

**MATERIALS MANAGEMENT PLAN
PENRHYN ROAD, KNOWSLEY
MERSEYSIDE
GMI CONSTRUCTION GROUP
MMP-30050-25-476
DECEMBER 2025**



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Document Issue Record

Status	Draft	Date of Issue	09/12/2025
Prepared by		Approved by	
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Rev	Prepared	Approved	Date of Issue	Reason(s) for Revision
0	LM	AH	09/12/2025	-

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SECTION 1 INTRODUCTION

- 1.1 This Materials Management Plan considers the approach taken to manage soils during enabling works operations at the development site on land located off Penrhyn Road, Knowsley. The aim of this Materials Management Plan is to set out the steps to be employed when handling, storing, placing and disposing of any materials generated during the project.
- 1.2 It is the intention to undertake enabling works in order to create a suitable development platform for the site.
- 1.3 If soils at the site are not suitable for re-use, then they will be regarded as waste. The 'Definition of Waste: Development of Good Practice' produced by CL:AIRE (the CL:AIRE document) sets out recommendations for the assessing whether materials should be classed as waste, and whether treated waste can cease to be waste for a particular set of circumstances, including consideration of end-use and material type. This Materials Management Plan has been developed to meet the outline requirements of the CL:AIRE document so that it can be reviewed by a 'Qualified Person' as defined by CL:AIRE, prior to the commencement of earthworks.
- 1.4 This is a live document and forms part of the environmental management documentation of the project.

APPENDIX 1 ▪ MMP Form

Materials Management Plan (MMP) Form - October 2014

This form should be completed once the lines of evidence have been marshalled in relation to suitability for use, certainty of use and quantity required. The answers to the questions posed within this form, together with the supporting information will constitute the MMP and must be provided to the Qualified Person.

A Qualified Person may comment on draft versions of this MMP, but will not complete the Declaration until all the relevant documents, demonstrating lines of evidence have been provided for each site.

The person / organisation who will pay the Declaration fee should confirm that they have read and understand the Terms and Conditions relating to the payment of the Declaration fee to CL:AIRE. These can be found on the CL:AIRE website.

The person / organisation agreeing to pay the Declaration Fee	
Company	Merebrook Consulting Ltd
Address	Cromford Mills, Mill Lane, Matlock, Derbyshire DE4 3RQ
Name	Julie McDowell
Email	accounts@merebrook.co.uk
Tel	01773 829988
Purchase Order Number	25-1202-AH-30050

☒ I confirm I have read and understood the Terms & Conditions.

Each question must be answered. If the question is not applicable, please state this and provide a brief explanation.

1. Specify the scenario to which this MMP relates, as described in the Definition of Waste: Development Industry Code of Practice (DoW CoP) (1, 2, 3 or 4):

- ☒ 1. Reuse on the Site of Origin
- ☐ 2. Direct Transfer of clean naturally occurring soil / mineral materials
- ☐ 3. Cluster Project
- ☐ 4. Combination of any of the above

In the case of a combination of reuse scenarios, please describe it below (e.g. (i) Reuse on Site of Origin and Direct Transfer of clean naturally occurring unpolluted soils, (ii) Reuse on the Site of Origin with Direct Transfer of clean naturally occurring soil to x number of development sites etc:

(NB: A Declaration is required for reuse on the Site of Origin and for any 2 site arrangement i.e. there is no facility for a combination Declaration)

2. Organisation and name of person preparing this MMP	
Company	Merebrook Consulting
Address	Cromford Mills, Mill Lane, Matlock, Derbyshire DE4 3RQ
Name	Andrew Harris
Email	andrew.harris@merebrook.co.uk
Tel	01773 829988

Document Control

Date issued	09/12/2025
Revision date	-
Summary of revision 1	
Summary of revision 2	

Insert additional lines to the table above for any subsequent revisions.

Note - revisions to the MMP do not trigger an additional Declaration by a Qualified Person, unless an additional site is added to the project.

Revisions to the MMP must be recorded and summarised in the Document Control box above.

Site Details

3. Site / Project name(s)	Penrhyn Road, Knowsley
Reuse / receiving site name :	Penrhyn Road, Knowsley
Donor site name (if Direct Transfer)	Not applicable

Landowners

4a. Name of Landowner(s) where excavated materials are to be reused	
Company	Graftongate Investments Ltd.
Address	The Old Forge, 49 High Street, Henley-in-Arden, England, B95 5AA
Name	Andrew Baker
Email	abaker@graftongate.com
Tel	+44 77911 43573

4b. Name of Landowner(s) where excavated materials are arising from	
Company	Graftongate Investments Ltd.
Address	The Old Forge, 49 High Street, Henley-in-Arden, England, B95 5AA
Name	Andrew Baker
Email	abaker@graftongate.com
Tel	+44 77911 43573

Summary and objectives

5a. Provide a brief description of the planned project and how excavated materials are to be reused.

The site is located off Penrhyn Road Knowsley, approximately 1km east of Junction 4 of the M57. The site covers an area of approximately 3.5ha, prior to demolition the site was formerly a chemical processing plant with tank farms, warehousing, and storage. The site has now been cleared and comprises of rough open ground with some stockpiles of crushed demolition rubble. The proposed development comprises a commercial warehouse with office space and car parking.

There is a project level expectation that site-won excavated material can be re-used and accommodated within the development. A programme of enabling works will be required to remove below ground obstructions and establish a suitable construction platform. A proposed development layout has been included in Appendix 2.

It is expected that approximately 8000m³ of spoil material will be excavated from the centre of the site, and then stockpiled on the north of the site, where it will be stabilised and then re-used as fill material.

The stabilisation to be carried out by Maher, will be for moisture modification with the addition of lime for geotechnical purposes and will be undertaken following the remediation works (treatment by Portway). The process will involve spreading of soils to be treated in a uniform layer, addition of lime (1-2%) and mixing with a tractor mounted unit. This will not affect overall volume of materials.

An Environment Permit to deploy mobile plant has been agreed with the Environment Agency (see Appendix 12 Environmental Permit Letter EPR/AP3896LU/D10001) as of 4th December 2025. The permit is held by Portway Plant who will be carrying out the treatment activity.

An existing stockpile of 10611m³ 6F2 material is to be utilised as fill material, with a proportion of this material crushed to be produce type 1 that will be used as capping fill material.

General Plans and Schematics

6. Attach a location plan for the site(s) and a plan of the site(s) which identifies where different materials are to be excavated from, stockpile locations (if applicable), where materials are to be treated (if applicable) and where materials are to be reused.	Plan Document Reference(s): Appendix 3 – Location Plan and Site Location Plan Appendix 6 – Current stockpile & spoil stabilisation area schematic - Maher Earthworks Movements Schematic Stockpile locations are currently unable to be fully allocated. Decisions around precise stockpile locations will be a site logistics issue but will be fully recorded. It is known that the existing 6F2 stockpile is located in the south-west of the site, and the spoil stabilisation (treatment) area is expected to be in the north-west of the site. These are shown in the Maher Earthworks Movements Schematic in Appendix 6.
7. Attach a schematic of proposed materials movement. Where there is only one source area and one placement area briefly describe it. For all other projects a schematic is required.	Description & Schematic Document Reference: Appendix 6 – Cut and Fill Plan The cut and fill drawing (25069-MJM-00-00-DR-C-9200 P03) provides an overview of cut and fill operations. The cut is mainly based in the northern quarter of the site. Materials excavated are to be re-used on site.

Parties Involved and Consultation – if more than one party please provide additional details for them and identify the location that they will be working e.g. where a site is zoned

8a. Main earthworks contractor(s) where excavated materials are to be reused	
Company	W Maher & Sons Ltd.
Address	Rixton Old Hall, Manchester Road, Rixton, Warrington, WA3 6EW
Name	Dany Tennant
Email	danny@wmahers.com
Tel	+44 7572 427077

8a. Main earthworks contractor(s) where excavated materials are arising from	
Company	W Maher & Sons Ltd.
Address	Rixton Old Hall, Manchester Road, Rixton, Warrington, WA3 6EW
Name	Dany Tennant
Email	danny@wmahers.com
Tel	+44 7572 427077

9. Treatment contractor(s) for treatment on site of origin, or at a Hub site within a fixed STF / Cluster Project	
Company	Portway Plant Ltd.
Address	Holly Farm White, Pits Lane, Portway, Birmingham, B48 7HP
Name	Jon Berry
Email	Jberry.portway@gmail.com
Tel	01564 826303

10. Where wastes and materials are to be transported between sites, provide details of the transport contractor(s) (full address, contact details and waste carriers registration details (if applicable))

Company	Not applicable
Address	
Name	
Email	
Tel	

11. Local Authority contact details where excavated materials are to be reused

Authority	Knowsley Council
Address	Huyton Library, Civic Way, Huyton, Knowsley, L36 9FB
Name	Eve Jones
Email	Not provided but can be written to at the above address. Contact number provided.
Tel	07385 145680

12a. Environment Agency contact details where excavated materials are to be reused (or Hub)	
Regional Office	Warrington
Address	Richard Fairclough House, Knutsford Road, Warrington, WA4 1HT
Name	Stephen Bostock
Email	GMMCWasteEnquiries@environment-agency.gov.uk
Tel	03708 506 506

Regional Waste Office	Warrington
Address	Richard Fairclough House, Knutsford Road, Warrington, WA4 1HT
Name	Stephen Bostock
Email	GMMCWasteEnquiries@environment-agency.gov.uk
Tel	03708 506 506

For all Cluster Projects:

12b. Attach any relevant documentation from the EA relating to the excavation and reuse of the materials to demonstrate no objection to the proposals (see 3.37 of DoW CoP)

If the EA has not been consulted please explain why (see paragraph 3.39 of the DoW CoP).

EA references:

Not applicable.

Lines of Evidence

There is no one single factor that can be used to decide that a substance or object is waste, or when it is, at what point it ceases to be waste; as complete a picture as possible has to be created.

The following sections require completion to ensure the correct decision is made.

If a requested item is not relevant it is important to clearly state why this is so (e.g. no planning permission required because permitted development status exists).

Suitable for use criteria

13. Please describe or provide copies of the required specification(s) for the materials to be reused on each site.

Document Reference(s): Appendix 5 – RSVP – G&J 2025

As part of the remediation works at the site, site wide verification will be carried out through the excavation of trial pits to allow identification of any obvious hotspots & verification sampling through analysis for VOCs (including 1,2-dichlorobenzene and chlorobenzene). Soil contamination hotspots will be inspected for visual and olfactory evidence of contamination, with verification samples obtained from the base and faces of the excavation. Samples will be screened against the contaminants of concern set out in the remediation strategy.

As part of the treatment process of excavated contaminated materials, such soils will be tested at a rate of one sample per 250m³, with a minimum of five samples taken from each windrow/biopile. Samples will be analysed for the contaminants of concern.

The volume and locations of contaminated soils excavated, treated, disposed and re-used will be carefully recorded by the contractor, along with all other material movements.

Where contamination is suspected or known to be present

14a. Please provide copies of or relevant extracts from the risk assessment(s) that has been used to determine the specification for use on the site. This must relate to the place where materials are to be used. This must be in terms of (i) human health (ii) controlled waters and (iii) any other relevant receptors. If a risk assessment is not relevant for a particular receptor given the site setting please explain why.

Document Reference(s):

Appendix 4 – DQRA – G&J 2025

A Detailed Quantitative Risk Assessment for the site was produced by G&J Geoenvironmental Consultants in March 2025 which was used to determine the specification for use on the site.

The risk assessment for human health from soil contamination is as follows:

- Impact on human health from soil contamination is likely minimal. No contamination was recorded in excess of the GAC for commercial land use. However there is potential for localised contamination above the GAC. There is also the potential for localised areas to be affected by asbestos.
- The GACs are considered to provide reasonable target concentrations for future verification and/or remediation works in order to be protective of human health. Should more significant/widespread contamination from asbestos be encountered, this would likely be managed by source removal of breaking exposure pathways (hardstanding or clean cover capping).

The risk assessment for human health from contaminated controlled waters is as follows:

- There is a potential risk to human health from volatile contamination in groundwater, through the inhalation of contaminant vapours.
- To gauge the risk to human health, concentrations of volatile contaminants in groundwater have been assessed against GACs developed by SoBRA for assessing vapour risks from volatile contaminants in groundwater. No recorded concentrations of volatile contaminants in groundwater are close to the SoBRA GACs for a commercial land use.

The risk assessment for the impact on groundwater quality from soil contamination is as follows:

- The impact has been estimated using ConSim modelling. The model was run for 1,2-dichlorobenzene, as this was the only contaminant recorded at significant concentrations in both soil and groundwater.
- To summarise the modelling outputs, the concentrations of 41mg/kg was found to be an appropriate soil remedial target for 1,2-dichlorobenzene that is protective of the water environment.
- Remediation works to be validated against an absence of visual or olfactory evidence of contamination.
- It was found that an appropriate benchmark for groundwater contamination is no observed increase in concentrations and a declining plume with the ultimate aim of betterment as a result of future remedial works and natural attenuation processes.

The full information is provided on pages 33 to 49 of the DQRA.

14b. Please attach any relevant documentation from the LA relating to the excavation and reuse of the materials to demonstrate no objection (see 3.37 of the CoP)

LA Document references:

Appendix 7 – Local Authority Correspondence

See correspondence demonstrating no objection from Knowsley Council, dated 23rd October 2025.

14c. Please attach any relevant documentation from the EA relating to the excavation and reuse of the materials to demonstrate no objection (see 3.37 and Table 2 of the CoP)

EA Document references:

Appendix 8 – Environmental Agency Correspondence

The EA were notified on the 10th November 2025 and responded on the 17th November 2025 with no objections. This can be seen within Appendix 8 and is reproduced below:

“Thank you for informing us you intend to use the DoWCoP for materials re-use on this site, providing that the DoWCoP is followed in full we have no objections to materials use, in accordance with our Regulatory Position Statement.

Materials not used in accordance with the DoWCoP process in full may be deemed waste and will require a relevant permit for deposit. A formal Declaration must be submitted by a Qualified Person before any use of materials on site or transfer is permitted.

The Qualified Person should be aware that based on our records the Greater Manchester, Merseyside and Cheshire Groundwater and Contaminated Land team in the Environment Agency has not reviewed any land quality documents associated with this development in respect of controlled waters. It is therefore

important that the Qualified Person is satisfied that all relevant planning conditions associated with land contamination and risks to the environment have been met and the relevant conditions discharged."

14d. Please attach any relevant documentation from any other regulators (if relevant) relating to the excavation and reuse of the materials to demonstrate no objection (see 3.37 of the CoP)

Document Reference(s):
Not applicable.

Where contamination is not suspected 15a. Please attach copies or relevant extracts from the Desk Top Study that demonstrates that there is no suspicion of contamination.	Document Reference(s) Not applicable.
15b. Please attach copies of or relevant extracts from the site investigation/testing reports that adequately characterise the clean materials to be used (if appropriate).	Document Reference(s) Not applicable.
15c. Please attach copies of any other relevant information (if available) confirming that land contamination is not an issue.	Document Reference(s) Not applicable.

NB: It is your responsibility to assess the nature of the material to be used and that it fits within the limitations of the scenario under which it is to be used

Certainty of use

Various lines of evidence are required to demonstrate that the materials are certain to be used. This includes:

- The production of this MMP
- An appropriate planning permission (or conditions that link with the reuse of the said materials)
- An agreed Remediation Strategy(ies)
- An agreed Design Statement(s)
- Details of the contractual arrangements

Please identify in the following sections what lines of evidence relate to the site(s) **where the materials are to be used**.

16a. Planning Permission(s) relating to the site where materials are to be reused

Please provide a copy of the relevant planning permission

Document Reference:

Appendix 9 – Planning Permission and Officer comments.

Under planning permission application number 22/00099/FUL in section 8 it states:

If site won materials (waste and non-waste) are to be reused on site, then prior to this work being carried out, a Materials Management Plan, signed off by a Qualified Person, shall be submitted to and agreed in writing with the local planning authority. The MMP shall demonstrate that any reuse of contaminated materials does not result in increased risk to the environment or human health.

16b. Explain how the reuse of the excavated materials fits within the planning permission(s) for each site.

As part of planning permission Condition 8, imposed by the local authority, the preparation of a remediation strategy to 'deal with the risks associated with contamination of the site in respect of the development' is required. The RSVP produced by G&J in Appendix 5 meets Condition 8's requirements by producing a preliminary risk assessment as well as how to deal with contaminated and site won material. Also, multiple investigative reports have been produced for the site in and are presented in Appendix 4 which satisfies points 2 and 3 of Condition 8.

16c. If planning permission is not required for any one site please explain why below e.g. permitted development, clean up of a chemical spill, surrender of an Environmental Permit, re-contouring within the existing permission.

Not applicable as planning permission is required for the whole site.

Where contamination is suspected or is known to be present

17. Please provide a copy of any Remediation Strategy(ies) that have been agreed with relevant regulators.

Document Reference(s):
Appendix 5 – RSVP – G&J 2025

Section 4 discussing remedial targets for contaminants of concern to protect human health and the environment, this section also sets out acceptable soil remedial targets to ensure contaminants are below GAC levels for commercial use.

Section 5 covers the remedial options for the contaminated soils to address how material will be remediated and then fit for use. This document also outlines how the remedial treatments address relevant pollutant linkages to reduce the overall risk.

Ex-situ bioremediation will be undertaken at the site to treat and validate the impacted material to allow reuse within the site. It is proposed that material will be used to backfill the voids after removing the impacted material to a depth of 2.5mbgl or just above the resting groundwater level, whichever is encountered first. The void will have material placed inside to act as backfill to assist in controlling the ingress of groundwater.

The ex-situ bioremediation process will be complete by the end of April 2026, the monitoring periods of the groundwater will continue on from this date as noted in the remediation strategy, but the final decision on the end of the monitoring period is at the discretion of the EA.

Where contamination is not suspected

18. Please provide a copy of any Design Statement(s) that have been agreed (e.g. with the planning authority or in the case of permitted developments the client).

Document Reference(s):
Not applicable.

Quantity of Use

19. Please provide a breakdown of the excavated materials for each site and how much will be placed at each site or sub area of each site.

Where this is not specific to a single readily identifiable source refer to an annotated plan, schematic or attach a tabulated summary.

Document Reference(s):

Appendix 6: Cut and fill drawing (ref: 25069-MJM-00-00-DR-C-9200 P03) and the Maher Earthworks Movements Schematics

	Bulk Earthworks Cut (m ³)	Bulk Earthworks Fill (m ³)	Bulk Earthworks Net (m ³)
Total	12,372	13,852	-1500

The general cut and fill volumes can be seen in the above table. The main cut will be in the north of the site with the minimum cut level of -4.00m and in the east with a minimum cut level of -2.00m. The fill will be placed in the centre of site as well as the south and west. The minimum fill level in these areas will be 2.00m.

From the Maher Earthworks Movements Schematics, three sets of remediation excavation areas have been identified on site at 3500m³, 3000m³, and 1500m³. The total spoil produced is therefore estimated at 8000m³ which will form part of the 12,372m³ of cut. The final anticipated material re-use volume is estimated to be approximately 13,852m³. The net -1,500m³ will be from arisings from excavating the attenuation tank area.

20a. How has consolidation/compaction been considered in the above mass balance calculations?	A small amount of long-term consolidation and settling is expected but it is understood most settlement will take place during the construction period.
20b. How has loss due to treatment being considered in the above mass balance calculations (if applicable)?	The assumed volume of 8000m³ of remediated material will supposedly come from three separate areas with totals of 3500m³, 3000m³, and 1500m³. This material will make up the -1500m³ from the bulk earthworks net. Any material left over will be transported off of site. It is not expected that treatment of this material (spreading of soils, addition of 1-2% lime and mixing) will affect the overall volume.
20c. How has the addition of treatment materials been considered in the above mass balance calculations (if applicable)?	It is not expected that treatment of this material (spreading of soils, addition of 1-2% lime and mixing) will affect the overall volume.
Note - An exact figure is not required but one that is reasonable in the circumstances and can be justified if challenged.	

Contingency arrangements

Explain what is to happen in the following situations and **identify the appropriate clauses** in the contract(s) (Such clauses must be provided to the Qualified Person, preferably as a summary document): or

21a. What is to happen to, and who is to pay for out of specification materials?

Unsuitable material will be disposed of off-site, at the cost of the client. Any unanticipated material encountered, including asbestos containing materials which are unsuitable for retention will be disposed of at the client's cost. Geotechnically unsuitable material, if encountered it would have to be removed at the client's cost.

21b. What is to happen to, and who is to pay for any excess materials?

Excess material shall be removed at the client's cost.

21c. What happens if the project programme slips in relation to excavated materials or materials under -going treatment?

The client will bear the risk.

21d. Other identified risk scenarios for the project (relating to excavated materials)?

Reference:
No other risks identified.



CONTAMINATED LAND: APPLICATIONS IN REAL ENVIRONMENTS

CL: AIRE

The Tracking System

Where contamination is suspected or known to be present, state the procedures put in place to:

22a. For all sites please describe the tracking system to be employed to monitor materials movements.

The tracking system will include:

1. Annotated plans of the site(s) identifying different excavation areas (referenced to site investigation data, as appropriate), stockpile locations, treatment areas (if applicable) and placement locations.
2. Inspection procedures:
 - a. Visual and olfactory;
 - b. Field tests (as appropriate); and
 - c. Laboratory confirmation (as appropriate).
3. Registered waste carrier and non-waste haulier (who may be the same person);
4. Tracking form / control sheets (including a running tally);
5. Movement through any authorised treatment facility will also have to be tracked, e.g. stockpiles 1 and 2 from site A and stockpiles (i) and (ii) from site B combined in to windrow A (if applicable) to ensure materials accountability;
6. Treatment results (if applicable);
7. Delivery tickets for non-waste materials (if moving from one site to another):
 - a. Drivers name and vehicle registration;
 - b. Quantity (running tally for each receiving site / sub area); and
 - c. Destination (receiving site and / or sub area).
8. Acceptance procedures for non-waste materials:
 - a. Visual and olfactory;
 - b. Field tests (as appropriate); and
 - c. Laboratory confirmation (as appropriate);
 - d. Signed delivery tickets (including instructions where to off load, as appropriate); and
 - e. Record of where placed.

Where contamination is suspected or known to be present, state the procedures put in place to: 22b. Prevent contaminants not suitable for the treatment process being accepted	Appendix 5 – RSVP by G&J Section 7 states that ‘Verification of soil contamination hotspot excavations will be by inspection of the soils for visual and olfactory evidence of contamination, and the collection of verification samples from the base and faces of the excavation. Samples will be submitted to a UKAS/MCERTS accredited laboratory and analysed for the contaminants of concern.’ The results from these samples will inform whether the material is suitable for treatment at the treatment area. Materials that are not found to be suitable due to their contaminative nature will be disposed of off-site to a suitable waste disposal facility.
Where contamination is suspected or known to be present, state the procedures put in place to: 22c. Prevent cross contamination of materials not in need of treatment, wastes awaiting treatment and treated materials	Appendix 5 – RSVP by G&J Section 6.3.1 on contaminated soils addresses this concern in two parts, ‘The excavated soils displaying evidence of contamination, or from areas where laboratory testing has shown concentrations above the remedial targets, will be separated and transported to a stockpile located in a designated treatment area within the site.’ It also states, ‘The soils affected by significant organic contamination will be transported to the treatment area and formed into windrows / biopiles. The soils will be periodically turned and nutrients added as appropriate to enhance the bioremediation process. Representative samples will be taken at regular intervals to monitor the progress of bioremediation and determine when soils are suitable for re-use.’ The windrows/biopiles will be segregated separately to other materials such as waste awaiting treatment and already treated materials.

Where contamination is suspected or known to be present, state the procedures put in place to:

22d. Demonstrate that materials that do not require treatment and successfully treated materials reach their specific destination

Appendix 5 – RSVP by G&J

Section 7 sets out a verification plan in accordance with the Environment Agency document: 'Verification of Remediation of Land Contamination' (Report: SC030114/R1) and other relevant industry good practice guidance including The Environment Agency's Land Contamination Risk Management (LCRM) framework. Site wide verification will occur on site with trial pits to allow identification of obvious hotspots and suitable material, there is also a sampling strategy in place to analyse for contaminants of concern.

Material movement will also be tracked on site through topographic records, photographic evidence and descriptions of the excavations, and volumes/locations of material.

Where contamination is suspected or known to be present, state the procedures put in place to:

22e. Ensure that waste for off-site disposal or treatment is properly characterised and goes to the correct facility

Excess material destined for disposal will be characterised in accordance with the requirements of Environment Agency WM3 Guidance to determine whether they are hazardous or non-hazardous.

Non-hazardous soils do not require Waste Acceptance Criteria testing if disposal at non-hazardous landfill is intended. WAC testing will be carried out for any hazardous soils and also for any non-hazardous soils where an inert classification is potentially viable.

The number of required tests will be determined by suitable engineers subject to homogeneity and volume. Test results and waste transfer notes will be included in the final verification report.

23. Please attach a copy of the tracking forms / control sheets that are to be used to monitor materials movements.

Document reference(s)

Appendix 11 – Material Tracking Form

To include transfer of loads on site into stockpiles prior to treatment (if applicable), stockpiled after treatment (if applicable), stockpiled awaiting use (as appropriate) and final placement.

For Hub Sites within Cluster Projects & where materials need treatment before reuse

24. Please attach a copy of the Environmental Permit covering the treatment process.

Alternatively if the treatment is covered by a Mobile Plant Permit and associated Deployment Form, attach a copy of the EA agreement to the Deployment Form.

Permit reference / EA letter reference:

Not applicable as not a cluster project and therefore no associated hub sites.

Records

25. Where, and in what form, are records to be kept?

Note – records e.g. transfer notes, delivery tickets, Desk Top Study, Site Investigation, Risk Assessment(s), Verification Report(s) need to be kept for at least 2 years after the completion of the works and production of the Verification Report

Material movement tracking forms will be kept onsite.

Daily Material Movements Tracking Forms are to be kept on site.

Site movement records will be kept by site managers, in written or electronic format.

Material delivery and waste transfer tickets will be kept by site managers, in written or Electronic format.

Verification Plan

26. Provide or explain the Verification Plan which sets out how you will record the placement of materials and prove that excavated materials have been reused in the correct location and in the correct quantities within the development works (see 3.4 of the DoW CoP).

Verification Plan – ref

MMP VP-30050-25-477

In line with Section 3.4 of the CL:AIRE DoW CoP, the Verification Report shall comprise the following information:

- Site Plans – Demonstrating material movements, stockpile locations and final placement of material;
- Experience and qualification of the person preparing the report in relation to the specific project;
- Description of the project;
- Description of how the use of materials link with the Remediation Strategy or Design Statement;
- Reference to site investigation data;
- Reference to risk assessments (including qualitative risk assessments);
- Reference to the MMP and associated tracking system, including alterations made and why;
- Suitable for use criteria;
- Laboratory analysis;
- Reference to waste transfer documentation, where necessary.
- Signed delivery tickets;
- Record of contingency arrangements if any have been implemented;
- Record of quantity of materials used; and
- Copies of signed Declaration(s) by Qualified Person.

Contact details for person responsible for writing the Verification Report

Company	GMI Construction Group
Address	Carvers Warehouse, 77 Dale Street, Manchester, M1 2HG
Name	Ian Roberts
Email	ian.roberts@gmi.co.uk
Tel	07971240590

Estimated production date for the Verification Report

29 January 2027

Person Filling in this Form – I have supplied the following documentation

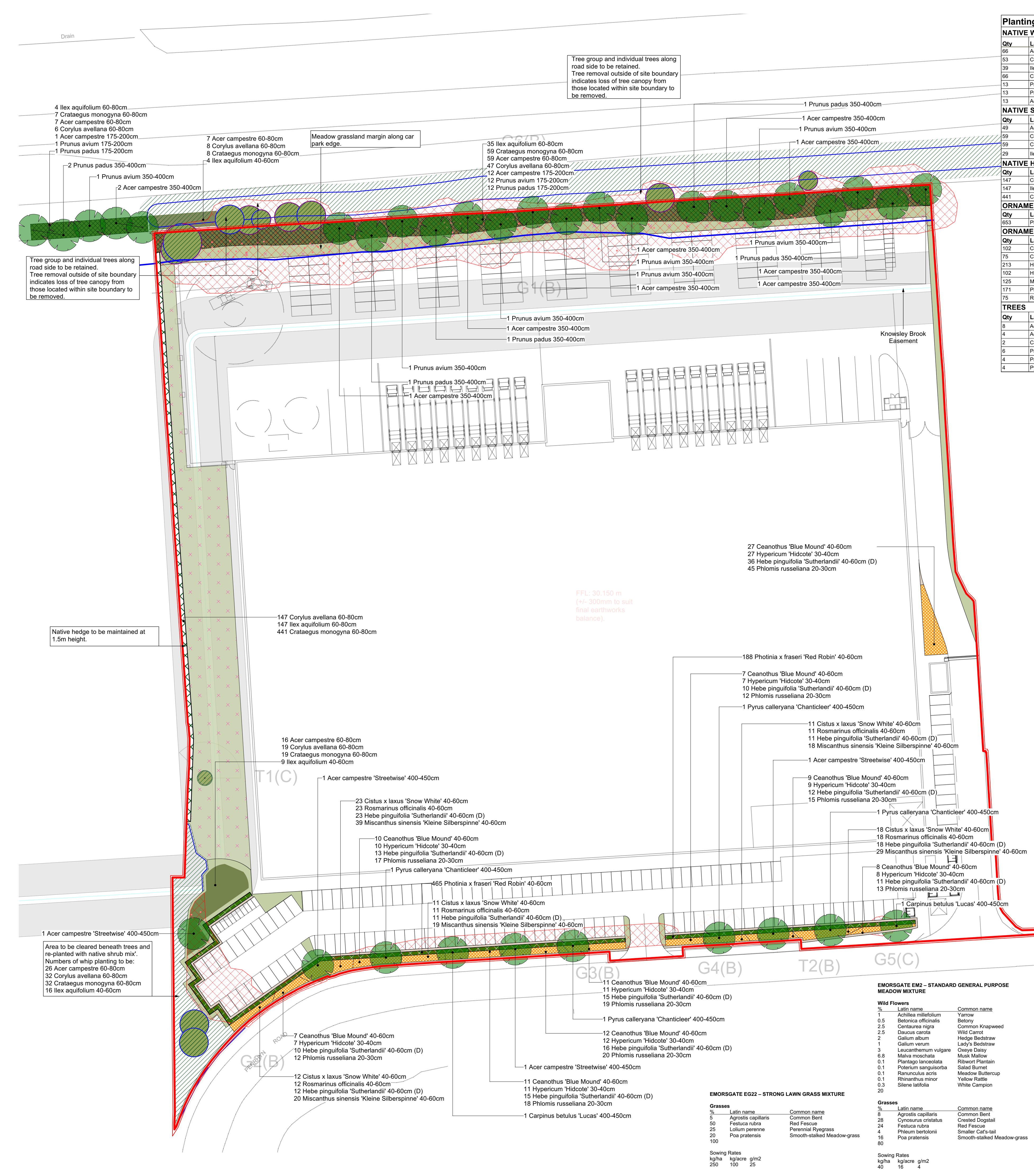
Item	Check	Appendix Ref
Material Management Plan	☒	
Risk Assessment for site where material is to be used	☒	
EITHER Remediation Strategy	☒	
OR Design Statement	☐	
Site location plans	☒	
Tracking system forms	☒	
Desk Top Study	☒	
Material balance evidence	☒	
Verification Plan	☒	
Evidence of Planning status	☒	
Evidence of EHO approval	☒	
Evidence of EA approval	☒	
Evidence that client has provided contractual relationship in place between the supplier and recipient of soil materials	☒	
Evidence that the EA/NRW has been asked to consider any financial arrangement if necessary	☐	

Date required for QP declaration to be made

06/01/2026

APPENDIX 2

- Development Plan
- Detailed Softworks Plan
- Site Layout Plan



Planting Schedule

NATIVE WOODLAND MIX

Qty	Latin Name	Common Name	Height	Form	Root Condition	Rate/m2	Percentage
66	Acer campestre	Field maple	60-80cm	Whip	BR	0.25	25
53	Corylus avellana	Hazel, Cobnut	60-80cm	Whip	BR	0.25	20
39	Ilex aquifolium	Holly	60-80cm	Whip	BR	0.25	15
66	Crataegus monogyna	Common hawthorn	60-80cm	Whip	BR	0.25	25
13	Prunus padus	Bird cherry	175-200cm	Feathered	RB	0.25	5
13	Prunus avium	Wild cherry	175-200cm	Feathered	RB	0.25	5
13	Acer campestre	Field maple	175-200cm	Feathered	RB	0.25	5

NATIVE SHRUB MIX

Qty	Latin Name	Common Name	Height	Form	Root Condition	Container	Percentage
49	Acer campestre	Field maple	60-80cm	Whip	BR		25
59	Corylus avellana	Hazel, Cobnut	60-80cm	Whip	BR		30
59	Crataegus monogyna	Common hawthorn	60-80cm	Whip	BR	5L	30
29	Ilex aquifolium	Holly	40-60cm	Whip	C	2L	15

NATIVE HEDGEROW

Qty	Latin Name	Common Name	Height	Form	Root Condition	Container	Percentage
147	Corylus avellana	Hazel, Cobnut	60-80cm	Whip	BR	5L	20
147	Ilex aquifolium	Holly	60-80cm	Whip	BR	5L	20
441	Crataegus monogyna	Common hawthorn	60-80cm	Whip	BR	5L	60

ORNAMENTAL HEDGEROW

Qty	Latin Name	Common Name	Height	Form	Root Condition	Container	Percentage
653	Photinia x fraseri 'Red Robin'	Christmas berry 'Red Robin'	40-60cm	Whip	C	5L	100

ORNAMENTAL PLANTING MIX

Qty	Latin Name	Common Name	Height	Form	Root Condition	Container	Percentage
102	Ceanothus 'Blue Mound'	California lilac	40-60cm	C	C	5L	15
75	Cistus x laxus 'Snow White'	Rock rose 'Snow White'	40-60cm	C	C	3L	20
213	Hebe pinguifolia 'Sutherlandii'		40-60cm (D)	Bushy	C	5L	20
102	Hypericum 'Hidcote'		30-40cm	C	C	3L	15
125	Miscanthus sinensis 'Kleine Silberspinne'	Eulalia grass	40-60cm	C	C	3L	20
171	Phlomis russeliana	Turkish Sage	20-30cm	C	C	3L	15
75	Rosmarinus officinalis	Rosemary	40-60cm	C	C	5L	20

TREES

Qty	Latin Name	Common Name	Height	Form	Root Condition	Clear Stem	Girth
8	Acer campestre	Field Maple	350-400cm	Heavy Standard	RB	Min 200cm	12-14cm
4	Acer campestre 'Streetwise'	Fied maple 'Streetwise'	400-450cm	Extra Heavy Standard	RB	Min. 200cm	14-16cm
2	Carpinus betulus 'Lucas'	Hornbeam	400-450cm	Extra Heavy Standard	RB	Min. 200cm	14-16cm
6	Prunus avium	Gaan, Wild cherry	350-400cm	Heavy Standard	RB	Min 200cm	12-14cm
4	Prunus padus	Bird cherry	350-400cm	Heavy Standard	RB	Min 200cm	12-14cm
4	Pyrus calleryana 'Chanticleer'	Callery pear 'Chanticleer'	400-450cm	Extra Heavy Standard	RB	Min 200cm	14-16cm

GENERAL NOTES

- All planting and seeding to be undertaken during the first planting season following completion of infrastructure. Deciduous trees and shrubs: Late October to late March. Conifers and evergreens: September/ October or April/ May. Container grown plants: At any time if ground and weather conditions are favourable (provide watering and weed control as necessary).
- Existing trees to be retained and protected throughout construction period in accordance with BS 5837 2012 - Trees in Relation to Design, Demolition and Construction - Recommendations.
- Materials and workmanship shall generally be in accordance with the following documents - BS3936 Nursery Stock and BS4428. Recommendations for General Landscape Operations. Plant material to be the sizes and dimensions as stated in the schedule and shall be healthy with good fibrous root systems.
- Site Preparation: Break up compacted soil to full depth for planting areas. Remove undesirable material brought to the surface. Apply approved herbicides as per manufacturer's guidelines to all areas to be seeded or planted and allow suitable time to elapse to ensure all weeds are dead before cultivation. Leave regular and even.
- Setting out of planted areas to be approved on site by Contract Administrator (CA). All tree and shrubs to be planted in top soil @ 450mm depth. Amenity Grass Areas will be sown in top soil @ 150mm depth.
- Woodland and shrub mix amended to be planted in accordance with UU Standard Conditions

ORNAMENTAL SHRUBS, HEDGES AND TREES

Ground Preparation

Where necessary treat existing weeds with herbicide and allow a suitable period as recommended by the manufacturer for this to take effect. A general purpose slow release fertiliser at the rate of 75g/m² and Tree Planting and Mulching Compost at the rate of 20litres/m² are to be incorporated into the top 150mm of topsoil during final cultivations. All extraneous matter such as plastic, wood, metal and stones greater than 50mm in any dimension shall be removed from site. Tree pits are to be excavated and the base broken up a further 150mm with the sides well scarified to prevent smearing.

Planting

Shrubs and hedges are to be set out as shown on the drawing and pit planted into the prepared soil at the specified centres with minimal disturbance to the rootball and well firmed in shrub planting. Planting to be implemented in random groups of 5-9 single species blocks with larger species to the back of the border.

Trees are to be placed into the pits and backfilled with topsoil incorporating slow release fertilizer including mycorrhiza powder to aid root growth and tree planting and mulching compost as specified. Firm trees in well and secure with proprietary rubber tree ties and spacers. Water all trees and shrubs at the end of each day of planting. Spread ornamental pine bark mulch to a depth of 75mm across all new planting areas, ensuring groundcover plants are not buried.

Tree species suitable for the street planting and conditions have been selected. Trees to be planted with correct species and in the locations specified in accordance with NHBC Standards Chapter 4.2. All rootball, container grown and trees heavy standard and over shall be double staked. Stakes should be driven 500mm into undisturbed ground before planting the tree, taking care to avoid underground services and cables etc. All trees to be protected by tree guards. Trees located within the highway edge or other public pedestrian locations within the site will need to be adequately protected (selected system to be approved). Trees planted in bare ground to have 1m radius circle of woodchip or crushed bark mulch to a depth of 100mm.

Maintenance

The landscape contractor shall maintain all areas of new planting for a period of 12 months following practical completion. All stock deemed to be dead, dying or diseased within the defects period shall be replaced by the contractor at their own cost. The site is to be visited monthly throughout the year to undertake the following operations.

Weed clearance: All planting areas are to be kept weed free by hand weeding or herbicide treatment.

Litter clearance: All litter is to be removed from planting beds.

Watering: Planting areas are to be brought up to field capacity at each visit and each tree is to receive 20 gallons. All plants / seeding to be watered to ensure survival.

Checking trees: All tree ties and stakes are to be checked and adjusted if too loose, too tight or if chaffing is occurring. Any broken stakes are to be replaced.

Formative pruning: Any damaged shoots/branches are to be pruned back to healthy wood. Plants are to be pruned in accordance with good horticultural practice to maintain healthy well-shaped specimens.

Shrubs, hedgerows and planting within visibility displays should be kept at a height no greater than 600mm.

PLANTS/TREES - GENERAL

- Condition: Materially undamaged, sturdy, healthy and vigorous.
- Appearance: Of good shape and without elongated shoots.
- Hardiness: Grown in a suitable environment and hardened off.
- Health: Free from pests, diseases, discoloration and weeds.
- Budded or grafted plants: Bottom worked.
- Root System and Condition: Balanced with branch system.
- Standard: The relevant parts of BS 3936.
- Species: True to Name.
- Origin/Provenance: British provenance as per the National Plant Specification.
- Names, Forms, Dimensions, Provenance and other Criteria: To BS 3936-1 Trees and Shrubs.
- Where proposed trees are located adjacent to roads/pathways root protection barriers to be provided on footpath side of tree pit. Where landscape works encroach on root protection areas non-dig / hand dig methods to be used in accordance with the Arboricultural Method Statement.

PROTECTION OF EXISTING GRASS

- General: Protect areas affected by operations using boards/ tarpaulins.
- Appearance: Of good shape and without elongated shoots.
- Hardiness: Grown in a suitable environment and hardened off.
- Health: Free from pests, diseases, discoloration and weeds.
- Budded or grafted plants: Bottom worked.
- Root System and Condition: Balanced with branch system.
- Standard: The relevant parts of BS 3936.
- Species: True to Name.
- Origin/Provenance: British provenance as per the National Plant Specification.
- Names, Forms, Dimensions, Provenance and other Criteria: To BS 3936-1 Trees and Shrubs.
- Where proposed trees are located adjacent to roads/pathways root protection barriers to be provided on footpath side of tree pit. Where landscape works encroach on root protection areas non-dig / hand dig methods to be used in accordance with the Arboricultural Method Statement.

SHRUB PROTECTION:

- Manufacturer: Contractor's choice, to LA approval.
- Material: UV stabilised Polypropylene Shrub Shelter
- Size: 600mm high 63mm diameter.
- Support: Stout bamboo cane or softwood alternative.

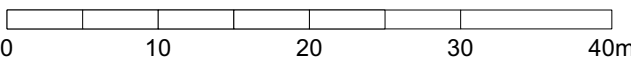
PROPOSED GRASSLAND

- Follow supplier's guidance for seed quantities per area and sowing method and timing.
- Wildflower seed mix to be applied to subsoil following scraping off the topsoil.

PLANTING MAINTENANCE GENERALLY- REFER TO LANDSCAPE MANAGEMENT PLAN

NOTES

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KEY

- Site Boundary
- Existing vegetation to be removed
- Existing vegetation to be retained
- Existing tree to be retained
- Root protection area
- Proposed trees (Shown on plan with mature canopy spread)
- Woodland mix (planted at 1.5m centres)
- Native shrub mix (planted at 1m centres)
- Ornamental shrub mix
- Native Hedgerow
- Ornamental Hedgerow
- Gravel edge
- Meadow seed mix (such as Emorsgate 'EM2 Standard General Purpose Meadow Mixture' or similar)
- Amenity grass mix (such as Emorsgate 'EG22 Strong Lawn Grass Mixture' or similar)
- Water Main Pipeline

P09	11/08/2023	Updated planting	PJM	CEH
P08	22/02/2023	Woodland and shrub mix amended	PJM	CEH
P07	14/02/2023	Planting schedule updated,	PJM	CEH
P06	14/12/2022	Tree planting added to northern boundary.	PJM	CEH
P05	05/08/2022	Amendments based on comments	EMA	SLS

rev	date	description	dm	chk
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masterplanning

environmental assessment

landscape design

urban design

ecology

architecture

arboriculture

fpcr

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client
Knowsley Redevelopments Ltd

project
Penrhyn Road, Knowsley Business Park, Merseyside

drawing title
Detailed Softworks Plan

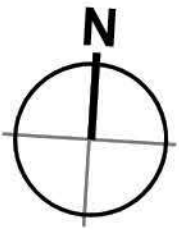
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1:500 @ A1	EMA	CEH	05 August 2022

project number	status	issue
10585	S3	P09

document number
10585-FPCR-XX-XX-DR-L-0001

Project Code: L:\10500\10585\LANDS\Drawings\10585 - Planting Plan P09 - Copy.vxd

A580 - E Lancashire Road

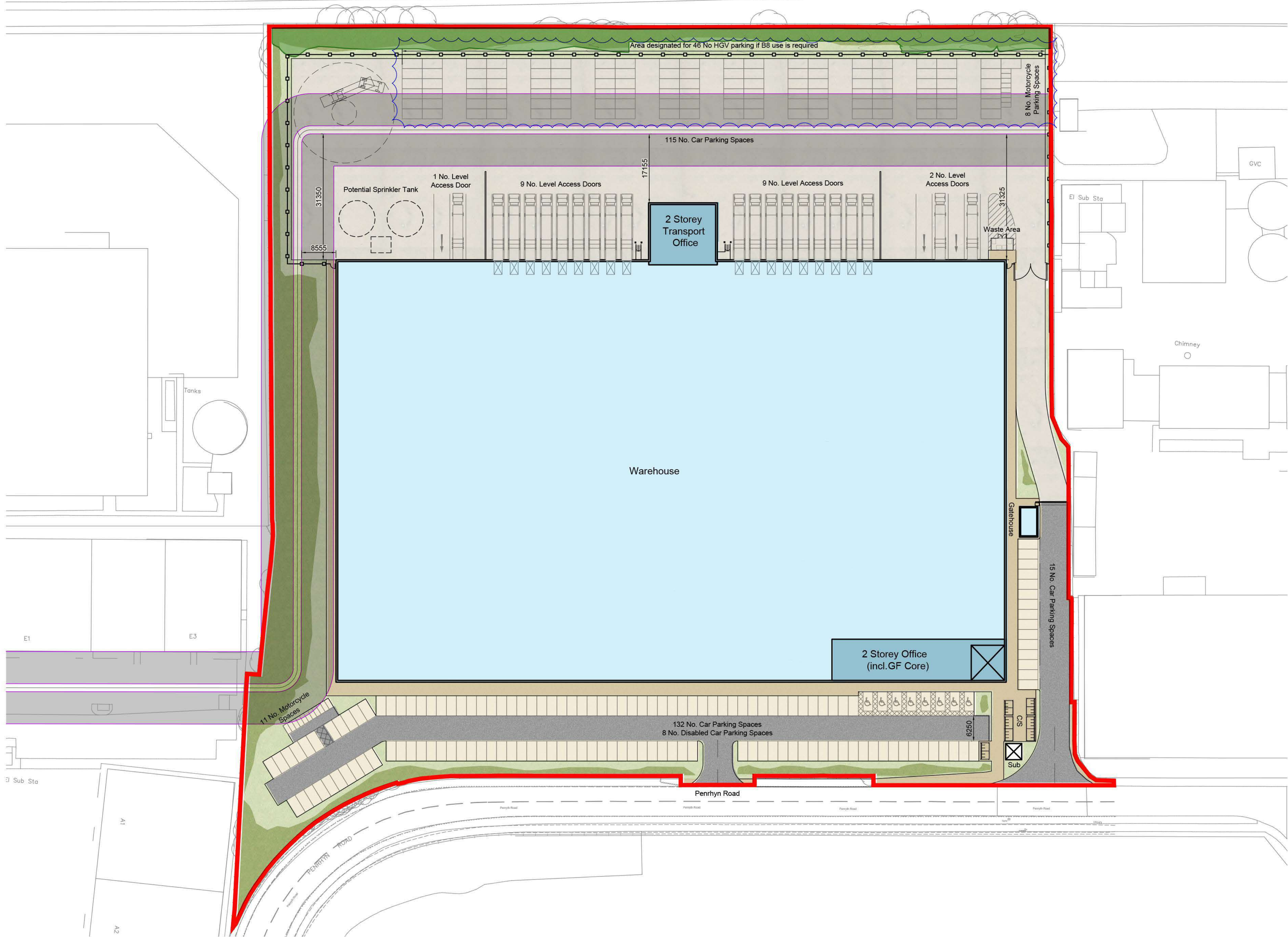


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- It is the recipient's responsibility to print this document to the correct scale.
- All relevant drawings and specifications should be read in conjunction with this drawing.

- Layout to be confirmed
- C1** - Revision reference
- Plot Boundary**
- C** Car Charging Spaces
5% active EV charging spaces to be provided location tbc.
- Knowsley Brook Easement
(8m wide)

**SCHEDULE OF ACCOMMODATION
(Gross Internal Area)**

Unit 100			
Warehouse Area	-	184,700 ft²	(17,159 m²)
Office	-	9,720 ft²	(903 m²)
(Incl. GF core)			
Transport Office	-	5,000 ft²	(465 m²)
Gatehouse	-	300 ft²	(28 m²)
Total Area	-	199,720 ft²	(18,554 m²)
Planning Boundary	-	9.38 Acres	(3.79 Hectares)
Site Density	-	49.14%	
Car Parking Spaces	-	262 No.	
Level Access Doors	-	3 No.	
Dock Loading Doors	-	18 No.	
Cycle Spaces	-	56 No.	
Motorcycle Spaces	-	19 No.	



10m SCALE 1:500

PLANNING

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AND SHOULD NOT BE USED FOR ANY OTHER PURPOSE

rev amendments by ckd date
Penrhyn Road, Knowsley Business
Park, Merseyside
Site Layout

GRAFTONGATE

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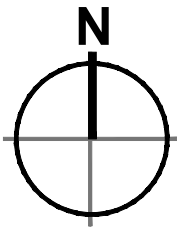
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Drawn / Checked:	RF / LF
Date:	12/01/2022
Scale:	1:500 A1
Drawing no:	Revision:
21002 P0102	H

APPENDIX 3

- Location Plan
- Site Location Plan



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- Layout to be confirmed

- Revision reference

Key

Planning Boundary
9.38 Acres / 3.79 Ha

PLANNING
THIS DRAWING IS FOR PLANNING CONSIDERATION ONLY
AND SHOULD NOT BE USED FOR ANY OTHER PURPOSE

A	Initial Issue	CJD	LF	19.01.22
rev	amendments	by	ckd	date

Penrhyn Road, Knowsley Business
Park, Merseyside
Location Plan

GRAFTONGATE

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o. +44 (0)1636 653027 e. info@umcarchitects.com

Drawing Status:	Planning
Drawn / Checked:	CJD / LF
Date:	19.01.2022
Scale:	1:1250 A2
Drawing no:	Revision:
21002 P0101	A

APPENDIX 4

- Investigative Reports
- Bromododecane Spill Investigation, Amec 2012
- GCO Environmental Consultants Interpretative Desk Study and GI
- GJ224-03-R002-DQRA-V1
- IPP Desk Study - AIG 1999
- Portway Remediation Phase 1 Validation Report August 2025
- Preliminary Site Investigation Report - Cremer and Warner 1993
- Trade Effluent Overspill Sampling Report - Entec UK 2011

BROMODEDECANE SPILLAGE INVESTIGATION, CONTRACT CHEMICALS SITE, KNOWSLEY

1. Introduction

AMEC was commissioned by Contract Chemicals Ltd on 5th April 2012 to undertake an intrusive investigation of a spillage of 1-bromododecane on the Contract Chemicals Ltd property located at Knowsley Business Park, Prescot. The site is located at approximate National Grid Reference 342978, 396733.

The recent spillage occurred at the western boundary of the Contract Chemicals site, and was observed to have flowed overland onto the adjacent property, occupied by Matalan Ltd.

The spillage is understood to have comprised the loss of the contents of an intermediate bulk container (IBC) containing 1-bromododecane only, which was damaged on contact with the ground following toppling from a forklift. The spillage is understood to have been witnessed to flow downslope onto the Matalan site down to a large fire water storage tank forming part of the Matalan site infrastructure, and subsequently drained away towards the north-west.

AMEC has previously undertaken exploratory works in the same area with respect to the delineation of an overspill of process waste from trade effluent drainage on the Contract Chemicals Ltd. site onto the Matalan Ltd. site. The findings of this investigation were presented within a final interpretative report dated January 2011.

The purpose of this report is to provide an outline interpretation of the soil and groundwater sample data relevant to the recent 1-bromododecane spillage, and to compare these data with baseline data collected during the delineation of the earlier trade effluent spillage.

The scope of the investigations undertaken by AMEC were in general accordance with that agreed in advance in discussions between the Environment Agency and Contract Chemicals. The scope of investigation comprised the following:

- The advancement of four boreholes by dynamic sampling methods, to be placed within the known area of the spill to assess the potential for vertical migration through the underlying strata; and
- The advancement of six hand dug pits within the upper 0.5m of the soil profile, to be dug on the periphery of the known spill area to assess the lateral extent of the contamination.

Due to access constraints within the Matalan Ltd site, it was considered that a hand held dynamic sampling rig would be required to advance the dynamic sampling holes.

Two of the dynamic sampling holes (nominally one on the Contract Chemicals site and one situated at the toe of the slope on the Matalan Ltd. site) were proposed to be installed with a monitoring standpipe in order to allow the collection of shallow groundwater for subsequent analysis.

The area of the spillage is located within Zone III (Total Catchment) of a groundwater Source Protection Zone, to be protective of a potable water abstraction point located approximately 1.1km to the north-east at Moss Side. According to online mapping published by the Environment Agency, the site is immediately underlain by a Secondary A Aquifer associated with drift geology, which overlies a Principal Aquifer associated with bedrock.

Knowsley Brook, a Main River, passes beneath the area of the spillage within an underground culvert (see below), flowing from north to south along the boundary between the Contract Chemicals and Matalan sites before being diverted towards the west to the south of the area of the spillage. No chemical quality information with relation to Knowsley Brook is available from the Environment Agency.

2. Details of Site Investigation

2.1 Constraints to Proposed Scope of Work

As described above, due to the potential for damage to be caused to the effluent drainage network and culverted Knowsley Brook within the boundary of the Contract Chemicals site, the proposed dynamic window sampling hole at that location was substituted with a hand dug pit. At this location, due to instability of the sidewalls of the pit (due to significant coarse gravel content) the hand dug pit was abandoned at 0.7m bgl. A black plastic duct was noted at a depth of 0.1m bgl at this location, in the western face of the pit, which is anticipated to be associated with electrical cabling supplying the perimeter lighting of the Contract Chemicals site (the cabling was identified as having been terminated by the site representative, and was visibly cut at a short distance to the south, where an effluent drain manhole had been built up. The site representative identified that the built up manhole was the source of the 2010 drainage overflow.

Dynamic window sampling hole WS01 was not originally intended to be installed for groundwater sampling, however following the substitution of the proposed window sampling hole within the Contract Chemicals site with a hand dug pit, this was selected for installation in order to provide groundwater data from as close to the source to the spillage as possible.

Black plastic ducting was noted at 0.50m bgl in the centre of hand dug pit HDP02, trending approximately north-south. This was considered likely to be associated with the perimeter sensors, however was not identified during service clearance. No damage was done to the ducting during excavation. It was noted that the orientation of the duct appeared to lead directly beneath the marked position of HDP03, which was subsequently repositioned approximately 1m towards the south to avoid damage to the duct. No other exploratory holes were required to be repositioned as a result of the duct.

Proposed dynamic window sampling hole WS03 was intended to be installed for groundwater sampling. However, due to ground conditions making hand excavation difficult, the service inspection pit was halted at 0.40m bgl. As the service inspection pit was of insufficient depth, the hole was not advanced by mechanical means.

Sampling location WS04 was originally intended to be advanced as a hand dug pit, but following the abandonment of WS03 as a dynamically sampled hole this was selected as a substitute. Ground conditions, although enabling easier excavation than those at WS03, were also difficult and it was not possible to advance the service inspection pit past 0.80m bgl. This was considered to be insufficiently protective to allow for continuation of the hole by dynamic window sampling methods, however, was of sufficient depth to allow the installation of a monitoring standpipe.

Prior to the undertaking of intrusive works, AMEC attended the site with a specialist service clearance contractor, Amethyst Surveys Ltd, and a representative of Contract Chemicals on 22 June 2012. During this time the Contract Chemicals representative identified that at the location proposed for investigation by dynamic sampling methods within the boundary of the Contract Chemicals site, a trade effluent drain carrying liquid collected from within the site was likely to be present at a depth of approximately 1.5m below ground level (m bgl). Due to a high level of water within the closest inspection manhole, and the inability of the service clearance contractor to reliably identify the location of the drain, it was considered too great a risk to be able to advance the planned exploratory hole by dynamic sampling means.

Combined with the above, the Contract Chemicals representative also identified that the proposed exploratory location within the Contract Chemicals boundary, and possibly exploratory holes on the Matalan site close to the common boundary, were also likely to be positioned directly above a culvert containing Knowsley Brook, anticipated to be present at a depth of circa 2m below ground level (bgl) and witnessed via an access grid located to the south along the Contract Chemicals site boundary. Furthermore, restrictions with respect to the use of petrol engine equipment were also in place on the Contract Chemicals site, which would have made the use of a dynamic sampling rig problematic.

On the Matalan Ltd. site, the potential for the culverted brook to extend onto the higher part of the slope forming the eastern site boundary resulted in the repositioning of two proposed window sampling holes further downslope to the toe of the slope.

At the time of the exploratory investigations on 27 June 2012, it was discovered that access to the proposed exploratory locations on the Matalan site could be achieved by tracked 'terrier' dynamic window sampling rig. This was used instead of a hand-held dynamic sampling rig due to its greater power and it posing fewer manual handling risks.

A plan showing the exploratory hole locations is provided as Figure 1.

2.2 Ground Conditions Encountered

Made Ground was encountered in all exploratory hole locations, extending to a depth of between 0.35m bgl (HDP06) and 0.80m (WS04). However, the base of Made Ground was not proven in the majority of exploratory holes as these were primarily concerned with shallow sampling.

The composition of Made Ground was noted to be highly variable across the site, with three main types noted:

- Granular fill (HDP01): Light grey coarse gravel of limestone and other lithologies;
- Clayey gravelly sand with pockets of clay/sandy gravelly clay (HDP02, HDP03, HDP04, HDP05, HDP06, WS01, WS02, WS04; and
- Clayey sandy gravel with brick, concrete, slag and occasional metal rivets (WS03).

Natural ground was encountered in HDP06 from 0.35m bgl, WS01 from 0.50m bgl, and WS02 from 0.70m bgl. Natural ground comprised typically red brown silty gravelly fine sand with low sandstone and mudstone cobble content, overlying red brown weathered mudstone in WS01 and WS02.

Exploratory hole logs are provided as Appendix A, and site investigation photographs are included as Appendix B.

2.3 Observations of Contamination

Soil arisings at HDP01 were noted to have a light to strong chemical odour from throughout the exploratory hole (from surface to 0.70m bgl).

Soil arisings from HDP04 between surface and 0.20m bgl were noted to have a possible chemical odour.

Soil arisings from WS01 taken from between the surface and 0.60m bgl were noted to have a chemical odour.

No observations of visible contamination (e.g. hydrocarbon sheens or dark staining) were noted in soils, and during groundwater sampling on 11 July 2012 no visual or olfactory evidence of contamination was noted.

2.4 Chemical Analytical Data

Following the spillage of contaminated water from the Contract Chemicals Ltd effluent drain in 2010, AMEC (as Entec UK Limited) undertook shallow soil sampling to delineate the extents of the spill and determine the impact on soil and water quality on the Matalan Ltd site. A full summary of these works is provided in the subsequent report, 'Trade Effluent Overspill Sampling – Final Interpretive Report', issued in January 2011.

The analysis scheduled as part of the 2010 investigations included SVOC tentatively Identified Compounds (TICs), as part of which bromododecane can be identified. The concentrations of bromododecane recorded in 2010 have, therefore, been considered within this report as representative of baseline conditions prior to the recent spillage event.

Table 1 Bromododecane Concentrations, 2010 AMEC Site Investigations

Exploratory Location	Depth (m bgl)	Bromododecane Concentration (mg/kg)	Leachable Bromododecane Concentration (mg/l)
HDP1	0.10	Not detected	Not tested
	0.80	Not detected	Not tested
HDP2	0.10	Not detected	Not detected
	0.70	10.523	Not tested
HDP3	0.10	27.605	Not tested
	0.60	Not detected	Not tested
HDP4	0.10	Not detected	Not tested
	0.70	Not detected	Not tested
HDP5	0.10	Not detected	Not tested
	0.50	Not detected	Not tested

The results of soil and groundwater analysis undertaken as part of the 2012 investigations are presented as Appendix C.

Although it was not possible for the analytical laboratory to differentiate between 1-bromododecane, 2-bromododecane and 3-bromododecane, Contract Chemicals Ltd has confirmed that the recent spillage which was to be investigated would comprise 1-bromododecane only, and that other derivatives of lauryl bromide, which would include 2-bromododecane and 3-bromododecane, are not likely to be present. As such, samples of soil and groundwater collected during the 2012 sampling were submitted for specialist analysis of bromododecane as an SVOC TIC only.

During the exploratory works on 27 June, standing water was noted within HDP02 at a level of 0.4m bgl, after a period of approximately two hours. A sample of this was collected and submitted for chemical analysis alongside the soil samples.

A groundwater level monitoring and sampling visit was undertaken on Wednesday 11 July 2012. Samples of groundwater were taken from the monitoring installations in WS01 and WS04, and submitted for analysis of bromododecane as an SVOC TIC.

The methodology and results of chemical analysis are presented as Appendix C, and a summary table is provided below.

Table 2 Bromododecane Concentrations, 2012 AMEC Site Investigations

Exploratory Location	Depth (m bgl)	Bromododecane Concentration (mg/kg)	Bromododecane Concentration (mg/l)
HDP01	0.40	2,500.00	Not tested
	0.70	640.00	Not tested
HDP02	0.27	Not detected	Not tested
	0.40	Not tested	Not detected
HDP03	0.10	1,300.00	Not tested
	0.40	410.00	Not tested
HDP04	0.20	Not detected	Not tested
	0.40	Not detected	Not tested
HDP05	0.30	Not detected	Not tested
HDP06	0.20	Not detected	Not tested
WS01	0.35	61.00	0.980
	0.80	10.00	Not tested
WS02	0.20	Not detected	Not tested
	0.50	Not detected	Not tested
WS03	0.40	Not detected	Not tested
WS04	0.80	Not detected	Not detected

The results of analysis have confirmed the presence of 1-bromododecane both within the Contract Chemicals site (HDP01) and on the adjacent Matalan site (HDP03 and WS01). The results appear to demonstrate that the extent to which 1-bromododecane has impacted shallow soils on the Matalan site is minor, having been identified only within approximately 4.5m of the site boundary.

Concentrations of bromododecane recorded in the 2012 sampling event range up to 2,500.000 mg/kg in soil within the Contract Chemicals site boundary and 1,300.000 mg/kg in soil within the Matalan Ltd. boundary. These concentrations are substantially greater than those identified in SVOC TIC analysis during the 2010 investigation

(27.605 mg/kg in soil maximum) and therefore are considered likely to reflect contamination by the recent spill rather than pre-existing contamination associated with the 2010 effluent drain overspill.

Bromododecane was not encountered within shallow groundwater in sampling locations HDP02 and WS04. However, a bromododecane concentration of 0.980 mg/l was identified in the sample retrieved from WS01. Only limited quantities of perched shallow groundwater have been identified at the site, and groundwater recharge rates were noted to be poor during the sampling event on 11th July. The available data are not considered to indicate a significant impact to groundwater quality from the recent spillage.

3. Conclusions and Recommendations

The results of recent sampling and analysis undertaken by AMEC demonstrate the presence of detectable concentrations of bromododecane within shallow soils on the Matalan site, adjacent to the Contract Chemicals site boundary. These concentrations are significantly greater in concentration than those previously recorded in the same area, suggesting a demonstrable impact from the recent spillage. It is, however, noted that the affected areas are localised in lateral and vertical extent. Low permeability clay deposits are likely to have retarded downward migration through underlying strata and runoff across the surface appears to have affected only two small areas. These two areas relate to the locale of WS01 and HDP03, near to the point of the spillage and HDP01, some 12 m to the south. As such it appears likely the spillage directly affected the former, with some possible, secondary effect on the latter, potentially as spilt material flowed southward along the hardstanding in the Contract Chemicals site, before entering the Matalan site at a second point.

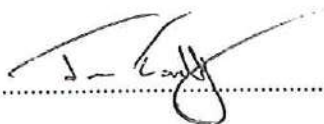
The results of shallow groundwater analysis are generally considered not to show the presence of significant contamination with bromododecane on the Matalan site. However, perched groundwater retrieved from WS01, in close proximity to the common boundary between the Contract Chemicals and Matalan sites and the point of the recent spillage, has been found to be impacted by bromododecane (0.980mg/l).

Although there is currently insufficient toxicological information on bromododecane, to quantitatively assess the risk to environmental and human receptors, the limited extent of the impact is likely to indicate risks to controlled waters, referenced earlier in this report, is unlikely to be significant. Although it is not possible to quantify risks to site users, in the commercial context of the Matalan site, some potential for significant harm cannot be discounted, if direct contact with impacted soils were to take place.

On the basis of the above it is therefore recommended that limited remedial action may be required, involving treatment of affected soils, likely by source removal, to depths able to mitigate against direct exposure.

Author:

Jim Eardley


.....

Reviewer:

P.P. Mike Sheard

S.L. SPAIN

.....

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Figure



Appendix A

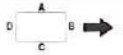
Trial Pit Log

Logged ML Checked MW		Start 27/06/2012 End 27/06/2012	Equipment, Methods and Remarks Hand dug Sampling by AMEC. Terminated due to sidewall collapse.	Dimensions and Orientation Width 0.45 m Length 0.60 m	Ground Level - Coordinates - National Grid - Chainage -	
Samples and Tests			Strata	Depth, Level (Thickness) Legend Backfill/ Instruments		
Depth	Type & No.	Date Records	Description			
0.40	ES 1		1 MADE GROUND: Light grey subangular coarse GRAVEL of limestone. 0.10 m Black plastic ducting, western face of pit 0.10-0.60 m Grey brown 0.40 m Terrain	(0.60)		
0.70	ES 2		2 MADE GROUND: Grey slightly sandy clayey GRAVEL. Gravel is angular fine to coarse of mixed lithologies. EXPLORATORY HOLE ENDS AT 0.70 m	0.60 0.70		
Depth	Type & No.	Records Date				
Groundwater Entries No. Struck Post Strike Behaviour 1 0.30 Damp			Depth Related Remarks * From to (m) 0.00 0.70 Chemical odour throughout	Stability Unstable Shoring None Weather Overcast		
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1:25			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	Trial Pit HDP01 Sheet 1 of 1		

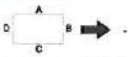
Trial Pit Log

Logged ML Checked MW		Start 27/06/2012 End 27/06/2012	Equipment, Methods and Remarks Hand dug Sampling by AMEC.	Dimensions and Orientation Width 0.30 m Length 0.40 m 	Ground Level Coordinates National Grid Chainage		
Samples and Tests			Strata				
Depth	Type & No.	Date Records	Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments	
0.27	ES 1		1 MADE GROUND: Grass over grey clayey gravelly SAND with pockets of firm grey brown sandy gravelly clay. Gravel is subangular fine to coarse of sandstone. EXPLORATORY HOLE ENDS AT 0.50 m	(0.50)			
0.40	W 1			0.50 m Ducting located in centre of pit, trending north to south			
Depth	Type & No.	Records Date					
Groundwater Entries No. Struck Post Strike Behaviour (m) 1 0.27 Rose to 0.40 m after 180 minutes. Seepage			Depth Related Remarks * From to (m)	Stability Stable Shoring None Weather Overcast			
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1:25			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	Trial Pit HDP02 Sheet 1 of 1			

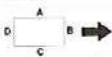
Trial Pit Log

Logged ML Checked MW		Start 27/06/2012 End 27/06/2012	Equipment, Methods and Remarks Hand dug Sampling by AMEC.	Dimensions and Orientation Width 0.25 m Length 0.35 m 	Ground Level - Coordinates - National Grid - Chainage -
Samples and Tests			Strata		
Depth	Type & No.	Date Records	Description	Depth, Level/ (Thickness)	Legend
0.10	ES 1		1 MADE GROUND: Grey brown sandy clayey TOPSOIL with pockets of firm sandy clay and lenses of red brown fine sand.	0.20	
0.40	ES 2		2 MADE GROUND: Firm grey brown mottled slightly sandy slightly gravelly CLAY with low cobble content. Gravel is angular to subangular fine to coarse of sandstone and siltstone and occasional plastic and red brick.	(0.30) 0.50	
			EXPLORATORY HOLE ENDS AT 0.50 m		
Depth	Type & No.	Records Date			
Groundwater Entries No. Struck Post Strike Behaviour (m) None observed (see Key Sheet)			Depth Related Remarks * From to (m)		Stability Stable Shoring None Weather Overcast
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC		Trial Pit HDP03 Sheet 1 of 1

Trial Pit Log

Logged ML Checked MW	Start 27.06.2012 End 27.06.2012	Equipment, Methods and Remarks Hand dug Sampling by AMEC.	Dimensions and Orientation Width 0.32 m Length 0.37 m 	Ground Level Coordinates National Grid Chainage		
Samples and Tests			Strata			
Depth	Type & No.	Date Records	Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
0.20	ES 1		1 MADE GROUND: Grass over grey brown slightly gravelly sandy clayey TOPSOIL. Gravel is subangular fine to coarse of sandstone and igneous lithologies. Possible light chemical odour.	0.20		
0.40	ES 2		2 MADE GROUND: Firm grey brown and brown mottled slightly gravelly sandy CLAY with pockets of red brown and blue grey clay, brown fine and medium sand and grey clayey fine and medium sand. EXPLORATORY HOLE ENDS AT 0.50 m	(0.30) 0.50		
Depth	Type & No.	Records Date				
Groundwater Entries No. Struck Post Strike Behaviour (m) None observed (see Key Sheet)			Depth Related Remarks * From to (m)	Stability Stable Shoring None Weather Overcast		
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1:25			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	Trial Pit HDP04 Sheet 1 of 1		

Trial Pit Log

Logged ML Checked MW		Start 27.06.2012 End 27.06.2012	Equipment, Methods and Remarks Hand dug Sampling by AMEC.		Dimensions and Orientation Width 0.30 m Length 0.38 m 		Ground Level Coordinates National Grid Chainage	
Samples and Tests			Strata					
Depth	Type & No.	Date Records	Description			Depth, Level/ (Thickness)	Legend	Backfill/ Instruments
0.30	ES 1		1 MADE GROUND: Grass over brown slightly gravelly sandy clayey TOPSOIL. Gravel is subangular fine to coarse. 2 MADE GROUND: Soft to firm dark grey brown slightly sandy slightly gravelly CLAY with low cobble content. Gravel is subangular fine and medium. 3 MADE GROUND: Soft to firm grey brown and brown mottled slightly gravelly sandy CLAY with pockets of red brown sandy clay and clayey fine and medium sand. Gravel is angular to subangular fine to coarse. EXPLORATORY HOLE ENDS AT 0.60 m			0.15 0.40 0.60		
Depth	Type & No.	Records Date						
Groundwater Entries No. Struck Post Strike Behaviour (m) None observed (see Key Sheet)			Depth Related Remarks * From to (m)			Stability Stable Shoring None Weather Overcast		
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC			Trial Pit HDP05 Sheet 1 of 1		

Scale 1:25

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430 4527 01 2012 15 20 R1



Trial Pit Log

Logged I/L Checked MW	Start 27/06/2012 End 27/06/2012	Equipment, Methods and Remarks Hand dug	Dimensions and Orientation Width 0.30 m Length 0.30 m 	Ground Level Coordinates National Grid Chainage		
Samples and Tests			Strata			
Depth	Type & No.	Date Records	Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
0.20	ES 1		1 MADE GROUND: Grass over grey brown slightly gravelly sandy clayey TOPSOIL. Gravel is angular to subangular fine to coarse.	0.10		
0.40	ES 2		2 MADE GROUND: Firm grey brown slightly sandy slightly gravelly CLAY with low cobble content. Gravel is angular to subangular fine to coarse of sandstone, siltstone and mudstone. Cobbles are siltstone and mudstone.	0.35		
			3 Firm red orange brown mottled grey silty CLAY. EXPLORATORY HOLE ENDS AT 0.50 m	0.50		
Depth	Type & No.	Records Date				
Groundwater Entries No. Struck Post Strike Behaviour (m) None observed (see Key Sheet)			Depth Related Remarks * From to (m)	Stability Stable Shoring None Weather Overcast		
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1:25 (c) ESG www.esg.co.uk 426.4327/07/2012 15.23.45 			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	Trial Pit HDP06 Sheet 1 of 1		

Window Sampler Hole Log

Drilled IH Logged ML Checked MW	Start 27/06/2012 End 27/06/2012	Equipment, Methods and Remarks Terrier Hand dug inspection pit to 1.20m. Window sampling to 2.30m. Terminated on refusal. Sampling by AMEC.	Depth from to Diameter Casing Depth	Ground Level Coordinates National Grid Chainage			
Samples and Tests			Strata				
Depth	Type & No	Records	Date Casing Time Water	Description	Depth, Level/ (Thickness)	Legend	Backfill/ Instruments
0.35	ES 1			MADE GROUND: Grey brown slightly gravelly clayey SAND. Gravel is subangular fine to coarse of sandstone and igneous lithologies. Chemical odour.	(0.60)		
0.80	ES 2			Red brown silty gravelly fine SAND with low cobble content. Gravel is subangular fine to coarse of sandstone.	0.60 0.80		
1.00	ES 3			Red brown slightly gravelly silty fine SAND. Gravel is subangular fine and medium of sandstone. (possible weathered bedrock)	(0.50) 1.30		SP
				Stiff friable red brown gravelly silty CLAY. Gravel is angular fine to coarse of mudstone. (possible weathered bedrock)	(0.50) 1.80		
				Red brown angular fine to coarse GRAVEL of mudstone. (possible weathered bedrock)	(0.50) 2.30		
EXPLORATORY HOLE ENDS AT 2.30 m							
Depth	Type & No	Records	Date Casing Time Water				
Groundwater Entries No. Struck Post strike behaviour 1 0.35 Seepage				Depth sealed (m) -	Depth Related Remarks * From to (m)		
Chiselling Depths (m) Time Tools used							
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.				Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	Borehole WS01 Sheet 1 of 1		

Window Sampler Hole Log

Drilled IH Logged ML Checked MW	Start 27/06/2012 End 27/06/2012	Equipment, Methods and Remarks Terrier Hand dug inspection pit to 1.20m. Window sampling to 2.00m. Terminated on refusal. Sampling by AMEC.	Depth from to Diameter Casing Depth	Ground Level Coordinates National Grid Chainage
Samples and Tests			Strata	
Depth	Type & No	Records	Date Casing	Time Water
0.20	ES 1			
0.50	ES 2			
			MADE GROUND: Grass over slightly gravelly sandy clayey TOPSOIL. Gravel is angular to subangular fine to coarse of sandstone and igneous lithologies. MADE GROUND: Grey brown slightly clayey fine and medium SAND with occasional pockets of firm red brown mottled grey clay. Firm friable red brown slightly sandy CLAY, locally sandy. Dark red brown fine SAND. Red brown silty fine SAND. (possible weathered bedrock) Red brown mottled blue grey angular fine to coarse GRAVEL of mudstone. (possible weathered bedrock) EXPLORATORY HOLE ENDS AT 2.00 m	
			0.15 (0.55) 0.70 (0.48) 1.18 1.23 (0.52) 1.75 2.00	
			Legend Backfill/ Instruments	
Depth	Type & No	Records	Date Casing	Time Water
Groundwater Entries			Depth Related Remarks *	
No.	Struck (m)	Post strike behaviour	Depth sealed (m)	From to (m)
1	0.50	Seepage		
			Chiselling Depths (m) Time Tools used	
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column. Scale 1:50 (c) ESG www.esg.co.uk 4/05/2012 07:20:12 15.28.50			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	
			Borehole WS02 Sheet 1 of 1	

Window Sampler Hole Log

Drilled IH Logged ML Checked MW	Start 27/08/2012 End 27/08/2012	Equipment, Methods and Remarks Terrier Hand dug inspection pit to 0.40m. Terminated on AMEC instruction. Sampling by AMEC.		Depth from to Diameter Casing Depth	Ground Level Coordinates National Grid Chainage			
Samples and Tests			Strata					
Depth	Type & No	Records	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
0.40	ES 1				MADE GROUND: Grass over dark red brown and red grey brown clayey sandy GRAVEL with low cobble content. Gravel is angular fine to coarse of brick, concrete, sandstone, slag and occasional metal rivets. Cobbles of brick. EXPLORATORY HOLE ENDS AT 0.40 m	(0.40) 0.40		
Depth	Type & No	Records	Date Casing	Time Water				
Groundwater Entries No. Struck Post strike behaviour None observed (see Key Sheet)					Depth Related Remarks * From to (m)	Chiselling Depths (m) Time Tools used		
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.					Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC	Borehole WS03 Sheet 1 of 1		

Window Sampler Hole Log

Drilled IH Logged ML Checked MW	Start 27.06.2012 End 27.06.2012	Equipment, Methods and Remarks Terrier Hand dug inspection pit to 0.60m. Terminated on AMEC instruction. Sampling by AMEC.		Depth from to Diameter Casing Depth	Ground Level Coordinates National Grid Chainage
Samples and Tests			Strata		
Depth	Type & No	Records	Date Casing	Time Water	Description
0.30	ES 1				MADE GROUND: Firm red grey brown mottled slightly sandy gravelly CLAY with low cobble content. Gravel is angular to subangular fine to coarse of sandstone, brick, slag and igneous lithologies. Cobbles are of sandstone and brick. EXPLORATORY HOLE ENDS AT 0.60 m
0.60	ES 2				
Depth	Type & No	Records	Date Casing	Time Water	Depth, Level (Thickness) Legend Backfill/ Instruments
					(0.60) 0.80 SP
Depth	Type & No	Records	Date Casing	Time Water	
Groundwater Entries No. Struck Post strike behaviour (m)			Depth sealed (m)	Depth Related Remarks * From to (m)	
None observed (see Key Sheet)				Chiselling Depths (m) Time Tools used	
Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.			Project Contract Chemicals, Knowsley Project No. F2019-12 Carried out for AMEC		Borehole WS04 Sheet 1 of 1



Appendix B

Site Investigation Photographs – Contract Chemicals Ltd



Arisings from HDP01



HDP01 excavation (duct
visible to right of image)



Arisings from HDP02



HDP02 excavation
(black duct visible)

Site Investigation Photographs – Contract Chemicals Ltd



Arisings from HDP03



HDP03 excavation



Arisings from HDP04



HDP04 excavation

Site Investigation Photographs – Contract Chemicals Ltd



Arisings from HDP05



HDP05 excavation



Arisings and excavation
HDP06



Arisings from WS01

Site Investigation Photographs – Contract Chemicals Ltd



Deep arisings from
WS01



WS01 excavation



Shallow arisings from
WS02



Deep arisings from
WS02

Site Investigation Photographs – Contract Chemicals Ltd



WS02 excavation



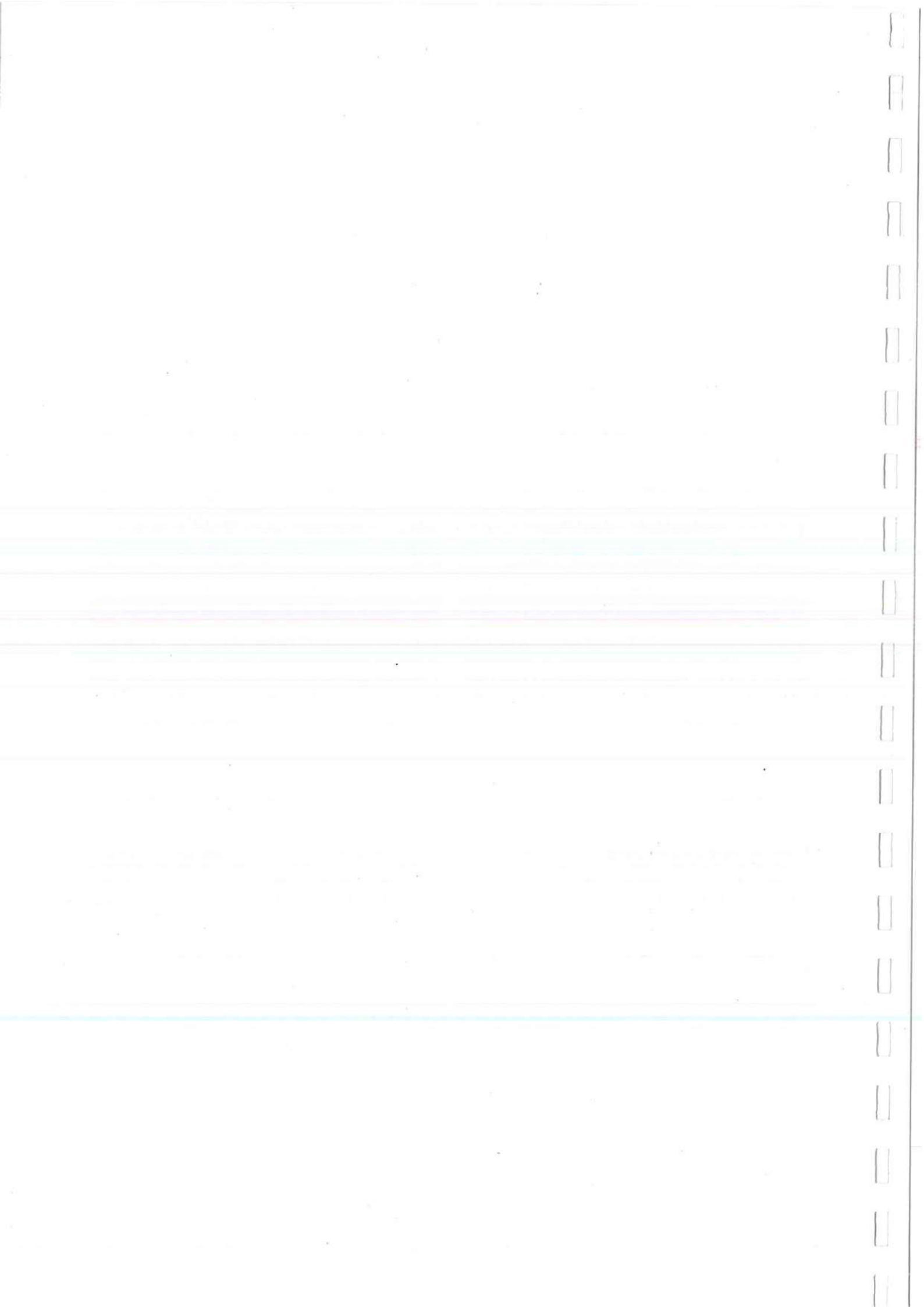
WS03 excavation and
arising



WS04 arising



WS04 excavation



Appendix C



ALcontrol Laboratories

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Tom Sheen
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Northwich
Cheshire
CW9 7TN

Non-routine Analysis Report

Date: 24th July 2012

Our Reference:	SDGs 120628-40 & 120714-71(12-126)
Quote Reference:	NRW147
Your Reference:	32144
Location:	Contract Chemicals

Samples from 19 sample events, 18 soils and 1 water, were received on 28th June 2012.
An additional two water samples were received on 14th July 2012.

We are pleased to enclose our non-routine analysis report.

Signed

R Malcolm
Deputy Technical Manager

Contents

1.0	<i>Introduction.....</i>	3
2.0	<i>Extraction and Analysis.....</i>	4
3.0	<i>Results.....</i>	5
4.0	<i>Conclusion.....</i>	5

1.0 Introduction

Samples from 19 sample events were received on the 28th June 2012. Bromododecane determination was requested on 15 soil samples and one water sample as detailed in table 1. An additional two samples were received on the 14th July 2012, detailed in table 2, for the same analysis. It was noted that the water sample, WS1 – HDP02, had not been delivered in a suitable container for semi-volatile analysis.

Alcontrol Sample Event No	Alcontrol Sample No	Client Sample ID and Depth	Matrix	Analysis Required ?
SE 5797089	5797173	HDP01 (0.4)	Soil	Yes
SE 5797091	5797191	HDP01 (0.7)	Soil	Yes
SE 5797093	5797255	HDP02	Water	Yes
SE 5797092	5797211	HDP02 (0.27)	Soil	Yes
SE 5797094	5797273	HDP03 (0.1)	Soil	Yes
SE 5797095	5797274	HDP03 (0.4)	Soil	Yes
SE 5797099	5797290	HDP04 (0.2)	Soil	Yes
SE 5797101	5797294	HDP04 (0.4)	Soil	Yes
SE 5797104	5797306	HDP05 (0.3)	Soil	Yes
SE 5797108	5797339	HDP06 (0.2)	Soil	Yes
SE 5797109	5797109	HDP06 (0.4)	Soil	No
SE 5797096	5797096	WS01 (0.35)	Soil	Yes
SE 5797097	5797283	WS01 (0.8)	Soil	Yes
SE 5797098	5797283	WS01 (1)	Soil	No
SE 5797102	5797296	WS02 (0.2)	Soil	Yes
SE 5797103	5797299	WS02 (0.5)	Soil	Yes
SE 5797105	5797310	WS03 (0.4)	Soil	Yes
SE 5797106	5797318	WS04 (0.3)	Soil	No
SE 5797107	5797333	WS04 (0.8)	Soil	Yes

Table 1 – Alcontrol reference numbers and client sample IDs, SDG 120628-40

Alcontrol Sample Event No	Alcontrol Sample No	Client Sample ID and Depth	Matrix	Analysis Required ?
SE 5886289	5886295	WS01	Water	Yes
SE 5886290	5886301	WS04	Water	Yes

Table 2 – Alcontrol reference numbers and client sample IDs, SDG 120714-71

2.0 Extraction and Analysis

Soil Extraction

A known mass of sample was extracted into an appropriate solvent using sonication extraction. Very high concentrations of bromododecane were detected in certain samples. Analysis of these samples was repeated using less sample to enable complete extraction to be obtained.

Water Extraction

A known volume of sample was extracted in an appropriate solvent at two different pH values using liquid/liquid extraction.

Analysis

A known volume of extract was spiked with internal standards and analysed using gas chromatography with mass selective detection. 1-Bromododecane was detected by searching for indicative ions and identified by comparing against a library of mass spectra. A positive match (98%) was obtained for 7 of the 18 analysed samples. It should be noted that only 1-bromododecane and 2-bromododecane are present in the mass spectra library. For this reason it cannot be confirmed if 1-bromododecane or another bromododecane isomer is present although it is unlikely that another bromododecane isomer would present the same mass spectrum.

The concentration of bromododecane present in the extract was quantified against the nearest internal standard and this value was then calculated back to give the concentration in the sample. Results from the analysis are summarised in tables 3 and 4.

3.0 Results

Tables 3 and 4 below summarise the results obtained from the soil and water samples. For convenience the soil results have been reported in mg/Kg rather than the more common µg/kg. The water sample has been reported in the normal units of µg/L.

Alcontrol Sample No	Client Sample ID and Depth	Matrix	Mass of Sample (g)	Bromododecane (mg/Kg)
5797173	HDP01 (0.4)	Soil	1.08	2500
5797191	HDP01 (0.7)	Soil	1.12	640
5797211	HDP02 (0.27)	Soil	10.18	<1
5797273	HDP03 (0.1)	Soil	1.01	1300
5797274	HDP03 (0.4)	Soil	1.10	410
5797290	HDP04 (0.2)	Soil	10.10	<1
5797294	HDP04 (0.4)	Soil	10.07	<1
5797306	HDP05 (0.3)	Soil	10.05	<1
5797339	HDP06 (0.2)	Soil	10.20	<1
5797096	WS01 (0.35)	Soil	10.00	61
5797283	WS01 (0.8)	Soil	10.04	10
5797296	WS02 (0.2)	Soil	10.16	<1
5797299	WS02 (0.5)	Soil	10.06	<1
5797310	WS03 (0.4)	Soil	10.11	<1
5797333	WS04 (0.8)	Soil	10.14	<1

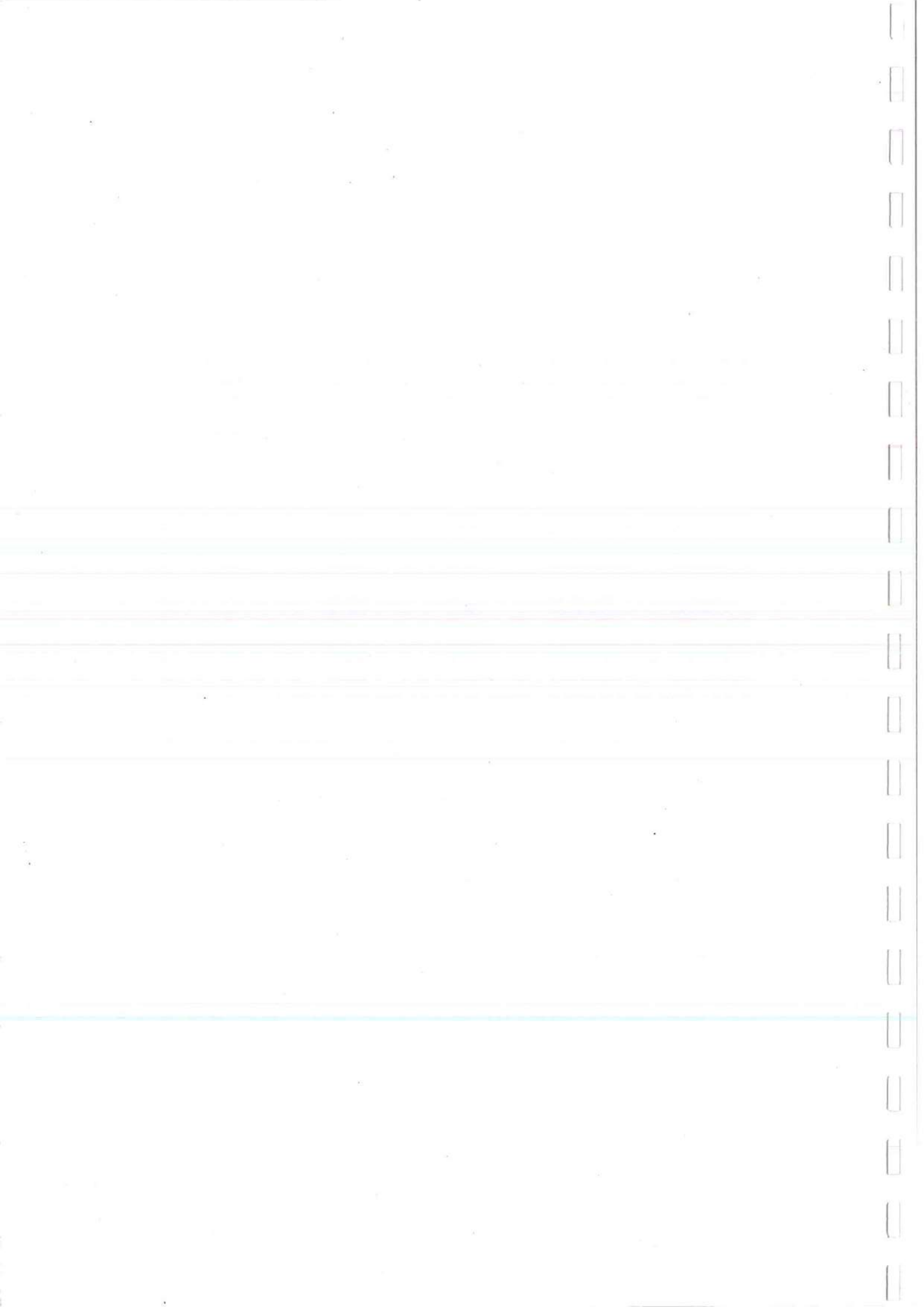
Table 3 – Summary of soil results, positive results are highlighted in bold

Alcontrol Sample No	Client Sample ID and Depth	Matrix	Volume of Sample (ml)	Bromododecane (µg/L)
5797255	HDP02	Water	150	<10
5886295	WS01	Water	150	980
5886301	WS04	Water	150	<10

Table 4 – Summary of water results, positive results are highlighted in bold

4.0 Conclusion

Bromododecane was found to be present in 7 of the 18 analysed samples with concentrations ranging from 10mg/Kg to 2500mg/Kg in the soils and at 980µg/L in the waters.





Knowsley Redevelopments Ltd

Former Contract Chemicals Ltd, Knowsley

Site Investigation Interpretative Report —

January 2022

35-37 High Street, Barrow-upon-Soar, Loughborough, LE12 8PY

Tel: 01509 410372

Email: info@gjgeoenvironmental.com





Contains Google data.

Report Title	Contract Chemicals, Knowsley Site Investigation Interpretative Report	Site Address	Former Contract Chemicals Ltd, Penrhyn Road, Knowsley Business Park, Knowsley, L34 9HY
Author	G&J Geoenvironmental Consultants Ltd	Contamination / Geotechnical	Contamination & Geotechnical
Work Stage	Site Investigation	Report Date	January 2022
Brief Description of the Report Contents	Report assessing the development constraints with the site with particular reference to the historical land uses and ground conditions. A site investigation was undertaken between 15th and 18 th November 2021, to evaluate the chemical and geotechnical properties of the underlying Made Ground and natural strata, with subsequent groundwater and gas monitoring. Provides preliminary recommendations for the site development.		

Document Control

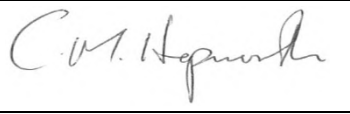
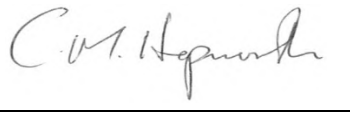
Project: Contract Chemicals, Knowsley – Interpretative Desk Study

Client: Knowsley Redevelopments Ltd

Job Number: GJ224

File Origin: N:\Projects\GJ224 Knowsley\Reports\GJ224-SI-INT-V1

Document Checking:

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Issue	Date	Status
1	January 2022	V1
2		
3		

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1.0 Introduction

1.1 Instruction

G&J Geoenvironmental Consultants Ltd (G&J) was commissioned by Knowsley Redevelopments Ltd to carry out a ground investigation at the former Contract Chemicals Ltd site in Knowsley, Merseyside. The investigation is required to support the redevelopment of the site, for a commercial end-use.

The objectives of this investigation are to assess the ground conditions in order to provide development options for the site by assessing the geotechnical and environmental risks.

The design of the ground investigation has been informed by the layout of the site, the ground conditions, the investigation objectives and available information from past studies.

1.2 Project Team

The key members of the project are listed below in Table 1.1.

Table 1.1 Project Team

Role	Organisation	Contact	Position
Client	Knowsley Redevelopments Ltd	Jim Kelly	Managing Director
Geoenvironmental Consultant	G&J	Chris Hepworth	Managing Director
Planning Consultants / Quantity Surveyors	Trinity Property Consultants	Andrew Wilson	Director

1.3 Report Format

This report is presented as follows:

Section 2 presents the site information and results of the initial desk-based research;

Section 3 presents details of the ground investigation, including the scope of the ground investigation and the scheduled analysis;

Section 4 of the report presents a factual summary of the ground conditions encountered including geology, the presence of visual or olfactory evidence of contamination, ground gas observations and a summary of the factual chemical and geotechnical results, with an assessment of the characteristic values of the geotechnical parameters;

Section 5 presents an assessment of the engineering design recommendations;

Sections 6, 7 and 8 of the report present the findings of a generic quantitative assessment in respect to risks to human health and controlled waters from land contamination, and from ground gases;

Section 9 of the report presents geo-environmental conclusions and recommendations; and

Section 10 presents a list of references used in the preparation of this report.

1.4 Terms and Conditions

This report has been prepared for Knowsley Redevelopments Ltd in consideration of the proposed commercial end use of the site. Much of the geo-environmental information relates to the site in its present state and should not be used in a different context without reference to G&J.

This report details the findings of work carried out between 15th – 18th November 2021, and monitoring visits undertaken on 6th, 16th, 23rd and 29th December 2021, and 6th and 14th January 2022. The report has been prepared by G&J on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, all potential environmental constraints or liabilities associated with the site may not have been revealed.

The report has been prepared for the exclusive benefit of Knowsley Redevelopments Ltd and those parties designated by them for the purpose of providing geo-environmental and geotechnical recommendations for the site. The report contents should only be used in that context. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

G&J has used reasonable skill, care and diligence in the design of the investigation of the site. Information provided by third parties has been used in good faith and is taken at face value; however, G&J cannot guarantee its accuracy or completeness. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths at the time of the investigation. At intermediate locations, conditions can only be inferred.

1.5 Policy Context – Land Contamination

The primary legal and policy mechanisms for managing contaminated land are Part IIA of the Environmental Protection Act 1990 and the National Planning Policy Framework.

Part IIA provides a statutory definition of Contaminated Land and supporting guidance which defines how to decide whether or not land meets this definition. For land to be determined as contaminated land, the onus is on demonstrating with sufficient certainty that land is in such condition, by reasons of substances in, on or under the ground that;

- a) Significant harm is being caused or there is a significant possibility of such harm being caused; or
- b) Significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.

Significant harm and how to determine if a significant possibility of such harm exists is defined in the statutory guidance which accompanies Part IIA. The guidance also defines four categories of land with respect to the risks to human health and the water environment and how the degree of risk relates to the statutory definition of contaminated land, as summarised in the following figure:

Figure 1.1 Part IIA Categories

Land Category	Human Health	Water	
1	Unacceptably high probability that Significant Harm would occur if no action taken	Strong case that a Significant Possibility of Significant Pollution exists	Part IIA Contaminated Land
2	The risks are sufficient that a Significant Possibility of Significant Harm exists	Of sufficient concern to present a Significant Possibility of Significant Pollution	
3	Not low risk but does not pose a Significant Possibility of Significant Harm	The risks are not sufficient to constitute Significant Possibility of Significant Pollution	Not Part IIA Contaminated Land
4	Low risk to human health and no possibility of meeting the statutory definition	No/low risk to controlled waters and would not meet the statutory definition	



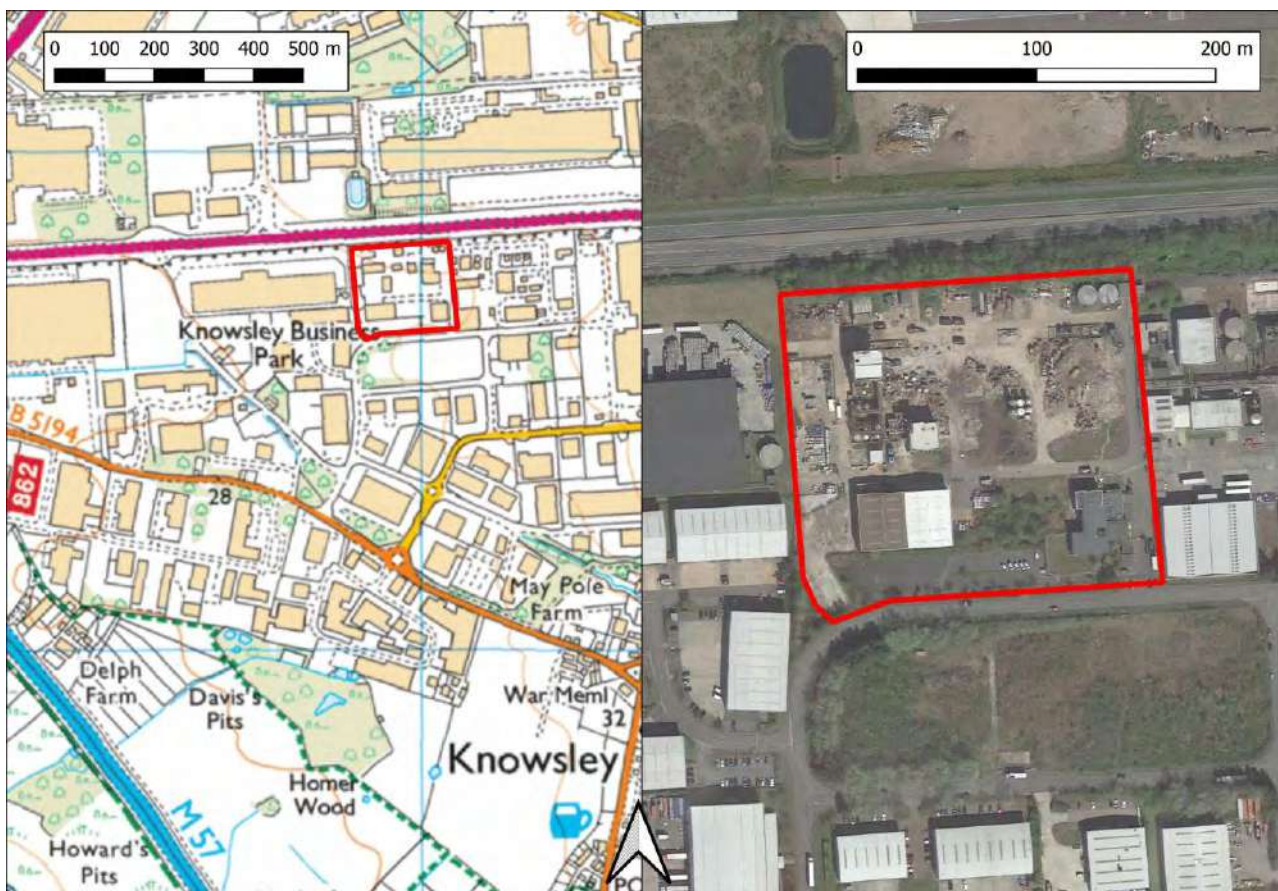
In terms of planning policy, a precautionary approach is adopted whereby it is necessary to demonstrate with sufficient confidence that the site cannot meet the statutory definition of contaminated land. Although the above categorisation is not explicitly applicable to planning decisions, a site classed as Category 4 should be considered suitable for development in accordance with planning policy. While a Category 3 site could be considered suitable, the reduced level of confidence associated with such a site means this is less likely.

2.0 Site Setting

2.1 Site Location and Layout

The site is located off Penrhyn Road, Knowsley, approximately 1km east of Junction 4 of the M57 motorway. The site is approximately centred on National Grid Reference 342970, 396725; the site location and current layout are shown in Figure 2.1.

Figure 2.1 Site Location and Layout



Contains OS and Google data.

2.2 Site Description

The site covers an area of approximately 3.5ha and is approximately rectangular in shape. Prior to recent demolition and clearance works the central and eastern portions of the site comprised disused chemical processing plants and tank farms, with warehousing and storage in the west and office space and car parking in the south. The details of the former layout and specific features is presented in G&J's previous desk study (see Section 2.3, below). At the time of the site works the only structures remaining on site

were the warehouse in the south-west, which was undergoing demolition, and part of the previous office block in the south east, which was being used as a site office. The northern two-thirds of the site had been cleared and comprised bare soil, with two stockpiles of crushed demolition rubble. In the southern third of the site, as well as the previously mentioned structures, limited areas of hardstanding remained together with an overground area of landscaping and a pond.

The site slopes very gently down to the south, with ground levels of approximately 32mAOD in the north and 30mAOD in the south, a gradient of approximately 1 in 90.

To the immediate north of site is the embanked A580 'East Lancashire Road' with the Brintonwood Trading Estate beyond. The southern boundary is formed by Penrhyn Road, with an area of rough ground beyond. To the west of the site is a distribution warehouse where a number of businesses operate. To the east is a chemical works operated by Algal Omega 3 Ltd, including an electricity sub-station.

2.3 Desk Study

A Phase I Interpretative Desk Study was carried out by G&J in February 2021, as referenced below;

- '*Former Contract Chemical Ltd, Knowsley – Interpretative Desk Study*', G&J Geoenvironmental Consultants Ltd, Report Ref: GJ224-DTS-V1, February 2021.

The principal findings of the Desk Study were as follows;

2.3.1 Geology and Hydrogeology

The site is anticipated to be underlain by Devensian Till in the north and the Shirdley Hill Sand Formation in the south, and then a bedrock consisting of the sandstone of the Chester Formation. A surficial layer of Made Ground is anticipated due to the past uses and development of the site;

The Shirdley Hill Sand Formation is classed as Secondary (A) Aquifer by the Environment Agency (EA), and the Devensian Till deposits as a Secondary (undifferentiated) Aquifer. The underlying Chester Formation is classed as Principal Aquifer. The site is within Zone 3 (total catchment) of a Groundwater Source Protection Zone. The closest groundwater abstraction is approximately 500m to the west of site where water is taken for evaporative cooling. Potable water is taken approximately 980m to the east of site from a number of boreholes.

2.3.2 Hydrology

The nearest watercourse is Knowsley Brook. Historical maps show this running east to west across the site; however, it now flows in a culvert, which plans show to run beneath the western margin of the site. Anecdotal evidence suggests it flows beneath the northern and western edges of the site.

2.3.3 Site History

The site was largely undeveloped agricultural land/rough ground until around 1980, when development of the current site commenced, including the culverting of Knowsley Brook. Since then the site has seen some development between 1988 and 2003, the most significant being the construction of the Bonner building in 1997.

Anecdotal evidence suggests that during the Second World War period the site was occupied by Nissan Hut accommodation for workers at the Royal Ordnance Factory Kirby, which was located to the north of the A580.

2.3.4 Potential Contamination Sources

The site history as a chemical works and the wide variety of chemicals and processes used during its operation have resulted in several potential contamination sources. The most prominent of these being the main processing areas such as the Surfactant Hall, Bonner building, Diol Plant, Technical Development Centre (TDC) and adjacent tank farms. In addition, other sources such as fuel tanks, electricity substations, IBCs and smaller chemical containers were identified during the site walkover.

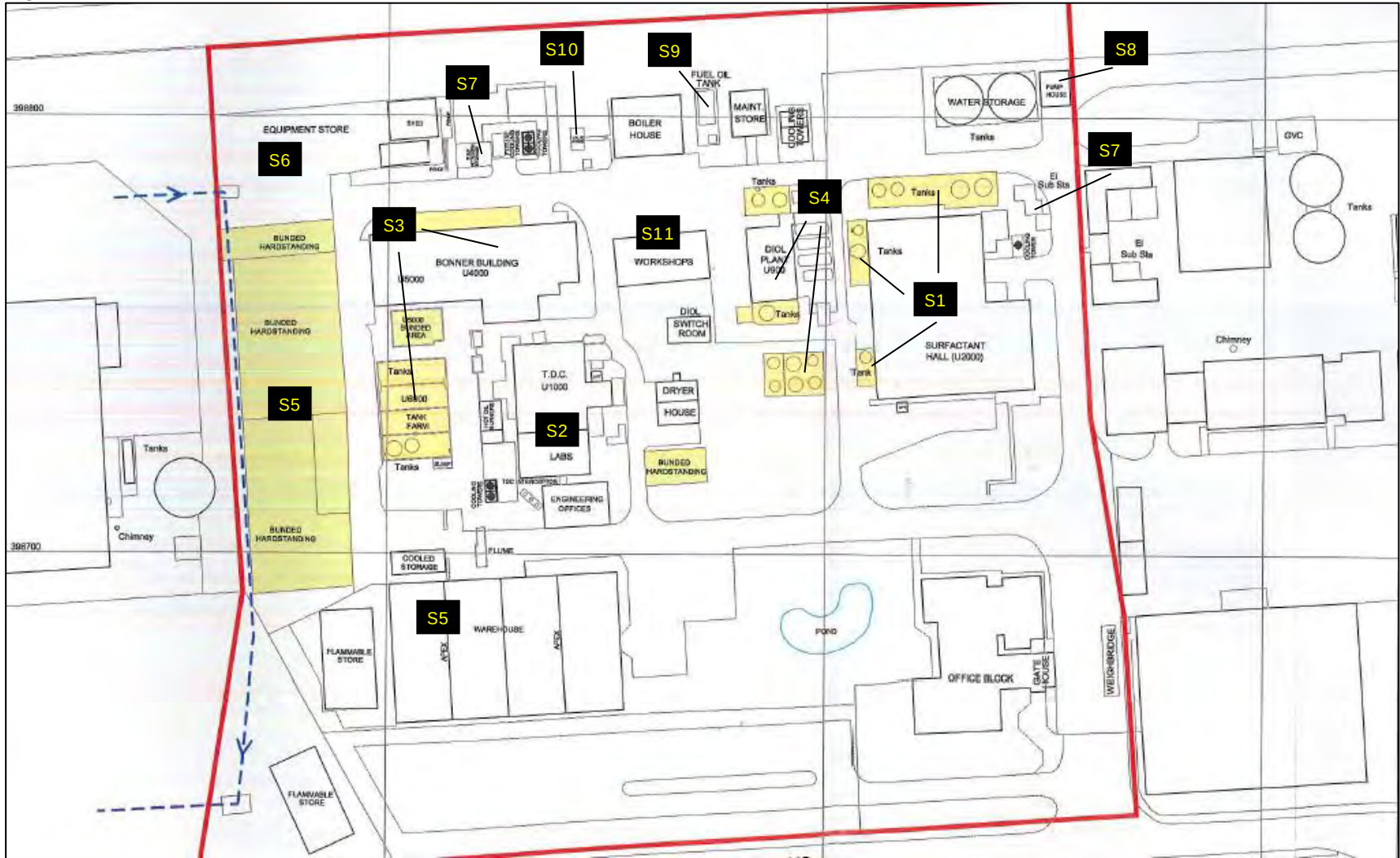
The potential for contamination originating off-site to have significantly affected the site is comparatively low, although another chemical works is present adjacent to the east.

Table 2.1 presents a summary of the main potential sources and the primary contaminants of concern. Figure 2.2 shows the locations of these identified sources.

Table 2.1 Summary of Main Potential Contaminant Sources

Source	Potential Contaminants
Surfactant Hall and Tank Farm (S1)	• Sodium cyanate • Sodium thiocyanate • Hydrochloric Acid • Acetic Acid
Technical Development Centre (TDC) (S2)	• Various organic and inorganic contaminants
Bonner Building and Tank Farm (S3)	• Bromine • Butyric acid • Hydrochloric acid • Ethanol
Diol Plant and Tank Farm (S4)	• Dimethyl amine (1, 2) propane diol • Hydrochloric Acid • Sodium Hydroxide
Warehouse & Bunded Hardstanding (west) (S5)	• Hydrochloric acid wastes • Hydrobromine acid wastes • Sulphur Dioxide absorber waste • Alkaline wastes • Solvent wastes • Diol wastes • Ammonium Sulphate wastes
Equipment Store (S6)	• Hydrocarbons • Inorganics
Substations (S7)	• Hydrocarbons (including PCBS)
Pump House (S8)	• Biocides • Bromgard 420 (zinc based water hardness treatment)
Fuel Tanks (S9)	• Fuel Oils • Petroleum Hydrocarbons
Valve House (S10)	• Gas Condensates
Workshops (S11)	• Petroleum Hydrocarbons
General Contaminants associated with the buildings and Made Ground (S12)	• Metals • PAHs • Asbestos

Figure 2.2 – Main Potential Contamination Source Locations



2.4 Proposed Development

It is proposed to redevelop the site for commercial use. The currently proposed development layout is shown in Figure 2.3, below.

Figure 2.3 Proposed Development Layout



2.5 Previous Ground Investigations

The desk study included a review of a number of previous ground investigations that were undertaken at the site between 1993 and 2012. The findings are described in the reports referenced below;

- '*Preliminary Contaminated Site Investigation Contract Chemicals Ltd, Knowsley*', Cremer & Warner Ltd, Report ref: C397/1, April 1993.
- '*Integrated Pollution Prevention and Control, Pre-Authorisation Desk Study of Contract Chemicals Ltd*', AIG Consultants Ltd, Report ref: UK99/A1421, July 1999.

- '*Contract Chemicals Ltd, Trade Effluent Overspill Sampling, Final Interpretive Report*', Entec UK Limited, Report ref: 11002il, January 2011.
- '*Bromododecane Spillage Investigation, Contract Chemicals Site, Knowsley*', AMEC Environment & Infrastructure UK Limite, Report ref: 32144, September 2012

In addition, five boreholes were drilled in 2021, primarily to allow the sampling of groundwater and provide information in support of the surrender of an environmental permit.

The following sections provides a brief overview of each intrusive investigation, including a summary of the geotechnical and environmental testing undertaken. A plan showing the locations of selected previous exploratory holes and investigation areas is provided in Figure 2.4, below.

Figure 2.4 Selected previous exploratory holes



2.5.1 BGS-held Boreholes 1969

The BGS holds borehole logs for three locations within the site, and for one on or very close to the site's south-western boundary. These boreholes were drilled in 1969, prior to the construction of the chemical works, as part of an investigation for the overall industrial estate.

The borehole in the north-western part of the site encountered a firm to stiff 'Boulder Clay' to a depth of 2.74m (beneath 0.3m of topsoil), overlying a 'stiff red marl with bands of shaley fine sandstone' to a depth of 5.18m, and then a 'red sandstone'. Similar strata were encountered in the north-east the site, but with a horizon of sand and gravel beneath the topsoil, to a depth of 0.74m.

In the south-east of the site the topsoil was underlain by a slightly gravelly sand to 2.44mbgl, and then the 'hard red sandy marl' with sandstone bands. In the south-western part of the site the near surface granular layer was thinner (to 0.76mbgl, and was a sand and gravel), and was underlain by a 'compact red coarse silt', considered to be weathered marl. A 'fine red shaley sandstone' was present below 1.68m depth.

The logs for these boreholes are provided in Appendix A.

2.5.2 Cremer & Warner 1993

Cremer & Warner were commissioned by Contract Chemicals to undertake a site investigation to assess ground contamination conditions on the western boundary of the current site and the eastern boundary of the adjacent distribution warehouse.

The intrusive investigation was designed on a grid pattern resembling four rows with two trial pit locations on each row, with a total of eight trial pits excavated to a maximum depth of 0.8mbgl. Additionally two boreholes were sunk to a maximum depth of 3.5mbgl, both of which were installed with gas/groundwater monitoring equipment.

Nine sub-surface soil samples were taken and then combined into four composite samples reflecting the four rows as mentioned above. Results indicated that soil contamination was greatest in the samples within the Contract Chemicals site, however, lower amounts were also detected in samples from the adjacent warehouse site. Contamination comprised organic compounds, the most prevalent being benzene compounds, naphthalene, benzophenone, diamines and an unknown brominate.

The results suggested that contaminated surface run-off was migrating from the Contract Chemicals site into the distribution warehouse site.

2.5.3 Sub Soils Surveys 1997 (information taken from Appendices of AIG 1999 Report)

The investigation carried out by Sub Soils in 1997 comprised 3 boreholes to between 9.1mbgl and 12.1mbgl located in the proposed footprint of the Bonner Building.

These boreholes revealed between 1.1m and 2.6m of Made Ground (gravelly clay) overlying the medium dense, locally gravelly sand of the Shirdley Hill Sand Formation which had a thickness of up to 1.8m. This was underlain by very stiff, locally firm, reddish brown very sandy, slightly gravelly clay (Glacial Till), and then reddish brown sandstone and mudstone; rockhead varied in depth from 6.6mbgl to 10.9mbgl, indicating significant local variation. Standing groundwater levels of between 5.7mbgl and 6.3mbgl were reported.

The very stiff Glacial Tills were found to have undrained shear strengths of between 189kPa and 572kPa. A test carried out on the underlying mudstone gave an undrained shear strength of 418kPa, whilst SPTs carried out in the 'rock' strata gave N-values ranging from 123 (for 300mm penetration) to between 50 and 106 blows for 225mm penetration or less.

Although the investigation was primarily geotechnical in nature, chemical testing showed chemical concentrations were below the lowest 'threshold trigger values' presented by the Interdepartmental Committee on the Redevelopment of Contamination Land (ICRCL).

The logs for these boreholes are provided in Appendix A.

2.5.4 CCL Investigation 1997 (information taken from Appendices of AIG 1999 Report)

CCL also undertook a series of investigations in the footprint of the Bonner building and the Flammable Store where 7 shallow soil samples were taken. In both locations the CCL investigation considered the soils to have only limited amounts of contamination when compared to the ICRCL threshold values.

2.5.5 Entec 2010

Entec UK Ltd undertook a site investigation in 2010 in response to an overspill from a trade effluent outflow within the Contract Chemicals site to the distribution warehouse to the west. The scope of the works comprised five hand dug pits excavated to a maximum depth of 0.8mbgl. Four of the pits were dug in areas directly impacted by the spill and one outside used as a 'control' sample. Two samples were taken from each pit and tested for a chemical suite comprising SVOCs, VOCs, alcohols, pH, metals, TPH-CWG and water soluble sulphate.

The results of the investigation found that there was slightly elevated organic contamination in samples from the spill area, however none of these exceeded Generic Assessment Criteria (GACs) for a commercial land use.

It was considered that the impact to soils in the affected area was not considerable and therefore residual contamination was not a hazard to human health.

2.5.6 AMEC 2012

AMEC were commissioned by Contract Chemicals in 2012 to undertake a site investigation after a spillage of 1-bromododecane from an IBC. The spill occurred on the western boundary of the Contract Chemicals site and was observed to have flowed into the adjacent distribution warehouse. The scope of the works comprised four dynamic boreholes advanced to a maximum depth of 2.3mbgl and six hand dug pits excavated to a maximum depth of 0.7mbgl. Two of the boreholes were installed with gas/groundwater monitoring equipment.

A total of 16 samples were taken during the investigation and were subsequently tested for SVOCs. The samples obtained during the 2012 investigation were compared to adjacent samples from the 2010 investigation, particularly for bromododecane concentrations. The 2012 results identified significantly greater concentrations of bromododecane in shallow soils suggesting the contamination was directly linked to the 2012 spill rather than the 2010 trade effluent outflow spillage. Data collected from subsequent groundwater monitoring indicated that the impact on groundwater quality was limited.

2.5.7 GRM 2021

GRM were commissioned by Portway Remediation to drill five boreholes to provide information to support the surrender of an environmental permit.

These boreholes (GRM BH01 to BH05 shown in Figure 2.4) encountered between 0.7m and 1.8m of Made Ground, overlying what were reported to be 'Glacial Deposits', including sand, gravelly sand, sandy clay, and gravelly clay; it is anticipated that some of this material actually represents the weathered Chester Formation bedrock strata. Rock strata (sandstone) was encountered in the two boreholes close to the site's southern boundary at depths of 2.4mbgl and 3.5mbgl.

The chemical testing of the soils that was undertaken as part of this investigation did not reveal concentrations in excess of the relevant GACs for a commercial end-use, although a concentration of 800ug/kg of 1,3-dichlorobenzene was noted in a sample from 0.6mbgl in BH2 (see Figure 2.4); no significant contamination was recorded in the groundwater, although no sample was retrieved from BH2.



The logs for these boreholes are provided in Appendix A.

3.0 Ground Investigation

3.1 General

A ground investigation was undertaken across the site, under the direction of G&J. The principle objective of the investigation was to determine the geotechnical and geo-environmental properties of the Made Ground and confirm the depth and nature of the underlying natural deposits.

3.2 Scope of Investigation Works

The intrusive ground investigation was undertaken between 15nd and 18th November 2021, and monitoring visits were undertaken on 6th, 16th, 23rd and 29th December 2021, and 6th and 14th January 2022.

The investigation was undertaken in general accordance with Eurocode 7 (EC7) Part 2 (BS EN 1992-2: 2007) and, where there is no conflict, also with BS 5930: 2015. Soil logging has been undertaken in accordance with the relevant European Standards, listed in the references for this report. G&J had responsibility for setting out exploratory holes and also for determining the in-situ testing and sampling regime, and for scheduling appropriate analysis based on the proposed scope.

The works comprised the following key elements:

- Clearance of positions for services and surveying of locations to National Grid and Ordnance Datum;
- Excavation of 14no trial pits to a maximum depth of 2.2mbgl;
- Drilling of 11no. window sample boreholes to a maximum depth of 3.45mbgl;
- Drilling of 5no. cable percussion boreholes to a maximum depth of 7.95m;
- In-situ Standard Penetration Tests in each borehole;
- Retrieval of representative disturbed soil samples from each borehole and trial pit;
- Installation of monitoring standpipes in 11no. borehole locations;
- 6 return visits to monitor gas and groundwater levels, and to sample groundwater on one occasion;
- Chemical and geotechnical laboratory analysis of selected soil and groundwater samples;

The exploratory hole locations were determined to target the main potential source areas described in Section 2.3.4, and to provide a good overall coverage of the site. However, the locations were also significantly influenced by site constraints including underground services (most notably the culverted stream the runs beneath the north of the site), remaining structures, stockpiles, standing water and ground conditions. The exploratory hole locations are shown in Figure 3.1, below, and Appendix B.

Figure 3.1 Exploratory hole locations



Exploratory hole locations were cleared and marked out prior to the investigation.

Standard Penetration Tests were generally carried out in the cable percussion and window sample boreholes at 1.0m intervals. The results of these tests are given as a Standard Penetration "N" value or as a blow count for a given penetration at the appropriate position on the borehole logs presented in Appendix B.

Representative small disturbed and bulk samples of materials encountered were obtained and these were placed in appropriate containers for transport to a UKAS/MCERTS accredited environmental or geotechnical laboratory.

The encountered soils were described by an experienced geo-environmental engineer. A detailed description of all strata encountered, groundwater conditions and the position and type of samples taken are included on the borehole logs presented in Appendix B, together with a larger scale location plan than that provided above.

Monitoring standpipes were installed in eleven of the borehole locations (BH101, BH103, BH104, BH105, WS101, WS102, WS106, WS107, WS108, WS109, and WS110), in order to allow subsequent monitoring of gas and groundwater levels, and the sampling of groundwater. Standpipes were located to provide representative coverage across the site.

Investigation photographs are presented in Appendix C.

Gas and groundwater monitoring has been undertaken on 6th, 16th, 23rd and 29th December 2021, and 6th and 14th January 2022. Monitoring visits comprised the measurement of concentrations of methane, oxygen, carbon dioxide, carbon monoxide, hydrogen sulphide, relative and atmospheric pressure, gas flow rate and groundwater level. Gas and groundwater monitoring records are presented in Appendix D.

3.3 Sub-Contractors Details

Table 3.1 below presents details of the contractors used during the ground investigation.

Table 3.1 Ground investigation Contractor Details

Ground Investigation Activity	Contractor	Contact Details
Window Sampling and Cable Percussion Drilling	DMW Drilling Ltd	58, Parkway, Westhaughton, Bolton, BL5 2RY
Trial Pitting (JCB-3CX)	Boundary Plant Ltd	Hammond Road, Knowsley Industrial Park, Liverpool, L33 7U
Chemical laboratory analysis	DETS Ltd	Unit 1, Rose Lane Industrial Estate, Rose Lane, Lenham Heath, Kent, ME17 2JN
Geotechnical laboratory analysis	i2 Analytical	i2 Analytical Ltd, 7 Woodshots Meadow, Croxley Green Business Park, Watford, WD18 8YS

3.4 Laboratory Testing

Table 3.2 presents details of the chemical and geotechnical testing undertaken. Chemical test certificates are provided in Appendix E, and geotechnical test certificates in Appendix F.

Table 3.2 Laboratory Analysis Summary

Analysis	Total No. Samples
Soil Chemical Analysis	
Heavy Metals	33
pH	
SOM	
PAH EPA 16	
TPH CWG (inc BTEX/MTBE)	
Asbestos ID and Screen	
Cyanide	
Phenols	
Thiocyanate	
Sulphur	
W/S Sulphate	
VOC + TICs, SVOC + TICs	22
PCBs	3
Groundwater Chemical Analysis	
Heavy Metals	10
pH	
PAH EPA 16	
TPH CWG (inc BTEX/MTBE)	
Cyanide, Sulphate, Phenols	
Soil Geotechnical Analysis	
Atterberg Limits & Moisture Content	13
Particle Size Distribution by wet sieve	10
OMC/MDD 2.5kg rammer	5
Remoulded CBR	5
Water soluble sulphate & pH	6
Quick Undrained Triaxial (shear strength)	3

4.0 Ground Conditions and Geotechnical Properties

4.1 Introduction

The cable percussion boreholes, window sample boreholes and trial pits were advanced to maximum depths of 7.95mbgl, 3.44mbgl and 2.2mbgl, respectively.

A description of the ground conditions encountered beneath the site is summarised below in Table 4.1. Exploratory hole logs are provided in Appendix B. The geotechnical laboratory test results are provided in Appendix F and contamination testing is included in Appendix E. Exploratory hole locations are shown in Figure 3.1, and in Appendix B.

Table 4.1 Strata Encountered

Stratum Location/Description	Depth to Top (mbgl)	Thickness (m)	SPT N Value
MADE GROUND Predominantly red-brown CLAY with varying components of sand and gravel, commonly including fragments of brick, concrete and sandstone and less frequent plastic, wood etc. Some more granular layers of clayey, gravelly SAND at various locations Loose, light grey sandy GRAVEL of limestone and sandstone recorded in TP111, TP112, TP113, WS107 and WS111, commonly in thin near surface bands.	GL	0.4 to 3.0	0 to 22 (typically 6 to 12)
GLACIAL TILL Generally firm to stiff, reddish brown, sandy, gravelly CLAY. The gravel is commonly fine to medium, subangular to rounded including quartzite, sandstone and mudstone. Loose to medium dense, reddish brown SAND present as thin horizons within the above.	0.4 to 3.00	0.3 to >4.75	8 to >50 (cohesive)

Stratum Location/Description	Depth to Top (mbgl)	Thickness (m)	SPT N Value
CHESTER FORMATION Commonly loose to very dense, reddish brown SAND with varying clay and gravel components. Also present as firm to very stiff, reddish brown CLAY with varying sand and gravel components. Quickly becomes weak SANDSTONE / MUDSTONE at shallow depth (occasionally present directly beneath the Glacial Till)	0.40 to 6.50	>0.45 to >1.75	13 to >50 (typically >50)

4.2 Made Ground

Made Ground was encountered throughout the site to depths of between 0.4m and 3.0mbgl, but typically between 1.0m and 2.0mbgl.

Although previous areas of hardstanding have been removed across most of the site, limited areas of tarmac or concrete hardstanding, underlain by hardcore, were locally still present (e.g. TP111 and around the remaining warehouse structure).

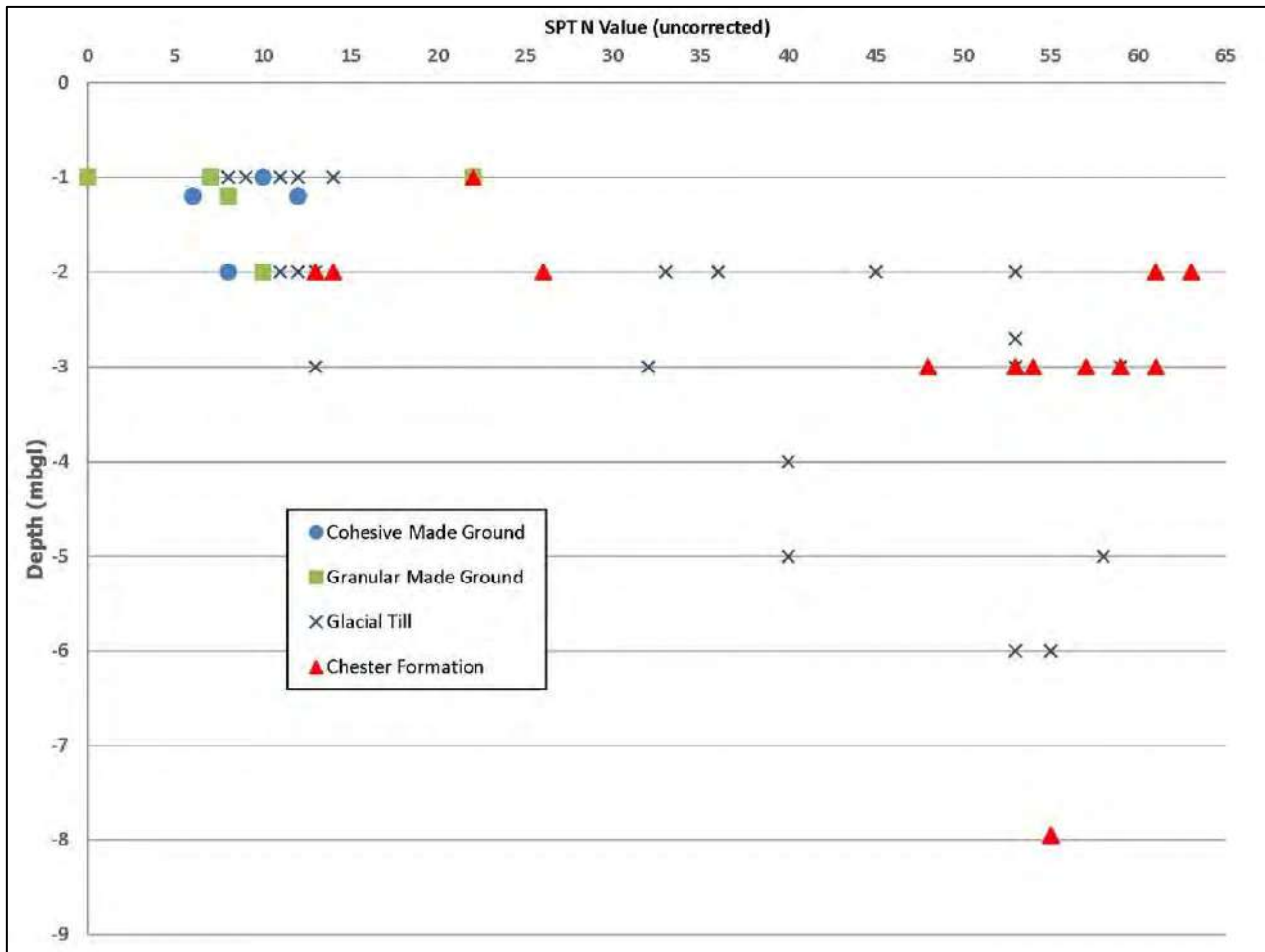
The observed Made Ground typically comprised reworked natural soils (Glacial Till and Chester Formation), with entrained man-made materials such as brick and concrete fragments. These materials were predominantly cohesive (e.g. sandy to very sandy, gravelly to very gravelly clay) but granular (e.g. slightly clayey, gravelly sand) horizons were also present. Cobble-sized brick and concrete fragments were present locally. These materials were typically reddish brown in colour, but were also locally dark grey, dark brown or black.

Other observed Made Ground materials included light grey sandy gravel of limestone and sandstone (in exploratory holes TP111, TP112, TP113, WS07 and WS111, where it provided a sub-base for hardstanding), and in WS106 only, a black clayey sand.

4.2.1 Strength

The uncorrected SPT N values in the Made Ground at depths of between 1m and 2mbgl predominantly range from 6 to 12, although N values of 0 (zero) and 22 were recorded. Plot 4.1 summarises these results.

Figure 4.1 Plot of uncorrected SPT N values against Depth (All strata).



Seven of the tests were undertaken on cohesive material, with N values typically ranging from 6 to 12; using the Stroud and Butler (1975) relationship with an f_1 of 5 for low plasticity soils, this range of typical N values suggests undrained shear strengths of 30 to 60kPa, indicating a range from low to medium strength in descriptive terms.

The uncorrected SPT N values in the five tests in granular Made Ground do not suggest a general increase with depth, probably attesting to their relatively recent and un-engineered placement, and localised 'surging' of the ground to remove substructures during the demolition works. Relative densities are typically loose, in descriptive terms, with materials locally being very loose or medium dense.

Based on the above information, a weight density of between 15kN/m³ and 18kN/m³ can be expected for the cohesive Made Ground (Figure 1, BS8004:2015), in its current state, and between 15kN/m³ and 17kN/m³ for the granular Made Ground.

At this stage, it is clear that the material has not been placed to an engineering specification and it is not a suitable formation in its present condition.

4.2.2 Particle Size Distribution

Particle size distribution analysis (PSD) was undertaken on seven samples of the Made Ground. The analysis is summarised in Table 4.2 below:

Table 4.2 Summary of PSD Analysis on Made Ground

Location	Depth (m)	% passing 63µm	% sand	% gravel	Uniformity Coefficient		SHW Class
TP105	1.5-1.6	50	45	4	>1.7	Sandy slightly gravelly CLAY	2A/2B
TP108	0.2-0.3	47	47	6	>2	Sandy slightly gravelly CLAY	2A/2B
TP109	1.2-1.3	20	51	29	>5.4	Very gravelly very clayey SAND	2C
BH101	0.0-0.5	31	48	21	>4	Very gravelly very clayey SAND	2C
BH102	0.5-1.0	27	55	18	>4.1	Very clayey gravelly SAND	2A/2B
BH104	0.5-1.0	28	37	34	>12	Very clayey SAND & GRAVEL	2C
BH105	0.5-1.0	26	37	37	>20	Very clayey SAND & GRAVEL	2C
Min	0.2	20	37	4	-	-	-
Max	5.0	50	51	37	-	-	-
Average (granular)	N/A	26.4	45.6	27.8	N/A	Very clayey very gravelly SAND	2C
Average (cohesive)	N/A	48.5	46.0	5.0	N/A	Sandy slightly gravelly CLAY	2A/2B

The analysis suggests that the cohesive Made Ground material is a sandy, slightly gravelly clay, and falls into SHW Classes 2A or 2B (wet or dry cohesive material). The 'granular' materials were determined to be very clayey, very gravelly sand, or very clayey sand and gravel; these materials comply with an SHW Class 2C (stony cohesive material).

4.2.3 Compaction

Three samples of the cohesive Made Ground material (from TP105, TP109 and TP110), and one of the granular material (BH102), underwent moisture content/dry density relationship testing using a 2.5kg

rammer in accordance with BS1377-4 1990. This enables the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) to be established.

The results of the compaction tests are summarised in Table 4.3 below.

Table 4.3 Summary of Compaction Testing on the Glaciofluvial Deposits

Location	Depth (m)	MC as received (%)	MDD (Mg/m ³)	OMC (%)
TP105	0.7-0.8	14	1.94	11
TP109	0.4-0.5	19	1.82	14
TP110	0.5-0.6	13	1.97	12
BH102	0.5-1.0	15	2.03	9.5
Min	0.4	13	1.82	9.5
Max	1.0	19	2.03	14
Average (cohesive)	N/A	15.3	1.91	12.3

The results show that the cohesive materials are variable with respect to MDD, but with little variation in the OMC (within 2% of the mean average OMC of 12.3%); the granular sample (very clayey sand) had an OMC of 9.5%.

The received moisture content of the granular sample was significantly wetter (5.5%) than its OMC value; the cohesive samples were also generally significantly wetter (1% to 5%) than their OMC values.

4.2.4 Atterberg Limits

Atterberg Limits testing was carried out on five samples of Made Ground, as summarised in Table 4.4, below. These samples were determined to be low plasticity clays, with a low volume change potential or non-shrinkable.

Based on the equation given in BS8002:2015 (section 4.3.1.4.8 page 19), these soils will have effective angles of shearing resistance of approximately 28° to 29°.

Based on these results it is considered that, in their present state, the cohesive Made Ground soils will fall into SHW Class 2A (wet cohesive material) for the purpose of earthworks.

Table 4.4 Summary of Atterberg Limits Testing on Made Ground

Location	Depth (m)	MC as received (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Corrected Plasticity Index
TP108	0.2-0.3	14	24	13	11	9.9
TP110	0.5-0.6	14	29	15	14	12.3
TP112	0.5-0.6	13	28	16	12	11.3
WS108	1.0-1.1	13	26	14	12	9.6
WS109	1.6-1.7	18	30	17	13	12.2
Min	N/A	13	24	13	11	9.6
Max	N/A	18	30	17	14	12.3
Average	N/A	14.4	27.7	15.0	12.4	11.1

4.2.5 CBR

Remoulded CBR testing was carried out on three samples of the cohesive Made Ground material (including two on which compaction testing, above, was also undertaken), and on one of the granular material. The CBR testing was undertaken with the sample at its 'as received moisture content', following compaction with a 2.5kg rammer; this was done to assess CBR values likely to be achievable following future earthworks with the material in its current state. The results are summarised in Table 4.5, below.

From the test results it appears that CBR values of less than 2% should be anticipated for much of the cohesive Made Ground material when compacted with its current moisture contents, and CBR values of greater than 5% are unlikely to be achieved without significant drying (potentially requiring the addition of lime or cement).

The granular material that was tested (from TP107), was observed to be very wet when sampled and had a 'as received moisture content' of 15%; it is suggested that a moisture content of 10% or possibly less would be required for optimum compaction. This material would require significant drying prior to use in earthworks if acceptable CBR values are to be achieved.

Table 4.5 Summary of CBR Testing on the Made Ground

Sample Location	Depth (m)	Test MC (%)	CBR (%)
TP105	0.7-0.8	14	3.1 & 4.0
TP107	0.4-0.5	15	0.4 & 0.5
TP109	0.4-0.5	18 & 19	1.6 & 2.2
BH105	0.5-1.0	15 & 14	1.1 & 1.6
Min	0.4	14	0.4
Max	1.0	19	4.0

4.3 Glacial Till

All five of the cable-percussion boreholes, four of the trial pits and nine of the window samples boreholes encountered deposits considered to be Glacial Till, at depths of between 0.4m (TP102) and 3.0mbgl (BH101). These deposits were predominantly cohesive, although thin granular horizons were present locally within them.

The cohesive deposits were typically firm to stiff (but locally soft to firm or very stiff), reddish brown (locally mottled grey), sandy to very sandy, slightly gravelly to gravelly clay; the gravel included quartzite, sandstone and mudstone.

The thin horizons of granular material were loose to medium dense, reddish brown sand.

It is considered possible that, due to their similarity, some of the materials described as Glacial Till are in fact weathered Chester Formation strata (Section 4.4, below).

4.3.1 Strength

The uncorrected SPT N values in the observed cohesive deposits ranged from 8 to 14 at 1m depth (4 tests), 11 to >50 at 2m depth (7 tests), 13 to >50 at 3m depth (5 tests), 40 at 4m depth (2 tests), and >50 at 5m and 6mbgl (1 test at each depth). The variation in SPT N values with depth in the Glacial Tills is shown in Figure 4.1, above. Using the Stroud and Butler (1975) relationship with an f_1 of 5 for low plasticity soils, these ranges of N values suggest undrained shear strengths of 40 to 70kPa at 1mbegl, 55 to >250kPa at 2mbegl, 65 to >250kPa at 3mbegl, 200kPa at 4mbegl, and >250kPa at 5mbegl. These strengths indicate the presence of clays of medium strength at 1m depth, to medium to very high strength at 2m and 3m depth, and very high strength deeper than 4m depth.

Three 'undisturbed' U100 samples of the Glacial Till underwent unconsolidated, undrained triaxial compression (quick undrained) testing, to determine the materials undrained shear strength. The results are summarised in Table 4.6, below.

Table 4.6 Summary of quick undrained triaxial tests on the Glacial Till

Location	Depth (m)	Moisture Content (%)	Bulk Density (Mg / m ³)	Dry Density (Mg / m ³)	Undrained Shear Strength (kPa)
BH101	4.0-4.45	9.8	2.26	2.06	404
BH102	2.0-2.45	14	2.19	1.92	153
BH103	2.0-2.45	10	2.28	2.07	142

Based on the above information, a weight density of between 16kN/m³ and 20kN/m³ can be expected for the cohesive glacial deposits (Figure 1, BS8004:2015).

4.3.2 Particle Size Distribution

Two particle size distribution analyses (PSD) were undertaken on the Glacial Till material; the analyses are summarised in Table 4.7 below:

Table 4.7 Summary of PSD Analysis on the Glacial Till

Location	Depth (m)	% passing 63µm	% sand	% gravel	Uniformity Coefficient		SHW Class
TP101	1.2-1.3	67	30	3	-	Slightly gravelly slightly sandy CLAY	2A/2B
TP102	1.4-1.5	50	41	9	>1.9	Slightly gravelly sandy CLAY	2A/2B
Average	N/A	58.5	35.5	6.0	N/A	Slightly gravelly sandy CLAY	2A/2B

The analysis suggests that the cohesive Glacial Till material is a slightly gravelly, slightly sandy to sandy clay; they comply with SHW Class 2A or 2B, wet or dry cohesive material.

4.3.3 Atterberg Limits

Atterberg Limits testing was carried out on seven samples of cohesive Glacial Till material, as summarised in Table 4.8, below. These samples were predominantly determined to be low to medium plasticity clays, and of a low volume change potential. Following correction, taking into account the <425µm fraction, four of the seven samples were found to be non-shrinkable (modified PI of <10).

Based on these results it is considered that, in their present state, the cohesive Glacial Till soils will fall into SHW Class 2A (wet cohesive material) for the purpose of earthworks.

Based on the equation given in BS8002:2015 (section 4.3.1.4.8 page 19), these soils will have effective angles of shearing resistance of approximately 26° to 30°.

Table 4.8 Summary of Atterberg Limits Testing on the Glacial Till

Location	Depth (m)	MC as received (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Corrected Plasticity Index (%)
WS101	0.8-0.9	17	38	18	20	17.6
WS103	2.3-2.4	7.9	23	12	11	9.1
WS105	1.3-1.4	18	27	16	11	9.7
WS106	1.7-1.8	15	23	13	10	8.6
WS107	1.4-1.5	18	37	18	19	19
WS111	2.3-2.4	12	23	13	10	8.1
BH101	4.5	9.3	26	13	13	11.3
Min	0.8	7.9	23	12	10	17.6
Max	4.5	18	38	18	20	8.1
Average	N/A	14.3	29.1	15.1	14.0	13.3

4.3.4 CBR

Remoulded CBR testing was carried out on one sample of Glacial Till material (TP101) that was determined by grading analysis (above) to be a slightly gravelly slightly sandy clay (Class 2A/2B). The CBR testing was undertaken with the sample at its 'as received moisture content', following compaction with a 2.5kg rammer. The results are summarised in Table 4.9.

Table 4.9 Summary of CBR Testing on the Glaciofluvial Deposits

Location	Depth (m)	Test MC (%)	CBR (%)
TP101	1.2-1.3	18	2.1

From the limited test results it appears that CBR values of 2% may be achievable for the cohesive Glacial Till material when compacted with its current moisture contents; however, to achieve greater CBR values (and to achieve satisfactory levels of compaction) some drying is likely to be required.

4.4 Chester Formation

Four of the cable-percussion boreholes, seven of the trial pits and seven of the window samples boreholes encountered strata considered to represent the Chester Formation, at depths of between 0.4m (WS110) and 6.5mbegl (BH101). Both sandstone and mudstone were encountered, with the weathered strata being both granular and cohesive.

Sandstone strata encountered were typically reddish brown, but locally yellowish brown, thinly bedded and locally slightly to very clayey. The mudstone strata (WS107) were thinly laminated.

The granular weathered Chester Formation strata were reddish brown, locally light brown, locally slightly clayey to very clayey, slightly gravelly to very gravelly sand; the gravel comprised sandstone lithorelicts.

The cohesive weathered Chester Formation strata were typically firm to stiff, reddish brown locally yellowish brown, slightly sandy to very sandy, slightly gravelly to gravelly clay; the gravel comprised sandstone and mudstone lithorelicts.

4.4.1 Strength

The variation in SPT N values with depth in the Chester Formation material is shown in Figure 4.1, above.

The limited SPT N values in the observed cohesive weathered strata were 14 at 2m depth and 50 blows for 280mm penetration (N approximates to 73) at 2.7m depth.

Using the Stroud and Butler (1975) relationship with an f_1 of 5 for low plasticity soils, the ranges of N values for the cohesive weathered material suggest undrained shear strengths of 70kPa at 2mbegl and >250kPa at 2.7mbegl. These strengths indicate the presence of clays of medium strength at 2m depth, and very high strength at 2.7m.

The limited SPT N values in the granular weathered strata were 22 at 1m depth (1 test), 13 and 50 for 240mm penetration (N approximates to 63) at 2m, and 50 for 275mm penetration (N approximates to 65) at 7.95mbgl. Based on these results the relative densities of the granular weathered material are typically medium dense at 1m depth, medium dense to very dense at 2m depth, and very dense at 7.95m depth.

SPT N values in the materials described as sandstone or mudstone rock typically exceed 50, with a range of 50 blows for 285mm penetration (N approximates to 53) to 60 blows for 245mm penetration (N approximates to 73). Using a simple correlation of UCS of 5 times N value, approximate strengths of 0.26 to 0.36MPa has been assessed for the upper level of the Chester Formation. Site observations suggested that the rock strengths ranged from extremely weak to weak.

Based on the above information, a weight density of between 18kN/m^3 and 21kN/m^3 can be expected for the weathered Chester Formation soils (Figure 1, BS8004:2015).

4.4.2 Particle Size Distribution

Particle size distribution analysis (PSD) was undertaken on one sample of the cohesive weathered Chester Formation material; the analyses are summarised in Table 4.10 below:

Table 4.10 Summary of PSD Analysis on the weathered Chester Formation

Location	Depth (m)	% passing 63µm	% sand	% gravel	Uniformity Coefficient		SHW Class
TP106	1.8-1.9	34	54	13	>3.2	Slightly gravelly sandy CLAY	2A/2B

The analysis suggests that the cohesive weathered Chester Formation material is a slightly gravelly, sandy clay which complies with SHW Class 2A or 2B, wet or dry cohesive material.

4.4.3 Compaction

One sample of the cohesive weathered Chester Formation material (TP107) underwent moisture content/dry density relationship testing using a 2.5kg rammer in accordance with BS1377-4 1990. This testing reveals an OMC value of 10%, and an MDD value of 2.06%; the slightly elevated 'as received moisture content' was 12%.

4.4.4 Atterberg Limits

Atterberg Limits testing was carried out on one sample of cohesive weathered Chester Formation material (TP105 at 1.5m to 1.6m depth). This sample was determined to be a low plasticity clay, and of a low volume change potential.

Based on these limited results it is considered that, in their present state, the cohesive weathered Chester Formation material will be fall into SHW Class 2A (wet cohesive material) for the purpose of earthworks.

Based on the equation given in BS8002:2015 (section 4.3.1.4.8 page 19), these soils will have effective angles of shearing resistance of approximately 27°.

4.5 Sulphate and pH

Representative samples of the Made Ground and natural strata were tested for water soluble sulphates and pH. Figure 4.2 summarises the results of the testing. The full results are included in Appendix F. Figure 4.2 shows an overall range of water soluble SO₄ between 0.01g/l to 1.67g/l and a pH ranging from 5.6 to 10.9. It is clear from the plot that most samples fall into the DS-1 and AC-1 area, with one sample of Made Ground material having a higher water soluble sulphate content, and one sample of the Glacial Till material having a lower pH; looking at the results for the site as a whole it is clear that these two results are anomalous. However, following the guidance in BRE Special Digest 1:2005, characteristic values have been determined for the site by taking the mean of the highest 20% of the water soluble sulphate results and



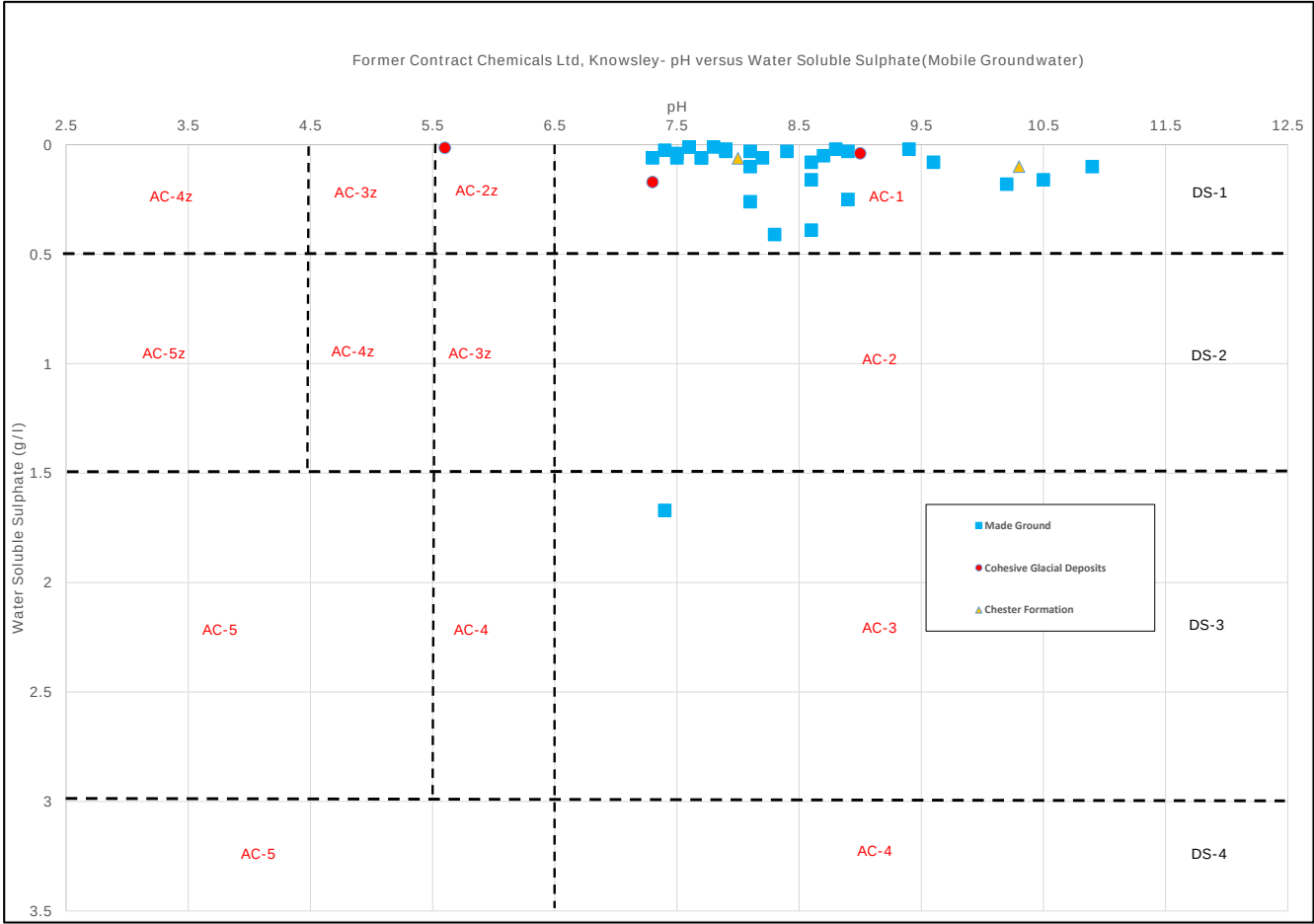
the lowest 20% of the pH results, giving values of 0.68g/l and 6.9, respectively. On the basis of mobile groundwater, the site as a whole can be categorised with a design sulphate value for subsurface concrete of DS-2 and an ACEC class of AC-2.

The results of the groundwater analysis (Appendix E) revealed sulphate contents ranging from 13mg/l to 273mg/l, and pH values between 6.9 and 12.3. These results suggest a design sulphate value for subsurface concrete of DS-1 and an ACEC class of AC-1; in agreement with many of the soil samples.

It is suggested that a design sulphate value for subsurface concrete of DS-2 and an ACEC class of AC-2 be adopted for this site.



Figure 4.2 pH against Sulphate (All Strata)



4.6 Summary of Geotechnical Parameters

Table 4.11 provides a summary of characteristic values of geotechnical parameters. For the Made Ground the values are for the material in its present state. It is considered that by appropriate ground engineering measures the material can be improved.

Table 4.11 Summary of Geotechnical Parameters

Geotechnical Parameter	Characteristic Values			
	Made Ground	Glacial Till	Weathered Chester Formation	Chester Formation (rock)
PSD (SHW Table 6/2)	2A/2B & 2C	2A/2B	2A/2B & 1A/1B	n/a
Plasticity Index (%)	11	14	17*	n/a
Angle of internal shearing resistance, ϕ' (°)	28*	27	27 (cohesive)* >30 (granular)*	n/a
Undrained Shear Strength (Cu)	35*	40@1m, 75@2m, 125@3m, 200@4m.	70@2m, >250@3m	n/a
UCS (MPa)	n/a	n/a	n/a	0.3
Weight Density (Mg/m ³)	16*	18	19	21*
CBR (%)	<2*	2	n/a	n/a
DS / ACEC	DS-2, AC-2	DS-1, AC-2z	DS-1/AC-1	DS-1/AC-1*
SHW Classification	2A & 2C	2A	2A & 1A/1B	n/a
OMC (%)	12 (cohesive) 10 (granular)	14*	12 (cohesive)*	n/a

*Assessed on limited or no test data; n/a - not applicable.

4.7 Groundwater Observations

Groundwater flow or seepages were observed in exploratory holes BH101, BH104, TP102, TP106, TP107, TP108, TP109, TP110, TP112, TP113, WS101, and WS106; however, the exploratory techniques used may have masked small water seepages in other boreholes. Where observed, groundwater was predominantly associated with the lower part of the Made Ground, although locally groundwater was encountered in the underlying natural deposits, cohesive and granular. It was typically struck, where present, at depths

shallower than 2mbegl; the exception being the strike at 4.5mgl in borehole BH101, in natural strata, and at 2.2mbegl in borehole BH104 at the base of the Made Ground.

Six groundwater monitoring visits were undertaken after the ground investigation. Monitoring was undertaken from the eleven standpipes installed by G&J (BH101, BH103, BH104, BH105, WS101, WS102, WS106, WS107, WS108, WS109 and WS110), plus one of the pre-existing GRM boreholes (GRM BH04). Table 4.12, below summarises the groundwater monitoring data.

Table 4.12 Summary of Groundwater Monitoring Results

Location	Depth of standpipe base (m)	Depth to Groundwater (mbgl)		Groundwater Level (mAOD)	
		Minimum	Maximum	Highest	Lowest
BH101	8.38	2.32	-	27.51	-
BH103	6.30	1.29	1.85	28.33	27.77
BH104	3.02	0.29	0.70	28.79	28.38
BH105	3.10	0.44	0.95	29.59	29.08
WS101	3.46	0.28	1.07	29.15	28.36
WS102	2.56	0.44	1.88	30.25	28.81
WS106	2.04	0.62	1.35	27.39	26.66
WS107	3.55	0.33	2.00	28.43	26.76
WS108	3.10	2.79	-	26.67	-
WS109	3.21	1.30	2.18	28.80	27.92
WS110	2.08	0.77	1.58	29.94	29.13
GRM-BH04	2.99	1.22	2.40	27.51	-

N/A = Ground levels of boreholes not known.

The standing water levels appear to be associated with the Made Ground (i.e. BH101, BH103, BH104, BH105, WS106, WS109 and WS110), natural cohesive deposits (i.e. WS101, WS102 and WS107), or natural granular deposits (i.e. WS108 and WS110). Where the data suggests that standing groundwater levels are

within the natural cohesive deposits; it seems more likely that in these cases groundwater has collected in the installations following minor ingress from overlying Made Ground or thin natural granular horizons.

4.8 Visual and Olfactory Evidence of Contamination

A 'solvent odour' was reported in the Made Ground in exploratory holes WS104, BH104, TP101, TP103 to TP106 inclusive, and TP108. A 'hydrocarbon odour' was reported in the Made Ground in exploratory holes TP106 and TP107. All of these exploratory holes were located in the northern half of the site. . Figure 4.3, below summarises the distribution of these reported odours.

Figure 4.3 Evidence of Contamination



4.9 Soil Chemistry

Table 4.13 presents a summary of the results of chemical analyses undertaken on soil samples from the site. The table presents the highest, 2nd highest and lowest concentrations for each contaminant (where appropriate), as an indication of the spread of results. Substances not recorded above laboratory detection limits are not included in the tables. The significance of these results is discussed in the Risk Assessment in Section 6.

Full soil chemical analytical results are presented in Appendix E.

Table 4.13 Summary of soil analytical results

Substance	No of samples	units	Highest	2 nd Highest	Lowest
Arsenic	29	mg/kg	22	9	<2
Cadmium	23	mg/kg	2.3	0.8	<0.2
Chromium	23	mg/kg	53	40	8
Copper	23	mg/kg	56	38	<4
Lead	23	mg/kg	78	63	<3
Nickel	23	mg/kg	86	37	4
Zinc	23	mg/kg	204	163	14
Total Sulphur	23	%	0.24	0.14	<0.02
Sulphide	23	mg/kg	65	<5	<5
Organic Matter (SOM)	23	%	4.5	3.5	0.4
Total Organic Carbon (TOC)	23	%	2.6	1.7	0.2
pH	23	pH units	10.9	10.5	7.2
EPH (C10-C40)	23	mg/kg	368	331	<6
Naphthalene	23	mg/kg	0.27	0.22	<0.1
Benzo(a)pyrene*	23	mg/kg	3.26	2.09	<0.1
Total PAHs*	23	mg/kg	30.9	15.4	<1.6
Total Aliphatic Hydrocarbons*	26	mg/kg	101	55	<21
Total Aromatic Hydrocarbons*	26	mg/kg	144	127	<21
Benzene	26	µg/kg	17	7	<2
Toluene	26	µg/kg	111	89	<5
Ethylbenzene	26	µg/kg	246	160	<2

Contract Chemicals, Knowsley
Site Investigation Interpretative Report



Substance	No of samples	units	Highest	2 nd Highest	Lowest
p & m-xylene	26	µg/kg	494	305	<2
o-xylene	26	µg/kg	296	71	<2
Asbestos	27	-	Detected in 1 sample		
Dibromomethane	18	µg/kg	52	29	<5
Dibromochloromethane	18	µg/kg	15	<5	<5
Bromoform	18	µg/kg	909	168	<10
Chloroform	18	µg/kg	136	70	<5
Isopropylbenzene	18	µg/kg	14	13	<5
Bromobenzene	18	µg/kg	6	<5	<5
Chlorobenzene	18	µg/kg	100	78	<5
2-Chlorotoluene	18	µg/kg	101	<5	<5
4-Chlorotoluene	18	µg/kg	104	<5	<5
n-Propylbenzene	18	µg/kg	17	11	<5
n-Butylbenzene	18	µg/kg	634	<5	<5
1,2,4-Trimethylbenzene	18	µg/kg	39	11	<5
1,3,5-Trimethylbenzene	18	µg/kg	10	8	<5
1,2-Dichlorobenzene	18	µg/kg	512400	41460	<0.1
p-Cresol	18	µg/kg	0.33	0.29	<0.15
2-Methylnaphthalene	18	µg/kg	0.4	0.4	<0.1
3-Nitroaniline	18	µg/kg	0.2	<0.1	<0.1
Dibenzofuran	18	µg/kg	0.4	<0.1	<0.1
Azobenzene	18	µg/kg	0.5	<0.1	<0.1
1-Bromo-2,4-dichlorobenzene	18	µg/kg	1750	55	<10
1-Bromo-2,3-dichlorobenzene	18	µg/kg	1990	88	<10
Benzene, 1,2-diethyl	18	µg/kg	104	<10	<10
Hexane, 1,6-dibromo-	18	µg/kg	75	<10	<10
Cyclic octaatomic sulfur	18	µg/kg	30.4	2.9	<0.1
1,4-Benzenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-	18	µg/kg	449	<0.1	<0.1

*For full Speciated PAH and TPH bandings see results in Appendix E

4.10 Groundwater Chemistry

Table 4.14 presents a summary of the results of chemical analyses undertaken on groundwater samples from the site. The table presents the highest, 2nd highest and lowest concentrations for each contaminant (where appropriate), as an indication of the spread of results. Substances not recorded above laboratory detection limits are not included in the tables. The significance of these results is discussed in the Risk Assessment in Section 7.

Full soil chemical analytical results are presented in Appendix E.

Table 4.14 Summary of groundwater analytical results

Substance	No of samples	units	Highest	2 nd Highest	Lowest
Arsenic	10	ug/l	63	27	<5
Boron	10	ug/l	387	125	56
Cadmium	10	ug/l	1.8	<0.4	<0.4
Chromium	10	ug/l	40	20	<5
Copper	10	ug/l	160	70	<5
Lead	10	ug/l	197	22	<5
Mercury	10	ug/l	1.14	0.79	<0.05
Nickel	10	ug/l	137	97	<5
Selenium	10	ug/l	21	13	<5
Zinc	10	ug/l	1500	314	12
Total Sulphate as SO ₄	10	mg/l	273	164	13
Cyanide	10	ug/l	215	168	<5
pH	10	pH units	8.4	8.2	8.0
Ammoniacal Nitrogen as NH ₄	10	ug/l	20000	18400	95
Total Organic Carbon	10	mg/l	370	147	12.9
Total Phenols (monohydric)	10	ug/l	694	294	<10
EPH (C10-C40)	10	ug/l	5277	3428	<10
Naphthalene	10	ug/l	1.8	0.15	0.01
Acenaphthylene	10	ug/l	0.01	<0.01	<0.01
Acenaphthene	10	ug/l	0.13	0.05	<0.01
Fluorene	10	ug/l	0.15	0.04	<0.01

Substance	No of samples	units	Highest	2 nd Highest	Lowest
Phenanthrene	10	ug/l	0.05	0.03	<0.01
Fluoranthene	10	ug/l	0.21	0.13	<0.01
Pyrene	10	ug/l	0.14	0.14	<0.01
Chrysene	10	ug/l	0.07	<0.01	<0.01
Benzo(a)pyrene	10	ug/l	0.09	<0.01	<0.01
Total PAHs*	10	ug/l	2.11	0.75	<0.16
Total Aliphatic Hydrocarbons*	10	ug/l	1219	895	<70
Total Aromatic Hydrocarbons*	10	ug/l	3324	1290	<70
Total Petroleum Hydrocarbons (>C5-C35)	10	ug/l	3770	2510	<140
Benzene	10	ug/l	33	<1	<1
Toluene	10	ug/l	582	86	<5
Ethylbenzene	10	ug/l	38	15	<5
p & m-xylene	10	ug/l	127	86	<10
o-xylene	10	ug/l	70	53	<5
Chloroform	10	ug/l	161	<5	<5
Chlorobenzene	10	ug/l	493	229	<5
1,3,5-Trimethylbenzene	10	ug/l	167	<5	<5
1,2-Dichlorobenzene	10	ug/l	8357	8151	<5
Propyl Sulphide	10	ug/l	787	184	<5
1,4-Dichlorobenzene	10	ug/l	1.1	1.0	<0.1
2,4,6-Trichlorophenol	10	ug/l	0.2	<0.1	<0.1
4-Chloroaniline	10	ug/l	1.6	0.7	<0.1

4.11 Ground Gases

A summary of the gas monitoring results is presented in Section 8 of this report. Records from the individual gas monitoring visits are presented in Appendix D. In brief:

- Methane has been detected on at least one visit in boreholes BH101, BH103, BH104, BH105, WS101, WS107, WS108 and WS109; concentrations in excess of 1% were detected in BH103 (3.6 – 14.1%), WS107 (2.3 – 3.5%) and WS108 (12.3%).



- A maximum of 9.4% by volume of carbon dioxide was detected, in borehole WS107 where readings were consistently above 5% by volume. Concentrations in excess of 5% by volume were also detected in boreholes BH102 and BH103.
- Oxygen levels as low as 2.8% by volume were detected in borehole BH103, with concentrations lower than 10% by volume also being detected in boreholes WS106, WS107 and WS108.
- The maximum recorded borehole flow rate was 1.2l/hr in borehole WS107.



5.0 Engineering Design Recommendations

5.1 Site Preparation

The principal geotechnical constraints to the development of the site are:

- Localised presence of Made Ground up to 3m thick (typically between 1m and 2m) comprising predominantly reworked natural soils with entrained man-made material. Locally very soft or very loose;
- Potential buried substructures associated with past development, including a culverted stream.

5.1.1 Made Ground

Although Made Ground is present across most of the site to some degree, thicker deposits are present in two main locations; the south-eastern area adjacent to and north of the office building (thicknesses of 2.6m (WS109) and 3.0m (BH101) recorded), and in the north-western part of the site, where thicknesses of 2.2m (BH104) and greater than 2.0m (TP103) were recorded). Figure 5.1, below, shows the observed thickness of Made Ground in relation to the proposed layout.

In its current state, due to its variable strength/relative density and typically high moisture content, the Made Ground is not considered a suitable bearing material for either foundations or a ground bearing floor slab, and ground improvement works will be required.

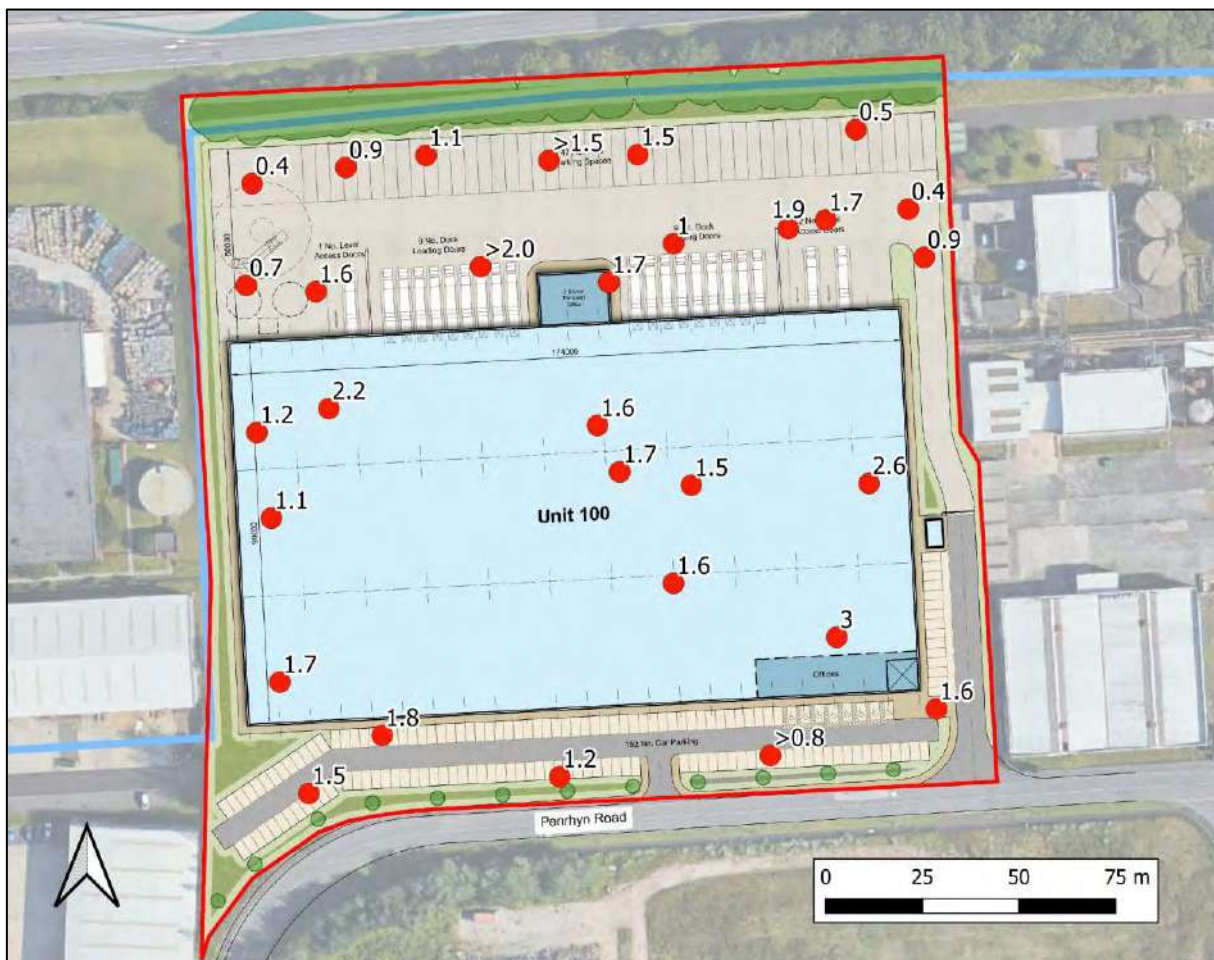
5.1.2 Buried Substructures

It is understood that generally substructures including old foundations have been removed as part of the site demolition/clearance works, resulting in locally deepened Made Ground or Disturbed Ground. There is the potential for previously unidentified substructures to remain; if encountered during future development works any new foundations should extend past the base of these sub-structures or any excavations resulting from their removal.

If not already achieved, the route and depth of the culverted Knowsley Brook should be confirmed, together with the integrity of the culvert. If the culvert is considered likely to underlie the proposed building footprint or be within influencing distance of future foundations then either the development proposals may

require modification or, with the agreement of the relevant authorities, the route of the culvert altered; alternatively, with the appropriate permissions, it may be possible to design the proposed building and its foundations to span across sections of the culvert.

Figure 5.1 Observed Made Ground thickness (m)



5.2 Foundations

In its current state the Made Ground within the site is considered unsuitable as a bearing stratum and all new foundations should be carried down through it, to found on the more competent natural cohesive, granular or rock strata.



Due to the variable minimum foundation depths and founding strata (firm clays to extremely weak rock), at this stage it is suggested that a foundation solution comprising concrete pads (nominally 1.5m x 1.5m) on vibro-replacement concrete columns be adopted, with the columns extending to either very stiff clay or extremely weak sandstone to minimise the risk of differential settlement. A minimum column length of 3m is suggested. The use of stone columns is unlikely to be acceptable considering the presence of contamination in the Made Ground and the underlying Principal Aquifer. A specialist vibro-replacement contractor should be consulted, regarding the suitability of the site for this technique and likely achievable allowable bearing capacities.

A potential alternative to the above foundation solution would be to utilise pad foundations at a relatively shallow depth in improved Made Ground (see Section 5.3, below); however, due to the variation in Made Ground thickness and the nature of the underlying natural strata, this solution may have a greater risk of differential settlement occurring. Significant further assessment would be required if this option were to be considered.

5.3 Floor Slabs

The composition of the Made Ground indicates that it is not a suitable subgrade in its current condition as it was not placed to any engineering specification. However, there are a number of options for improving the Made Ground as outlined below.

5.3.1 Excavate and replace

The existing Made Ground could be removed down to the natural strata and replaced to an engineering specification for Class 2C or 2A/2B materials, as appropriate, in accordance with the Specification of Highway Works, with compaction to 95% of maximum dry density. This option could provide a uniform subgrade, with an anticipated CBR of 2 to 3%. This will require a capping layer of Class 6F2 and sub base, or a thickened sub base without capping, to provide a suitable formation for the floor slab and areas of highway pavement. Due to the presence of locally thicker deposits of Made Ground, taking this approach would result in excavations locally as deep as 3m below FFL but typically less than 2m. It should be noted that in its current state the Made Ground materials will generally require drying prior to replacement.



5.3.2 High Energy Impact Compaction (HEIC)

As an alternative to full excavation and replacement, the Made Ground could potentially be compacted in-situ using HEIC (Landpac) or similar in-situ impact compaction technique. This will provide the same formation as excavation and replacement subject to verification testing (plate load testing and in-situ density testing). A similar capping / subbase and or subbase thickness will be required. The presence of existing underground services, adjacent properties and the culverted stream within the site area may restrict the use of this technique. A specialist contractor should confirm the suitability of the Made Ground for such techniques.

5.3.3 Lime Stabilisation

The Made Ground appears to be suitable for lime stabilisation. Based on the source material of the Made Ground, it is anticipated to generally have a low TOC (of less than 2%); an overall upper limit of 2% TOC is generally considered acceptable (British Lime Association Technical Data (BLATD)). The Plasticity Index of the source material Made Ground (average of 12.5%) is just above the lower limit of 10% (BLATD) and the generally low Sulphate content (0.001 to 1.67g/l) is also favourable (BLATD). Lime stabilisation can be used to increase the CBR to 5%, or possibly 15%, to eliminate the need for capping and reduce the subbase thickness. It is recommended that if this is an option to be taken forward further testing of the Made Ground for TOC, SO₄/pH and plasticity is undertaken to confirm the source material properties.

5.3.4 Piles or Vibro-replacement Concrete Columns

The use of a grid of piles or compacted concrete columns, through the untreated Made Ground, may be an appropriate method of supporting the floor slabs to avoid a need for extensive ground treatment works. A specialist contractor should be consulted regarding the suitability of the ground condition for this approach; significant further ground assessment, especially with respect to future settlement is likely to be required if the concrete column option is adopted.

5.4 Road Pavement

At this stage, prior to any improvement works, all Made Ground should be assumed to have a CBR values of less than 2%. Site observations, suggest that the near surface cohesive natural materials should be able to achieve CBR values of at least 2.5% when properly engineered or proof rolled. The granular deposits



should be able to achieve a CBR value of at least 5%, when suitably drained. Proof rolling and the improvement of soft spots may result in increased CBR values and the incorporation of a geotextile grid into sub-base layers may allow for reduced capping thickness.

Site observations should be confirmed by in situ or laboratory testing in accordance with the adopting Local Authority's preference.

5.5 Drainage

Due to the contaminated nature of the Made Ground and the near surface proximity of the Chester Formation Principal Aquifer it is considered unlikely that the site will be deemed suitable for soakaway drainage.



6.0 Generic Quantitative Assessment – Human Health

6.1 Methodology and Relevant Assessment Criteria

A Generic Quantitative Risk Assessment (GQRA) has been undertaken by comparing recorded contaminant concentrations to Generic Assessment Criteria (GAC) to identify the contaminants of concern that have the potential to adversely affect the health of site users. If the observed concentration of a particular substance is below the GAC then the risk is generally considered to be acceptable and does not generally warrant further assessment. Furthermore, a substance recorded in excess of a particular GAC does not necessarily indicate that a significant risk is present that would require mitigation. Where a GAC is exceeded, further assessment may be necessary to evaluate the significance in line with the current UK tiered risk assessment framework.

6.2 Assessment Criteria

In order to generate generic assessment criteria (GACs) which are protective of human health, the Environment Agency recommends the use of the CLEA 1.06 software in conjunction with advice found on their CLEA web pages. CLEA was initially used to derive Soil Guideline Values (SGVs), the last of which were published in 2009. These were produced for a limited number of substances for three common land uses; residential, allotments and commercial / industrial. SGVs represented concentrations that would present a minimal risk in the context of the exposure scenario for a particular land use.

Following the publication of updated Statutory Guidance for Part IIA of the Environmental Protection Act in 2012, new screening values, designated Category 4 Screening Levels (C4SLs), were published in 2014 which are consistent with the more pragmatic risk based approach adopted by the Guidance. They represent a level of risk which is 'low' rather than 'minimal', but are still strongly precautionary and are consistent with land within Category 4, as described in the Statutory Guidance and summarised in Section 1.5.

The C4SLs have been developed using a modified version of the CLEA framework for six of the most significant substances associated with contaminated land (although more are in development) and cover 6 classes of generic land use. For the purposes of this report, appropriate C4SLs have been used in the first instance, where available.

Where C4SLs do not exist, alternative GACs derived using CLEA are required. Accordingly, the Chartered Institute of Environmental Health (CIEH) in partnership with Land Quality Management (LQM) derived a set of Generic Assessment Criteria Values (GAC) for contaminants of concern using the CLEA software. The LQM/CIEH S4ULs (Suitable for Use levels) published in 2014 present GACs for 89 contaminants of concern under six land use scenarios and for three soil organic matter percentages. They differ from C4SLs in that they are derived based on 'minimal' rather than 'low' risk. The input parameters used for calculating each S4UL value are listed in the substance specific chapters of the reference document associated with the S4ULs, namely 'The LQM/CIEH S4ULs for Human Health Risk Assessment' (Land Quality Press, 2015, Unique publication number S4UL3312). S4ULs have therefore been used where no C4SL is available. In the absence of a C4SL or S4UL, reference had been made to Soil Generic Assessment Criteria (SGAC, CL:AIRE 2010).

6.3 Characterisation and Assessment

The generic screening values that G&J have used to establish whether soils are suitable for the proposed site use are detailed in Table 6.1. The screening values are presented for a commercial land use and a Soil Organic Matter content of 1.0%, which is roughly consistent with the lowest values in the Made Ground.

Table 6.1 GACs –Commercial land uses and 1.0 % SOM

Determinand	Commercial GAC (mg/kg)	Highest (mg/kg)	No. >Commercial GAC	GAC Source
Arsenic	640	22	0	C4SL
Cadmium	410	2.3	0	C4SL
Chromium	8600	53	0	S4UL
Copper	68000	56	0	S4UL
Lead	2300	78	0	C4SL
Nickel	980	86	0	S4UL
Zinc	730000	204	0	S4UL
Naphthalene	190	0.27	0	S4UL
Benzo(a)pyrene (as surrogate for genotoxic PAHs)	77	3.26	0	C4SL
Aliphatic hydrocarbons >C6-C8	7800	0.17	0	S4UL
Aliphatic hydrocarbons >C8-C10	2000	6	0	S4UL
Aliphatic hydrocarbons >C10-C12	9700	62	0	S4UL
Aliphatic hydrocarbons >C12-C16	59000	38	0	S4UL
Aliphatic hydrocarbons >C16-C35	1600000	26	0	S4UL
Aromatic hydrocarbons >C7-C8	56000	0.11	0	S4UL

Contract Chemicals, Knowsley
Site Investigation Interpretative Report



Determinand	Commercial GAC (mg/kg)	Highest (mg/kg)	No. >Commercial GAC	GAC Source
Aromatic hydrocarbons >C8-C10	3500	17	0	S4UL
Aromatic hydrocarbons >C10-C12	16000	21	0	S4UL
Aromatic hydrocarbons >C12-C16	36000	66	0	S4UL
Aromatic hydrocarbons >C16-C21	28000	41	0	S4UL
Aromatic hydrocarbons >C21-C35	28000	92	0	S4UL
Benzene	27	0.017	0	S4UL
Toluene	869	0.11	0	S4UL
Ethylbenzene	518	0.25	0	S4UL
p & m-xylene	1201	0.49	0	SGAC
o-xylene	478	0.30	0	S4UL
1,2,4-Trimethylbenzene	0.35	0.04	0	SGAC
Dibromomethane	-	0.05	-	-
Dibromochloromethane	-	0.03	-	-
Bromoform	760	0.9	0	SGAC
Chloroform	99	0.14	0	S4UL
Isopropylbenzene	1400	0.01	0	SGAC
Bromobenzene	97	0.006	0	SGAC
Chlorobenzene	56	0.1	0	S4UL
2-Chlorotoluene	-	0.1	-	-
4-Chlorotoluene	-	0.1	-	-
n-Propylbenzene	4100	0.02	-	SGAC
n-Butylbenzene	-	0.63	-	-
1,2,4-Trimethylbenzene	0.35	0.04	0	SGAC
1,3,5-Trimethylbenzene	-	0.01	-	-
1,2-Dichlorobenzene	2000	512	0	S4UL
p-Cresol	160000	0.0003	0	SGAC
2-Methylnaphthalene	-	0.0004	-	-
3-Nitroaniline	-	0.0002	-	-
Dibenzofuran	-	0.0004	-	-
Azobenzene	-	0.0005	-	-
1-Bromo-2,4-dichlorobenzene	-	1.75	-	-
1-Bromo-2,3-dichlorobenzene	-	1.99	-	-
Benzene, 1,2-diethyl	-	0.1	-	-
Hexane, 1,6-dibromo-	-	0.08	-	-
Cyclic octaatomic sulfur	-	0.03	-	-
1,4-Benzenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-	-	0.45	-	-



All soil data from the site investigation have been screened against the GAC, as detailed above, to determine the potential risk to human health users. In summary, no exceedances of the available GACs for a commercial end-use have been observed.

It should be noted that the health effects from petroleum hydrocarbons are additive, and so even when there are no exceedances of the GACs for individual fractions, or the exceedances are minor, there may still be an overall significant exceedance. This is calculated by dividing the recorded concentrations of each fraction by the relevant GAC, and adding all the results together. If the sum is less than 1, then there is no overall exceedance of the GAC. When accounting for this additivity, there were no exceedances of the petroleum hydrocarbon GAC for a commercial end-use.

Although some organic contamination was recorded in the soil, most notably in the form of dichlorobenzene, and was often associated with locations where odours were noted, the recorded concentrations do not exceed the commercial GACs and the risks to human health with respect to a commercial development are therefore not considered significant.

6.4 Asbestos

Due to the nature of asbestos and the wide range of factors that influence the level of risk associated with asbestos contamination, no GAC is available. Instead, the risks from asbestos are generally assessed based on lines of evidence which consider factors including the type and amount of asbestos present, its location and distribution, the ground conditions and potential exposure routes for site users.

Of the 33 samples analysed, only 1 was found to contain asbestos. Amosite was detected as a fibre bundle in borehole WS103 (at 0.4 to 0.5mbegl). No obvious ACMs were noted during G&J's site works.

Asbestos only presents a risk where fibres can become airborne. Any proposed development that results in the site being covered by hardstanding or buildings will mitigate the risks to future site users. Furthermore, any landscaped areas would most likely require a cover of clean soil as a growing medium, which would reduce the exposure to the underlying Made Ground. At this stage, based on the available evidence, the risks appear to be very low, but the presence of localised areas of more significant asbestos contamination cannot be ruled out given the site history.

A watching brief and/or validation sampling may be required as part of any redevelopment.

7.0 Generic Quantitative Assessment – Controlled Waters

7.1 Methodology

The potential for soil contamination to adversely affect controlled water receptors has been assessed at this stage by direct comparison of the results of laboratory analysis of groundwater samples with relevant Water Quality Standards (WQSs).

7.2 Water Quality Standards

The underlying Devensian Till deposits are classed as a Secondary (undifferentiated) Aquifer, and the Chester Formation as a Principal Aquifer, while the site also lies within Zone 3 (total catchment) of a Groundwater Source Protection Zone. The nearest 'surface water' feature to the site is Knowsley Brook which flows in a culvert through the site. For the purposes of this assessment, and for reasons of conservatism, the results of groundwater analysis have been compared to the lowest of either freshwater Environmental Quality Standards (EQSs) or UK Drinking Water Standards (DWS); where neither EQS nor DWS values are available the WHO guideline value for drinking water has been adopted (if available).

The following table presents the relevant WQSs for all contaminants that were recorded above detection limits and for which an WQS exists.

Table 7.1 Water Quality Standards

Substance	units	WQS	Source	No. of WQS exceedances (out of 10 samples)
Arsenic	µg/l	10	DWS	3
Boron	µg/l	1000	DWS	0
Cadmium	µg/l	0.15	EQS	1
Chromium	µg/l	4.7	EQS	4
Copper	µg/l	10	EQS	3
Lead	µg/l	7.2	EQS	4
Mercury	µg/l	0.05	EQS	7
Nickel	µg/l	20	EQS/DWS	3
Selenium	µg/l	10	DWS	3

Substance	units	WQS	Source	No. of WQS exceedances (out of 10 samples)
Zinc	µg/l	75	EQS	5
pH	pH units	6 – 9	EQS	1
Cyanide	µg/l	5	EQS	3
Sulphate	mg/l	250	DWS	1
Ammoniacal Nitrogen as NH ₄	µg/l	500	DWS	3
Naphthalene	µg/l	2	EQS	0
Acenaphthylene	µg/l	5.8	EQS	0
Acenaphthene	µg/l	5.8	EQS	0
Benzo(a)pyrene	µg/l	0.01	DWS	1
Fluoranthene	µg/l	0.01	EQS	2
Petroleum Hydrocarbons (EPH)	µg/l	10	Old DWS	4
Total Phenols	µg/l	7.7	EQS	7
Benzene	µg/l	1	DWS	1
Toluene	µg/l	50	EQS	2
Ethylbenzene	µg/l	20	EQS	1
p & m-xylene	µg/l	30	EQS (xylene)	2
o-xylene	µg/l			
Chloroform (Trichloromethane)	µg/l	2.5	EQS	1
Chlorobenzene	µg/l	-	-	-
1,3,5-Trimethylbenzene	µg/l	-	-	-
1,2-Dichlorobenzene	µg/l	1000	WHO	4
1,4-Dichlorobenzene	µg/l	300	WHO	0
Propyl Sulphide	µg/l	-	-	-
2,4,6-Trichlorophenol	µg/l	200	WHO	0
4-chloroaniline	µg/l	-	-	-

The WQSs in Table 8.1 are not directly applicable to groundwater and are therefore considered to be conservative when used as a benchmark for such. It is not unusual for shallow groundwater to record contaminant concentrations in excess of DWSs and EQSs, and exceedances do not therefore necessarily equate to a significant impact.



7.2.1 Inorganic Contaminants

A number of inorganic contaminants have been recorded at concentrations in excess of their respective WQSS. Generally metals were recorded in 2 or 3 locations at elevated concentrations when compared to the WQSS.

Mercury was the most widespread metal contaminant, with the WQS (0.05µg/l) being exceeded at 7 of the 10 sample locations, with a maximum concentration of 1.14ug/l recorded in BH104. The most significant metal contamination was in WS106 where 9 metals exceeded the WQS values.

Concentrations of cyanide exceed the EQS (5µg/l) at 3 locations (BH104, BH105 and WS110), with the highest concentrations in BH105 and WS110 (both 215µg/l).

Concentrations of ammoniacal nitrogen in boreholes BH104 (20,000µg/l), BH105 (18,400µg/l) and WS107 (9,740µg/l) exceed the WQS of 500µg/l.

7.2.2 Organic Contaminants

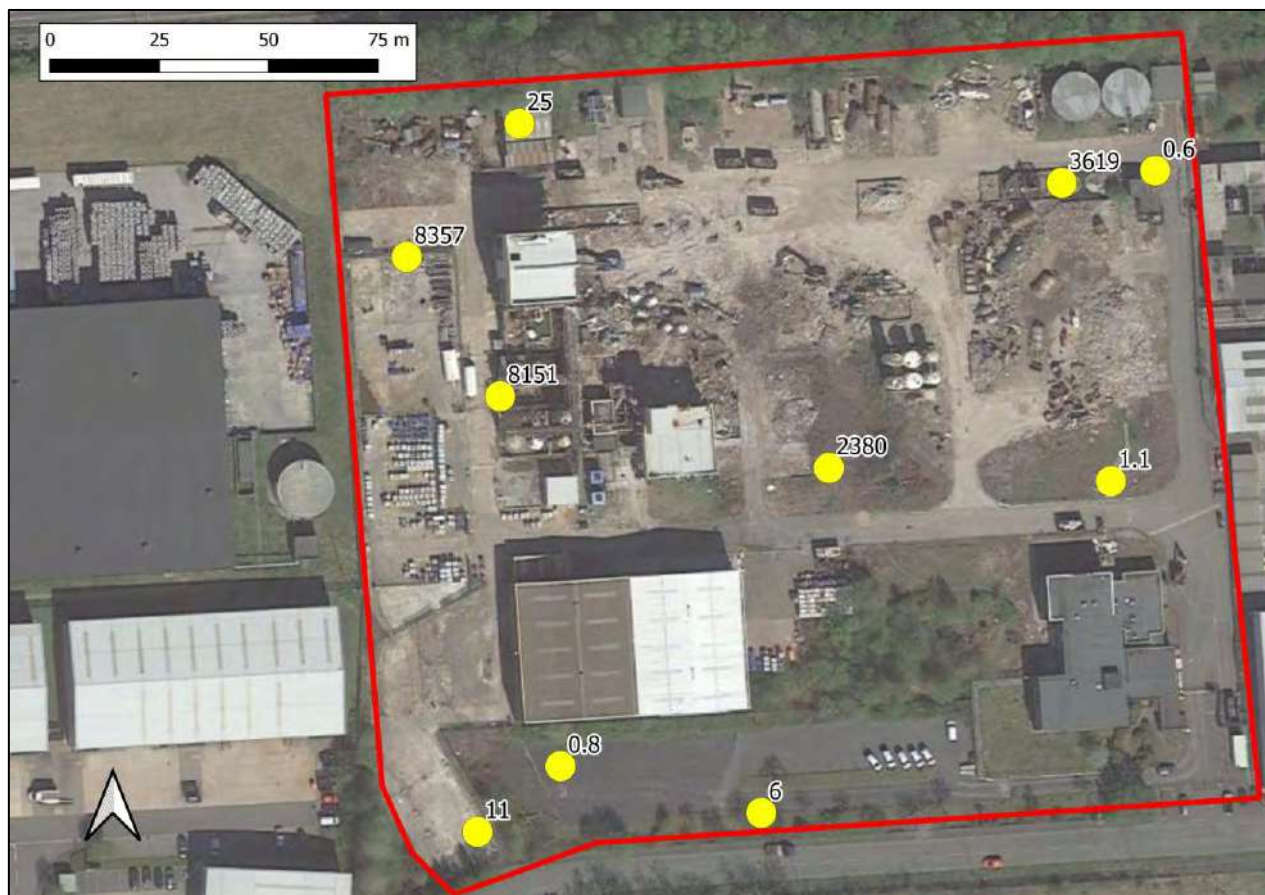
Significant organic contamination was recorded in four of the ten locations from where groundwater samples were obtained. These were BH103, BH104, BH105 and WS101, which are all located across the central band of the site where the main process areas and tank farms were located. The most notable individual organic compound was 1,2-dichlorobenzene, which was recorded in these four locations at concentrations between 2380 – 8357ug/l. Hydrocarbons in these locations were primarily within the aliphatic C10-12 and aromatic C8-C12 bands, although total hydrocarbon (TPHCWG banding) concentrations (816 – 3770ug/l) were less than the recorded concentrations of 1,2-dichlorobenzene.

Also elevated in one or more of these locations were BTEX compounds, phenols, chlorobenzene, trimethylbenzene, chloroform, propyl sulphide, 4-chloroaniline and a number of PAHs including naphthalene. However, these substances were less widespread and the concentrations much less significant.

All the other locations recorded only trace concentrations of 1,2-dichlorobenzene (<25ug/l), total hydrocarbons (<27ug/l) and some PAHs, most notably naphthalene which was recorded in all 10 locations at concentrations between 0.01 and 1.8ug/l.

Figure 7.1 below, summarises the concentrations of 1,2-dichlorobenzene recorded in all standpipes.

Figure 7.1 1,2-dichlorobenzene concentrations (ug/l)



7.2.3 Summary

Groundwater samples were predominantly taken from shallow groundwater contained either within the Made Ground, or permeable horizons of the Glacial Till. WS108 and WS110 were screened within the weathered Chester Formation, as Glacial Till was absent from these locations.

The most significant contamination is organic contamination (most notably 1,2-dichlorobenzene) in BH103, BH104, BH105 and WS101, all of which are located within the area previously occupied by the main process areas and tank farms. Only trace concentrations of organic contamination were recorded in the other locations.



Inorganic contamination is considered to be less significant. The most notable metal contamination was recorded in WS106 in the south-west of the site, while elevated cyanide was recorded in BH104 in the west, and BH105 and WS110, both located in the north-east. Elevated ammoniacal nitrogen concentrations were most significant in BH104 and BH105, but in general such concentrations are not unusual for shallow groundwater.

Given the presence of the Chester Formation Principal Aquifer at shallow depth, further assessment of the risks to the water environment (a Detailed Quantitative Risk Assessment) may be required, particularly with respect to the organic contamination. Following on from this, some mitigation measures (such as addressing any remaining potential soil sources) may be necessary.

8.0 Generic Quantitative Assessment – Ground Gas Risks

8.1 Background

Ground gases including methane, carbon dioxide and small concentrations of trace gases can occur naturally in soils containing organic material and are produced in greatest concentrations in soils with high organic content such as peat and Alluvial soils. These gases can also be generated from the degradation of buried organic materials which may be present in Made Ground materials.

Methane is the principal hazardous gas associated with the degradation of organic material in both natural organic soils and from any organic fraction within Made Ground. Methane is biochemically reactive and is readily oxidised to carbon dioxide under aerobic conditions. However, carbon dioxide can also be generated directly in soils.

Any hydrocarbon contamination on the site also has the potential to degrade and generate methane, carbon dioxide and trace gases, including carbon monoxide and hydrogen sulphide. The makeup of these trace gases will depend largely upon the origin of the organic material and degradation conditions but may include substances with odorous, toxic, carcinogenic or other hazardous properties.

The risks posed from ground gases are primarily from explosion or inhalation, both following accumulation in a confined space. The risks to site users from ground gas in areas of open space are not normally deemed to be significant.

Explosion of ground gases can only occur if the following elements are present:-

1. A source of flammable gas;
2. A confined or enclosed space;
3. A source of ignition; and
4. Sufficient oxygen to support combustion.

The flammability of a particular gas mixture is dependent on a number of factors including composition, temperature and pressure. The potential flammability of methane in a mixture increases with the relative

concentration of oxygen. In addition, the presence of carbon dioxide within a gas mixture will change the potential flammability as it will alter the upper explosive limit of methane.

Any gas or mixture of gases will cause physiological effects if it displaces oxygen in a confined space, to an extent when oxygen concentrations fall below 18 % v/v. This begins with impairment of judgement (17%), followed by anoxia and abnormal fatigue (10–16%), nausea and unconsciousness (6–10%) leading to death (<6 %). Physiological effects can be more severe if carbon dioxide is the cause of oxygen depletion.

8.2 Assessment Criteria

A ground gas risk assessment has been undertaken to quantify the risks to site users occupying any future proposed buildings on the site, based on the currently available information. The assessment of carbon dioxide and methane levels has been undertaken in accordance with the methods described in CIRIA guidance '*Assessing Risk Posed by Hazardous Ground Gases to Buildings*' (CIRIA C665, 2007), British Standard '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*' (BS 8485:2015+A1:2019), and other relevant industry guidance including '*A Pragmatic Approach to Ground Gas Risk Assessment*' (CL:AIRE RB17, 2012).

The methodology described in BS 8485, and used in this assessment, is based on the Modified Wilson and Card Classification (as set out in CIRIA C665), which requires the calculation of Gas Screening Values (GSVs) for the site for methane and carbon dioxide, which are the worst case rates at which hazardous gases are emitted from monitoring installations on the site.

Borehole hazardous gas flow rates (Q_{hg}) are calculated for each borehole standpipe on each monitoring visit using the formula:

$$Q_{hg} = \text{borehole flow rate (l/hr)} \times \text{gas concentration (\%)} / 100$$

To reflect a worst case scenario, for conservatism in the context of this report, this calculation has been applied to the maximum methane, carbon dioxide and flow rates recorded over the monitoring period at each borehole. The Q_{hg} values are used as the GSV to determine a '*Characteristic Situation*' under the Modified Wilson and Card classification.

Carbon monoxide and hydrogen sulphide levels have been assessed against long term exposure limits (LTELs), relating to an 8 hours exposure period, published in the Health and Safety Executive in 2005 in "Guidance Note EH40: Occupational Exposure". The LTEL for carbon monoxide is 30ppm and for hydrogen sulphide is 5ppm.

8.3 Characterisation

Gas readings were obtained from gas taps installed on the top of twelve borehole installations at the site on 6 occasions. Full details of the gas monitoring rounds are contained in Appendix D. A summary of gas readings recorded during the monitoring rounds is presented in Table 8.1 below. The table presents the maximum (CH₄ and CO₂) or minimum (O₂) gas concentrations and maximum flow rates, and includes an indication of the worst case Characteristic Situation (as described in BS 8485) for each location based on the available data.

Table 8.1 Ground Gas Monitoring Summary

Hole	Pressure Range	Gas Concentration (%)			Max. Flow (l/hr)	Max Q _{hg} (l/hr)		Characteristic Situation
		CH ₄ (Max)	CO ₂ (Max)	O ₂ (Min)		CH ₄	CO ₂	
BH101	1003	0.1	0.6	18.3	<0.1	<0.0001	<0.0006	CS1
BH103	991-1035	14.1	8.1	2.6	0.1	0.0141	0.0081	CS1*
BH104	991-1035	0.9	0.2	19.0	0.3	0.0027	0.0006	CS1
BH105	990-1035	0.3	0.2	16.4	0.5	0.0015	0.001	CS1
WS101	991-1035	0.1	1.6	19.9	0.1	0.0001	0.0016	CS1
WS102	991-1035	<0.1	1.7	19.5	0.1	<0.0001	0.0017	CS1
WS106	991-1035	<0.1	0.5	6.9	<0.1	<0.0001	<0.0005	CS1
WS107	992-1035	3.9	9.4	9.7	1.2	0.0468	0.1128	CS2
WS108	1002	12.3	3.1	9.7	0.1	0.0123	0.0031	CS1*
WS109	990-1035	0.2	1.7	12.8	0.7	0.0014	0.0119	CS1
WS110	991-1035	<0.1	0.3	19.9	<0.1	<0.0001	<0.0003	CS1
GRM-BH04	992-1036	<0.1	5.4	12.3	<0.1	<0.0001	<0.0054	CS1*

*Consideration should be given to increasing to CS2 if methane exceeds 1% or carbon dioxide exceeds 5%

The worst-case Q_{hg} value is taken as the Gas Screening Value; based on the available information, GSVs are typically consistent with Characteristic Situation 1 (CS1), which is representative of natural soils with low organic content and 'typical' Made Ground; the monitoring results for borehole WS107, however, are consistent with CS2.

Elevated concentrations of methane (>1%) and/or carbon dioxide (>5%) have been recorded at four



locations (BH102, BH103, WS107 and WS108) on at least one occasion; BS 8485 recommends consideration is given to increasing to sites classified as CS1 to CS2 in such cases.

Ground gas only represents a risk where hazardous gases have the potential to be emitted from the ground and collect in confined places, such as buildings. Flows rates were typically below 1l/hr, and only exceeded 1l/hr at WS107 on one occasion; this suggests that gases are not being generated in significant quantities.

A likely source of the elevated methane and carbon dioxide, at least in some of the standpipes, is the degradation of the hydrocarbons observed in the soil and groundwater beneath the site; however, in other locations such as WS107 and WS108, the source is less obvious.

Other than the presence of hydrocarbons, there is little evidence of significant degradable material in the ground, while organic matter contents of the soil were low.

While the risks are considered to be low, particularly with respect to the proposed warehouse type development, it is suggested that a CS2 classification is conservatively assumed at this stage. A CS2 classification requires the incorporation of basic gas protection measures (often comprising a well constructed slab with a properly installed gas membrane and all joints and penetrations sealed).

Following any remediation and / or earthworks, further monitoring may allow a classification of CS1. However, this approach should be agreed with the local authority before implementation.

Hydrogen sulphide was not detected during any of the monitoring visits. Carbon monoxide was detected on a single monitoring visit in boreholes BH104, BH105 and WS107, at concentrations of 24ppm, 6ppm and 1ppm, respectively; the detected concentrations were well below the Long Term Exposure Limit of 30ppm, respectively, and are therefore considered to pose no risk.

VOCs were detected in nine locations on at least one occasion, but significant concentrations were only recorded in BH104, with a maximum reading of 308ppm. Organic contaminants were recorded in both the soil and groundwater at this location, although locations where similar contamination was recorded did not have the same elevated VOCs.



9.0 Conclusions and Recommendations

9.1 Further Investigation

The investigation work undertaken is considered sufficient to allow a reasonable characterisation of the site in terms geo-environmental and geotechnical properties. However, the following additional works would be beneficial and may be a requirement of the Local Planning Authority;

- Additional ground investigation in the areas that were inaccessible during the site works reported here, particularly the areas beneath stockpiles, standing water and the warehouse that was undergoing demolition. This would likely involve the excavation of trial pits to allow the inspection and sampling of the upper soils, and subsequent chemical laboratory analysis. Such works could be undertaken as a validation exercise during any future remediation / earthworks, or as a stand alone investigation.
- The location, depth and condition of the culverted Knowsley Brook should be confirmed.

9.2 Geotechnical Recommendations

Preliminary geotechnical recommendations are summarised below.

9.2.1 Buried Concrete

Based on guidelines provided in BRE Special Digest 1, the site can be categorised with a design sulphate classification for subsurface concrete of DS-2 and an ACEC class of AC-2.

9.2.2 Foundation Solutions

It is anticipated that the most appropriate foundation solution for the proposed commercial structure will be either shallow pads in conjunction with vibro-concrete columns down to very stiff clay or rock strata, or pads bearing onto improved Made Ground.



9.2.3 Ground Floor Slab

Ground improvement will be required to enable the use of ground-bearing floor slabs on consistent material.

9.2.4 Roads and Pavements

The ground improvement required to allow the use of ground-bearing floor slabs will provide a suitable formation for the construction of road pavements.

In its current condition all Made Ground should be assumed to have a CBR value of less than 2%, re-engineering and/or proof rolling may allow this figure to be increased.

9.2.5 Drainage

Due to the presence of contaminated soils and shallow groundwater, and the underlying Principal Aquifer it is considered that soakaway drainage will not be considered appropriate. Additionally, low permeability clay underlies much of the site, which would impede infiltration.

9.3 Contamination Risk Assessment

Widespread soil contamination that would represent a significant risk to human health with respect to a commercial end-use has not been identified. The most notable soil contamination was in the form of 1,2-dichlorobenzene, but concentrations did not exceed the generic assessment criteria (GAC) for a commercial land use. Asbestos fibres were only detected at one location (WS103).

Elevated concentrations of contaminants have been identified in shallow groundwater. This is most notably in the form of 1,2-dichlorobenzene and other organic contaminants beneath the area of the site formerly occupied by the main process areas and tank farms. Other identified groundwater contamination includes cyanide in two isolated locations.

9.3.1 Detailed Quantitative Risk Assessment (DQRA)

Given the presence of the Chester Formation, which is considered a Principal Aquifer, at shallow depths beneath the site, and the presence of the culverted Knowsley Brook, it is considered that the identified soil



and groundwater contamination potentially presents a risk to controlled waters. It is therefore recommended that a detailed quantitative risk assessment (DQRA) is undertaken to identify any potentially significant risks and provide target concentrations for any remediation works (if required).

The DQRA could form part of the remediation and validation strategy for the site (see 9.3.3), which is a likely requirement of the Local Authority to support any planning application.

9.3.2 Mitigation

Significant mitigation measures are not required to protect human health based on the findings of the investigation and the proposed development. However, a cover of clean soil is likely to be required in any areas of soft landscaping to manage any residual risks (such as the low incidence of asbestos fibres in the Made Ground) and to provide a suitable growing medium.

The DQRA (described above) will determine if any mitigation measures are required to address the risks to the water environment. However, it is likely that the risks could be mitigated by identifying and excavating any soil sources for treatment or disposal, and the pumping out of contaminated groundwater from excavations.

9.3.3 Remediation Strategy and Validation Plan

A Remediation Strategy and Validation Plan will almost certainly be required to support the planning application. This will detail the remediation measures required to address any significant risks (as identified by the DQRA) and a validation strategy to confirm all significant contamination sources have been addressed. This will likely include further soil sampling and analysis as described in Section 9.1, and possibly a programme of groundwater monitoring.

9.3.4 Gas Protection

Based on the currently available information, a Characteristic Situation 2 classification should be assumed for the site, which requires basic gas protection measures in the proposed building. Further post remediation / earthworks monitoring may allow a re-assessment, and may be a requirement of the Local Authority if significant ground disturbance is proposed.



9.3.5 Water Pipelines

Concentrations of mineral oils (petroleum hydrocarbons), BTEX compounds, and VOCs in the Made Ground locally exceed the UKWIR thresholds for PE water pipes; upgraded water pipes are likely to be required for the future development, at least in some parts of the site. The appropriate material for water supply pipes should be discussed with the service provider at the earliest opportunity.

9.3.6 Previously Unidentified Contamination

Should any previously unidentified evidence of significant contamination (odours, staining, suspicious materials, potential ACMs) be encountered during earthworks or construction, the works should be paused and a geo-environmental specialist consulted to determine the most appropriate course of action.

9.3.7 Construction Workers

Given the unique exposure scenario for any construction, investigation or maintenance worker involved in groundworks or excavations, the risks are considered separately from those to other receptors which are described above.

There is always a risk of exposure to contamination for those involved in ground disturbance, particularly in Made Ground and near surface soils where materials such as asbestos can be present. Measures should be taken to minimise exposure of such workers to these risks, in accordance with common good practice and informed by the findings of this ground investigation



10.0 References

1. BS 5930: (2015): Code of Practice for Site Investigation. British Standards Institution
2. BS 10175: (2011): Code of Practice for the Investigation of Potentially Contaminated Sites. British Standards Institution
3. LCRM (2020): Land Contamination Risk Management. Environment Agency
4. BS EN 1997-2: (2007): Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing
5. BS EN ISO 14688-1: (2002): Geotechnical Investigation and testing – Identification and Classification of Soil – Part 1: Identification and Description.
6. BS EN ISO 14688-2: (2004): Geotechnical Investigation and testing – Identification and Classification of Soil – Part 2: Principles for a Classification
7. BS EN ISO 14689-1: (2003): Geotechnical Investigations and testing – Identification and Classification of Rock – Part 1: Identification and description.
8. BS EN ISO 22476-3: (2005): Geotechnical Investigation and Testing – Field Testing – Part 3: Standard Penetration Test.
9. BS 10175: (2011): Code of Practice for the Investigation of Potentially Contaminated Sites. British Standards Institution
10. BS 8485:2015+A1:2019: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. British Standards Institution
11. CIRIA C665 (2007): Assessing the risks posed by hazardous ground gases to buildings
12. RB17 (2012): A Pragmatic Approach to Ground Gas Risk Assessment. CL:AIRE
13. FB75: Building on fill: geotechnical aspects, 2015, BRE

Contract Chemicals, Knowsley
Site Investigation Interpretative Report



14. BRE Special Digest 1:2005; Concrete in aggressive ground.
15. BRE (2004): Cover Systems for Land Regeneration
16. BRE (2007): Digest 365: Soakaway Design.



APPENDICES



Appendix A – Previous Exploratory Hole Logs

HOLST & CO. LTD.

SITE INVESTIGATION DEPT.

5-7, NEW YORK ROAD

LEEDS, 2

42870, 96762.

SJ49NW-132

Contract No. M.1691/F.1217

Borehole No. 3

Location Knowsley

Ground Level

Client Liverpool City Engineer

Date 23rd April 1969

BOREHOLE LOG

STRATA	Legend	Depth below Ground Level	Thickness of Strata	Type of Sample	c lb/sq. ft.	φ deg.	m.c %	γ lb/cu. ft.	" N "
Topsoil		1'0"	1'0"						
Firm/Stiff Red Boulder Clay			8'0"	3'0" [	1440	0	16.1	132	
		9'0"		9'0" [	2740	17	13.3	138	
Stiff Red Marl with bands of red shaley fine sandstone			8'0"	14'0" [	2800	10	12.6	143	
		17'0"		17'3" I					50 for 3"
Red Sandstone		20'0"	3'0"						

Water Struck at 9'0"

Maximum Observed Water Level 6'0"

Undisturbed Sample []
Disturbed Sample o
Water Sample Δ
Penetration Test I

c = Cohesion
φ = Angle of Internal Friction
m.c = Moisture Content
γ = Bulk Density
N = Standard Penetration Value

Water levels are subject to seasonal or tidal variation and should not be taken as constant

HOLST & CO. LTD.

SITE INVESTIGATION DEPT. 43022, 96770

5-7, NEW YORK ROAD SJ49NW-133

LEEDS, 2

Contract No. M.1691/F.1217

Borehole No. 4

Location Knowsley

Ground Level

Client Liverpool City Engineer

Date 23rd April 1969

BOREHOLE LOG

STRATA	Legend	Depth below Ground Level	Thickness of Strata	Type of Sample	c lb/sq. ft.	ϕ deg.	m.c %	γ lb/cu. ft.	N
Topsoil		1'0"	1'0"						
Red Sand and Gravel		2'6"	1'6"						
Hard Brown Boulder Clay			7'6"						
		10'0"		8'0" □	3400	0	12.2	142	
Weathered red shaley fine sandstone with bands of red marl		17'0"	7'0"	14'0" I					50 for 8"
Red Sandstone		20'0"	3'0"	18'6" I					50 for 6"

Water Struck at 9'0"

Maximum Observed Water Level

3'6"

Undisturbed Sample □
Disturbed Sample o
Water Sample Δ
Penetration Test I

c = Cohesion
 ϕ = Angle of Internal Friction
m.c = Moisture Content
 γ = Bulk Density
N = Standard Penetration Value

Water levels are subject to seasonal or tidal variation and should not be taken as constant

HOLST & CO. LTD. 42875, 96645

SITE INVESTIGATION DEPT.
5-7, NEW YORK ROAD SJ49NW-141
LEEDS, 2

Contract No. M.1691/F.1217

Borehole No. 11

Location Knowsley

Ground Level

Client Liverpool City Engineer

Date 25th April 1969

BOREHOLE LOG

STRATA	Legend	Depth below Ground Level	Thickness of Strata	Type of Sample	c lb/sq. ft.	ϕ deg.	m.c %	γ lb/cu. ft.	N
Topsoil		1'0"	1'0"						
Sand and Gravel		2'6"	1'6"						
Compact red coarse silt (weathered marl)		5'6"	3'0"	4'0" [	1220	9	20.9	125	
Fine red shaley sandstone with yellow bands			12'6"						
		18'0"							

Water Struck at 5'6"

Maximum Observed Water Level 4'0"

Undisturbed Sample ☐
Disturbed Sample ☐
Water Sample Δ
Penetration Test I

c = Cohesion
 ϕ = Angle of Internal Friction
m.c = Moisture Content
 γ = Bulk Density
N = Standard Penetration Value

Water levels are subject to seasonal or tidal variation and should not be taken as constant