1972 Soil Mechanics – W S Atkins investigation in the western portion of the site record Boulder Clay between 18 and 20 metres depth. It's described as a stiff brown and grey silty CLAY with trace subangular and subrounded fine and medium gravel.

3.5.4 Solid Geology

The BGS 1:50,000 scale Sheet 34 Guisborough (Solid and Drift) map shows the majority of the site is underlain by strata of the Redcar Mudstone Formation, part of the Lias Group.

A smaller section of the site, approximately 20% is underlain by the Mercia Mudstone Group. Along the boundary of the two mudstone units, a thin area of 'Penarth Group – Ironstone' is mapped.

The Redcar Mudstone Formation is approximately 250m thick and overlies a thin band, approx. 15 metres, of the Penarth Group strata. Beneath this lies the Mercia Mudstone Group, approx. 200m thick. The succession is dipping approximately 14 degrees north-northwest.

The BGS Lexicon describes the Redcar Mudstone Formation as "grey, fossiliferous, fissile mudstones and siltstones with subordinate thin beds of shelly limestone in lower part, and fine-grained carbonate-

cemented sandstone in upper part with argillaceous limestone concretions throughout". The Penarth Group is described as "grey to black mudstones with subordinate limestones and sandstones that are predominantly marine in origin". The Mercia Mudstone Group is described as "dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite are widespread and sandstones are also present".

Historic borehole records show a broad trend of rock depth increasing from south to north. Borehole NZ52SE51 (W S Atkins, 1972) in the north of the site records bedrock at 20m.bgl. Borehole NZ52NE60 (W S Atkins, 1972) in the southwest corner of the site records bedrock at 9.0mbgl.

Rock is generally described as mudstone with occasional bands/laminations of siltstone.

Borehole records show several metres of moderate to highly weathered rock.

Table 3.3 - Summary of Historical Boreholes

Layer Name	Top Depth/s (mbgl)	Thicknesses	Details
Made Ground	**Ground level**	0.9 to 7m	Made Ground: Gravel to boulder sized slag with some clay, sand and assorted waste material.
Estuarine Deposits	**0.9 and 7.8**	0.7 and 1.9m	Estuarine Deposits - dark grey sand/silt/clay. Sporadic across the site, both above and beneath the yellow/brown sand layer.
Yellow/Brown Sand – Possible Made Ground	**1.6 to 7.0**	3.3 to 12.5 (unproven in Enviros 2004)	Yellow/Brown Sand with rounded pebbles and shell fragments.
Boulder Clay	**9.7 to 18.4m**	0.2 to 2.1m	Stiff silty clay with trace gravels. Boulder clay encountered in the west of the site.
Bedrock	**9.0 to 20m** broadly dipping northwards.	Unproven	Mudstone with occasional bands/laminations of siltstone.

3.6 Hydrology and Hydrogeology

Environment Agency aquifer designation maps record the superficial deposits as Secondary A Aquifer. The bedrock was recorded as Secondary (undifferentiated).

The site was not located in a Groundwater Source Protection Zone.

SSI 1 is within 250m of the mouth of the Tees estuary, so some hydraulic continuity with this is anticipated. Tidal fluctuation of groundwater levels is likely to increase closer to the estuary itself.

The 2004 Enviros Report records groundwater varying between 4.5m.AOD and 1.5m.AOD closest to the River Tees. Shallower groundwater levels in the central and southern portions of the site were observed, possibly due to large scale surface water infiltration through large areas of open permeable ground.

3.7 Man-made features

This section covers the existing man-made features and those which are associated with the current land use but have recently been removed.

3.7.1 Railway Lines

A Tramway was first recorded on the 1894 maps, running along the breakwater in the northeast corner of the site. Following expansion of the Coatham Ironworks, the 1915 maps show a number of lines crossing the northeast corner. These were removed during the extensive site expansion and land reclamation in the early 1970s.

Currently, a number of parallel railway lines run, east to west, between the blending yards and blended coal stocks. These are still in regular use by trains transporting material to/from RBT, west of the site.

3.7.2 Electrical Substations

Site plans show a total of 8 high voltage electricity substations on site:

- 1no x 66kV substation
- 6no x 3.3kV substations
- 1no x 11kV substation

In addition to the high voltage installations, there is expected to be numerous smaller substations for lighting towers, conveyor belt motors and other equipment.

3.7.3 Coke Oven Gas Main

The Coke Oven Gas Main runs along the north and eastern boundaries of the site, with a spur of pipe running on to the site along the access road between the TMO and Sinter Plant. The pipe was installed to provide gas to the Sinter Plant.

3.7.4 Coke Crushing and Blending Plant

The coke crushing plant and ancillary equipment occupies an area of approximately 1.5 Ha in the northwest corner of the site.

The Blending Plant occupies an area of approximately 2.4 Ha on the western edge of the site. The plant is connected by a series of rail-mounted conveyor feeds to the raw ore stockyard in the west. A second sequence of conveyors connect to the blended ore stocks east of the plant.

3.7.5 Pellet Plant

The Pellet Plant was demolished in the late 1980s. It occupied an area of approximately 4 Ha and was located to the east of where the Sinter Plant currently stands, on the land around TMO. Plans show conveyor belts connecting the Pellet Plant to the Pellet Stocks to the south.

3.7.6 Sinter Plant

The Sinter Plant is located in the eastern half of SSI1 and covers an area of approximately 3.5 Ha. The plant has a number of conveyors extending north and south to the stockyards and blast furnace. Historic maps and plans suggest it was built in the mid-1970s.

3.7.7 Sinter/Pellet Stocks

South of the Sinter Plant are the stockyards, occupying an area of approximately 8.7 Ha. These are fed by a pair of rail-mounted conveyor feeds, creating stockpiles along the length of each area. Historic maps suggest the east stockyard was used for pellet storage and later, after the demolition of the pellet plant, for sinter.

These stockyards have been emptied since the ironworks closure, with some residual material remaining on the surface.

3.7.8 Blended Ore Stocks

The Blended Ore Stocks area occupies approximately 20 hectares, across central and western SSI 1.

The area is intersected by a number of rails and conveyors running east-west. These rails are used by the stacker (a machine for piling up material from the central conveyor) and the blending wheel (a large drum with paddles that is rolled over material to commingle).

3.7.9 Blended Coal Stocks

The southernmost stockyards are noted on site plans as Raw (west) and Blended (east) coal stocks. The raw coal stockyards extend off the western site boundary in to RBT land. The area within SSI1 occupies approximately 17.5Ha.

Coal stored in these areas has been sold since the plant closed, although a thin covering (<50mm) across the area remains.

3.7.10 Tube City IMS later D Jones Ltd

Located in the northeast corner of the site, Tube City IMS was an on-site service provider that ceased operating when the plant shut-down in the winter of 2015. The warehouse and surrounding area is now used by D Jones Haulage and Construction for vehicle storage and maintenance.

3.7.11 Fuel Tanks

Plans of hazardous substance storage on site show a large diesel tank located east of the Sinter Plant, to the rear of the TMO. At the time the plans were produced (2012), 200 tonnes of diesel was stored in a concrete bund.

A second diesel tank is shown in the blending plant, containing 25 tonnes of diesel.

3.7.12 CATS Pipeline

The Central Area Transmission System pipeline, a 36” (91cm) diameter gas pipeline running from the North Sea, landfalls northeast of the site. The pipeline runs in a south-southwest direction, parallel to and within 50 metres of the SSI1 eastern boundary.

The pipeline started operating in 1993. While unlikely to be contaminative, it’s an extremely sensitive asset and poses a significant constraint to be considered during the development of SSI1.

3.8 Unexploded Ordnance

Middlesbrough and the Teesside Port area were home to many iron, steel and manufacturing plants during World War 2, this strategic significance made it a target for bombing. Locally, the Redcar Iron and Steel Works was located 250m north of SSI1 and was known to have been targeted on several occasions.

As the majority of SSI 1 was yet to be reclaimed or developed, full records of bombs landing in this area were not recorded or available. On this basis, with the proximity of a known target, the risk of Unexploded Ordnance (UXO) should be considered **moderate**.

3.9 Coal Mining

Information obtained from The Coal Authority shows there is no risk to development from mine workings and the site is not within a Coal Mining Reported Area.

3.10 Landfill

A number of authorised and historic landfills are recorded on Environment Agency mapping, accessed at 1:20,000 scale, near to the site. The table below summarises these:

Table 3.4 - Summary of Authorised and Historic Landfills

Name and Type of Landfill	Approximate location	Comment
Bran Sands *A02: Other Landfill Site taking Special Waste*, issued to I C I Chemicals and Polymers Ltd	Adjacent to southern boundary of SSI 1	Authorised Landfill Permit Ref No. EAEPR\EA/EPR/MP3790ZW/V002
Warrenby Landfill *A04: Household, Commercial and Industrial Waste Landfill,* Issued to Tata Steel UK Ltd	Approx. 300m E of SSI 1 boundary.	Historic Landfill Permit Ref No. EAEPR\EA/EPR/KP3790ZE/V002
Buried Inert and Industrial Waste (Limited Info)	Land adjacent to Redcar Blast Furnace, approx. 450m N of SSI 1 boundary.	Historic Landfill License No. 60250
Teesport Eston Tip Types of buried waste: Inert, Industrial, Commercial and Household.	Approx. 650m SSW of SSI 1.	Historic Landfill License No. not listed
Bells Containers Sludge Farm Types of buried waste: Liquids/Sludge	Teesport Refinery Approx. 650m SW of SSI 1	Historic Landfill License No. not listed

3.11 Designations, hazards, permits

The designations, hazards and permits that affect the site have been reviewed at 1:20,000 scale. The following designations, hazards and permits affect the site:

Table 3.5 - Designations, hazards and permits summary

Designation/hazard/permit	Approximate location	Comment
COMAH Upper Tier Establishment, issued to SSI UK IL. Last inspection 29/06/2016.	Entire SSI site at Redcar, Cleveland and Lackenby, including SSI 1.	Upper Tier classification upheld due to continued presence of large quantities of PAH on site, contained within the coke oven gas main.
Pollution Incident; Significant 03-10-2009 721753	On site, northwest quadrant	Atmospheric Pollutant and Effects Significant impact to air Minor impact to land No impact to water
Pollution Incident; Significant 16-5-2007 495387	540m SSW	Organic Chemicals/Products Minor impact to air No impact to land Significant impact to water
Pollution Incident; Significant 15-7-2014 1256199	491m SSW	Sewage Materials No impact to air No impact to land Significant impact to water

Pollution Incident; Significant 23-10-2001 38554	780m E	Pollutant Not Identified No impact to air No impact to land Significant impact to water
Corus UK Ltd Industrial Pollution Fuel and Power Production and Associated Processes AF8530 1998 to 2003	License covering iron and steel works registered to Steel House	Gasification, refining etc. License includes info on Releases to Air and Land/Waste Transfer
Corus UK Ltd Industrial Pollution Fuel and Power Production and Associated Processes AF8548 1998 to 2003	Redcar Sinter Plant, license covering iron and steel works registered to Steel House	Gasification, refining etc. License includes info on Releases to Air and Water
Corus UK Ltd Industrial Pollution Metal Production and Processing AO9684 1998 to 1999	Teesside Works, license covering iron and steel works registered to Steel House	Ferrous Metals License includes info on Releases to Air and Land/Waste Transfer
Corus UK Ltd Industrial Pollution Metal Production and Processing AR0241 1998 to 2003	Teesside Works, license covering iron and steel works registered to Steel House	Ferrous Metals License includes info on Releases to Air and Land/Waste Transfer
Corus UK Ltd Industrial Pollution Radioactive Substance Sites BA6259 2005 to 2010	Redcar Sinter Plant, license covering iron and steel works registered to Steel House	Radioactive Substances License includes info on Releases to Air
Corus Construction and Industrial (British Steel Plc) Industrial Pollution Waste Landfilling BRI003/60138 2002-2008	License covering iron and steel works registered to Steel House	License includes info on releases to air and groundwater. No mention of landfill waste other than in title.

Geo-environmental and Contamination

4.1 Processes on site

4.1.1 Made Ground

Large areas of the site have up to 10 metres cover of Made Ground. This is mostly made up of slag along with ash and ferrous materials.

Slag is a by-product from various stages of the iron and steel manufacturing process, therefore its composition varies by its origin and the method by which it was cooled.

Slag in fill material generally results in alkaline pH with high concentrations of sulphide and sulphate. The 2004 Enviros report includes soil samples with a tested pH value of 12.8. Refractory and other materials in made ground can result in high silica, metals and other hydrocarbons.

4.1.2 Railway Lines

Railway lines and ballast are commonly contaminated with hydrocarbons, metals, phenols, sulphates and PAHs. These are often localised as a result of spillages, but the occurrence and extent of this was unclear at the time of reporting.

4.1.3 Electrical Substations

Prior to the 1980s, Polychlorinated Biphenyls (PCBs) were routinely used as an insulator in electrical substations. Either during maintenance or disassembly, PCBs were often spilled on to the surrounding ground. The PCBs used in substations were generally of high viscosity and low leaching potential, so contamination can be expected to be localised.

While the exact dates of installation are unclear, it is reasonable to assume that some or all of the substations on site contained PCBs.

4.1.4 Highways and car parking areas

There are a number of roadways and car parking areas on site. Current traffic is likely to be minimal following site closure.

There is a risk of minor fuel spills and oil leaks from vehicles but these are comparatively negligible.

4.1.5 Coke Oven Gas Main

A by-product of the coke oven process is a high energy gas which, after quenching and treatment to remove impurities, can be recycled and used to fuel boilers and furnaces elsewhere on the site. Typical Coke Oven Gas is approximately 50% hydrogen, 30% methane and 3% higher hydrocarbons, 7% nitrogen, 7% carbon monoxide and 3% carbon dioxide.

The pipeline enters the site and connects to the eastern end of the Sinter Plant. The exact use of coke oven gas within the Sinter Plant is unclear.

Information provided on-site states that the pipeline has been pressurised with Nitrogen in an effort to minimise the risk of explosion. The pipeline is an extremely sensitive asset.

4.1.6 Coke Crushing and Blending Plant

Coke was produced in the ovens to the north of SSI1. The coke crushing plant prepared material for firing. A typical system uses a sequence of toothed rollers to reduce grain size and screen material for its intended usage.

This process will have likely required considerable dust suppression, the treatment/drainage system for run-off was unclear at the time of reporting.

4.1.7 Pellet Plant

Pellets are, like sinter, produced by heating and bonding together a very finely ground material. Pellets only contain iron ore and do not contain the limestone and coke found in sinter.

Plans of the site show that following the demolition of the pellet plant the pellet stock area was used for sinter.

4.1.8 Sinter Plant

Sinter comprises small, irregular nodule-shaped agglomerate of iron ore fines, limestone and coke, used as a feedstock for the blast furnace. It is produced by mixing and blowing hot air through very fine grained material until liquefied and fused. The ingredients bond together while undergoing little chemical change.

4.1.9 Sinter and Pellet Stock

Sinter and Pellets production built up a surplus of material to support the continuous running of the blast furnace. Hundreds of tonnes of material would have been piled, using the stacker, before transport to the blast furnace.

When both plants were operation, Sinter was stored in the western area and Pellets in the east. Following the closure of the pellet plant in the late-1980s, both stocking areas were used for sinter.

4.1.10 Blended Ore

The process of ore blending was carried out to standardise, improve and tailor ingredients to specific iron products. A number of methods were used, such as blending low quality ore with high-iron-content flue dust from the Basic Oxygen Steel (BOS) plant to raise the iron content.

The specific process is unclear at the time of reporting, but it is believed that a number of conveyor belts and junction houses mix material from the raw ore stocks, with some additions made through a number of hoppers on site, before they are deposited by the ‘stacker’ in to the blended yards.

4.1.11 Raw and Blended Coal Stocks

Coal is blended to achieve the optimal mix for its end application. The blending is carried out using a number of conveyor belts and junction houses from the raw stock ground over to the blended coal area. While the materials will differ slightly, potential contaminants are not expected to differ between raw and blended coal stocks.

In some instances, condensed volatile residues from the coke ovens were blended with inferior coal stocks to increase the calorific value and usability.

4.1.12 Tube City IMS later D Jones Ltd

Tube City IMS provided on-site services to SSI-UK during the ironworks operation. The exact use of the Tube City IMS building within SSI 1 is unclear, although on-site sources suggest it was used for industrial cleaning.

Since the plant closure, the building has been used by D Jones Haulage and Construction Ltd, an on-site contractor that has remained operational. At the time of reporting, the building is used for vehicle/heavy plant maintenance and the outside area has been used for vehicles, heavy plant and equipment storage.

Potential contaminants could include heavy fuel oils, grease, hydraulic oil and assorted hydrocarbon run-off from vehicle maintenance. Contaminants from historic usage will require confirmation of the processes conducted here.

4.1.13 Fuel Tanks

Diesel and Coke Oven Gas are known to have been stored on site, but the nature of the works means that a number of smaller diesel/hazardous substance storage tanks are likely.

Contamination could arise from spillages when refuelling, leaking pipes or a rupture of the tank itself. The larger tanks on site are situated in a concrete bund, normally of equal volume to the tank itself. In the event of a rupture, the integrity of these bunds or any plan of how to empty them is unclear.

4.2 Summary of previous geoenvironmental testing

The 2004 Enviros investigation covered Redcar, Lackenby and Cleveland works. The investigation within SSI1 comprised 31no trial pits and 2no borehole. The findings of the environmental study are detailed below:

- Soil pH was alkaline to highly alkaline. Values up to 12.7 were recorded.
- Exceedance of 'Tier 1 Soil Screening Criteria' was recorded for the following compounds in the majority of exploratory holes (Screening value in brackets):
    - Acid Soluble Sulphide (1,000mg/kg)
    - Water Soluble Sulphate as SO_4 (1,200mg/kg)
- In a smaller number of exploratory holes exceedance of 'Tier 1 Soil Screening Criteria' was recorded for:
    - Zinc (720mg/kg)
    - PAH Total EPA16 (40mg/kg)
    - Boron (3mg/kg)
    - Lead (750mg/kg)
- Groundwater testing returned pH values between 7.8 and 10.1
- No surface water testing was conducted within SSI 1.

Preliminary Conceptual Site Model

5.1 General

In the UK the main legislation behind the contaminated land regime is Part 2A of the Environmental Protection Act 1990 (EPA) and the subsequent and updated Contaminated Land Statutory Guidance (2012). This provides a basis for identifying land that is considered to be unacceptable due to the risks posed by the presence of the contamination, and a mechanism by which sites can be determined as contaminated based on current risk.

However, the main aim of the planning regime with respect to contaminated land is to ensure that future risks posed by land contamination will not be unacceptable (as a minimum any site, following its development, should not be capable of being determined as contaminated under Part 2A). This philosophy is enshrined within the National Planning Policy Framework, 2012 (Paragraphs 120 and 121), which places the onus on the party undertaking the development to demonstrate that the proposed development does not constitute an unacceptable risk to either the human health of future site users or the surrounding environment.

The CLR11 Guidance is used to provide a consistent framework for the assessment and management of potential risks associated with contaminated land including sites assessed, managed and redeveloped under the planning regime. CLR11 requires that sites are evaluated on an individual / site specific basis, using a risk based approach. Risks are evaluated according to the site specific conceptual site model that defines the relationship between, sources of contamination, the receptors at risk of impact / exposure / harm and the pathways that link the sources and the receptors. For a risk to exist there needs to be a potential linkage between a source of contamination, a pathway and a receptor.

Sources and receptors have been established based on the findings of this Desk Study. Potential pathways have been based on reasonable scientific knowledge of contaminants properties and their behaviour in the ground.

A pollutant linkage does not exist unless a source can be linked by a pathway to a receptor; without any one of these elements, a linkage does not exist.

5.2 Potential Sources of Contamination On-site

Table 5.1. - Potential Sources of Contamination

Site feature	Contaminant group	Contaminant	Likelihood	
			Likely	Unlikely
Made Ground	Slag		✓	
	Elevated pH		✓	
	Soil gases	Carbon dioxide,	✓	
		Methane,	✓	
		Hydrogen sulphide	✓	
	Metals		✓	
	Domestic Waste			✓
	Sulphides/Sulphates/Carbonates		✓	
	Asbestos		✓	
Railway Lines	Asbestos	Chrysotile/Amosite	✓	
	Fuel and oil	Diesel, Petrol	✓	
		Oil/grease	✓	
Electrical Substations (8+no)	Transformer oils	PCB	✓	
		Oil	✓	
	Metals	Various metals	✓	
	Asbestos	Chrysotile/Amosite	✓	
Coke Crushing and Blending Plant	Metals	Various metals	✓	
	Coke/Coal		✓	
	Flue Dust		✓	
Sinter Plant	Asbestos		✓	
	Metals	Various metals	✓	
	Coke/Coal		✓	
	Flue Dust		✓	
Pellet Plant	Asbestos		✓	
	Metals	Various metals	✓	
	Coke/Coal		✓	
	Flue Dust		✓	
Sinter and Pellet Stocks	Asbestos		✓	
	Metals	Various metals	✓	
	Coke/Coal		✓	
	Flue Dust		✓	
Blended Ore	Metals		✓	

Site feature	Contaminant group	Contaminant	Likelihood	
			Likely	Unlikely
	Flue Dust		✓	
Blended Coal Stocks	Metals	Various metals	✓	
	Coke/Coal		✓	
	Flue Dust		✓	
Tube City IMS	Asbestos	Chrysotile/Amosite	✓	
	Fuel and oil	Diesel,	✓	
		Oil/grease	✓	
	Metals	Various metals	✓	
	Flue Dust		✓	
Fuel Tanks	Fuel and oil	Diesel,	✓	
		Oil/grease	✓	
Tidal Flats /Glaciolacustrine deposits	Soil gases	Carbon dioxide, methane hydrogen sulphide	✓	

5.3 Potential Pathways

- Vertical migration through geological deposits
- Surface water runoff
- Migration via groundwater flows
- Inhalation
- Airborne migration
- Dermal contact
- Ingestion

5.4 Potential Receptors

- Human Health - Construction workers and site visitors
- Human health - Future/End users of the site
- Human Health - Site neighbours and public
- Controlled water - Groundwater
- Controlled water - Surface Water
- Controlled water - Nearby estuary and sea
- Air quality
- Ecosystems
- Construction materials

5.5 Potential pollutant linkages

Appendix A presents a comprehensive catalogue of the potential linkages between the identified site features, potential receptors and the pathways by which they may be connected. Those linkages which are considered to be plausible are summarised in Table 5.4 below. Where linkages are considered to be plausible, their likelihood and consequences are qualitatively evaluated in accordance with the tables in Appendix A.

Table 5.2 – Plausible Pollutant Linkages

Source			**Pathway**	**Receptor**	**Risk**
Site feature	Contaminant group	Contaminant/s			
Made Ground	Slag	Sulphates Sulphides and Carbonates	✓	✓	High
	Elevated pH		✓	✓	Moderate/Low
	Asbestos		✓	✓	Very High
	Metals & Flue Dust		✓	✓	High
	Soil Gasses	Carbon Dioxide, Methane, Hydrogen Sulphide	✓	✓	Low
Railway Lines	Asbestos		✓	✓	High
	Fuel and oil	Diesel Petrol Oil and grease	✓	✓	High
Electrical Substations (8+no)	Transformer oils	PCB	✓	✓	High
	Asbestos		✓	✓	High
Coke Crushing and Blending Plant	Coke/Coal		✓	✓	Low
	Metals & Flue Dust		✓	✓	High
Sinter plant	Metals & Flue Dust		✓	✓	High
	Asbestos		✓	✓	High

	Coke/Coal		✓	✓	Moderate
Pellet plant	Metals & Flue Dust		✓	✓	High
	Asbestos		✓	✓	High
	Coke/Coal		✓	✓	Moderate
Sinter and Pellet stock	Metals & Flue Dust		✓	✓	High
	Coke/Coal		✓	✓	Moderate
	Asbestos		✓	✓	High
Blended Ore Stocks	Metals & Flue Dust		✓	✓	High
Blended Coal Stocks	Coke/Coal		✓	✓	Moderate
	Metals & Flue Dust		✓	✓	High
Tube City IMS later D Jones Ltd	Fuel and Oil	Diesel Petrol Oil and Grease	✓	✓	Moderate
	Asbestos		✓	✓	High
	Metals & Flue Dust		✓	✓	High
Fuel Tanks	Fuel and Oil	Diesel Petrol Oil and Grease	✓	✓	Moderate

Geotechnical Constraints and Potential Opportunities

6.1 Introduction

In addition to the geoenvironmental considerations, the site and its historic uses pose a number of potential geotechnical constraints to both construction and development of the site, and to ground investigation.

6.2 Ground conditions

The site walkover identified a number of waste piles across the site which comprised a mixture of waste raw materials, process waste (i.e. slag and coke), demolition rubble, railway sleepers and general waste. In places this material has been used to create bunds, which in some places have been created to limit access. Given the source, varied composition of the material and history of SSI 1, it is possible that these areas of Made Ground are contaminated. Potential contaminants of concern include heavy metals, hydrocarbons, organic and inorganic compounds in addition to an elevated pH. The possible presence of asbestos should also be considered as well as the generation of ground gas.

6.2.1 Made Ground - slag

Engineering fills which contain a significant proportion of certain types of slag may pose a risk to future buildings and structures due to their potential to exhibit volumetric instability (i.e. the potential to expand) resulting in differential ground movements and intolerable disruption to foundations (including piles) and services. Subject to the nature of the fill encountered on site, determination of the properties of these materials will be required. In addition slag bearing materials can contain ‘slag skulls’, which may comprise fused slag concretions may prove to be extremely difficult to excavate and break up.

Slag can also weather resulting in the creation of tufa (calcium hydroxide and calcium carbonate precipitates). This can be mobilised in surface and groundwater leading to damage to drainage infrastructure and unsightly deposits in watercourses.

Slags are also characterised by elevated sulphate content, which will need to be taken into consideration when specifying concrete

Material containing slag may be “conditioned”, by its excavation, crushing to a suitable grading, and subsequent processing by a long-term programme of hydrating and turning the material. The purpose of such a process would be to homogenise the materials, and to promote the occurrence of expansive behaviours within the material. The material would be subsequently used as an engineering fill, being placed and compacted in layers.

6.2.2 Compressible Soils

The site is underlain by tidal flat and glaciolacustrine deposits, which by the nature of their depositional environment means that have the potential to contain significant deposits of peat and high plasticity clays. These materials are highly susceptible to compression, resulting in excessive settlement. Their high organic content would also likely lead to long term secondary compression.

6.2.3 Obstructions

The potential for buried service runs/culverts and basements cannot be discounted, particularly those associated with older parts of the site, which may not have been as accurately recorded as more recent developments

6.2.4 Existing foundations

A number of former buildings and hardstanding's and existing buildings and hardstanding's are present on site. Their foundations are largely unknown but could include significant foundation structures with groups of piles.

Reference to drawings RGEN8670 has indicated that, elsewhere on site, foundations comprised a composite pile design. A bored, cast-in-situ pile was constructed between the base of the Made Ground and the ultimate termination depth of the pile, with a steel "I-Beam" pile embedded into the concrete, and extending through the Made Ground, with a compressible void filling material installed. The purpose of this detail would be to mitigate the effects of lateral expansion of the slag within the Made Ground.

6.2.5 Ground aggressivity

Given the nature of the site buried concrete is likely to be susceptible to sulphate attack that can lead to expansion/softening of the concrete.

6.2.6 Halite dissolution

A portion of the site (approx. 20%) is underlain by the Mercia Mudstone Group, which the BGS lexicon describes as having "thick halite-bearing units in some basinal areas" and "thin beds of gypsum/anhydrite widespread".

Halite is a sodium-chloride mix; gypsum is a hydrous calcium sulphate. More broadly described as evaporate minerals, these can pose a construction hazard due to dissolution.

Site development considerations

7.1 Introduction

Considerations that may affect later development can be largely addressed through controls and mitigation, mostly during the Supplementary Ground Investigation.

7.2 Construction Hazards

Table 7.1 - Potential hazards to construction with controls and mitigation

Consideration	Detail	Control and Mitigation
Geotechnical		
Soft ground	Likely disruption to shallow foundations.	Further investigation required to obtain samples to assess the strength characteristics of the superficial deposits
Potentially expansive slag	Potential to disrupt foundations. Potential requirement for mitigation measured, to either protect piled foundations (in the short term), such as sleeving piles, to provide engineering mitigation measures (long term).	Slag sampling and classification testing included in the G.I scope to assess extent of problem.
Variable thickness of Made Ground	Potential for differential ground movements.	Investigation to identify thickness of Made Ground across site
Aggressive soils	Potential for high sulphate content in soils could damage buried concrete structures.	Sulphate testing included in laboratory testing and BRE assessment performed prior to construction.
Buried services	Large numbers of buried services across the site, some not shown on as-built drawings.	Rigorous procedure of excavation permits and CAT scanning prior to excavation.
Uneven Ground	Area C known to be extremely uneven, with large hummocks and potholes.	Detailed walkover prior to construction and awareness of terrain before any entry on-foot or by vehicle.
Dissolution	A portion of the site is underlain by soils with halite/gypsum beds that are vulnerable to dissolution, which can lead to ground instability.	Detailed logging of soils with special care taken to record the presence of halite/gypsum beds. Confirm the lateral boundary between the two mudstone units (Mercia Mudstone Group and Redcar Mudstone Formation.
Geo-environmental		
Asbestos in soil	Potential for unanticipated disposal costs.	Investigate to establish whether there is an asbestos issue. Selected use of potential ACM (i.e. use beneath areas of hard standing)
Slag	Potential to cause deposits of tufa, leading to damage to drainage infrastructure and unsightly deposits in watercourses.	Further investigation to confirm the presence of slag. Considered use of the slag in the earthwork, e.g. distal from watercourses.

Coke Oven Gas Main	Coke oven gas main is pressurised with nitrogen and contains condensed PAHs.	Operatives briefed on location and risks posed by coke oven gas main. All works to be a safe distance away. Seek further information on contents and condition of pipeline.

7.3 Gap Analysis

Table 7.2 summarises the findings of a gap analysis, undertaken to determine the required site investigation to fully address the issues identified in Table 7.1.

Table 7.2 - Gap Analysis

Feature or Element	Existing Ground Investigation Records	Recommended Ground Investigation
Geotechnical		
Properties of natural superficial deposits	Historic ground investigations have very limited exploration coverage beneath 5m.bgl in SSI 1. Only 3 boreholes within SSI 1.	Exploratory holes to >5m.bgl across the site.
Properties of bedrock	Historic ground investigations have very limited exploration coverage beneath 5m.bgl in SSI 1. Only 3 boreholes within SSI 1.	Exploratory holes to >5m.bgl across the site.
SSI 1 – Area C	Historic ground investigations did not include any of DVA SSI 1 Area C.	Full coverage ground investigation inclusive of Site Investigation Area C.
Slag Classification	No slag classification testing has been carried out to establish presence/quantity of expansive sulphates.	Slag classification testing to be included in the scope of works.
Geoenvironmental		
Current hazardous chemical storage on site	No current records of types and quantities of hazardous materials stored on site	Survey of storage tanks and pipelines to establish material type and quantitiy stored.
Full inventory of substations on site	Plans available from SSI-UK only include major substations, on-site sources state there's a much larger number of 'minor' substations.	Survey of all electrical substations on site to establish type, location and condition.
Surface Water Contamination	No historic data on surface water contamination in SSI 1.	Proposed G.I to include surface water sampling and testing.
Coke Oven Gas Main	No information on the contents, condition and exact location of the Coke Oven Gas Main.	Seek further information on the condition and contents of the pipeline and any plans for decommission.
Land north of the Sinter Plant	Limited information on historic uses of the land parcel north of the Sinter Plant	Site investigation to cover this land as well as seeking further information on the land use.

Proposals for further investigation

8.1 Introduction

Based on the preliminary risk evaluation and the Site Development Considerations, the following proposals for further studies are presented:

8.2 Desk-based studies

Further investigation in to Pellet Plant demolition and likelihood of buried structures. Any information on where waste material was deposited would be useful.

Seek further information on the form of foundations present for the Sinter Plant

Seek further information on location and form of basements and tunnels, specifically the cable tunnels around the old Pellet Plant.

8.3 Site Walkover

A site walkover by an engineering geologist or geotechnical engineer is recommended to review the features identified in this report. This in turn may identify additional features not picked up during the desk study.

8.4 Intrusive investigation

Table 8.1 - Proposals for Intrusive Investigation

Feature	Initial G.I	Supplementary G.I	Installation and Monitoring
Sinter plant	35 Trial pits (Area H)	7no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.
Sinter stocking ground	43 Trial pits (Area A)	5 no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.
Pellet plant	37 Trial pits (Area I)	8 no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.
Pellet stocking ground	12 Trial pits (Area B)	5 no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.
Blended ore stocking ground	78 Trial pits (Area E)	16 no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.
Coke crushing plant	14 Trial pits (Area F)	3 no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.
Coal yards	44 Trial pits (Area D)	9 no boreholes to 15m or bedrock, whichever is shallower.	Standpipes in selected boreholes to monitor and sample groundwater.

References

BRE. (2005). *Special Digest 1: Concrete in Aggressive Ground* (Third ed.). Watford: BRE.

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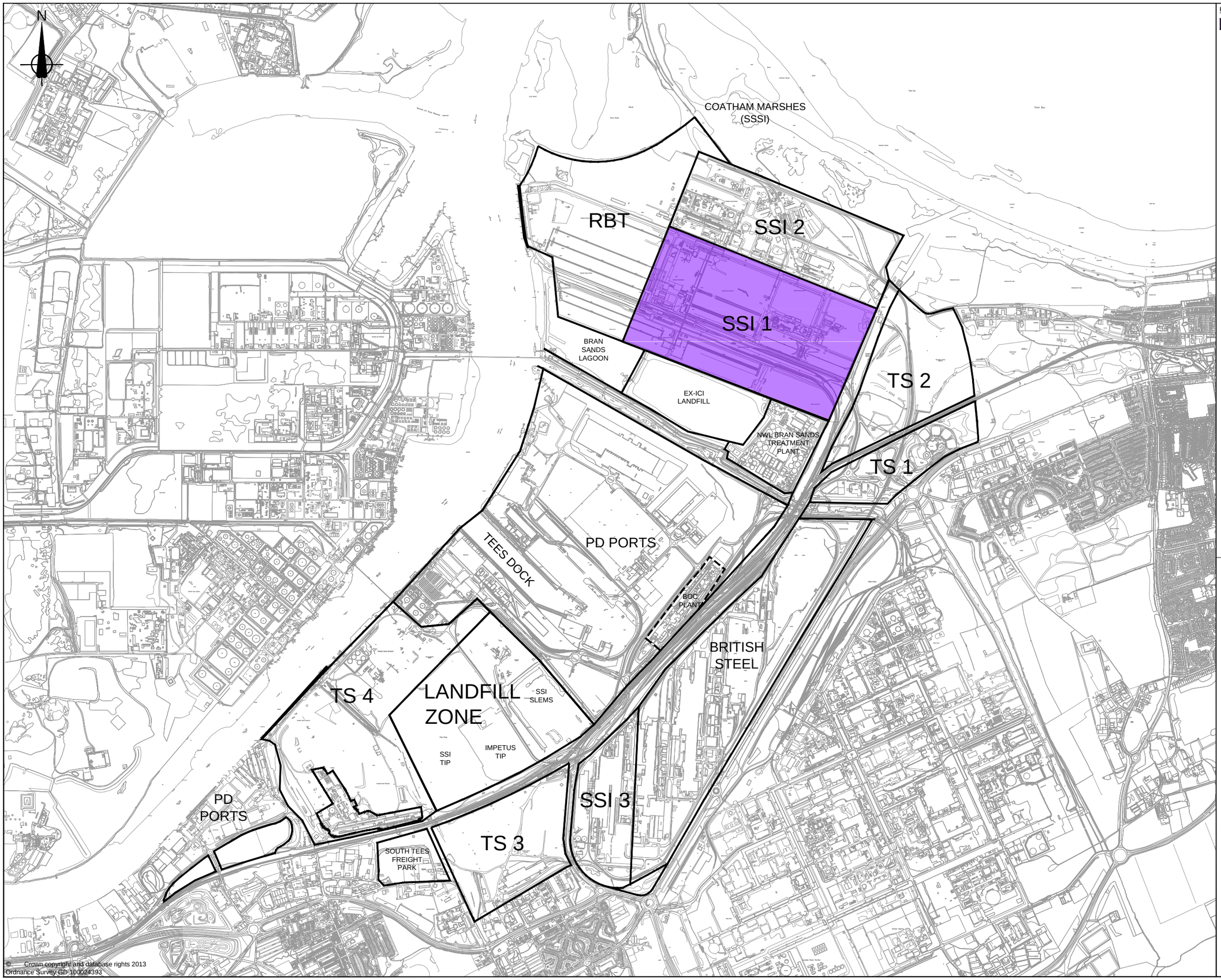
Figures

Figure 1 – Site Location Plan



KEY

SSI 1 SITE AREA

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

Client

Homes & Communities Agency

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SSI REDCAR

Drawing

SSI 1
LOCATION PLAN

Drawn by: GR	Date: 02/05/2017
Checked by: TL	Date: 15/06/2017
Approved by: IDK	Date: 15/06/2017

Drawing No.

FIGURE 1

Revision

-

Drawing Scale: 1:12500 @ A1; 1:25000 @A3

Drawing file path & name:
Xreference file path:
User and Plot date:

Figure 2 – Site Setting

N

SSI 2

LIMITED INDFO

COKE CRUSHING PLANT

LIMITED INFO

LIMITED INFO

TMO & CAR PARK

TUBE CITY IMS

LIMITED INFO

PELLET PLANT (DEMOLISHED)

RBT

BLENDED ORE STOCKS

SINTER PLANT

TS 2

ORE BLENDING/ HANDLING

SINTER STOCKS

SINTER STOCKS (FORMERLY PELLETS)

RAW COAL STOCKS

BLENDED COAL STOCKS

LIMITED INFO

EX-ICI LANDFILL

Teesside Works, Redcar

Water

Sewage Works

KEY

SSI 2 SITE AREA

-	-	-	-	-	-
Rev	By	Chkd	Apprvd	Date	Description

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SSI REDCAR

Drawing

SSI 1
SITE SETTING

Drawn by: GR	Date: 15/05/2017
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Approved by: IDK	Date: 15/06/2017

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FIGURE 2

Revision

-

Drawing Scale: 1:3000 @ A1; 1:6000 @A3

Drawing file path & name :
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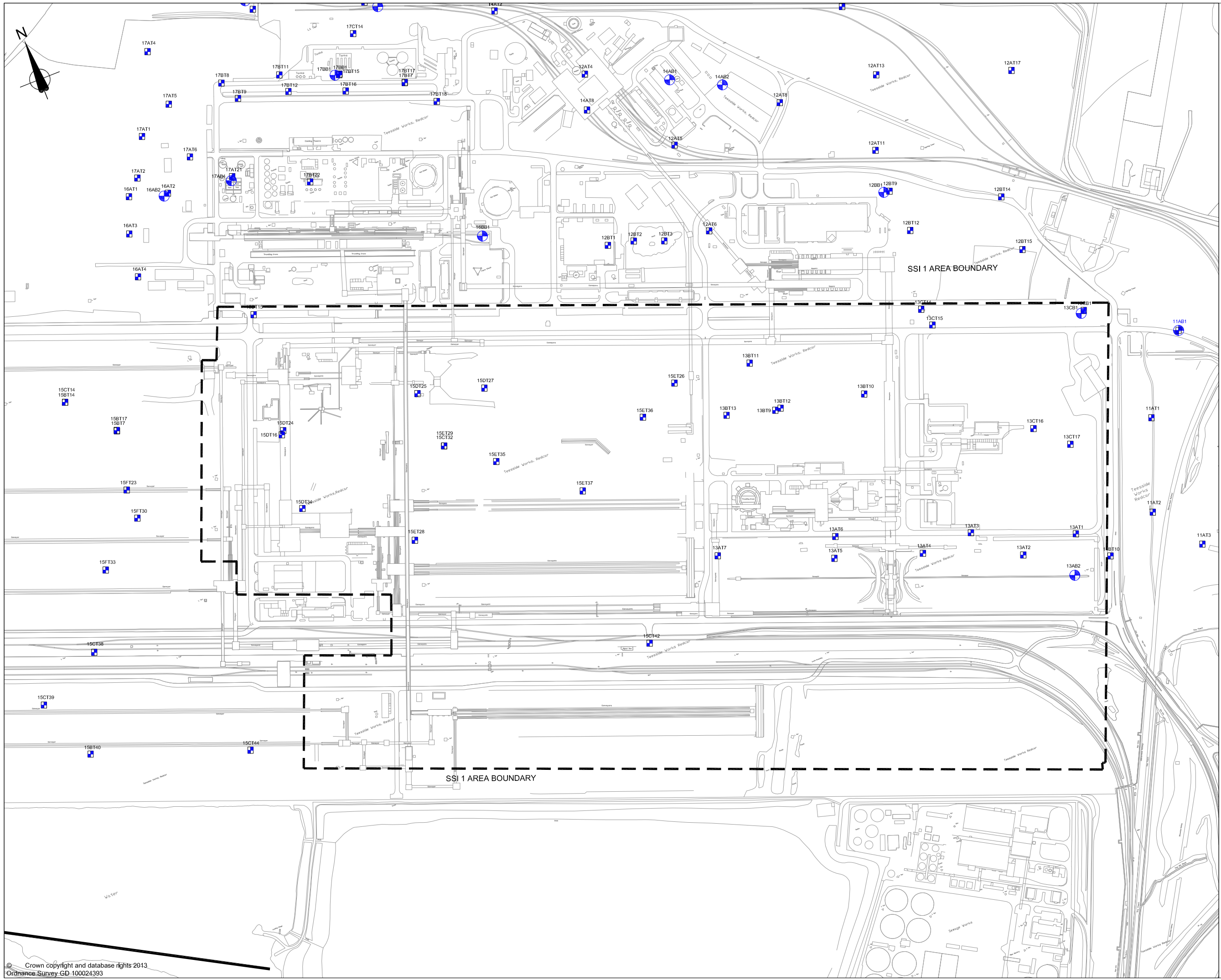
User and Plot Date

Figure 3 – Historical Exploratory Hole Location Plan



NOTES:

1. EXPLORATORY HOLE LOCATIONS BASED ON ENVIROS SOIL AND GROUND WATER STUDY REPORT JUNE 2004.

KEY

- ENVIROS 2004 TRIAL PITS
- ENVIROS 2004 BOREHOLES
- SSI 1 SITE AREA

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SSI 1 HISTORIC BOREHOLES AND TRIAL PITS LOCATION PLAN

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Approved by: IDK	Date: 15/06/2017

Drawing No.

FIGURE 3

Revision

-

Drawing Scale: 1:4000 @ A1; 1:8000 @A3

Drawing file path & name
Xreferance file path
User and Plot Date

Figure 4 – Historical Site Layout

KEY

- SSI 1 SITE AREA
- HISTORICAL RAIL TRACKS
- HISTORICAL BUILDING FOOTPRINTS
- HISTORICAL WATERCOURSE
- HISTORICAL POND
- SOUTH GARE BREAKWATER PRIOR TO LAND RECLAMATION
- TMO = TEESIDE MANAGEMENT OFFICES
- EXISTING RAIL TRACKS

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

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Drawing

SSI 1
HISTORICAL SITE LAYOUT

Drawn by: GR	Date: 02/05/2017
Checked by: TL	Date: 15/06/2017
Approved by: IDK	Date: 15/06/2017

Drawing No.

FIGURE 4

Revision: -

Drawing Scale: 1:4000 @ A1; 1:8000 @A3

Drawing file path & name:
Xreference file path
User and Plot Date

Figure 5 – Existing Utilities Plan

N

COKE/ORE
66KV SUBSTATION

POWER STATION
66KV SUBSTATION

PELLET/SINTER
66KV SUBSTATION

SSI 1 AREA BOUNDARY

SSI 1 AREA BOUNDARY

NOTES

1. INDICATIVE ONLY.

KEY

- SSI 1 Site Area
- BT — BT Openreach Underground
- BOC — BOC Oxygen Pipeline
- BOC — BOC Nitrogen Pipeline
- BOC — BOC Hydrogen Pipeline
- CATS — CATS Pipeline
- NPG — Northern Power Grid
- COG MAIN — Coke Oven Gas Main Above Ground
- Fibre Optic Cables
- Service Reservations - HV Cable Routes
- Portable Water Main
- Industrial Water Main
- Natural Gas Pipeline
- Blast Furnace Gas Main
- Estuary Water Main
- GAS — BREAGH 20" High Pressure Gas Pipeline
- FO — Fuel Oil Pipeline
- SS — 11kv Substations

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

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Drawing

SSI 1
EXISTING UTILITIES

Drawn by: GR	Date: 19/05/2017
Checked by: TL	Date: 15/06/2017
Approved by: IDK	Date: 15/06/2017

Drawing No.

FIGURE 5

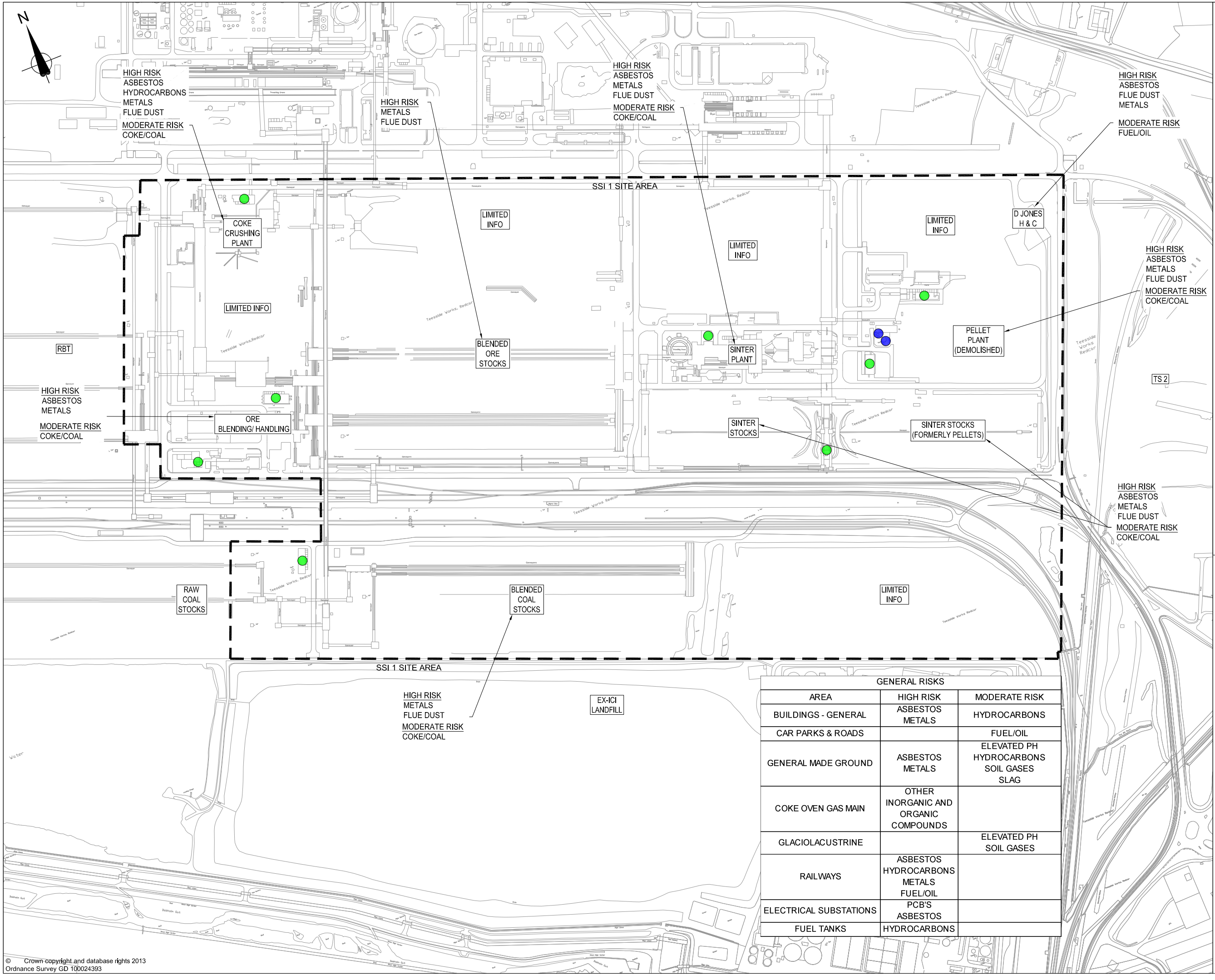
Revision

-

Drawing Scale: 1:4000 @ A1; 1:8000 @A3

Drawing file path & name: Xreference file path User and Plot Data

Figure 6 –Site Constraints Plan



KEY

- SSI 1 SITE AREA
- ELECTRICAL SUBSTATION
- PRESENT TANK

NOTES

- D JONES HAULAGE AND CONSTRUCTION FORMERLY TUBE CITY IMS

RBT = REDCAR BULK TERMINAL

TBT = TEESSIDE MANAGEMENT OFFICES

GENERAL RISKS		
AREA	HIGH RISK	MODERATE RISK
BUILDINGS - GENERAL	ASBESTOS METALS	HYDROCARBONS
CAR PARKS & ROADS		FUEL/OIL
GENERAL MADE GROUND	ASBESTOS METALS	ELEVATED PH HYDROCARBONS SOIL GASES SLAG
COKE OVEN GAS MAIN	OTHER INORGANIC AND ORGANIC COMPOUNDS	
GLACIOLACUSTRINE		ELEVATED PH SOIL GASES
RAILWAYS	ASBESTOS HYDROCARBONS METALS FUEL/OIL	
ELECTRICAL SUBSTATIONS	PCB'S ASBESTOS	
FUEL TANKS	HYDROCARBONS	

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

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Project: SSI REDCAR

Drawing: SSI 1 SITE CONSTRAINTS

Drawn by: KW	Date: 20/06/2017
Checked by: RK	Date: 20/06/2017
Approved by: IDK	Date: 20/06/2017

Drawing No.: FIGURE 6

Revision: -

Drawing Scale: 1:3000 @ A1; 1:6000 @A3

Drawing file path & name:
Xreference file path:
User and Plot Date

Appendix A – Pollutant linkages

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
Slag - Sulphates, Sulphides and Carbonates	Made Ground	Vertical migration through geological deposits	Human Health - Construction workers and site visitors					
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Medium	Moderate	Moderate	
			Controlled water - Surface Water	✓	Medium	Moderate	Moderate	
			Controlled water - Nearby estuary and sea	✓	Medium	Low	Moderate /Low	
			Air quality					
			Ecosystems	✓	Mild	Moderate	Moderate /Low	
			Construction materials	✓	Mild	Moderate	Moderate /Low	
		Surface water runoff	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	
			Human health - Future/End users of the site	✓	Mild	Moderate	Moderate /Low	
			Human Health - Site neighbours and public	✓	Mild	Low	Low	
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
			Controlled water - Surface Water	✓	Medium	Moderate	Moderate	
			Controlled water - Nearby estuary and sea	✓	Medium	Low	Moderate /Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Construction materials	✓	Medium	Moderate	Moderate	
		Migration via groundwater flows	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	Greatest risk during excavation and exploration works.
			Human health - Future/End users of the site	✓	Mild	Low	Low	
			Human Health - Site neighbours and public	✓	Mild	Low	Low	
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
			Controlled water - Surface Water	✓	Mild	Unlikely	Very Low	
			Controlled water - Nearby estuary and sea	✓	Medium	Unlikely	Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials	✓	Medium	Moderate	Moderate	
		Inhalation	Human Health - Construction workers and site visitors	✓	Mild	Low	Low	Greatest risk during excavation and exploration works.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Dermal contact	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	Risk applies to excavation workers and ground investigation crews sampling soil.

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	Future/End users unlikely to come in to contact with material unless excavating or through groundwater run-off.
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
Soil Gases; Carbon Dioxide, Methane, Hydrogen Sulphide	Made Ground	Vertical migration through geological deposits	Human Health - Construction workers and site visitors	✓	Mild	Unlikely	Very Low	Release of gas from soil in to atmosphere. Access to supported excavations will require gas monitoring equipment.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	Migration of soil/atmospheric gases beyond site boundary.
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea	□				
			Air quality					
			Ecosystems	✓	Mild	Unlikely	Very Low	
			Construction materials	✓	Severe	Low	Moderate	Risk of gas ingress in to structures, e.g basements, service tunnels and excavations.

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
		Inhalation	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	Risk greatest during excavations works. Inhalation at dangerous concentrations unlikely in open air. Man-access to excavations should not be permitted.
			Human health - Future/End users of the site	✓	Medium	Low	Moderate /Low	
			Human Health - Site neighbours and public	✓	Mild	Low	Low	Migration of soil/atmospheric gases beyond site boundary.
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
Elevated pH	Made Ground	Vertical migration through geological deposits	Human Health - Construction workers and site visitors					
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
			Controlled water - Surface Water	✓	Medium	Moderate	Moderate	
			Controlled water - Nearby estuary and sea	✓	Medium	Unlikely	Low	
			Air quality					
			Ecosystems					
			Construction materials	✓	Medium	Moderate	Moderate	pH attack of buried concrete structures.

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
		Surface water runoff	Human Health - Construction workers and site visitors	✓	Mild	Unlikely	Very Low	
			Human health - Future/End users of the site	✓	Minor	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Minor	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water	✓	Mild	Low	Low	
			Controlled water - Nearby estuary and sea	✓	Mild	Unlikely	Very Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials	✓	Medium	Low	Moderate /Low	
		Migration via groundwater flows	Human Health - Construction workers and site visitors	□				
			Human health - Future/End users of the site	□				
			Human Health - Site neighbours and public	✓	Minor	Unlikely	Very Low	
			Controlled water - Groundwater	✓	Mild	Low	Low	
			Controlled water - Surface Water	✓	Mild	Low	Low	
			Controlled water - Nearby estuary and sea	✓	Minor	Unlikely	Very Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials	✓	Medium	Moderate	Moderate	pH attack of buried concrete structures.
		Dermal contact	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
			Human health - Future/End users of the site	✓	Mild	Low	Low	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
Asbestos	Made Ground	Inhalation	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	Areas where asbestos and asbestos containing materials are known to exist should be recorded within the site's Asbestos Register, which should be reviewed ahead of any future works. However, there is a risk that unrecorded asbestos may be encountered and therefore those at greatest risk will be Construction Workers and Maintenance Staff.
	Railway Lines		Human health - Future/End users of the site	✓	Severe	Low	Moderate	
	Electrical Substations		Human Health - Site neighbours and public	✓	Severe	Low	Moderate	
	Sinter Plant		Controlled water - Groundwater					
	Pellet Plant		Controlled water - Surface Water					
	Tube City IMS		Controlled water - Nearby estuary and sea					
	Sinter and Pellet Stocks		Air quality	□				

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Ecosystems					
			Construction materials					
		Airborne migration	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	Asbestos is expected to be present in many locations across the site. Depending on the type and extent of disturbance, asbestos fibres can be transported by wind.
			Human health - Future/End users of the site	✓	Severe	Unlikely	Moderate /Low	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Moderate /Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality	✓	Minor	Unlikely	Very Low	
			Ecosystems					
			Construction materials					
		Ingestion	Human Health - Construction workers and site visitors	✓	Severe	Low	Moderate	Shall be mitigated with PPE, enforced hand-washing routines and adherence to the asbestos management plan. Areas where asbestos and asbestos containing materials are known to exist should be recorded within the site's Asbestos Register, which should be reviewed ahead of any future works. However, there is a risk that unrecorded asbestos may be encountered and therefore those at greatest risk will be Construction Workers and Maintenance Staff.
			Human health - Future/End users of the site	✓	Severe	Low	Moderate /Low	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Moderate /Low	
			Controlled water - Groundwater					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Dermal contact	Human Health - Construction workers and site visitors	✓	Medium	Moderate	Moderate	Shall be mitigated with PPE. Areas where asbestos and asbestos containing materials are known to exist should be recorded within the site's Asbestos Register, which should be reviewed ahead of any future works. However, there is a risk that unrecorded asbestos may be encountered and therefore those at greatest risk will be Construction Workers and Maintenance Staff.
			Human health - Future/End users of the site	✓	Minor	Low	Very Low	
			Human Health - Site neighbours and public	✓	Minor	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
Polychlorinated biphenyls (PCB)	Electrical Substations	Vertical migration through geological deposits	Human Health - Construction workers and site visitors					
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Severe	Moderate	High	

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Controlled water - Surface Water	✓	Severe	Moderate	High	Potential for migration through geological deposits in to surface water courses.
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems	✓	Severe	Unlikely	Moderate /Low	
			Construction materials					
		Migration via groundwater flows	Human Health - Construction workers and site visitors					
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Severe	Low	Moderate	
			Controlled water - Surface Water	✓	Severe	Unlikely	Moderate /Low	
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems	✓	Severe	Moderate	High	
			Construction materials					
		Surface water runoff	Human Health - Construction workers and site visitors	✓	Severe	Low	Moderate	
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public					
			Controlled water - Groundwater					
			Controlled water - Surface Water	✓	Severe	Moderate	High	

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Airbourne Migration	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	
			Human health - Future/End users of the site	✓	Severe	Low	Moderate	
			Human Health - Site neighbours and public	✓	Severe	Low	Moderate	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Dermal contact	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	
			Human health - Future/End users of the site	✓	Severe	Low	Moderate	
			Human Health - Site neighbours and public	✓	Severe	Low	Moderate	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
			Ecosystems					
			Construction materials					
Diesel & Petrol	Railway Lines	Vertical migration through geological deposits	Human Health - Construction workers and site visitors					
	Tube City IMS		Human health - Future/End users of the site					
	Fuel Tanks		Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	Spillages could range from minor (during refuelling) up to a rupture of a 1000 gallon tank. Potential for migration through geological deposits in to surface water courses.
			Controlled water - Surface Water	✓	Medium	Low	Moderate /Low	
			Controlled water - Nearby estuary and sea	✓	Medium	Low	Moderate /Low	
			Air quality					
			Ecosystems					
			Construction materials					
		Surface water runoff	Human Health - Construction workers and site visitors	✓	Medium	Low	Moderate /low	
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public	✓	Minor	Unlikely	Very Low	
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
			Controlled water - Surface Water	✓	Medium	Moderate	Moderate	
			Controlled water - Nearby estuary and sea	✓	Medium	Low	Moderate /Low	Surface water runoff in to drainage channels or directly in to sea or nearby estuary.

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials					
		Migration via groundwater flows	Human Health - Construction workers and site visitors					
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public	✓	Minor	Low	Very Low	Migration via groundwater flows only likely in the event of a larger spillage e.g Fuel tank rupture.
			Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea	✓	Medium	Low	Moderate /Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials					
		Ingestion	Human Health - Construction workers and site visitors	✓	Severe	Low	Moderate	Can be mitigated through PPE and an enforced hand washing routine.
			Human health - Future/End users of the site	✓	Severe	Unlikely	Moderate /Low	
			Human Health - Site neighbours and public	✓	Severe	Low	Moderate	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Construction materials					
		Inhalation	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	Contact possible in both soil contamination and direct contact with spillage.
			Human health - Future/End users of the site	✓	Severe	Low	Moderate	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Moderate /Low	Any risk to public only likely in event of major spill.
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Dermal contact	Human Health - Construction workers and site visitors	✓	Severe	Moderate	Moderate /Low	Contact possible in both soil contamination and direct contact with spillage.
			Human health - Future/End users of the site	✓	Severe	Low	Low	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Moderate /Low	Any risk to public only likely in event of major spill.
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
Oil and Grease	Railway Lines	Surface water runoff	Human Health - Construction workers and site visitors	✓	Medium	Unlikely	Low	
	Tube City IMS		Human health - Future/End users of the site	✓	Medium	Unlikely	Low	
	Fuel Tanks		Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Mild	Unlikely	Very Low	Surface water run off only likely for less viscous liquids e.g low weight oils. Quantities of oil and grease on site likely to be much less than diesel/petrol so less chance of a major spillage.
			Controlled water - Surface Water	✓	Mild	Low	Low	
			Controlled water - Nearby estuary and sea	✓	Mild	Unlikely	Very Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials					
		Migration via groundwater flows	Human Health - Construction workers and site visitors					
			Human health - Future/End users of the site					
			Human Health - Site neighbours and public					
			Controlled water - Groundwater	✓	Medium	Unlikely	Low	
			Controlled water - Surface Water	✓	Medium	Low	Moderate /Low	
			Controlled water - Nearby estuary and sea	✓	Medium	Unlikely	Low	
			Air quality					
			Ecosystems	✓	Mild	Unlikely	Very Low	
			Construction materials					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
		Ingestion	Human Health - Construction workers and site visitors	✓	Medium	Low	Moderate /Low	Can be mitigated through PPE and an enforced hand washing routine.
			Human health - Future/End users of the site	✓	Medium	Unlikely	Low	
			Human Health - Site neighbours and public	✓	Medium	Unlikely	Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Inhalation	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	
			Human health - Future/End users of the site	✓	Severe	Low	Moderate	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
Coke/Coal	Coke Crushing and Blending	Vertical migration through	Human Health - Construction workers and site visitors					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
	Sinter Plant	geological deposits	Human health - Future/End users of the site					
	Pellet Plant		Human Health - Site neighbours and public					
	Sinter and Pellet Stocks		Controlled water - Groundwater	✓	Medium	Low	Moderate /Low	
	Blended Coal Stocks		Controlled water - Surface Water	✓	Medium	Low	Moderate /Low	
			Controlled water - Nearby estuary and sea	✓	Mild	Unlikely	Very Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials					
		Surface water runoff	Human Health - Construction workers and site visitors	✓	Minor	Unlikely	Very Low	
			Human health - Future/End users of the site	✓	Minor	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Minor	Unlikely	Very Low	
			Controlled water - Groundwater	✓	Mild	Unlikely	Very Low	
			Controlled water - Surface Water	✓	Mild	Low	Low	
			Controlled water - Nearby estuary and sea	✓	Mild	Unlikely	Very Low	
			Air quality					
			Ecosystems	✓	Mild	Low	Low	
			Construction materials					
		Inhalation	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	Greatest risk during excavation and exploration works.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality	□				
			Ecosystems					
			Construction materials					
		Ingestion	Human Health - Construction workers and site visitors	✓	Mild	Low	Low	Can be mitigated through PPE and an enforced hand washing routine. Greatest risk to contruction workers and during sampling of exploratory holes.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Airborne migration	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	Wind-blown dust. Greatest risk to construction staff disturbing/loosening soil.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
			Human Health - Site neighbours and public	✓	Minor	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality	✓	Minor	Unlikely	Very Low	
			Ecosystems	✓	Mild	Low	Low	
			Construction materials					
		Dermal contact	Human Health - Construction workers and site visitors	✓	Mild	Moderate	Moderate /Low	Greatest risk during excavation and exploration works. Easily mitigated using PPE.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
Metals & Flue Dust	Made Ground	Surface water runoff	Human Health - Construction workers and site visitors					
	Coke Crushing and Blending		Human health - Future/End users of the site					
	Sinter Plant		Human Health - Site neighbours and public					

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	**Site Feature**				**Consequence**	**Likelihood**	**Risk**	
	Pellet Plant		Controlled water - Groundwater	✓	Medium	Moderate	Moderate	
	Sinter and Pellet Stocks		Controlled water - Surface Water	✓	Medium	Moderate	Moderate	
	Blended Ore		Controlled water - Nearby estuary and sea	✓	Medium	Moderate	Moderate	
	Blended Coal Stocks		Air quality					
	Tube City IMS		Ecosystems	✓	Medium	Moderate	Moderate	
	Electrical Substations		Construction materials					
		Migration via groundwater flows	Human Health - Construction workers and site visitors	✓	Severe	Low	Moderate	
			Human health - Future/End users of the site	✓	Severe	Unlikely	Moderate /Low	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Moderate /Low	
			Controlled water - Groundwater	✓	Medium	Moderate	Moderate /Low	Leachate potential of flue dust unknown.
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea	✓	Mild	Unlikely	Very Low	
			Air quality					
			Ecosystems	✓	Minor	Low	Very Low	
			Construction materials					
		Inhalation	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	Wind-blown dust. Exposure can be reduced by halting work during high winds.
			Human health - Future/End users of the site	✓	Severe	Low	Moderate	
			Human Health - Site neighbours and public	✓	Severe	Unlikely	Moderate /Low	Wind blown dust migrating off-site.

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Ingestion	Human Health - Construction workers and site visitors	✓	Severe	Moderate	High	Can be mitigated through PPE and an enforced hand washing routine. Greatest risk to contruction workers and during sampling of exploratory holes.
			Human health - Future/End users of the site	✓	Severe	Low	Moderate	
			Human Health - Site neighbours and public	✓	Severe	Low	Moderate	
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					
		Airborne migration	Human Health - Construction workers and site visitors	✓	Medium	Moderate	Moderate	Wind-blown dust. Exposure can be reduced by halting work during high winds.
			Human health - Future/End users of the site	✓	Mild	Low	Low	
			Human Health - Site neighbours and public	✓	Mild	Low	Low	Dust-blowing on to neighbouring sites is dependent on wind intensity and direction.

Source		Pathway	Receptor	Plausible	Initial Assessment			Comment/Data Gap
Contaminant	Site Feature				Consequence	Likelihood	Risk	
			Controlled water - Groundwater					
			Controlled water - Surface Water	✓	Mild	Low	Low	
			Controlled water - Nearby estuary and sea	✓	Mild	Low	Low	
			Air quality	✓	Mild	Low	Low	
			Ecosystems	✓	Minor	Low	Very Low	
			Construction materials					
		Dermal contact	Human Health - Construction workers and site visitors	✓	Medium	High	High	Dermal contact can be minimised with PPE. Greatest risk during excavation and exploration eg. Sampling soils. Wind-blown dust can migrate around the site.
			Human health - Future/End users of the site	✓	Mild	Unlikely	Very Low	
			Human Health - Site neighbours and public	✓	Mild	Unlikely	Very Low	Wind-blown dust migrating offsite and coming in to contact with neighbours/public.
			Controlled water - Groundwater					
			Controlled water - Surface Water					
			Controlled water - Nearby estuary and sea					
			Air quality					
			Ecosystems					
			Construction materials					

Appendix B –Risk Classification

Classification of Consequence

Classification	Definition	Examples
Severe	Short term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short term human health risk if buildings are occupied).
Medium	Chronic damage to Human Health ("significant harm" as defined in the DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (note: the definitions of ecological systems within Circular on Contaminated Land, DETR , 2000).	Concentrations of a contaminant from site exceed the generic, or site specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to buildings/structures and crops ("significant harm" as defined in the Draft Circular on Contaminated Land, DETR, 2000). Damage to sensitive buildings/structures or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as Personal Protective Clothing, etc). Easily repairable effects of damage to buildings/structures.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discolouration of concrete.

Classification of Likelihood

Classification	Definition
High	There is a pollution linkage and an event which would either appear very likely in the short term and almost inevitable over the long term, or, there is evidence at the receptor of harm or
Moderate	There is a pollution linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Risk evaluation of Consequence against Likelihood

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Likelihood	**High**	Very High Risk	High Risk	Moderate Risk	Moderate/ Low Risk
	Moderate	High Risk	Moderate Risk	Moderate/ Low Risk	Low Risk
	Low	Moderate Risk	Moderate/ Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/ Low Risk	Low Risk	Very Low Risk	Very Low Risk