Persimmon Homes

REMEDIATION STRATEGY

for

Former Marchon Site, Whitehaven

August 2023

REPORT No: 22PER008/RS

- *Desk Studies and Site Walkovers*
- *Intrusive Contaminated Land Investigations*
- *Geotechnical Appraisals and Ground Investigations*
- *Landfill Gas Assessments and Remedial Design*
- *Remediation Design and Implementation*
- *Remediation Project Management and Supervision*
- *Site Abnormal Assessments (Foundations and contaminated land)*

GEOTECHNICAL - CONTAMINATED LAND - FLOOD RISK

DOCUMENT ISSUE RECORD

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0	Aug 2023	Draft for comment	JS
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TABLE OF CONTENTS

1. INTRODUCTION

1.1 The Commission and Brief

Betts Geo Environmental (Betts) has been commissioned by Persimmon Homes to prepare a Remediation Strategy for the remediation and preparatory works for the former Marchon site redevelopment in Whitehaven. The plan below shows the proposed site layout;

This Remediation Strategy has been prepared for the purpose of demonstrating to both the Local Planning Authority & the Environment Agency the proposed remediation methodology going throughout the duration of the development.

Regulatory approval of this document is advised.

The Site Investigation undertaken to date has a good spread across site, however Betts reserves the right to amend this remedial strategy in the light of any unforeseen conditions during the remedial works.

1.2 Proposed Development

The proposed development at time of issue comprises of a mixture of residential dwellings and associated gardens, public open spaces, new road and associated infrastructure.

1.3 Previous Reporting

This report provides remedial recommendations which are based on the findings of the following Betts Geo report:

- Ground Investigation Report for Former Marchon Site, Whitehaven by Betts Geo for Persimmon Homes – July 2023 – Report ref: 22PER008/GI

The above report also contains details of a number of pervious reports that have been undertaken for the site and are detailed below;

- Former Marchon Works, Whitehaven – Proposed Residential Redevelopment Preliminary Ground Conditions Report for Whitehaven Developments – March 2017 – by Smith Grant (SG) Environmental Consultants LLP – Report ref: R1533-R01-v2-Final.

Rhodia (landowners at the time) instructed environmental consultants URS to undertake various site investigations and monitoring to design and verify remediation works in connection with the Part IIA designation. These reports have also been summarised in the SG report. This report was also obtained off the Copeland Council website and is as follows:

- Former Albright & Wilson Works, Whitehaven, Cumbria – Phase II Investigation and Environmental Assessments – 13th March 2007 – by URS – Report ref: 44320110.

The report by SG is solely a desk study review of ground conditions and contamination identified in the URS site investigation.

Where necessary the above reports have been used throughout this report and referenced accordingly. The following 'Site History Summary', 'Geology' and 'Previously Undertaken Site Investigation' has been summarised from the report.

Whilst Betts Geo Environmental Ltd cannot be held liable for the third party, client furnished, results/data, it is suggested that it is reasonable to assume that the data provided in these reports have been undertaken with suitable care and due diligence by suitably experience consultants. As such the data is regarded as being of an appropriate standard to utilise within this report.

2 Background

2.1 Site Description and Site History

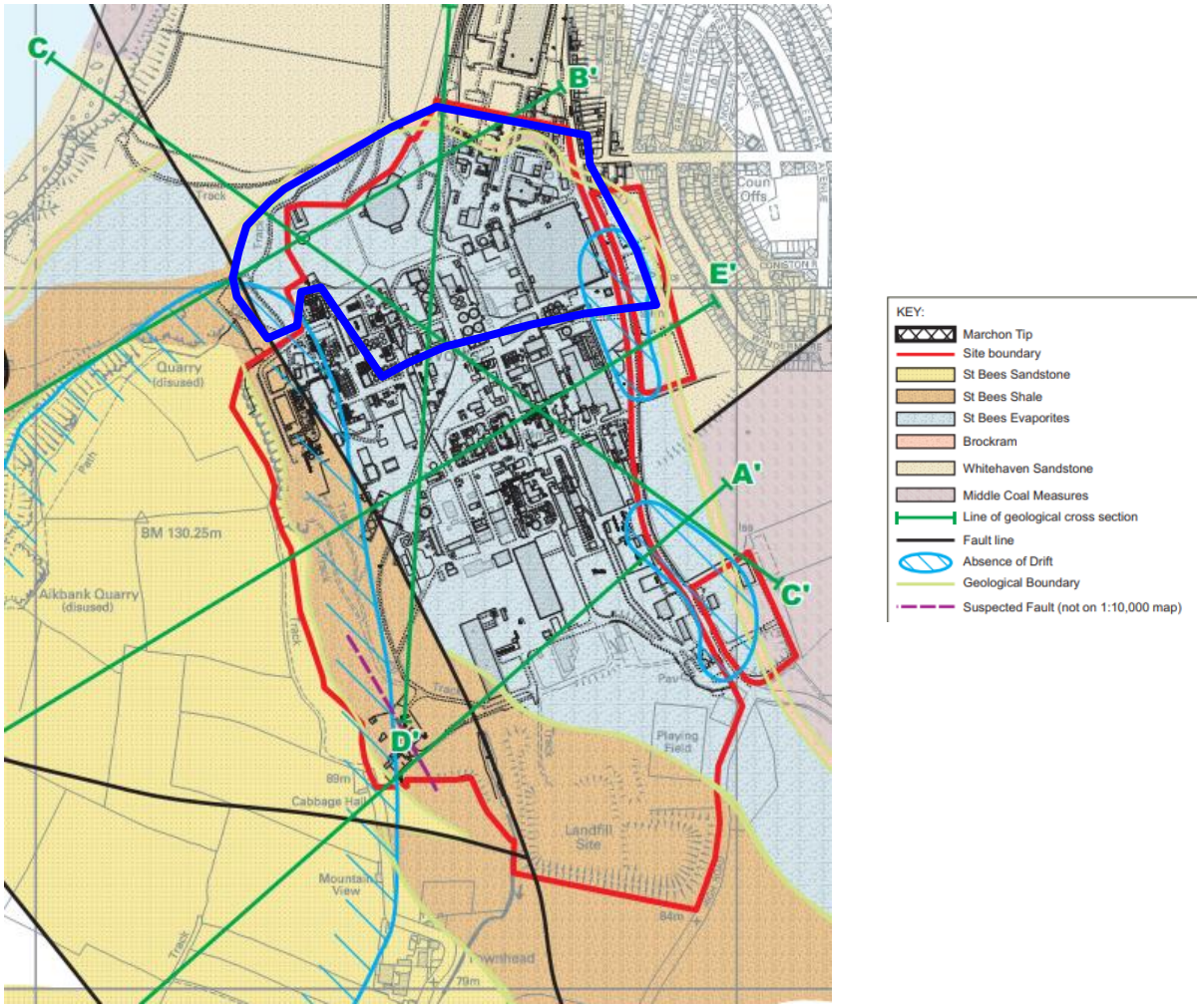
The following summary has been taken from the third party reports referenced in 1 above.

Source	Site	Surrounds
1866 OS map (1:500)	Croft Pit (coal) in centre of site with well and tramroad leading north;	Open land with scattered houses and farms; High Road to east; farmstead of Langdale (later Lingydale) in northwest
1874 OS map (1:2,500)	No significant changes	Lime kiln, quarry and rifle range to northwest; 3 mine levels (alabaster) to west
1899 OS map (1:2,500)	Croft Pit expanded with second rail line to north; rail connection to west to Barrowmouth Alabaster Works; house to west adjacent to site boundary (later named Alabastor Cottage)	Barrowmouth Gypsum mine and Aikbank Quarry to west
1925 OS map (1:2,500)	Colliery renamed Ladysmith Pit, with enlarged and reconstructed pithead complex, second shaft and additional industrial structures (washery and coke ovens) to north; Alabaster Works marked as disused	Gypsum mine and quarry to west marked as disused
1938 OS map (1:2,500)	Aerial ropeway shown extending west from washery to coastal cliff	Woodhouse residential estate constructed to east of High Road
1957 OS map (1:10,560)	New industrial buildings outlined to east of colliery	No significant changes
1961 OS map (1:1,250)	Mine marked as disused, with former pithead buildings largely removed; extensive chemical works developed across much of site, with tip area on southern boundary, and banks indicating creation of development plateaux	Works plant and railway lines extend to south; new quarry present on site of former Hutbank Cottages to southwest of site; unlabelled structure and spoil tips to south of quarry assumed to be new anhydrite drift mine entrance; aerial ropeway from coal washery no longer shown, but conveyor leads to spoil heaps to west
1967 OS map (1:1,250)	Site labelled as chemical works with various structures including sub-stations, tanks, cooling towers and a chimney	Hutbank quarry extended north and labelled as anhydrite
1979 OS map (1:10,000)	Several large works buildings on western side of site no longer shown, with new plant in central areas; Alabastor Cottage no longer shown	Hutbank Quarry marked as disused
2003 aerial photo	Former Alabaster works building and coal washery removed, octagonal shaped structure (rock phosphate store) present in north; field in northernmost part of site is grassland	Hutbank Quarry infilled and restored to grassland; aerial ropeway from washery to west removed and former spoil tips restored to grassland; some clearance of works buildings and regrading shown to south of site
2008 aerial photo	Site is cleared of all above ground structures, with concrete slabs and roadways remaining, and areas of bare ground (possible demolition rubble); gas governer compound present alongside High Road in south of site	Former works buildings all cleared with the exception of warehouse and office buildings alongside High Road to north of site

2.2 Geology, Hydrology & Hydrogeology

"*The geology and hydrogeology of the site is complex. This is largely due to the faulting of a sequence of geological units with distinctly different characteristics that has been further complicated by anthropogenic influences including site processes (particularly relating to the use of acid) and former anhydrite and coal mining (shafts, adits, abandoned workings).*

The figure below presents the geology of the site and surrounding area:



Betts Geo note – The site boundary for the site detailed within this report is not as extensive as the URS site boundary and is shown in blue on the plan above.

"Shallow groundwater appears to be affected by a similar flow divide to the surface water. Shallow groundwater flows from both east and west towards the central line of the site. In the northern part, flow turns north towards the Irish Sea, and in the southern part flow turns south towards Sandwith Beck.

Faulting

Numerous faults transect the site and surrounding area. The two key faults considered to have an influence on contaminant migration are the Byerstead Fault and the 'North-South' Fault.

Betts Geo note – The site boundary for the site detailed within this report is not as extensive as the URS site boundary and the faults are not located on site (extract shown in section 4.1 above).

Coal Mining

No specific coal mining sections have been presented within the third party reports referenced in Section 1 above.

Coal Mining is present below the site with two shafts located within the site boundary detailed within this report. Beyond the southern site boundary is the newly approved site for Woodhouse Colliery.

Coal mining is known to be deep on site (>30.00mbgl) and therefore poses a low risk to site end users.

Details on the on site shafts can be seen below (taken from the URS report):

Shaft	Grid ref.	URS Observation
Croft	NX 9660 1588	*"No visible mineshaft or cap and no visible area of subsidence to indicate weakness in the existing cap. This area is currently covered in compacted brick and concrete rubble from demolition works. It is understood from Fred Proud of Rhodia that this shaft was well capped because it was proposed to develop and build upon the area above. It was not possible to see the state of the cap beneath the rubble."*
Ladysmith	NX 9654 1588	*"Like the Croft shaft, it is understood that this shaft was well capped as it was built upon with newer areas of plant. No visible shaft cap or entrance was apparent during the walkover survey, though a number of concrete plinths, with the remains of thick metal T and H bars were noted which may have once supported the above ground machinery above the shaft. The area is on the edge of the road, which once bordered the Phosphoric Acid storage tanks and the surrounding area has been levelled and consists of compacted brick and concrete rubble."* URS also noted on a geological section drawing that the Ladysmith Shaft extended to 254m depth and was filled and capped in 1997.

Radon

No specific radon sections have been presented within the third-party reports referenced in Section 1 above.

Betts Geo utilised the online UK Radon Interactive Mapping tool which suggested that the site is located within both a 1-3% potential band and a >1% potential band, therefore no specific radon protective measures are required in new buildings.

Hydrogeological and Hydrological Features

"There is one surface water feature on the main site. This is the pond located in the southern part of the site, adjacent to the Ufex Landfill which is currently being extended for use as a storm water storage pond to alleviate flooding. This pond was previous used to store leachate for the Ufex Landfill, and removal of contaminated bottom sediments have formed part of the construction process. Rhodia are planning to construct a second pond to

increase water storage capacity, which will be connected by an underground pipe to the first pond. Both ponds will discharge to the Sandwith Beck to the south of the site under a discharge consent.

Betts Geo note – this pond is located outside of the new development area covered by this report.

A number of small watercourses are present in the surrounding area. Immediately outside but adjoining the site boundary lies Sandwith Beck and flows in a generally south to south south east direction.
Historical maps indicate that a stream ran across the centre of the site in a north south orientation prior to development of the site, following the line of lowest topography. This extended towards the current source of Sandwith Beck suggesting historically that the Beck had its source on the site itself.

Deep groundwater is complicated and not well understood, however in general terms appears to move westwards towards the Irish Sea. Some rapid pathways appear to be present through faults, dissolution features, shafts and adits, and these result in rapid movement of groundwater from the site to the coast."

Betts Geo note – The site boundary for the site detailed within this report is not as extensive as the URS site boundary.

2.3 Previously Undertaken Site Investigation

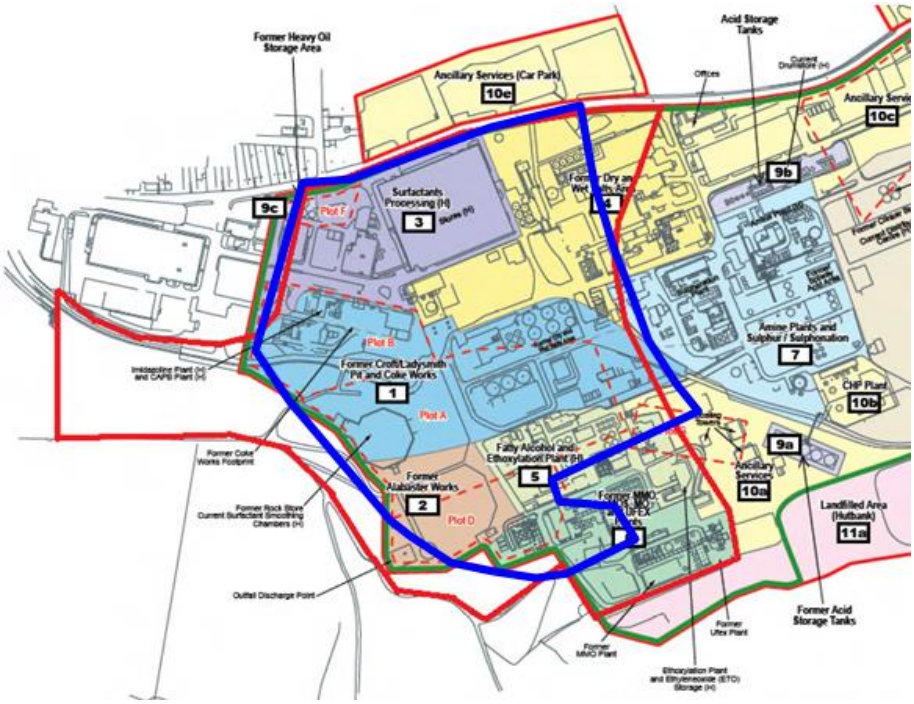
Introduction

The following summary has been taken from the third party reports referenced in Section 1 above.

"The site has been subject to extensive phased investigations initially associated with the previous Environmental Permit for the works, and more recently in connection with the Part IIA notification and with voluntary remediation works undertaken by Rhodia.

Initial investigations were organised according to zones of the site based upon the major activities carried out (see drawing below).

- *Zone 1 – Former Ladysmith Pit, including pit, railway, coke works and storage, more recently housed organic chemical plants and effluent processing areas;*
- *Zone 2 – Former Alabaster Works and part of former effluent processing area/works effluent drain;*
- *Zone 3 – Surfactants processing, stores, bulk oil storage*
- *Zone 4 – (northern part only) – Wet and dry salts area, including organic chemical manufacture, with various plants and tank farms.*
- *Zone 5 (northern part only – fatty alcohol and ethoxylation plants)*
- *Zone 6 (only just encroaches onto site) – Former chemical manufacturing including phosphoric acid production (MMO, MOS, MO plants) and waste treatment (UFEX plant)*
- *Zone 9c (southern part) – former tank farm*
- *Zone 10a (northern part only) – ancillary services: cooling towers, fire water and treatment basins and unused land."*



The proposed residential development detailed within this report includes all or parts of Areas 1, 2, 3, 4, 5 & 6.

"Following the initial investigation, certain plots within the former works were identified as requiring further investigation and risk assessment in order to satisfy Part IIA requirements; the scope of these investigations was agreed with the Environment Agency. These plots are detailed above and include plots A, B, D, F & the north of plot G."

URS Site Investigation

"The URS site investigation findings are reviewed below. The level of investigation was considered to be satisfactory for the purpose of the Part IIA remediation requirements and the Contaminated Land designation was discharged by CBC as a consequence.

The ground conditions identified by URS were as below";

Table 3.4: Shallow Geology Encountered During Site Investigations

Depth (m bgl)	Soil Description
0-3.4 (All trial pits and boreholes)	MADE GROUND: Comprising reinforced concrete, coarse gravel of limestone (hardcore), sand with gravel and boulders, reworked silty/sandy clay slag and clinker.
0.7-5.0 (All boreholes and trial pits progressed below the Made Ground).	DRIFT DEPOSIT: Orange brown sandy/silty CLAY. Varies from soft to stiff and gravel content commonly increases with depth.
1.5-2.45 (TP517)	DRIFT DEPOSIT: Gravel with silty medium SAND.
3.2-4.0 (WS401, WS413, TP505)	DRIFT DEPOSIT: BOULDER CLAY with fine-medium, angular-rounded gravel.
2.45-unknown (TP517, WS401, WS413)	BEDROCK: SANDSTONE.

"Shallow groundwater was encountered in the limited number of monitoring wells available for sampling at depths ranging from 0.04mbgl in WS415 to 3.21mbgl in WS411. Across the site shallow groundwater elevations range from approximately 94m AOD in the extreme east and western parts of the site to 80m AOD in the central and southern parts of site. Shallow groundwater is considered to flow topography, flowing from the western and eastern areas towards the central north south axis of the site.

The previous site investigation has noted voids formed in the Evaporite bedrock at certain locations. This may result from natural dissolution processes, but could have been exacerbated by leaks or spills of acidic fluids at locations associated with previous acid manufacture and use within the plant. All of the most recent sulphuric acid manufacturing plant lies outside the southern site boundary, however some of the older smaller processes making or using sulphuric acids may have been located within the subject site. Localised dissolution of bedrock will require further investigation and foundation solutions for new development similar to the techniques typically required over naturally weathered (karsified) limestone or chalk bedrock surfaces.

The two mineshaft locations were inspected by URS who reported in March 2007 as follows":

Shaft	Grid ref.	URS Observation
Croft	NX 9660 1588	*"No visible mineshaft or cap and no visible area of subsidence to indicate weakness in the existing cap. This area is currently covered in compacted brick and concrete rubble from demolition works. It is understood from Fred Proud of Rhodia that this shaft was well capped because it was proposed to develop and build upon the area above. It was not possible to see the state of the cap beneath the rubble."*
Ladysmith	NX 9654 1588	*"Like the Croft shaft, it is understood that this shaft was well capped as it was built upon with newer areas of plant. No visible shaft cap or entrance was apparent during the walkover survey, though a number of concrete plinths, with the remains of thick metal T and H bars were noted which may have once supported the above ground machinery above the shaft. The area is on the edge of the road, which once bordered the Phosphoric Acid storage tanks and the surrounding area has been levelled and consists of compacted brick and concrete rubble."* URS also noted on a geological section drawing that the Ladysmith Shaft extended to 254m depth and was filled and capped in 1997.

URS site investigation findings within the define contamination hotspots are summarised below:

Zone	uses	relevant information from URS
1.	former Croft / Ladysmith Pit, coke works then organic chemical plants and effluent processing areas, producing surfactants, inorganics (caustic), imidazoline and acetic acid	includes most of Plot A and most of Plot B Plot A – URS concluded that further remediation under Part IIA was not needed – however residual contamination includes localised hot-spots, e.g.TP631A – oil, naphthalene and cyanide; WS115 – TPH (diesel) Plot B – URS concluded that no remediation was required; the SI findings note the presence of PAH hot-spots and extensive heavy concrete foundations

Zone	uses	relevant information from URS
2.	former Alabaster Works and part of former effluent processing area / works effluent drain	includes much of Plot D (also extends into zones 5 and 6); reference to naphthalene contamination Plot D - investigations found contamination by chlorinated solvents, VOCs, PAHs and metals; further investigation for Pt IIA controlled waters risk assessment was recommended (May 2007) around: TP708D - chloroform TP706D - PAH WS123, WS416, WS717D – metals and naphthalene
3.	surfactants processing, perfume building, stores, bulk oil storage, and possible ammonia	
4.	wet and dry salts area, included organic chemical manufacture such as alcohols (methanol), esters and petrol additives, with various plants and tank farms	no identified hotspots
5.	fatty alcohol and ethoxylation plants; associated substances such as alcohols, esters, amides, amines, acetic acid, ammonia, barium, copper, chromium, hydrochloric and nitric acids	includes part of Plot D and Plot G – see comments under Zone 2 and Zone 10a respectively; reference to naphthalene contamination and voids in underlying limestone formed as a result of acid leaks; one void referred to near to WS130
6.	former MMO, MOS, MO and UFEX plants, used for chemical manufacturing including phosphoric acid production	includes part of Plot D – see comments under Zone 2; 2 voids in bedrock referred to 60m northwest of Plot G below former tank farm
9c.	bulk heavy fuel oil storage	includes part of Plot F – former bulk oil storage tanks – previously subject to remediation, URS investigation found some residual oil / diesel contamination; further monitoring was recommended but no remediation due to remote location of receptors away from designated Part IIA receptors (although free phase oil found above sandstone minor aquifer)
10a.	Ancillary services – cooling towers, fire water and treatment basins and unused land	includes part of Plot G – investigations found elevated TPH, naphthalene and other PAHs requiring further investigation, some timbers in mixed fills

Chemical Contamination

The site has been well characterized as a result of the previous Part IIA designation, with detailed investigations

having taken place in the key areas of interest identified by the Environment Agency. It should be noted that the northern most parts of the site lie outside the Part IIA site boundary and have never been determined as Contaminated Lane within the meaning of the Environmental Protection Act 1990.

The site has generally been affected by alkaline pH and elevated sulphates, phosphates and surfactants in the made ground, plus low-level poly-aromatic hydrocarbon (PAH) and metal contamination associated with ash and slags and local hotspots of hydrocarbons.

Generally, outside the oldest part of the works in the northeast associated with the former coking works and original chemical works, the contamination was localised and sporadic. The coking plant area (Plot B) contains the more significant contamination and is typical of such plants, being characterised by a range of by-products from coal gasification ranging from coal tars to petroleum and diesel range hydrocarbons and phenols. Observations of localised oils or tars in the made ground extending into the natural soils and bedrock surface were noted in a few entries, together with rubble filled cellars and at least one void. It is possible that tar-filled sumps or pipes may be present in this area.

Contamination levels were found to be sufficiently lower for the Part IIA designation to be withdrawn without requiring any specific treatment or removal of contamination from the subject site, on the basis of the site as open space with casual public access. The principal reason for the original determination was pollution impact upon controlled waters, and since decommissioning of the works it has been found that water pollution has diminished to levels that no longer pose a significant environmental risk.

Hotspots of other contaminants could exist, particularly around former bulk oil and diesel stores and effluent storage/treatment areas. Inspections and observations during site preparatory works will enable any such deposits to be identified and remediated as necessary in order to ensure that the site is made suitable for the proposed future residential use and significant source of pollution to controlled water are addressed.

Radioactive Contamination

Rock phosphate imported to the site contained naturally elevated concentrations of uranium. Most uranium would have been removed during phosphorous extraction either via the effluent stream or in the fine solids deposited at the off-site UFEX landfill. The concentrations of naturally occurring radioactive material (NORM) associated with wastes from the site would typically be sufficiently low for them to fall within regulatory exemptions for radioactive substances for disposal purposes.

Previous assessment of residual radioactivity resulting from phosphate ore processing have determined that no significant levels of radioactivity are present, and the site has not been determined as Radioactive Contaminated Land under Part IIA legislation. Further screening assessment will be required during site preparatory works for the development to check that the previous assessments remain appropriate when access is gained to additional areas of the site."

Smith Grant Conclusion

"National planning policy guidance in relation to contaminated land states that planning authorities should be satisfied that sufficient information exists in order to grant a planning consent, and that the proposed development should be feasible and practicable. Smith Grant LLP has reviewed the extensive site investigation reports

available for the site and concludes that these provide a suitable and sufficient basis of factual information for understanding the nature and extent of contamination at the site. This means that the risks from unknown contamination or unforeseen conditions that could comprise development proposals are lower than is normally the case.

Planning consent when granted for potentially contaminated sites will include conditions that specify the measures to be taken prior to development to identify contamination via site investigations, and to inform the preparation of a detailed remediation strategy. However, in order to be satisfied that planning consent may be granted, the planning authority must be satisfied that it understands the potential risks associated with the development. These risks may include the likelihood that contamination exists that for technical, environmental or economic reasons is impracticable to deal with, thereby sterilising part of or all of the development site. We are satisfied that no such risks exist on the site, and that various issues (listed below) do not pose unusual or unacceptable constraints for residential development on brownfield land.

<u>Development Constraints</u>
The following matters concerning residential development of the site and their solutions are identified below:

- *Irregular topography with some steep slopes – remodelling (cut and fill) to suitable development contours*
- *Foundation slabs, sub-structures, loose fills, relic services – systematic strip of obstructions and loose fills with recovery of suitable hard materials (concrete and brick) for crushing and reuse or sale, recovery of scrap metal and timber and disposal of any other residues.*
- *Polluting liquids in tanks, pipes or other voids – pump out and remove from site for treatment or disposal as appropriate;*
- *General fills with low level contamination – regrade to future development levels to accommodate clean soil cover/service corridors etc; clean soil cover would be placed in garden areas during house-building with validation of soil depth and quality.*
- *Contamination 'hot-spots' – excavation and removal to quarantine/soil treatment area for treatment of off-site disposal;*
- *Possible low-level radioactivity – previous assessment has rules this out and precautionary screening only is advised; if sources were encountered then these would be assessed and removed to low sensitivity landscape areas if necessary;*
- *Solution cavities in bedrock – either removed during preparatory earthworks or, subject to size, grouted if below sensitive areas (houses or roads).*

Additional site investigation will be required in some areas of the site to fill gaps in previous coverage, further examine locations previously constrained by services, presence of contained liquid contaminants, or extensive sub-structures, and to confirm and update the previous investigation findings. The scope of further investigations and monitoring should be agreed in consultation with the Local Planning Authority and Environment Agency and will be designed with specific respect to the proposed change of use to residential and current risk to controlled waters.

Following completion of updated investigations and risk assessment a detailed remediation strategy will be required."

Betts Geo note – It appears that no ground gas monitoring has been undertaken for the SG or URS reports. SG stated the following in their report:

"Some of the fills contain various unsuitable materials including organic materials that could act as sources of gases and vapours. However, generally across the site there have been no significant sources of ground gas identified, and the majority of the Made ground and natural soils are inert in terms of gassing potential.'

2.4 Summary of Additional Betts Geo Ground Investigation

Introduction

Betts Geo undertook an additional investigation in late 2022 and early 2023. The exploratory holes were positioned to target areas requiring additional investigation as outlined by the Smith Grant SI report and as agreed with the Environment Agency, and to target the void encountered during the first phase of the Betts Geo investigation.

Fieldwork

The fieldwork was carried out between the 28th November – 13th December 2022 for the trial pitting, 9th January – 18th January 2023 for the window sampling and the 23rd January – 27th January 2023 for the rotary boreholes. The additional works comprised of the following;

- One hundred and seven (107 No) machine excavated trial holes to a maximum depth of 5.50mbgl (TP207) targeting the areas identified in Section 7.3 above.
- Sixty (60 No) window sample boreholes to a maximum depth of 5.00mbgl targeting the areas identified in Section 7.3 above.
- Thirty (30 No) of the boreholes were installed with gas/groundwater monitoring wells (early refusal of the other thirty holes prevented installation).
- Six (6 No) rotary open boreholes drilled to up to 30.00mbgl in the Evaporite deposits to check for subsidence features/hollows/voids (agreed with Coal Authority that permit not required as coal is deep on site).
- Five (5 No) deep water monitoring wells by open hole rotary.
- Chemical analysis (Metals, PAH's, TPH's) of two hundred and thirty nine (239 No) samples.
- Analysis of one hundred and thirty five (135 No) samples for asbestos analysis.
- Screening of forty-seven (47 No) samples for organics (VOCs & SVOCs by GCMS inc TICs)
- Screening of five (5 No) samples for carbonisation suite (phenols/cresols, total and free CN)
- Screening on one (1 No) additional sample for solely speciated TPH's (TPHCWG inc. BTEX)
- Six (6 No) ground gas and groundwater monitoring visits over the course of three (3 No) months at varying barometric pressures.
- In addition to the agreed SG scope, trial trenches under a Coal Authority Permit were undertaken to locate the 2 known deep coal mine shafts

Further additional investigation was undertaken between the 9th May 2023 – 11th May 2023 and comprised of the following:

- Five (5 No) rotary open boreholes drilled to up to 30.00mbgl in the vicinity of the potential void identified in the original Betts Geo borehole RBH GWM 01 to check for further subsidence features/hollows/voids.
- Installation of one (1 No) deep monitoring well to replace the aborted collapsed hole.

The original exploratory hole positions were selected and set out by Smith Grant and agreed with the EA prior to the additional work commencing. The locations of which are shown on the Exploratory Hole Location Plan in Appendix B.

The additional borehole locations were set out by Betts Geo to target the previously identified void area in RBH GWM 01. More information on this work can be found in Section 18 below.

Water testing was undertaken on the 22nd February 2023, 27th March 2023 and the 7th June 2023 and consisted of the following:

- Collection of samples from the ten (10 and 11 No) wells that were identified to contain significant water for both deep and perched water bodies during the first few groundwater monitoring visits.
- Screening of ten (10 No) groundwater water samples for the following: pH, EC, As, B, Cd, Cu, Hg, Ni, Pb, V, Zn, Cl, NH3, NO3, Sd, TPH, VOCs, SVOCs (including PAHs), phenols, CN, MBAS, SO4, PO4 on each visit.
- Eleven (11 No) water samples were collected from the visit in June 2023.

Following discussions with the EA, it is proposed that an additional water sampling visit is undertaken in the final season - Autumn to capture all seasonal groundwater levels.

An additional water sample was taken from the additionally installed well (RBH01A) on the 25th May 2023.

Ground Conditions

Ground conditions consisted of various types of MADE GROUND (to a maximum depth of 5.50mbgl) generally overlying a soft to stiff dark brown sandy gravelly silty CLAY/clayey SILT. In a number of the holes, the made ground was not bottomed out due to extent of made ground/collapse/groundwater/free product/obstructions.

Bedrock was encountered in the majority of holes (apart from along the south western boundary where cohesive cover was thicker) with SANDSTONE being prominent in the very northern area of site and St Bees Evaporite (LIMESTONE) across the remainder of site. The LIMESTONE was shallower along the eastern and south eastern edge of the site boundary. SILTSTONE was encountered in some of the trial pits along the south western site boundary.

Visual and Olfactory Contamination

The following visual and/or olfactory contamination was encountered during the additional works:

- TP2 – Occasional sulphuric odour between 0.75mbgl – 1.00mbgl (former coke works area).
- TP6 – Hydrocarbon/creosote odour between 0.00mbgl – 1.30mbgl (former coke works area).
- TP8 – Strong volatile odour between 0.70mbgl – 1.60mbgl (former coke works area).
- TP8 – Sheen on groundwater ingress at base of pit (3.40mbgl) (former coke works area).

- TP9 – Strong soap odour between 0.20mbgl – 2.10mbgl (surfactants processing area).
- TP16 – Strong solvent/oil odour between 2.30mbgl – 2.60mbgl (former coke works area).
- TP17 – Faint coal odour (former coke works area).
- TP22 – Strong soap/bleach odour between 0.15mbgl – 0.40mbgl (surfactants processing area).
- TP25 – Free thick black product noted at 1.90mbgl – possible tar with strong chemical odour (former coke works area).
- TP25 – Isolated pocket of slimy grey gloop substance – non Newtonian in nature (solid and liquid) between circa 1.90mbgl – 3.20mbgl (former coke works area).
- TP28 – Faint creosote odour between 0.10mbgl – 2.00mbgl (no area designated).
- TP28 – Iron oxide iridescence noted on groundwater in old land drain at 2.40mbgl (no area designated).
- TP29 – Slight creosote odour between 0.30mbgl – 2.30mbgl (Former MMO area).
- TP33 – Black tarry free product noted below 2.00mbgl with strong hydrocarbon odour (former coke works area).
- TP33 – Relic fuel tank – tank dimensions circa 4m long x 2m wide (former coke works area).
- TP34 – Strong soap odour between 0.30mbg – 0.90mbgl (surfactants processing area).
- TP36 – Slight soap odour below 2.00mbgl (surfactants processing area).
- TP38 – Slight hydrocarbon odour between 0.30mbgl – 0.60mbgl (surfactants processing area).
- TP49 – Slight volatile odour between circa 0.90mbgl – 2.50mbgl (former coke works area).
- TP52 – Strong hydrocarbon/creosote odour from water in drain at 0.80mbgl along with sheen on top of water (former coke works area).
- TP82 – Slight sheen in seepages noted between 0.60mbgl – 2.05mbgl (former coke works area).
- TP88 – Sheen on ingress from water pipe between 0.35mbgl – 0.60mbgl. Moderate hydrocarbon odour (former dry and wet salts area).
- TP89 – Sheen on groundwater at 1.90mbgl. Hydrocarbon odour (former dry and wet salts area).
- TP90 – Oily sheen on standing water at 0.80mbgl (former dry and wet salts area).
- WS28 – Oily sheen in top 1m (former coke works area).
- WS41 – Slight sulphur odour (former coke works area).
- WS59 – Coke works odour between 0.30mbgl – 1.00mbgl (former dry and wet salts area).

Additional rotary boreholes in the vicinity of RBH GWM 01:

- RBH01A Contamination –19m visually contaminated groundwater (monitoring well installed and water sample obtained from this well – results of this detailed further down in the report)
- RBHV1 Contamination 19m visually contaminated groundwater,
- RBHV2 Coal Tar odour and visible oil sheen - possible surfactants / fatty acids? at 18m – drilling stopped due to level of contamination/risk to underlying aquifer
- RBHV3 Surfactant odour in Made ground – oily sheen 8.0 in flush

Obstructions

The following obstructions were encountered during the ground investigation (other than the bedrock that caused early refusal):

- Shaft 1 – Concrete cap at 3.30mbgl (former coke works area).

- Shaft 2/TP81 – Concrete cap at 5.50mbgl (former coke works area).
- TP5 – Concrete slab at 2.30mbgl (former coke works area).
- TP7 – CAT scanner signals/interference (former coke works area).
- TP10 – Dense lean mix concrete/sub-base at 1.20mbgl (former coke works area).
- TP11 – Concrete at 1.50mbgl (former coke works area).
- TP40 – Inspection chamber 2.2 x 1m at 1.90mbgl (former coke works area).
- TP45 – Pit not undertaken due to proximity to gas main (surfactants processing area).
- TP48 – Pit not progressed due to high scintillation readings within a broken drain (max reading of 640) (former coke works area).
- TP49 – Terminated at 2.50mbgl due to unknown obstruction – difficult to dig (former coke works area).
- TP53 – Large hollow identified directly under former drain to 6.70mbgl (former dry and wet salts area).
- TP54 – Concrete slab at 0.90mbgl (former dry and wet salts area).
- TP58 - Pit not undertaken due to proximity to gas main (surfactants processing area).
- TP68 – Concrete slab on right hand side of pit at 1.10mbgl (former coke works area).
- TP69 – Very dense brick fill at 1.50mbgl (former coke works area).
- TP71 – Concrete slab at 1.30mbgl (former coke works area).
- TP74 – Heavily re-enforced concrete at 0.35mbgl – cannot break through (former fatty alcohol plant area).
- TP76 – Concrete at 0.40mbgl (former coke works area).
- TP87 - CAT scanner signals/interference (former dry and wet salts area).
- TP89 – Possible obstruction or bedrock at 2.10mbgl (former dry and wet salts area).
- TP90 – Boulders of re-enforced concrete at 0.80mbgl (former dry and wet salts area).
- TP91 – Concrete slab at 0.20mbgl (former dry and wet salts area).
- TP96 – Concrete slab at 0.90mbgl (former dry and wet salts area).
- TP100 – trial pit not undertaken due to proximity of services (former dry and wet salts area).
- TP101 - Pit not undertaken due to proximity to gas main (former dry and wet salts area).
- TP105 (WS54) – Concrete slab at 1.20mbgl (surfactants processing area).
- TP106 – Concrete slab at 0.40mbgl (former dry and wet salts area).
- WS01 – not undertaken due to proximity to sewer (no area designated).
- WS02 – not undertaken due to proximity to sewer (no area designated).
- WS03 – Refusal at 0.40mbgl (no area designated).
- WS06 - not undertaken due to proximity to sewer (no area designated).
- WS10 – Refusal at 0.70mbgl (former coke works area).
- WS11 – Obstruction at 0.60mbgl (former coke works area).
- WS12 – Refusal at 0.30mbgl (former coke works area).
- WS13 – Refusal at 1.00mbgl (former surfactant processing area).
- WS14 - not undertaken due to proximity to high pressure gas main (former MMO Area).
- WS15 – Refused at 1.50mbgl (former alabaster works).
- WS19 – Refused at 0.60mbgl (former coke works area).
- WS20 – Refused at 1.30mbgl (former coke works area).
- WS21 – Refused at 0.70mbgl (former surfactants processing area).
- WS22 – Refused at 0.40mbgl (former surfactants processing area).
- WS23 – Not undertaken due to high pressure gas main (former surfactants processing area).

- WS25 – Refusal at 0.50mbgl (former fatty acid plant).
- WS27 – Refusal at 0.90mbgl (former coke works area).
- WS31 – Not undertaken due to high pressure gas main (former surfactants processing area).
- WS32 – Refused at 0.10mbgl (former fatty acid plant).
- WS33 – Refused at 0.40mbgl (former coke works area).
- WS34 – Refused at 1.00mbgl (former coke works area).
- WS35 – Refused at 0.30mbgl (former dry and wet salts area).
- WS36 – Refused at 0.50mbgl (former surfactants processing area).
- WS38 – Refused at 0.70mbgl (former surfactants processing area).
- WS39 – Refused at 1.50mbgl (former MMO Area).
- WS40 – Refused at 0.10mbgl (former fatty acid plant).
- WS41 – Refused at 1.00mbgl (former coke works area).
- WS42 – Refused at 1.00mbgl (former coke works area).
- WS43 – Refused at 0.70mbgl (former dry and wet salts area).
- WS46 – Refused at 0.70mbgl (former surfactants processing area).
- WS47 – Refused at 0.40mbgl (former fatty acid plant).
- WS49 – Refused at 1.50mbgl (former coke works area).
- WS52 – Refused at 1.10mbgl (former surfactants processing area).
- WS53 – Refused at 1.20mbgl (former surfactants processing area).
- WS54 – Not undertaken due to high pressure gas main (former surfactants processing area).
- WS55 – Refused at 0.20mbgl (former dry and wet salts area).
- WS56 – Refused at 0.10mbgl (former dry and wet salts area).
- WS58 – Refused at 0.40mbgl (former dry and wet salts area).
- WS59 – Refused at 1.00mbgl (former dry and wet salts area).
- WS60 – Not undertaken due to high pressure gas main (former dry and wet salts area).
- RBHV4 – Steel obstruction at 4.65mbgl – burnt out HW casing shoe on drilling rig – hole moved 1.5m west and re-drilled
- RBHV4A – Steel obstruction at 3.65mbgtl – burnt out HW casing shoe on drilling rig.

Note: 1) extensive buried concrete and brick structures should be anticipated throughout the site.
2) ground investigation was move around existing at surface concrete and as such more obstructions should be anticipated.

Due to the use of Uranium rich Phosphate sand the possibility of radioactivity above background / NORM needed investigation. As mentioned above TP48 encountered a high scintillation reading within a broken drain. A plan of this location is shown below;

Scintillation levels were generally <100 elsewhere across the site with coal carbonisation processes giving higher readings than natural deposits which is what would be expected. None of these results are of concern when revieing background levels.

<u>Voids</u>

A number of possible void features were identified in the exploratory holes as detailed below:

- TP12 between 1.50mbgl – 2.40mbgl (surfactants processing area).
- TP53 – large void feature on side of pit directly under former drain. Void measured from 3.10mbgl – 6.70mbgl (former dry and wet salts area).
- WS48 potential void between 4.00mbgl – 5.00mbgl (former coke works area).
- WS52 – Void to side of hole (surfactants processing area).
- RBH GWM 01 – Hole was terminated at 23.00mbgl due to loss of flush. Upon completion the borehole collapsed back to 5.00mbgl and no standpipe was installed.

There is no correlation between the location of the features other than RBH GWM01 being in the location of the known outfall pipe and flume The URS report also mentioned bubbling froth coming out of the ground at this location.

It is important to note that since the trial pitting exercise, reports of a sink hole in the vicinity of TP53 have been made by local walkers. The reported sink hole correlates with the former drain and narrow void encountered in TP53 and mentioned above. In addition further investigation around the discharge drain in the NW corner of site has identified what appears to be a collapsed manhole which may be dissolution orientated.

Further investigation works were deemed necessary in the area of RBHGWM01 to identify the full depth and extent of this void feature and these were undertaken in May 2023 (detailed above).

Additional voids were found in the following additional rotary boreholes:

- RBHV1 – Total loss of returns at 22.40mbgl (voiding) – abandoned location
- RBHV3 – Very broken/fast drilling 6.6 – 10.1mbgl borehole noted as unstable/collapsing
- RBHV4 – Very fast/broken drilling with loss of flush between 5.50mbgl – 6.00mbgl (voids).
- RBHV4A – Very fast/broken drilling with total loss of returns at 4.60mbgl. Void from 5.5m – 6.6m.

It is important to note that the acid / fatty alcohol / naphthalene production area was historically all upstream of the area where the additional boreholes were undertaken to investigate the void identified in RBH GWM 01 (in the drainage run) and has reported voids historically in the far south west and NW corner of site (SG report references them). Given the visual and olfactory contamination encountered in the groundwater in this area, it is suggested that the voiding is exacerbated dissolution by acids most probably and has historically been filled with colliery spoil in this locality.

In regards to the voids – these features seem to be originating from surface down and linked with water / acid drainage leaks concentrated in the lower northern area of site (shown below in yellow). It is deemed a high risk to try to develop these areas both geotechnically and contaminative grounds.

Areas highlighted as being more prone to dissolution due to the published geological faults are shown below. These areas (in pink) will require an increased level of scrutiny geotechnically and ideally to reduce development risk layouts planned around to avoid the areas and replace with low risk open space of commercial end use. Following extensive detailed geophysical and intrusive investigation once the site is cleared of obstructions these areas may be reconsidered for residential end use.

Contamination

For full details and breakdowns on the individual contamination encountered on site during the Betts Geo investigation please refer to the Betts Geo SI report referenced in Section 1.3 above.

In summary, previous investigation by Smith Grant identified that the site was "*generally affected by alkaline pH and elevated sulphates, phosphates and surfactants in the made ground, plus low-level poly-aromatic hydrocarbon (PAH) and metal contamination associated with ash and slags and local hotspots of hydrocarbons.*

Generally, outside the oldest part of the works in the northeast associated with the former coking works and original chemical works, the contamination was localised and sporadic. The coking plant area (Plot B) contains the more significant contamination and is typical of such plants, being characterised by a range of by-products from coal gasification ranging from coal tars to petroleum and diesel range hydrocarbons and phenols. Observations of localised oils or tars in the made ground extending into the natural soils and bedrock surface were noted in a few entries, together with rubble filled cellars and at least one void. It is possible that tar-filled sumps or pipes may be present in this area."

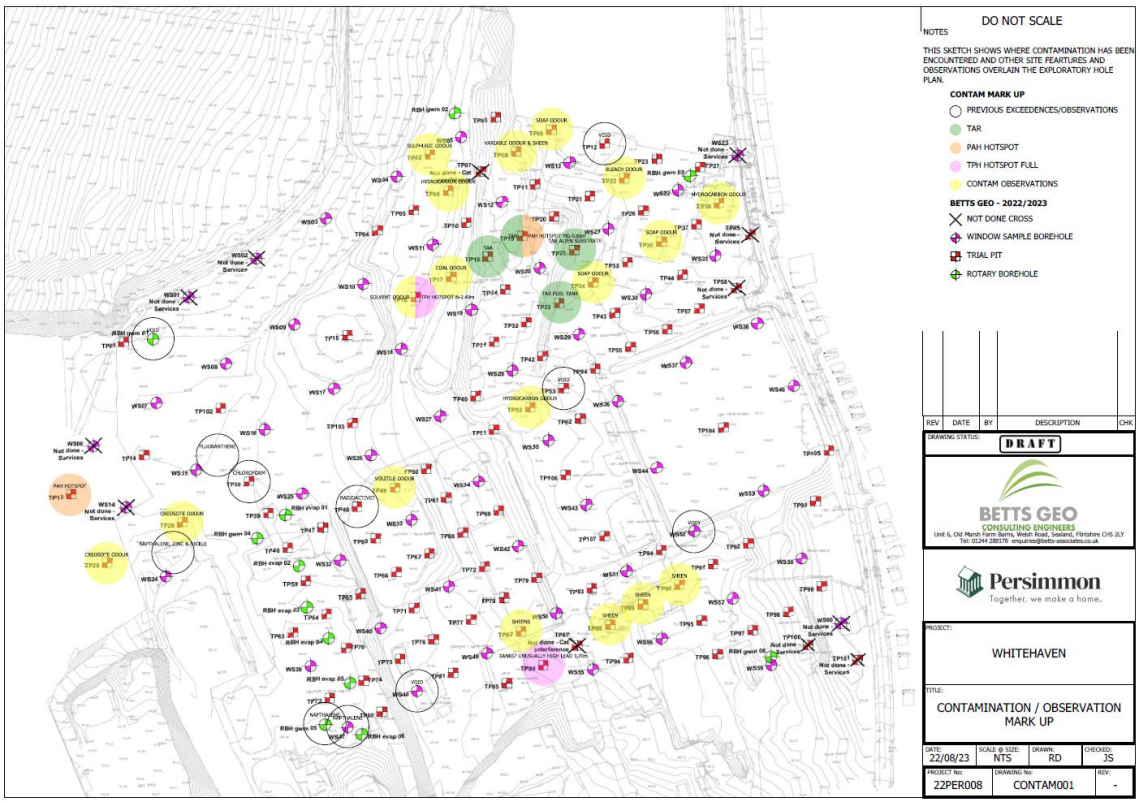
The findings from the Betts Geo additional investigation support Smith Grants' original conclusions. Elevated contamination was identified across site but was generally found to be contained within the Made Ground strata (apart from the in Former Coke Works/Surfactants Processing Area where some exceedances were noted in the natural strata). Higher levels of contamination were also found to be contained within the Former Coke Works/Surfactants Processing Area, with less elevations and lower values encountered across the remainder of the site. This is likely due to the concrete construction used in all areas across the remainder of the site, preventing any significant contamination pathway into the underlying strata.

Betts Geo undertook additional targeted investigation in the higher risk areas identified by Smith Grant. Free product in the form of tar was noted in the north eastern area of the Former Coke Works Area along with a number of strong hydrocarbon/chemical/creosote/volatile odours in the immediate vicinity. Two TPH & PAH hotspots were also noted in this area in TP16 & TP19 and a cyanide hotspot in TP16.

A lead hotspot was also identified in TP86 along the southern boundary of the Former Coke Works Area. According to historic maps, this location used to house a number of fuel tanks which could be the reason behind the significantly elevated lead. A number of sheens were also noted in the trial pits in the immediate vicinity of TP86 in the groundwater entering the pit from drains within the exploratory hole.

Creosote odours were also noted in TP28 & TP29 during the Betts Geo investigation despite chemical testing identifying no determinants to be significantly elevated. The former Smith Grant investigation identified naphthalene, zinc and nickel in this area during their investigation. These trial pits sit within the Former MMO, MOS, MO and UFEX plant area.

A sketch showing these areas can be seen below;



As a result of the contamination identified, both by Smith Grant & Betts Geo, Betts Geo recommend that a site turnover is required down to natural strata across the site with all unsuitable Made Ground & obstructions being removed / processed.

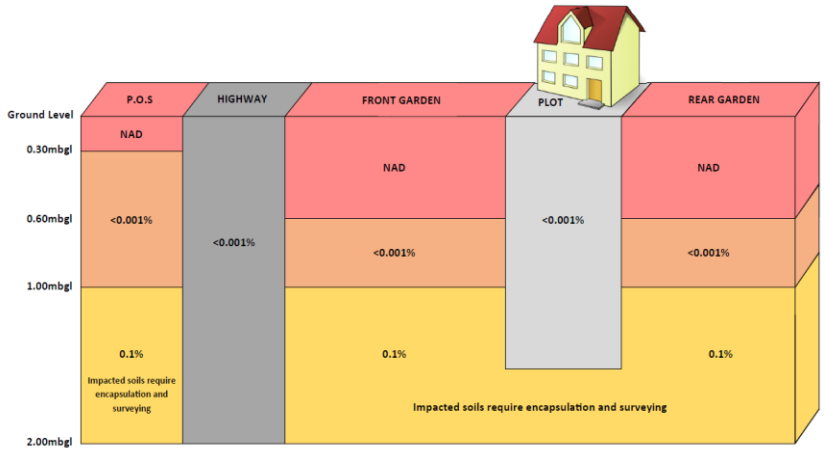
It recommended that any free product/impacted perched groundwater (particularly within the Former Coke Works Area) is either pumped to a treatment tank on site to allow for the removal of dissolved phase organic compounds

or is tankered off site and disposed of at a suitably licensed facility. Possible discharge of slightly elevated water to foul sewer under discharge consent is to be a considered avenue for remedial work. It is possible that lime stabilisation techniques can be utilised to treat the more contaminated material within the Former Coke Works Area and Surfactants Processing Area to remove any leaching potential and placed at depth below less sensitive areas (in areas of POS or gardens below 1mbgl) depending on resulting contamination levels post treatment.

Positive asbestos identifications were found across site (likely due to poor demolition practices). Based on the testing to date, the asbestos is likely to be site wide therefore based on this factored in with the contamination identified across site it is recommended that either of the following remedial measures are implemented across the site (dependent on proposed site levels):

- a 1000mm clean cover system comprising of 150mm topsoil and 850mm of subsoil; or
- a 600mm clean cover system with a no dig layer at the base comprising of 150mm topsoil, 450mm subsoil and either a 6f2 layer or geotextile membrane at the base.

Asbestos quantification results being ranged between <0.001% - 0.217%. The diagram below shows acceptable asbestos levels for certain areas of site and should be referred to when the quantification values come back from the lab.



Notes:

P.O.S - Public Open Space

NAD - No Asbestos Detected

0.001% - Soils may contain ≤0.001% using composite testing to ensure there is no potential risk to human health. Value is present where there may be short-term low level exposure of soils containing trace asbestos fibres by construction workers where an appropriate level of asbestos management is employed (e.g. dust suppression).

0.1% - Soils at depth of >1.00mbgl may contain <0.1% asbestos using composite testing where they will be not likely not be disturbed in the future and will therefore be in an area of Low Sensitivity. Risk assessment completed in accordance with the Asbestos JIWG Risk Assessment Tools.

Undefined - Dependant upon soils encountered during earthworks, which may be placed at depths to ensure no potential risk to human health.

Burial and encapsulation of asbestos should be agreed with regulators and consultant prior to the works being undertaken. Consideration should also be made to CAR-SOIL ™.

Groundwater, Surface Water and Aquifer Risk

Betts Geo identified a number of sheens on the groundwater coming from broken drains within the trial pits (mainly TP82 and TP88 – TP90 on the south western boundary for the Former Coke Works Area) and free product within the area to the north east of the Former Coke Works area. Both the impacted perched groundwater and free product is proposed to be either treated on site or pumped and tankered off site during the remediation of the site, as detailed above as such lowering any risk to groundwater within the underlying aquifer.

If the free product/groundwater is to be treated on site, a suitable foul water discharge point for any treated water

to be disposed of under an appropriate license is to be agreed before any works begin. If free product/groundwater is to be pumped and tankered off site, it is recommended that the results of the contamination testing be presented to the proposed end site to obtain their acceptance of the information to date. Remaining perched water deemed contaminative will be assessed to see if it can be disposed of via foul discharge consent.

Groundwater sampling was undertaken in 10 wells across the site during the first visit and 11 wells across the site during the second and third visit (in wells with sufficient depth of water to sample). The results of the groundwater sampling identified generally clean groundwaters across the site, however a benzene, fluorantene Ammoniacal Nitrogen and MBAS hotspot area within the vicinity of RBH GWM 04 & RBH EVAP 02 and 03 (former MMO Plant area). It is thought that the groundwater within RBH GWM 04 is perched on top of the impermeable Brockram lowering any migration risk into the underlying aquifers however that within RBH EVAP 02 is that of the general groundwater table.

It is proposed that an additional water sampling visit is undertaken over the remainder of the seasons – Autumn to capture all seasonal groundwater levels. It was originally advised that based on the first round of groundwater testing, this area will require delineation and if a source of contamination cannot be identified, the groundwater testing scope is expanded to include speciated waters for TPH banding.

When looking at TPH levels again, the results in water were very limited (limited to just the boreholes) and on the second round of monitoring, the TPH values reduced significantly on the second round (only in RBHGWM 04) and none were elevated on visit three. It was originally conceived to run analysis against a wider banding CWG, however based on these low results this is no longer deemed necessary.

Hearsay information: Following discussions with a senior gas / ventilation analyst previously employed by Haig Pit in the 1970's/80's, it was mentioned that all the deeper colliery ground water was known to drain from Croft through Haig pit to the north and then via Saltom Pit. Apparently, it was discussed if it was viable in the 1970's to backfill Croft pit with chemical waste from Marchon – however due to the concurrent coal working the proposed deposition wasn't approved by the NCB due to the migration risk. This would differ from the previous discussions with URS and EA believing that the majority of groundwater flow was to the west and to the Byrestead Fault. Clearly man-made fractures due to mining has significantly influenced groundwater flows locally.

Site investigation identified the superficial geology as generally a firm to stiff CLAY across the majority of site which appears to be limiting any migration into the underlying aquifer. Extreme care is required to ensure the clay barrier to the Secondary A Aquifer remains intact during the remediation. Where shallow bedrock was identified, special protection measures should be implemented to ensure no contaminated groundwater enters the underlying aquifer.

The row of monitoring wells in the west identify various contaminants but limited to the northern holes. There are various possible sources suggested Landfill (offsite to the south but discharge pipe runs along this area) former coke works to the north east of here (down gradient and site drainage leading between the two) and historical tanks overlying this location.

When reviewed with different products / a typical hydrocarbon plume, very little correlation is possible i.e. we

would expect the benzene to be at the front of the plume.

Given the historical ground water review and our own, we suspect that mobility of water is very high due to micro drainage systems within the evaporites and faulting – it is possible that this contamination has been held back by the faulted block to the west acting as an aquitard to movement of water in this locality at depth.

The geology in this area is complicated in that there is faulting and a mine drainage adit at relatively shallow depth (circa 85m), dissolution features at rock head and water table interface. In addition man-made influence in the form of effluent drainage and flume are also factors impacting groundwater flow and contamination potential, all of which makes accurate assessments very difficult. What can be concluded is that the area in the NW where dissolution is evident will pose development issues and development in form of grouting / piling to overcome geotechnical issues will have knock on effects to groundwater and regulatory concern.

Ground Gas

Elevated methane (>1%) was encountered in WS59 on 5/6 visits (however only slightly elevated on visits 5 & flooded on visit 6) and elevated carbon dioxide close (>5%) was encountered in WS59 on four out of the six visits. Significantly depleted oxygen was also noted in this well on all five visits (between 16.1 – 3.7%v/v – visit 6 was flooded).

No significantly elevated gases were encountered in the remaining wells across the site over the course of the six visits.

WS59 encountered a coke works odour between 0.30mbgl – 1.00mbgl which is highly likely to be the source of the elevated ground gas encountered to date. As a result, it is recommended that the area surrounding WS59 is excavated and delineated to remove any source.

Following the excavation and delineation of WS59, and based on the rest of the gas results for the remainder of the site, it is anticipated that despite no significant ground gas levels being encountered, given the historic site use, Amber 1/CS2 ground gas protection measures should be implemented across the site. This can be confirmed now the ground gas monitoring visits are complete.

SVOC/VOC resistant membranes will be required across the site given the PID readings and odours encountered during the SI, however due to the proposed site turn over it may be possible to reduce this requirement with further monitoring and remedial work. For pricing it is however suggested that the allowance for this is made.

Foundations

Due to the variable nature of ground conditions, possible dissolution risk and proposed earthworks required across site, conventional foundations are not deemed applicable.

The site requires extensive turn over to remove existing foundations / drainage runs and buried services to allow development platforms and earthworks. Following excavation / turn over / crush and replace it is proposed that uniform development platforms are developed to allow raft foundations to be constructed.

Following discussions with the NHBC, a rigid 'mining' raft is proposed due to the residual risk of dissolution / karst features. Careful design of remedial work is required to reengineer fill / crush to provide a bearing platform for the rafts and ensure NHBC differential settlement / tilt requirements are met.

The use of piling has been discussed with the Environment Agency (correspondence attached) and it is agreed that the use of such foundations is not viable on the basis of contamination. The use of piles is also problematic given the possible increased dissolution due to piles acting as conduits to groundwater flow.

An alternative to placed engineered fill in the form of vibro treated ground for the placement of the raft upon it, which may be more favourable should the earthworks fall outside of the traditional season to get best compaction and may prove cheaper than extensive earthworks testing verification costs. Following discussions with the Environment Agency, (Letter ref NO/2021/113582/03-L01 12 July 2023) they would request significant further risk assessment if this was the chosen solution.

Given the nature of the site, all proposed foundation designs should be agreed in advance with the NHBC.

Care is required to ensure shallow bedrock doesn't influence the raft tilt – this needs consideration within the remedial earthworks.

The following bearing capacities are recommended for the following natural strata's:

- Soft to firm CLAYs – 75kN/m2 – 100kN/m2
- Firm to stiff CLAYs - 125kN/m2 – 150kN/m2
- Weak SANDSTONE/LIMESTONE/SILTSTONE – 250kN/m2

3 REMEDIAL ACTIONS

All remedial works are to be completed under the supervision of an independent and suitably qualified consultant.

A summary of the proposed remedial scope can be seen below with further detail found in each subheading:

- Site clearance and vegetation strip
- Placement of sedimentation traps and surface water run off control measure put in place
- Targeted remediation to the tar/free product hotspots (former coke works area) and areas with sheens on groundwater.
- Breaking out, grubbing up and crushing of existing and relic slabs, foundations, hardstand, drains and sewers.
- Turnover the full thickness of made ground materials across site, including screening of oversize and deleterious materials & crushing of oversize materials generated by the screening of made ground before placement as engineered fill to support new infrastructure
- Disposal of deleterious materials generated by the screening of made ground to a suitably licensed waste facility
- Any tanks encountered to be broken down and filled with site won material
- Grouting of existing mine shafts & voids
- Provision (via importation) of suitable topsoil/subsoil materials required in garden and landscaped areas
- Independent consultancy supervision, validation, verification (including provision of chemical and geotechnical analysis) and production of drawings (as built survey etc)
- Ongoing vigilance for unforeseen contamination.
- Amber 1 Ground Gas Protection Measures to be installed across site.

3.1 Site Clearance and Vegetation Strip

Excavation in close proximity to any existing services will need to ensure that the excavation walls are stable or appropriately battered to a safe angle, temporary slope stability works may be required in any deep excavations.

Topsoil and any unsuitable Made Ground should be removed from beneath all proposed buildings and hard standing areas. Vegetation and topsoil strip must be undertaken in sequence.

Excavations of shallow soils should not present any difficulty for conventional plant and equipment.

3.2 Placement of Sedimentation Traps and Surface Water Run Off Control Measure Put in Place

Due to the sites proximity to surface water courses, sediment traps and surface water run off control measures (such as cut off ditches and earth bunds) should be put in place before any excavations commence due to contamination potential of the site and the underlying soils. All ditches/bunds must be 10m from the surface water course. Redundant pipework across the site must that isn't being removed as part of the remedial works will also require blocking up to prevent any contamination migration pathways.

Targeted remediation to the tar/free product hotspots (former coke works area) and areas with sheens on groundwater.

Due to both the contamination and obstructions encountered in the former coke works area, extraction of the area down to natural ground will be required.

Any areas of free product or tar being identified will need to be removed and disposed of at a suitably licensed facility. The free product could possibly be treated on site or pumped and tankered off site during the remediation of the site.

If the free product/groundwater is to be treated on site, a suitable discharge point for any treated water to be disposed of under an appropriate license is to be agreed before any works begin. If free product/groundwater is to be pumped and tankered off site, it is recommended that the results of the contamination testing be presented to the proposed end site to obtain their acceptance of the information to date. Remaining perched water deemed contaminative will be assessed to see if it can be disposed of via foul discharge consent.

This should be the first remedial action to be completed on site due to its possible impact on the remainder of the site if left in situ or disturbed during further earthworks.

Consideration to the stabilisation of the material and retention on site in low risk areas should be given.

3.3 Breaking Out, Grubbing Up and Crushing of Existing and Relic Slabs, Foundations, Hardstand, Drains and Sewers

Buried obstructions are anticipated given the historic site use and SI findings therefore an allowance for breaking out should be allowed for. Examples of archive photos showing typical foundations / structures are shown below:

Workmen constructing formwork for the machine base in the kiln building at the Solway Chemical Works in Whitehaven

Date: 8 Oct 1953

Construction of the Solway Chemical Works in Whitehaven, showing excavation in progress for the kiln building with limestone being cleared and tested for faults

Date:18 Jul 1953

A view of construction in progress at the Solway Chemical Works in WhitehaveN

Date: 18 Jul 1953

Suitable arisings generated by the grubbing of these structures can be processed to produce a product graded as 6F2, suitable for re-use on-site as a granular running surface or as capping materials beneath adoptable or private highways.

If former piled foundations are encountered they will be cropped to 3m below finished ground level. The remaining pile locations will be surveyed to record their position and allow appropriate foundation solutions to be designed.

A number of the trial pits within the Made Ground were noted as unstable. All excavations should be planned, and due consideration should be given to providing temporary support or suitable battering. Excavations should

be regularly inspected by a competent person to ensure continued safety. Further advice on the safety of excavations is given in Health and Safety in Construction. Shallow (<1.20mbgl) excavations for service trenches could be complicated by collapsing sands, silts/clays, and care should be taken.

3.4 Turnover the Full Thickness of Made Ground Materials Across Site, Including Screening of Oversize and Deleterious Materials & Crushing of Oversize Materials Generated by the Screening of Made Ground Before Placement as Engineered Fill to Support New Infrastructure

Any oversized material is to be crushed and any structures present below ground are to be removed and crushed before being placed back as engineered fill.

Earthworks materials shall be acceptable material which meets the requirements of Table 6/1 and Appendix 6/1 of the Highways Specification for use in the Works.

It is anticipated that excavation will be undertaken in a continuous series of panels from west to east.

No more than a 75m width shall be open to the full depth of the excavation at any one time, and the maximum time that a 75m width is open shall be no more than 4 weeks.

All works to be designed and supervised by a suitably qualified earthworks engineer.

The Engineer shall request supplementary testing to enable satisfactory classification of materials. Notwithstanding the above, compaction of materials shall not take place until classification of materials has taken place.

The method of placement as engineered fill shall be confirmed by field trials and geotechnical testing.

Field trials shall yield the following information:

- Number of passes with the compaction plant (to be used during subsequent earthworks)
- Maximum layer thickness
- Allowable moisture content range

The field compaction trials will need to demonstrate that the required level of compaction can be achieved with the chosen compaction plant and method.

Separate compaction trials should be undertaken for each material type.

Sufficient material shall be obtained from the proposed source to form an approximately 10m by 4m trial pad at least 0.5m thick.

The trial pad shall be formed on a previously rolled horizontal area of the site, and any soft spots in the sub-grade beneath the trial pad shall be removed and replaced with compacted granular material.

If it is proposed to use a Nuclear Density Gauge (NDG) to determine bulk density during the main earthworks, then measurements of bulk density and moisture content shall be made using the NDG on the test pad at locations adjacent to the sand replacement density tests (to ensure effective calibration of the NDG).

3.5 Disposal of Deleterious Materials Generated by the Screening of Made Ground to a Suitably Licensed Waste Facility

Any material that is not deemed suitable for re-use on site should be disposed of at a suitably licensed waste facility.

Copies of relevant Waste Transfer Notes must be provided when requested to prove suitable disposal.

3.6 Any Tanks Encountered to be Broken Down and Filled with Site Won/Imported Material

An underground metal tank was encountered in TP33 at 0.90mbgl – 2.80mbgl. This tank, along with any other tanks encountered during the ground breaking works will require breaking down to base. Care must be taken to ensure the tank is empty before being broken down, and that any remnants within the tank do not leak out onsite during the de-construction. The tank/structure material is to be disposed off at a suitably licensed facility. The concrete removed is likely to be crushed for reuse within the remedial works. Detailed contractor methodology required.

Any site won/imported material being placed into the void is to be places using the methodology described in the section above.

3.7 Treatment of Existing Coal Mine Shafts

Shaft 1 – 296515-001 (Lady Smith)

Shaft 1 was successfully located at Grid Reference 296555,515904. The shafts concrete cap was identified at 3.30mbgl with MADE GROUND comprising black sand & gravel and colliery spoil overlying the cap. The CA original recorded the drift thickness as 3.60m. It is thought that bedrock is also present at 3.30mbgl in this location.

It is proposed that this shaft will be re- capped at bedrock at a later date with a Coal Authority permit and positioned outside of the development area.

Shaft 2 – 296515-002 (Croft Pit)

Shaft 2 was successfully located at Grid Reference 296579,515910. The shafts concrete cap was identified at 5.50mbgl with MADE GROUND comprising black sand & gravel and colliery spoil overlying the cap. The CA original recorded the drift thickness as 5.15m. LIMESTONE bedrock was encountered in the far side of the trial trench at 2.60mbgl and was followed down to the cap.

Groundwater ingress was noted in this location at 3.80mbgl.

It is proposed that this shaft will be re- capped at bedrock at a later date with a Coal Authority permit and positioned outside of the development area.

No ground gas was encountered during the shaft location works.

It is proposed that the cap will be of an approved structural construction (detailed design to be submitted). The cap will be founded upon bedrock strata and undertaken via CA permit. The masterplan has accommodated easements proposed in the ground investigation report.

3.8 Dissolution Features/Voids

A number of possible dissolution features/voids have been encountered on site and are thought to be due to the natural evaporite bedrock encountered across site and the extent of the acids used as part of the site history.

If the voids are to be grouted then consideration must be given to influencing groundwater flow. Voiding is likely to be from the interface of made ground and bedrock. Historical voiding is indicated to be from acid leakage predominantly. It is anticipated that excavation and backfill for shallow voiding is preferred over grouting. Geophysics is only possible post site turn over therefore works will be undertaken in a phased approach.

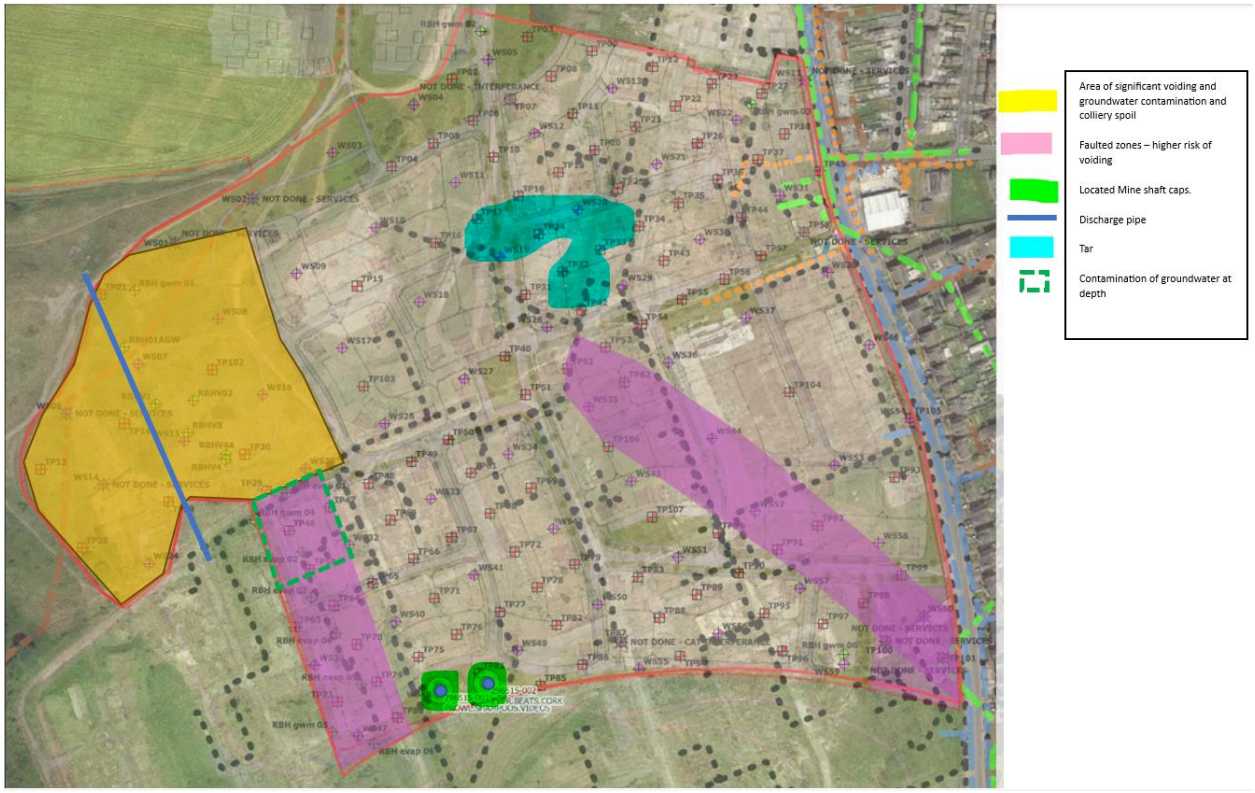
As part of the remedial works post removal of concrete reinforced obstructions it is proposed that a geophysical survey is undertaken following on behind to capture any near surface previously unidentified voids. Should any voids be encountered grouting and or excavation / replacement will be required.

Consideration to use of basal geogrids to roadways and driveways is advised to mitigate any residual risk.

It is important to note that URS previously undertook extensive SI across the site, with the additional Betts Geo investigation targeting any hotspots and filling in any gaps. Based on the lack of significant voids encountered during the URS investigation, and the localised voids (minus RBH GWM 01) encountered during the Betts Geo investigation, confidence can be sought the ground conditions have been sufficiently analysed. Geophysics will be utilised across the site once all concrete and obstructions have been excavated to confirm (needed to get sufficient accuracy).

In regards to the voids – these features seem to be originating from surface down and linked with water / acid drainage leaks concentrated in the lower northern area of site (shown below in yellow). It is deemed a high risk to try to develop these areas both geotechnically and contaminative grounds.

Areas highlighted as being more prone to dissolution due to the published geological faults are shown below. These areas (in pink) will require an increased level of scrutiny geotechnically and ideally to reduce development risk layouts planned around to avoid the areas and replace with low risk open space of commercial end use. Following extensive detailed geophysical and intrusive investigation once the site is cleared of obstructions these areas may be reconsidered for residential end use.



3.9 Public Open Space

No specific remedial action is proposed in areas of public open space other than a cover system. No removal of obstructions or geophysics is proposed due to the low risk end use. It is proposed that the following cover system is applied to areas of POS across site.

POS areas

150mm topsoil
150mm subsoil (free of coarse granular material)

3.10 Provision (via importation) of Suitable Topsoil/Subsoil Materials Required in Garden and Landscaped Areas

A clean cover will be required over the re-worked made ground across the site, with the possible use of deeper natural arisings (subject to further chemical testing) or alternatively import.

Due to the additional contamination and asbestos identified during the additional Betts Geo site investigation, it was recommended that either a 1000mm capping layer (150mm topsoil/850mm subsoil) OR a 600mm capping layer (150mm topsoil/450mm subsoil) with no dig layer at the base is placed within all proposed garden areas across site.

Within Garden Areas and Soft Landscaped Areas – Across Site

150mm topsoil
850mm subsoil (free of coarse granular material in the upper 150mm)

Or

150mm topsoil
450mm subsoil (free of coarse granular material in the upper 150mm)
Geotextile Membrane or 150mm no dig layer of stone/crush

Imported soils will be required on site to make up any short fall in growing mediums/cover systems (it is likely that site won natural subsoils will be cut and placed in a suitable area of the site for re-use as cover soils). Any imported soils should be tested for contamination to ensure that they are suitable for the proposed use. It is generally advisable to test a minimum of three samples, or one sample per 150m3 (greenfield source- topsoil) and 250m3 (greenfield source- subsoil) so that a representative mean value can be calculated.

Areas of cut where natural geology is exposed will be reviewed as the Earthworks progress as a clean cover system is deemed unnecessary in these areas.

The above cover system recommendations are proposed to comply with NHBC Chapter 9 regulations regarding physical composition of cover (i.e. no course granular material within the first 300mm) and exceeds the minimum requirement of 100mm depth of topsoil – extract from Ch9 below:

'9.2 - S5 Garden areas shall be free from obstructions beneath the surface old foundations, concrete bases and similar obstructions occurring within 300mm of the finished ground surface should be removed.

9.2 - S6 Garden areas shall be adequately prepared for cultivation construction rubbish and debris should be removed from garden and other areas around the home. Garden areas should be provided with topsoil to a thickness of not less than 100mm. The topsoil should not contain contaminants which are likely to present a hazard to users of the garden area.'

3.11 Independent Consultancy Supervision, Validation, Verification (including Provision of Chemical and Geotechnical Analysis) and Production of Drawings (As Built Survey etc)

Betts understand that the Engineer will ensure that the requirements of this RS are complied with in a safe and orderly manner.

The responsibilities of the Engineer shall include, but not be limited to, the following:

- Ensuring that all site personnel are suitably qualified and given an appropriate induction at the beginning of their first day.
- Supervision of the remedial and ground preparatory works by a competent and independent consultancy.
- Advice on the correct handling of materials and conditions encountered.
- Guidance on the appropriate protective clothing and safety equipment that is to be made available and

used.

- Ensuring that personal hygiene arrangements are adequate.
- Retrieval of soil and water samples and the subsequent scheduling of appropriate laboratory analysis to enable validation of various aspects of the works, and to advise the Project Manager of progress
- Liaison with statutory authorities as required.
- Where material is found to contain concentrations of potential contaminants at levels in excess of the site specific screening criteria the engineer will undertake further assessment and recommendations on the appropriate use for the material in question, which may involve the disposal of such materials off-site to a suitable waste management facility.

The Engineer will maintain records of the works to include the following:

- Daily record sheets to include a summary of the day's activities.
- Date and weather conditions.
- Plant, personnel and visitors present.
- Aspects relating to Health and Safety, Environmental Control, or non-compliance with this RS.
- Site surveys as necessary to record the locations of demolition, excavation and filling activity.
- Test results.

On satisfactory completion of all the works the Engineer will prepare a Validation Report. Copies of the Validation Report will be issued to the Client and the Local Authority.

The Validation Report will stand as certification that the remedial and ground preparatory works have been carried out in accordance with this RS.

The **Validation Report** will include:

- A summary of the preparatory & remedial works undertaken, including any works associated with unforeseen ground conditions.
- Geotechnical test results associated with ground improvement or re-engineering beneath proposed highways and buildings.
- Cross reference NHBC conditions applicable to ground and provide sign off details agreed with the NHBC
- Chemical testing for suitability for reuse and compliance with the MMP (undertaken by others)
- Copies of any correspondence with Regulators relating to specific aspects of the remedial works.
- Waste transfer notes are to be provided as part of the validation report to show an audit trail of where soil has been deposited.

For reasons of practicality, detailed daily records prepared by the Engineer during the works will not be appended to the Validation Report, but copies can be viewed at Betts offices if required.

The above recommendations will take account of the actual remedial works undertaken and may differ significantly from recommendations originally presented in the site investigation report and remedial strategy.

All placement of engineered fill as part of the excavations will required compaction in general accordance with H/A Series 600 Specification. Test pad of compactions/site trials with corresponding Nuclear density calibration

required. In the absence of a specification, 1:1,000m3 verification sample is required to achieve 95% compaction <5% air voids.

3.12 Ongoing Vigilance for Unforeseen Contamination

Despite the substantial SI works carried out to-date and the main contaminated areas identified, there remains the potential for unforeseen contamination to be uncovered.

Should any suspicious material be encountered during the remediation works, the area will be investigated further by a Betts Geo Environmental engineer and sampled as necessary. The Contaminated Land Officer at the Local Authority will also be notified if the material is deemed to represent a risk to environmental receptors or public health. Samples will be forwarded to a UKAS accredited laboratory for a suite of analytical testing deemed appropriate based upon a visual and olfactory appraisal of the material identified.

Once the results of any analysis are known, the required remedial action (if any) will be determined.

Should any water abstraction boreholes be located, they must be quarantined until they can be recorded, sampled and decommissioned. Site arisings must be kept away, ensuring none enter the well.

3.13 Amber 1 Ground Gas Protection Measures to be Installed Across Site

Elevated methane (>1%) was encountered in WS59 on 5/6 visits (however only slightly elevated on visits 5 & flooded on visit 6) and elevated carbon dioxide close (>5%) was encountered in WS59 on four out of the six visits. Significantly depleted oxygen was also noted in this well on all five visits (between 16.1 – 3.7%v/v – visit 6 was flooded).

No significantly elevated gases were encountered in the remaining wells across the site over the course of the six visits.

WS59 encountered a coke works odour between 0.30mbgl – 1.00mbgl which is highly likely to be the source of the elevated ground gas encountered to date. As a result, it is recommended that the area surrounding WS59 is excavated and delineated to remove any source.

Following the excavation and delineation of WS59, and based on the rest of the gas results for the remainder of the site, it is anticipated that despite no significant ground gas levels being encountered, given the historic site use, Amber 1/CS2 ground gas protection measures should be implemented across the site. This can be confirmed now the ground gas monitoring visits are complete.

SVOC/VOC resistant membranes will be required across the site given the PID readings and odours encountered during the SI, however due to the proposed site turn over it may be possible to reduce this requirement with further monitoring and remedial work. For pricing it is however suggested that the allowance for this is made.

4 REMEDIATION STRATEGY

4.1 Aims

Remediation aims are:

- Remove / treat ground contamination issues in order to protect human health and potential environmental receptors, and render the site suitable for the proposed development
- Satisfy planning requirements of the Local Planning Authority.
- Satisfy Environmental Protection Act 1990 Part IIa requirements of the Environment Agency.

4.2 Remediation Scope

Specific remedial methodology has been detailed in Section 3 above. More generic remedial methodology is detailed below.

4.3 Remediation Methodology

4.3.1 Site Set-up, Organisation and Safety

Site works will be supervised throughout by a suitably qualified Engineer, who will report to the Project Manager. Consultancy supervision may be part-time for certain activities but must be full-time during the removal of any grossly contaminated soil\fill and any placement of fill to an engineering specification.

Site cabins and welfare facilities are to be established at a location to be agreed with the Engineer. All welfare facilities must be established in accordance with the relevant health & safety statutory requirements. Provision shall be provided on site for car parking for all site employees.

All site personnel will undergo a site-specific health and safety induction prior to commencement of work on site.

The Engineer will be informed prior to any proposed entry of a confined space or deep excavation. Entry must be restricted to suitably qualified and equipped personnel.

Works will be carried out with proper regard to current statutory requirements.

During the remediation works, all personnel on site will comply with guidance provided in the Health and Safety Executive (HSE) document “Protection of Workers and the General Public during the Redevelopment of Contaminated Land”. In summary, the following shall be provided:

- Protective clothing, footwear and gloves (Personnel should be instructed in why and how they are to be used).
- Hand-washing and boot-washing facilities.
- Smoking shall be limited to designated areas.

If at any time during the works, personnel begin to feel unwell, they are to inform the Engineer or Site Manager, who will determine appropriate action.

All visitors to site must enter and register at the main Site Office.

4.3.2 Responsibilities

Prior to the commencement of any works, in agreement with the Engineer, The Client will:

- Establish the boundaries of the site and the working areas.
- Undertake a dilapidation survey of site boundaries, adjacent properties and highways, via dated photographs or video footage.
- Liaise with the Local Authority regarding working hours, noise\dust\odour control, and protected trees.
- Liaise with the Local Water Company regarding any proposed discharge to sewer.
- Liaise with the Coal Authority regarding any disturbance to coal seams / coal bearing strata regarding any proposed discharge to sewer.
- Complete a full services search and liaise with all relevant utility companies regarding work in close proximity to their apparatus
- Inform the Engineer of any risk, identified and assessed, which could impact upon the Engineer's activities.
- Prepare the necessary COSHH statements and Health & Safety Plan in accordance with CDM regulations.

The contractor will ensure that:

- Secure the full site boundary (if necessary, provide and erect herras-type fence to protect members of the public from the works).
- Personnel, plant, materials and other equipment related to the contract are confined within the boundaries of the site.
- Any live services lying within the site boundary are marked and protected, or appropriate arrangements made to truncate them.
- Good practices relating to personal hygiene are adopted.
- Suitable precautions are implemented at all times to prevent off-site migration of pollutants via airborne dust and vapours.
- Suitable precautions are taken to prevent the spread of mud and debris on public highways.
- Refuelling of mobile plant is undertaken in a designated area. Above ground oil storage tanks shall comply with the requirements of Pollution Prevention Guideline PPG2. A spill kit shall be kept on site, adjacent to the designated refuelling area.

5 REMEDIAL WORKS (CONSTRUCTION OBJECTIVES)

5.1 Site Clearance

Hardstanding areas will need to be excavated and placed within less sensitive areas, such as areas of public open space and roadways. Trees/bush/shrub clearance will be undertaken prior to the remedial measures.

Vegetation is present in some areas of site (although limited). Any vegetation/trees present will require clearing with all root balls chipped before removal off site.

5.2 Excavation of Hardstanding/Foundations

It is anticipated that all the foundations/obstructions encountered during the ground investigation will be broken out. Where obstructions exist they will be chased to full depth wherever possible. If this proves not possible in agreement with the engineer the location will be surveyed in by the contractor as part of the as built plan.

Heavy plant will be operated generally between the hours of 8:00AM and 6.00 PM Monday to Friday, and 8:00am to 1:00 PM Saturday or otherwise dictated to by planning conditions.

Noise levels will generally be less than the 80 – 85 dB range, with occasional breaches in excess of 85 db. Periods of noise generation in excess of 85 dB are anticipated as being during the initial enabling works and slab removal stage and thereafter for short periods. All construction plant will be selected from well maintained and silenced stock.

Suitable uncontaminated reclaimed material from the demolition operation will be crushed to an appropriate specification (6f2 anticipated) and, if required, processed for re-use as part of any general site raise. The crushing of this material will be supervised and monitored by an appropriately qualified person, with selected samples periodically obtained and tested to confirm its suitability. The contractor will provide representative sample ratios for geotechnical testing for the proposed end use.

Any material that is deemed to be unsuitable for crushing and re-use will be removed from the site to licensed landfill.

Any areas of tar/free product that are identified will be removed and disposed of at a suitably licensed facility.

Foundation/obstruction arisings will need to be carefully managed to not contaminate natural soils and should be segregated as they are dug out. Arisings are physically different and as such should be able to be segregated accordingly. Subsoils will be physically assessed upon placement within garden areas, should any suspected made ground be encountered within the subsoil material placed then additional chemical validation will be required to confirm the suitability of the material placed.

Tarmac hardstanding (and tarmac containing Made Ground) contains hydrocarbon compounds which are potentially contaminating. Tarmac should be lifted and placed in a stockpile separate from other arisings in order to avoid contamination. It is anticipated that tarmac arisings are suitable for re-use below proposed car parking areas or highways once they have been crushed.

Given that the underlying natural strata is likely to be deemed chemically suitable in areas where it is shallower, it may be possible to re-use foundation arisings as subsoil within garden areas. Foundation arisings will need to be carefully managed to not contaminate natural soils with the overlying made ground, arisings should be segregated as they are dug out of foundation trenches/roadways etc. Arisings are physically different and as such should be able to be segregated accordingly. Subsoils will be physically assessed upon placement within garden areas, should any suspected made ground be encountered within the subsoil material placed then additional chemical validation will be required to confirm the suitability of the material placed.

A Materials Management Plan is to be put in place by both the contractor and developer to ensure soils are not deemed as waste / landfill and subject to HMRC taxes or fines.

5.4 Arisings

Foundation arisings of natural strata may be deemed chemically suitable for clean cover system and may be feasible to use in the lower capping layers. Chemical testing will be required.

Any material that is deemed to be unsuitable for re-use will be removed from the site to licensed landfill.

Stockpiles must not be generated within 10m of any surface water course or in such a manner that stability / roll off material to the surface water course is a potential. Detailed methodology is required.

5.5 Dust, Vapour & Odour Control

The excavation of fill should not present a significant problem with regard to emission of dust during excavation. Nonetheless, the monitoring and mitigation measures outlined below may be required if dust, vapour or odour are noticeable. Dust reducing measures will be employed where required.

5.6 Odour Monitoring

If necessary, olfactory monitoring for tar and hydrocarbon odour nuisance will be undertaken at the site boundary down-wind of the excavation area during all excavation works.

5.7 Trigger Levels

Proposed action limits for requiring respirator protection in the vicinity of the excavations and for taking corrective action to mitigate against the generation of air-borne dust or volatile organic contamination are outlined below. They are based on EH40/2002, Occupational Exposure Limits, Health and Safety Executive. EH40 trigger levels for total VOCs and dust are:

VOC & Dust Trigger Levels

Determinand	Long-Term Exposure Limit (8 hour time-weighted average)	Short-term Exposure Limit (15 minute reference period)
Total VOCs	1 ppm	3 ppm
Dust	4 mg/m^3	12 mg/m^3

5.8 Mitigation

At all times during the excavation works, Best Practicable Means shall be employed to minimise dust, odour and VOC generation and their emission off site.

If dust or VOC concentrations in air exceed the long-term trigger levels in the vicinity of the excavation area, but are below the long-term trigger levels at the site boundary, then respirator protection will be required for all site personnel working in the excavation area.

Respiratory protection that conforms to the European Product Directive (CE) shall be readily available for personnel exposed to odours. Twin cartridge respirators, that conform to EN140, fitted with class A1 filters cartridges, which conform to EN141 (organic gases and vapours), shall be used. If highly odorous material is encountered on site then masks with Class A2 filters shall be used.

In addition, one or more of the following corrective actions to mitigate against the generation of air-borne dust or volatile organic contamination will immediately commence:

- Mist and water spraying to eliminate dust and/or reduce generation of volatile compounds.
- Reduction of the exposed active excavation area by backfilling or covering to reduce the generation of volatile compounds.

If dust or VOC concentrations in air exceed the long-term trigger levels at the site boundary then excavation activities will be stopped immediately and one or more of the above corrective actions will commence. Work will not begin again until the air quality at the site boundary has returned to an acceptable level and only after all reasonable actions have been taken to prevent the air quality at the site boundary from again declining to an unacceptable level.

5.9 Export to Landfill

Any material exported from site to landfill will be hauled by a registered waste carrier in accordance with the requirements of the Duty of Care Regulations, 1991 and the Landfill (England & Wales) Regulations 2002.

A transfer note shall be completed, signed and retained by the parties involved. The transfer note shall include the volume of waste, the nature of the material and a statement of its chemical composition, details of the source and destination sites, and details of the haulier.

In order to protect the general public from dust, wagons that are to be used for the haulage of the contaminated material from the site will be sheeted. In addition, the Contractor must ensure that no fluids seep from the wagons.

In order to provide the landfill facility with information regarding chemical composition of the waste, analysis results from the ground investigation and the desk study will be supplied to the site prior to removal for classification.

As of 16th July 2005 the Waste Acceptance Criteria of the Landfill Regulations 2002 were fully implemented, which will result in the enforcement of a more stringent approach to waste assessment and its disposal to landfill.

All hazardous waste going for disposal at landfills must be classified according to the new European Waste Catalogue (EWC).

Contaminated soils are "Mirror entries" in the EWC. Waste contaminated soils may be classified as either *hazardous* or non-hazardous depending on the concentrations of "dangerous substances" in the waste soil. An assessment of the composition of the waste soil will therefore be undertaken to determine if it is hazardous waste.

The WAC set threshold concentrations for leachable components of the waste stream and landfill operators will have waste acceptance procedures in place to ensure that only compliant waste is landfilled. Most waste will need to be treated before it can be landfilled to reduce its quantity and the hazard it presents. Leaching compliance testing will be required in accordance with BS EN 12457-3:2002.

In addition, the site will be operating under a Site Waste Management Plan recording both import and export of materials.

5.10 Backfill of Excavations

Excavations (to remove relict structures, contamination etc) are to be "surveyed in" and backfilled as necessary to achieve the desired levels, with suitable materials and subjected to compaction specification, to be agreed with the Engineer, Highways and the NHBC.

However, where an excavation conflicts with the footprint of a proposed adopted highway, compaction in accordance with the Specification for Highway Works Table 6/1 will be undertaken.

Where excavation conflicts with proposed rafted plots, detailed design of extending excavation to stop differential settlement is required.

5.11 Boundary Issues

The Client's Designer should ensure that proposed levels tie in with the surrounding infrastructure, and ground levels of adjacent properties.

5.12 Highways

The contractor will agree acceptable performance criteria, and an appropriate Specification for any necessary ground improvement, with the Client and the adopting authority where necessary.

The Contractor will arrange for the necessary compliance testing to be undertaken at formation level on road alignments, as required by the adopting Authority and Engineer. Responsibility for regulatory sign off with the adopting Authority is the Contractors responsibility.

5.13 Protection of Buried Concrete

The Betts Geo SI report stated the following:

It is considered for concrete design purposes that a brownfield site and static groundwater conditions are applicable, and the results are summarised below. The site has been split into areas as per the former uses.

It is important to note that alkaline pH's were noted across the site with the highest being 12.4 (former alabaster works area). The average pH for the site was calculated at 8.35.

Former Alabaster Works Area

Concrete Classification	
Design Sulphate Class	DS-3
ACEC Class	AC-2s

(highest water soluble sulphate value of 1900mg/l and highest pH of 12.4)

Former Coke Works Area

Concrete Classification	
Design Sulphate Class	DS-4
ACEC Class	AC-3s

(highest water soluble sulphate value of 3800mg/l and highest pH of 11.2)

Former Dry and Wet Salts Area

Concrete Classification	
Design Sulphate Class	DS-2
ACEC Class	AC-1s

(highest water soluble sulphate value of 1100mg/l and highest pH of 10.2)

Former Fatty Alcohol Area

Concrete Classification	
Design Sulphate Class	DS-2
ACEC Class	AC-1s

(highest water soluble sulphate value of 1500mg/l and highest pH of 11.0)

Former MMO Plants Area

Concrete Classification	
Design Sulphate Class	DS-3
ACEC Class	AC-2s

(highest water soluble sulphate value of 1600mg/l and highest pH of 8.5)

Former Surfactants Processing Area

Concrete Classification	
Design Sulphate Class	DS-3
ACEC Class	AC-2s

(highest water soluble sulphate value of 1800mg/l and highest pH of 12.1)

No Former Use

Concrete Classification	
Design Sulphate Class	DS-3
ACEC Class	AC-2s

(highest water soluble sulphate value of 1800mg/l and highest pH of 8.1)

It is important to note that pH & sulphate values may change on site as a result of the proposed soil treatment and stabilisation, therefore additional testing should be undertaken post earthworks. The NHBC may require the higher level of protection site wide.

Following placement of engineered fill to rafts, additional testing may prove beneficial to determine if the rafts need to be designed to the aggressive soils previously encountered.

5.14 Control of Groundwater

Results of the three groundwater testing visits undertaken to date indicated that there is no significant groundwater contamination across the majority of site (apart from the in north western corner of site at depth). A benzene, fluorathnene and MBAS hotspot was identified in a localised area that URS previously identified as contaminated (RBH GWM 04 & RBH EVAP 02 at depth).

Limited shallow perched groundwater was identified within made ground on site and should be anticipated within excavations.

It is proposed that an additional water sampling visit is undertaken over the remainder of the seasons –Autumn to capture all seasonal groundwater levels.

Groundwater with sheens (from drainage runs) were encountered in the northern areas of site (former coke works area) and the southern area of site (former dry and wet salts area).

It has been recommended that any free product/impacted perched groundwater is either pumped to a treatment area on site to allow for the removal of dissolved phase organic compounds or is tankered off site and disposed of at a suitably licensed facility.

If the free product/groundwater is to be treated on site, a suitable discharge point for any treated water to be disposed of under an appropriate license is to be agreed before any works begin. If free product/groundwater is to be pumped and tankered off site, it is recommended that the results of the contamination testing be presented to the proposed end site to obtain their acceptance of the information to date.

Once this has been removed, along with contaminated soil, it is likely that provision of pumping/shuttering will be necessary during excavation of foundation trenches during wet weather and to deeper excavations for sewers etc. It is good practice to have such equipment on standby in case of seasonal / abnormal weather conditions.

It is important to note that the acid / fatty alcohol / naphthalene production area was historically all upstream of the area where the additional boreholes were undertaken to investigate the void identified in RBH GWM 01 (in

the drainage run) and has reported voids historically in the far south west and NW corner of site (SG report references them). Given the visual and olfactory contamination encountered in the groundwater in this area, it is suggested that the voiding is exacerbated dissolution by acids most probably and has historically been filled with colliery spoil in this locality

It is advised that the north western area of site is not developed due to the deep groundwater contamination present. Remediation of this area, at such depth would prove problematic.

A Silt Management Plan shall be prepared by the Contractor, describing the mitigation measures that will be put in place to intercept direct run-off from any disturbed areas, stockpiles etc, thereby preventing any potential impact of adjacent land and nearby watercourses. Surface water run-off will probably require treatment (as a minimum to allow settlement of fines) prior to consented discharge.

Perched waters encountered during the earthworks, and / or water associated with redundant drains and buried structures, may be contaminated with hydrocarbons and\or VOCs. Any potentially contaminated water should not be allowed to escape to other areas until the results of the analysis are available and, if required, a suitable means of water treatment has been agreed.

Water collected in sumps should be passed through a series of oil/water separators to remove any oily contamination. Oils trapped in the absorbent medium shall be disposed of to a suitably licensed landfill site. Treated water shall then be tankered off-site, or be discharged to sewer, subject to analytical results and local water treatment company consent.

Groundwater levels may vary from those at the time of the investigation, for example in response to seasonal fluctuations.

6 METHODOLOGY / PROGRAMME

6.1 Site Won Soils

There is the potential to use site won subsoil in areas of shallower natural strata. This subsoil material would need to be sampled and analysed for contamination to prove this material was chemically and physically suitable for re-use on site. If the subsoil contains anthropogenic materials such as brick, concrete or glass then this material will not be suitable for re-use in the clean cover system. The number of samples required will be determined from the table in section 6.2 below.

6.2 Imported Soils

If imported soils are to be used on site (anticipated) then the following is required:

- Desk study undertaken to establish source
- Source used to determine sampling frequency / chemical analysis scheduling.
- Engineer to attend source site and collect representative samples for assessment.
- Samples analysed and screened for end use suitability for residential with root uptake.
- Validation from Local Authority for suitability.
- Import soil to site and place in garden areas to the agreed cover thickness.
- Engineer to attend site and undertake photographic cover thickness validation via hand dug exposure pits on the basis of 1:3 gardens. Report to be produced and submitted to the local Authority for approval.

Chemical analysis should be assessed using a desk study/details of historic use of the site where the imported soil originated. Chemical analysis is likely to include (but is not limited to); CLEA Metals (Arsenic, cadmium, chromium (Vi), lead, mercury, selenium, copper, nickel and zinc), pH values, Sulphate - soluble 2:1 extract, speciated polycyclic aromatic hydrocarbons (PAH), extractable petroleum hydrocarbons (EPH), TPH CWG, Asbestos screening and Organic matter.

This work may be undertaken as part of the contract for the preparatory & remedial works, in which case imported soils should be stockpiled in a location agreed with the Engineer. Alternatively, the Developer may choose to import soil at a later stage in the development.

In order to demonstrate that the required depth of 'clean' cover material has been placed across the required areas (i.e. within garden areas and areas of landscaping) a post-fill survey will be undertaken by hand-dug pits and provision of photographic evidence of the cover system within rear gardens. This will be provided to the contractor for their records.

It is suggested that given the garden size proposed, the simplest way to validate the soil is to sample 1 garden in 3 for imported topsoil and subsoil, along with a depth test in each plot to prove depth of cover is sufficient in garden areas.

Any soils intended for use as part of the growing medium (including site won material) will be tested at source or stockpiled on site until approved for use by the Supervising Engineer. Topsoil and subsoil testing will be carried out at the suggested frequencies below unless this differs from Local Authority guidance;

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Site Generated		
Site Generated 6F2	1 Sample Per 1000m^3	A / B / C / D
Site Won Made Ground General Backfill	1 Sample Per 1000m^3	A / B / C / D
Site Won Made Ground General Backfill	1 Sample Per 2000m^3	I
Site generated Sub-Soil *(450mm garden cover)*	1 Sample Per 200m^3	A / B / C / D
Hotspot Validation Samples Hydrocarbons	1 Sample per 10m of linear excavation to base and sidewall.	E / G
Imported		
6F2	1 Sample Per 1000m^3	A / B / C / D
Subsoil Greenfield Source *(150mm garden cover)*	1 Sample per 200m^3	A / B / C / D
Subsoil Brownfield Source *(150mm garden cover)*	1 Sample per 50m^3	A / B / C / D
Topsoil Greenfield Source *(150mm garden cover)*	1 Sample per 150m^3	A / B / C / D
Topsoil Brownfield Source *(150mm garden cover)*	1 Sample per 50m^3	A / B / C / D
General Engineering Fill (Class 1 & 2 Soil)	1 Sample Per 1000m^3	A / B / C / D

A) Speciated PAH
B) Speciated TPH
C) Asbestos (ID and quantification if positive)
D) CLEA Inorganic Heavy Metals
E) Speciated PAH, Banded TPH and VOCs
F) SVOC / Speciated TPH
G) On-site screening for VOC using calibrated PID
H) Leachate 2:1 Speciated PAH and Banded TPH
I) Leachate analysis of Inorganic heavy metals, TPH, sulphate and PAH.

6.2 Contingency for Unknown

Despite the substantial SI works carried out to-date and the main contaminated areas identified, there remains the potential for unforeseen contamination to be uncovered.

Should any suspicious material be encountered during the remediation works, the area will be investigated further by a Betts Geo Environmental engineer and sampled as necessary. The Contaminated Land Officer at the Local Authority will also be notified if the material is deemed to represent a risk to environmental receptors or public health. Samples will be forwarded to a UKAS accredited laboratory for a suite of analytical testing deemed appropriate based upon a visual and olfactory appraisal of the material identified.

Once the results of any analysis are known, the required remedial action (if any) will be determined.

Should any water abstraction boreholes be located, they must be quarantined until they can be recorded, sampled and decommissioned. Site arisings must be kept away, ensuring none enter the well.

6.3 Construction Workers

Due to the presence of contaminated Made Ground soils and asbestos within soils, a risk exists (in the short term) to any ground/construction workers involved in the redevelopment of the site.

Site workers should wear gloves, boots and overalls and wash their hands before eating, drinking and smoking. Excessive dust generation should be avoided. The site manager will inspect the risk assessments of the contractors on site/inspect on a regular basis to make sure this is upheld as per HSE / CDM guidance.

If areas of suspected contamination are found then a suitably qualified person should undertake appropriate sampling, testing and further risk assessment.

A full discussion of the results of existing chemical analysis and the levels of contamination within these soils is to be included within the Pre-Tender Health and Safety File. The Contractor is aware of the presence of such soils and has therefore allowed for adequate Personal Protective Equipment to be provided on site.

It is recommended that full reference should be made to current guidance documents such as the HSE document "Protection of Workers and the General Public during the Redevelopment of Potentially Contaminated Land" HS (G) 66, HSE.

The results of all relevant chemical analysis will be provided to the relevant service providers in order to confirm any special precautions that may be required in respect of the installation of services and the protection of their workers.

6.3 Drinking Water Supplies

A relevant pipeline risk assessment is required once the pipeline route is known. However due to the extensive groundworks/earthworks/cut and fill proposals on site, it is recommended that targeted testing is undertaken on completion of the earthworks. Based on the current contamination encountered Protectaline should be assumed for pricing.

6.4 Site Certification

Once the remediation works have been undertaken, a 'completion' report (as described in Section 3.9 of this report) will be prepared. This will comprise relevant site records and stand as certification that the appropriate remediation works have been carried out in accordance with the agreed redevelopment strategy. Reports will be submitted to the Local Authority for their approval, thereby enabling the release of the site for subsequent development.

Notes on Limitations

This report does not consider ecological impacts (e.g. bats) or botanical risks (e.g. Japanese knotweed). It is recommended that these are considered as part of the assessment of development constraints for the site.

The assessment and judgements given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed. The data essentially comprised a study of available documented information from various sources (including Client Furnished reports) together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information. Actual risks can only be assessed following a physical investigation of the site.

The site investigation has been carried out to provide information concerning the type and degree of contamination, and ground and groundwater conditions to allow a reasonable risk assessment to be made. Betts Geo Environmental Ltd undertake to exercise all reasonable skill, care and due diligence in the exercise of the investigation with respect to sampling techniques, sample storage and report interpretation.

Data acquisition is subject to the limitations of the methods of investigation used. Exploratory holes undertaken during fieldwork investigate small a small volume of ground in relation to the size of the site and as such can only provide an indication of site conditions. There may be conditions pertaining to the site and the proposed development i.e. localised “hotspots” of contamination, which have not been disclosed by the investigations.

The findings and opinions are relevant to the dates of our site works and should not be relied upon to represent conditions at substantially later dates. Conditions at the site will change over time due to natural variations and anthropogenic activities. Groundwater, surface water and soil gas conditions should be anticipated to change with diurnal, seasonal and meteorological variations.

The opinions expressed in this report regarding any contamination are based on simple statistical analysis and comparison with available guidance values. No liability can be accepted for the retrospective effects of any changes or amendments to these values.

This report was prepared by Betts Geo Environmental Ltd for the sole and exclusive use of Persimmon Homes. In response to particular instructions, any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

This document has been prepared for the titled project only and should any third party wish to use or rely upon the contents of the report, written approval from Betts Geo Environmental Ltd must be sought.

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