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HOUSES OF PARLIAMENT
R&R DELIVERY AUTHORITY

GROUND INVESTIGATION REPORT- INTERIM FACTUAL

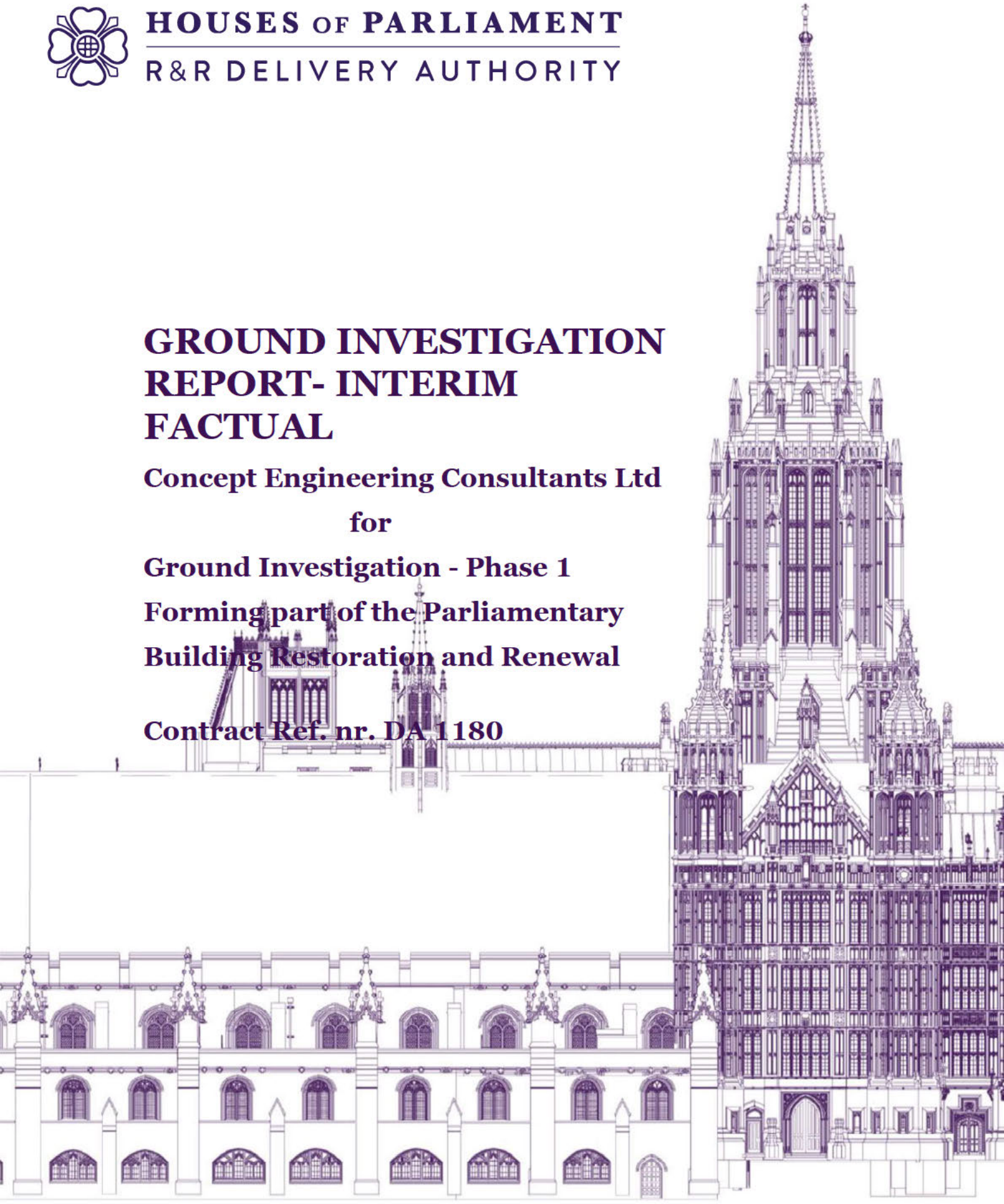
Concept Engineering Consultants Ltd

for

Ground Investigation - Phase 1

Forming part of the Parliamentary Building Restoration and Renewal

Contract Ref. nr. DA 1180



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HOUSES OF PARLIAMENT
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P01	Interim	13/02/2023
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P03	Interim	02/11/2023

CONTENTS

1. INTRODUCTION

The site was The Palace of Westminster. The works were carried out in accordance with the RIBA Stage 2 Surveys – CIV002 - Ground Investigation Phase 1 Specification document, with reference 00POW-4107-BDP-XX-XX-Y-XX-SW-00088 dated 22/07/2022 P11 and Concept's Method Statement with reference: 223715-PoW General RAMS 00 RAG2 dated 30/09/2022 P03.

The report has been prepared in accordance with the current Eurocode Standards, including the relevant National Annexes:

- BS EN 1997-1:2004+A1:2013 and National Annex NA to BS EN 1997-1:2004
- BS EN 1997-2:2007 and National Annex NA to BS EN 1997-2:2007

2. LIMITATIONS

This report contains factual information only and forms part of the Ground Investigation Report for the project as determined in BS EN 1997-2: 2007. Desktop studies, evaluation of geotechnical information and any interpretation of the data obtained other than the extrapolation of the test results where appropriate is beyond the scope of this report.

The data presented in this report reflects the ground conditions encountered at the locations of the investigation points at the time of the investigation. Ground conditions may vary away from the investigation locations and it is possible that ground conditions other than those indicated in this report may exist at the site. Test results of parameters sensitive to seasonal variations such as groundwater may also differ if carried out at a different time.

This report has been prepared for Restoration & Renewal Delivery Authority Ltd and is based on their specific requirements and instructions and reasonable skill and care have been exercised in its preparation in accordance with the technical requirements of the brief. Any other party using the information in this report for any other purpose does so at their own risk and any duty of care to that party is excluded unless as determined in the contract documents of this project.

3. PROJECT PARTICULARS

Site Location:	Palace of Westminster Restoration and Renewal Ground Investigation Phase 1
Client:	Restoration & Renewal Delivery Authority Ltd
Investigation Supervisor:	Geotechnical Consulting Group

Fieldwork:	The fieldwork was carried out in discrete periods to align with access and consents as follows: 02/08/2022 – 02/09/2022; 26/09/2022 – 07/10/2022; 10/02/2023 – 06/03/2023; 24/03/2023 – 17/04/2023; 21/07/2023 – 31/08/2023
Laboratory Work:	16/08/2022 – *Ongoing*

4. SITE DESCRIPTION

The Palace of Westminster Site was bound by Bridge Street, Parliament Square, Abingdon Street, Victoria Tower Gardens and the River Thames. The approximate OS grid reference for the centre of the site is 530270 E 179490 N.

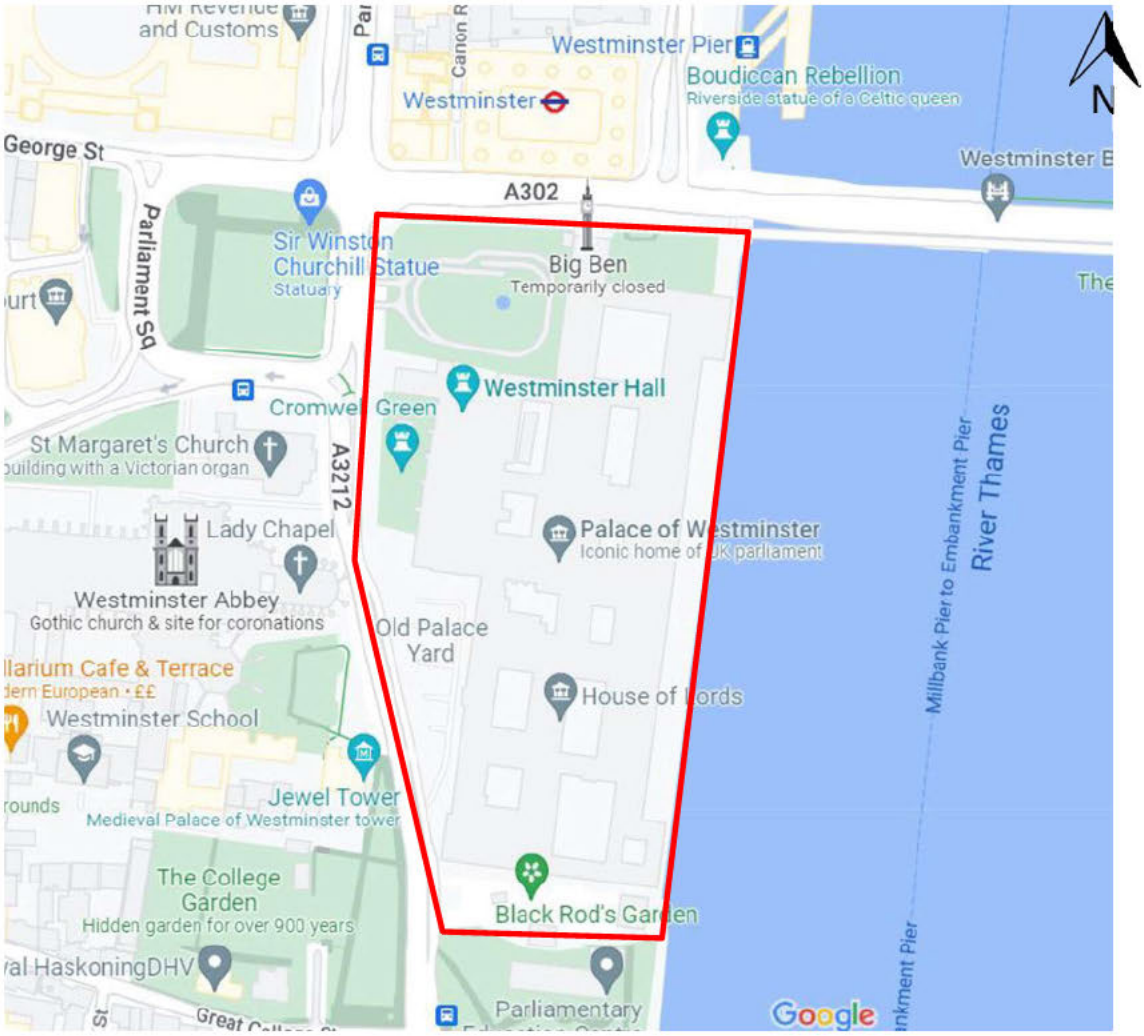

Figure 1.1 Site Location Plan Not to Scale / Map data ©2022 Google

5. PURPOSE AND SCOPE OF WORKS

The purpose of the investigation was to understand the ground and groundwater conditions at the site and to determine the nature and extent of any ground and groundwater contamination and establish geotechnical parameters for use in design.

The main works involved in the restoration and refurbishment of the Palace of Westminster. These included the provision of new basements and tunnels and the reconfiguration of existing basements.

The scope of the works comprised the following:

- 14 No. Cable Percussion Boreholes to a maximum depth of 45.00m;
- 6 No. Cable Percussion follow on Rotary Boreholes to a maximum depth of 80.50m;
- Permeability Testing;
- Pressuremeter Testing;
- Logging and Photographing;
- Instrumentation Monitoring and Sampling;
- Geotechnical & Chemical Testing.

Table 1 – Exploratory Hole List

Hole ID	Hole Type	Depth (m)	Easting	Northing	Level (mATD)	Level (mOD)
[redacted]						

Hole ID	Hole Type	Depth (m)	Easting	Northing	Level (mATD)	Level (mOD)
[redacted]						

**approximate level to be accurately measured in the next visit*

Key

CP – Cable Percussion Borehole
CP/RC – Cable Percussion follow on Rotary Borehole
OH – Open Hole
IP – Inspection Pit/ Aborted Location

6. INVESTIGATION METHODS

6.1 Geoarchaeological Watching Brief

MOLA has undertaken a geoarchaeological watching brief on Ground Investigation Surveys at the site of the Palace of Westminster, relating to The Houses of Parliament Restoration and Renewal Programme.

[redacted]

6.2 Utilities Survey and Inspection Pits

The detection of underground services followed the guidelines of PAS 128:2014. Prior to boring commencing all exploratory hole locations were checked for utilities / buried services using a CAT and genny, existing utility information and hand dug inspection pits to an appropriate depth as identified by the services plans to a maximum depth of 1.50m.

6.3 Unexploded Ordnance Clearance

UXO survey clearance was undertaken at all borehole locations at 1.50m intervals during drilling by a specialist contractor to a maximum depth of 12.00m.

6.4 Cable Percussion Drilling

[redacted]

6.4.1 Sampling and Testing during Cable Percussion Drilling

Bulk and occasionally large bulk samples were taken at regular intervals in the Made Ground and thereafter at each change in strata. Undisturbed Thin Walled samples (UT) and Undisturbed 102mm (U100) nominal diameter samples were taken in accordance with EC7 using a down-hole sliding hammer in cohesive material at regular intervals or as instructed by the Investigation Supervisor. UT/U samples were not retrieved from OPY11, RC17 and SG05.

Standard Penetration Tests (SPT) were carried out at specified intervals or as otherwise instructed by the Investigation Supervisor. The resulting SPT "N" blowcount values are presented in the relevant borehole records. Where an SPT using a split spoon sampler was not possible, due to the granular nature of the material, a solid cone was used. The SPT hammer calibration sheets are included in Section 11 of this report.

Small, disturbed samples were retrieved from the cutting shoe of the UT/U100 sampler, the SPT split spoon sampler and at intervals specified by the Investigation Supervisor.

Environmental samples (tubs, jars and vials) were taken for chemical analysis in the Made Ground or at each change of strata and where visual or olfactory evidence of contamination was noted or as instructed by the Investigation Supervisor. Following the guidance in the ICE Specification for Ground Investigation 3rd Edition - Headspace readings for volatile organic compounds (VOC) content were taken in all of the samples using a Phocheck Tiger photoionization detector (PID) with a 10.6 eV Krypton PID lamp. In accordance with the manufacturers guidelines, the PID was tested with a source of vapours at the start of each shift to ensure that it was not blocked and that the instrument calibration was within acceptable limits.

The borehole logs are presented in Section 11 of this report.

6.5 Rotary Drilling Follow On from Cable Percussion

[redacted]

6.5.1 Sampling and Testing during Cable Percussion and Rotary Drilling

Sampling and testing during cable percussion drilling was carried out as described in Section 6.4.1

During rotary drilling near-continuous samples were recovered in core runs nominally 1.50m long within semi-rigid plastic liners, sealed at each end after recovery and stored in wooden core boxes. Where required, core run lengths were reduced in an attempt to improve core recovery.

The liners were split and the material was geologically logged in accordance with BS5930:2015+A1:2020 and photographed. Selected sub-samples of core were taken at various intervals where possible. Alternatively small disturbed and bulk samples were retrieved. The sub-samples were wrapped in layers of wax and polythene awaiting testing. The remaining sub-cores in the liners were sealed and stored in core boxes.

Water samples were collected from the flush of boreholes [redacted]

Grout samples were also taken from [redacted] during installation to test for permeability and shear vane.

The rotary borehole logs are presented in Section 11 in combination with the cable percussion borehole logs and the core photographs in Section 17.

6.6 Permeability Tests

6 No. Falling Head Tests were carried out in the boreholes during drilling in accordance with BS 5930:2015+A1:2020 as follows:

Table 2 – Permeability Testing Schedule

Hole ID	Base of Borehole (m bgl)	Response Zone		Type of Test
		Top (m bgl)	Bottom (m bgl)	
[redacted]	30.00	4.20	4.50	Falling Head
[redacted]	30.00	7.80	8.30	Falling Head
[redacted]	30.00	7.50	8.00	Falling Head

Hole ID	Base of Borehole (m bgl)	Response Zone		Type of Test
		Top (m bgl)	Bottom (m bgl)	
	44.00	8.20	8.70	Falling Head
	45.00	7.90	8.30	Falling Head
	42.60	8.50	8.50	Falling Head

The results of the tests are presented in Section 12 of this report.

6.7 Self-Boring Pressuremeter Testing

Self-Boring Pressuremeter tests were carried out in the by the specialist Cambridge In-situ Ltd. A preliminary pressuremeter testing report for s presented in Section 13.

6.8 Standpipe Installations and Backfill

Monitoring wells were installed in the boreholes as follows:

Table 3 – Monitoring Installation Details

Hole ID	Base of Borehole (m bgl)	Diameter of Installation (mm)	Type of Installation	Base of Installation (m bgl)	Response Zone	
					Top (m bgl)	Bottom (m bgl)
	30.00	-	VWP	7.50	-	-
		-	VWP	17.50	-	-
		-	VWP	27.50	-	-
	29.50	-	VWP	17.50	-	-
		-	VWP	27.50	-	-
		50	GWMP	8.50	5.50	8.50
		24	GWMP	65.00	62.00	65.00
	9.50	50	GWMP	9.00	6.00	9.50
	44.00	50	GWMP	9.50	6.50	9.50

Hole ID	Base of Borehole (m bgl)	Diameter of Installation (mm)	Type of Installation	Base of Installation (m bgl)	Response Zone	
					Top (m bgl)	Bottom (m bgl)
		24	GWMP	44.00	42.00	44.00
	80.50	24	GWMP	79.50	76.50	79.50
		-	VWP	20.00	VWP	20.00
		-	VWP	30.00	VWP	30.00
		-	VWP	40.00	VWP	40.00
		-	VWP	50.00	VWP	50.00
	30.00	50	GWMP	8.00	3.80	8.00
		19	SPIE	25.00	24.00	25.00
	30.50	50	GWMP	8.00	4.00	8.00
		19	SPIE	30.00	29.00	30.50
	30.00	50	GMP	11.00	7.50	11.50
		24	GWMP	27.00	23.50	27.50
	30.00	50	GMP	6.50	5.50	6.50
		50	GWMP	22.50	21.50	22.50
	44.00	50	GMP	10.50	7.50	10.50
		24	GWMP	22.00	20.50	22.00
	30.00	50	GWMP	8.00	3.80	8.00
		19	SPIE	25.00	24.00	25.00
	30.50	50	GWMP	8.00	4.00	8.00
		19	SPIE	30.00	29.00	30.50
	44.00	50	GMP	10.50	7.50	10.50
		24	GWMP	22.00	20.50	22.00
	79.00	24	GWMP	8.60	5.60	9.00
		-	VWP	20.00	VWP	20.00
		-	VWP	30.00	VWP	30.00
		-	VWP	40.00	VWP	40.00
		-	VWP	50.00	VWP	50.00
	45.00	50	GMP	9.80	6.80	9.80

Hole ID	Base of Borehole (m bgl)	Diameter of Installation (mm)	Type of Installation	Base of Installation (m bgl)	Response Zone	
					Top (m bgl)	Bottom (m bgl)
		50	GWMP	27.00	24.00	27.00
	63.50	-	VWP	20.00	-	-
		-	VWP	30.00	-	-
		-	VWP	40.00	-	-
		-	VWP	50.00	-	-
	42.60	50	GMP	10.50	7.50	10.50
		19	GWMP	42.30	39.60	42.60
	53.20	50	GMP	10.00	7.50	10.00
		-	VWP	20.00	VWP	20.00
		-	VWP	30.00	VWP	30.00
		-	VWP	40.00	VWP	40.00
		-	VWP	50.00	VWP	50.00
		-	VWP	50.00	VWP	50.00

KEY

GMP – Gas and groundwater Standpipe
GWMP – Groundwater Standpipe
VWP – Vibrating Wire Piezometer
SPIE – Standpipe Piezometer

The boreholes were backfilled at the base with cement / bentonite grout with the gas/groundwater response zones backfilled with a 10mm pea shingle filter with a geosock surround and bentonite seal above and below the response zones. Where standpipe piezometers were installed, the boreholes were backfilled with a pea shingle around the piezometer tip with a bentonite seal above, and where vibrating wires were installed, the boreholes were backfilled with cement / bentonite grout mix. All installations were finished with concrete and a lockable cover flush with the ground.

The boreholes with no installations were backfilled with bentonite.

On completion of works the ground surface at all fieldwork locations was permanently re-instated to its original condition as appropriate.

All waste was handled in accordance to the waste management plan of the project.

6.9 Instrumentation Monitoring and Sampling

Groundwater monitoring was carried out by Concept during fieldworks on 4 No scheduled visits between the 25/08/2022 and 01/09/2023. Gas monitoring was carried out on 06/10/2022 and 01/09/2023.

Groundwater monitoring was also carried out in historic boreholes [redacted] No scheduled visits on 10/11/2022 and 30/08/2023. Due to inaccessibility groundwater monitoring was not carried out on historic borehole [redacted]

All boreholes were developed at least one week prior to sampling using a Wasp pump which provides a relatively high pumping rate to remove water and entrained sediment. Development continued until either the well ran dry, the water ran clear or at least 10 well volumes were removed.

Water samples were taken from [redacted] The samples were retrieved using a peristaltic pump at a low pumping rate. The pump tubing was lowered to target the standpipe response zone and a dipmeter was used during purging to ensure that the pumping rate did not reduce the water level. Generally, the water level remained steady at pumping rates of 1 litre every 3 minutes. Water parameters (pH, conductivity, dissolved oxygen, temperature and Redox levels) were recorded during purging using a flow cell and a YSI Professional Probe. Purging was considered complete when parameters stabilised to within 10%. Generally the water was noted as clear and the purging complete after 3 litres were removed. On completion of purging, the water samples were collected in containers (3x300ml and 3xvial). They were then transferred to Concept laboratory inside cool boxes protected by bubble wrap and kept in the fridge until collection from the chemical laboratory was arranged. Each borehole was purged and sampled using a new length of tubing. The water quality field records are presented in Section 14.

An In-Situ Rugged interface probe was used to prove/disprove the presence LNAPL and DNAPL. However neither LNAPL nor DNAPL were detected throughout the water column in the boreholes therefore a Geosense dipmeter was used for the subsequent visits. The gas concentrations were recorded using two Gas data GFM436 monitors. Where 0.00 is shown on the results indicates value lower than the detection limit of the machine. PID readings were taken during all monitoring rounds. The accuracy of the instruments is summarised in Section 14 where the gas monitoring reports and groundwater results are presented along with the instruments calibration sheets.

The vibrating wires were monitored using a Geosense G200 Vibrating Wire Readout unit and the results are presented in the same section.

6.10 Logging / Laboratory Testing

Logging of all soil samples was carried out in accordance with BS5930:2015+A1:2020.

Geotechnical testing was performed at Concept Site Investigations laboratory in accordance with BS1377:1990 unless otherwise stated in the report. Concept is accredited by UKAS for tests where the UKAS logo is appended to the individual test report or summary. Approved signatories for laboratory testing are as follows:

- [redacted] (Quality Manager)
- [redacted] (Laboratory Manager)

Where subcontracted analysis has been carried out, the details of the laboratory (and accreditation where applicable) are shown in the individual test report or summary.

The results are presented in tabular format in Section 15 of this report.

All chemical testing was carried out by Eurofins in accordance with the requirements of UKAS ISO17025 and MCERTS. The results are presented in tabular format in Section 16 of this report.

6.11 Setting Out

The locations of all exploratory holes were agreed with the Investigation Supervisor and set out prior to commencement of the site works.

The completed boreholes were surveyed on 05/10/2023 and the locations and elevations of the boreholes recorded.

The locations of the boreholes are shown on the Exploratory Hole Location Plan presented in Section 10 of this report.

7. RISK REGISTER

This entire report forms part of the Health and Safety File of the project. The table below highlights particular risks only and is not inclusive of every risk that is encountered on site. The various sections of this report describe the site and ground conditions encountered during the investigation works whilst laboratory testing determines the level of contamination encountered during the works.

Underground services where encountered were identified on the exploratory hole logs and where necessary, the holes were repositioned locally to avoid identified services. The presentation of services information is beyond the scope of this report.

Table 4 – Risk Register

HAZARD	DESCRIPTION	MITIGATION
Monitoring installations	Monitoring installations were constructed at several locations as detailed in Section 6.8 of this report.	Decommissioning of the installations which will involve either filling the pipe with cement-bentonite grout where possible or by drilling out the pipework and then backfilling using cement- bentonite grout.
UXO	UXO surveys were carried out at certain locations only as detailed in the report.	No UXO was encountered at any of the exploratory hole locations. No further mitigation required at these locations but may still be necessary at nearby locations.
Asbestos	No visible asbestos fibres were encountered. Asbestos may be present at other locations but may have not been detected.	Awareness required during execution of shallow excavation works at these locations.
Contamination	Potentially contaminated ground was encountered at several locations during the investigation	Contamination testing results are detailed in Section 16 of this report.

HAZARD	DESCRIPTION	MITIGATION
	as detailed in the logs.	

8. GEOLOGICAL GROUND PROFILE

The geological strata encountered during the investigation are summarised in the table below. The Top and Bottom of the strata noted in the table indicates the highest and lowest boundaries encountered in all exploratory holes.

Table 5 - Geological Ground Profile

STRATUM	TOP (mATD)	BASE (mATD)	DESCRIPTION
TOPSOIL	101.91	101.76	Dark grey and dark brown slightly gravelly sandy silty CLAY with occasional rootlets. Gravel is angular fine flint.
MADE GROUND	104.76 to 86.40	104.36 to 86.30	Concrete, Asphalt, Paving slab over, Brown very sandy GRAVEL and COBBLES. Gravel comprises subangular to subrounded fine to coarse fine to coarse flint, brick, concrete, coal, clinker, mortar and asphalt fragments. Cobbles are brick and concrete fragments. Dark brown gravelly very clayey fine to coarse SAND with medium chalk cobble content, frequent pockets of brown slightly gravelly slightly sandy clay and rare white shell fragments. Firm, dark grey slightly gravelly silty CLAY with low organic matter, occasional pockets of peat and orangish brown silty fine sand, semi decayed roots and rootlets and dark grey discoloration.
ALLUVIUM	100.56 to 98.71	100.26 to 96.16	Loose, light brown silty fine to medium SAND. Firm, dark grey locally mottled bluish grey slightly gravelly silty CLAY with occasional rare pockets of brown and grey fine to medium sand, pockets of dark brown peat, dark grey organic content, occasional shell fragments, decayed rootlets and moderate hydrocarbon odour. Gravel is angular fine to medium flint.
RIVER TERRACE DEPOSITS	100.26 to 94.11	98.91 to 93.41	Loose, dark brown, grey and white sandy GRAVEL with occasional white shell fragments, rare dark grey shell fragments and bone fragments. Gravel is subangular to subrounded fine to coarse flint. Medium dense, yellowish brown slightly gravelly slightly clayey fine to medium SAND with occasional pockets of grey slightly sandy clay

STRATUM	TOP (mATD)	BASE (mATD)	DESCRIPTION
WEATHERED LONDON CLAY FORMATION	95.16 to 86.30	94.12 to 86.05	Stiff, brown mottled brownish grey and light bluish grey slightly gravelly slightly micaceous silty CLAY with occasional pockets of orangish brown fine to medium sand, extremely weak to weak grey claystone fragments and rare pyrite nodules. Gravel is angular to rounded fine to coarse flint.
LONDON CLAY FORMATION	94.86 to 67.03	85.85 to 59.45	Stiff, very closely to closely fissured dark grey slightly sandy slightly micaceous silty CLAY with occasional pyrite nodules, lenses of fine sand, rare shell fragments and white flecks. Fissures are subvertical to subhorizontal, smooth and rough, polished.
HARWICH FORMATION	61.80 to 60.52	61.72 to 60.32	Medium strong, dark grey shelly CLAYSTONE. Very stiff, greyish brown slightly gravelly sandy silty CLAY with very closely to closely spaced partings of light brown fine sand, pockets of light brown fine sand, occasional pockets of glauconitic fine sand, frequent shell fragments and white flecks. Gravel is subangular to rounded fine to coarse dark grey flint.
LAMBETH GROUP	61.99 to 42.97	60.73 to 42.28	Strong, green locally mottled yellowish brown AGGLOMERATE recovered as: medium to coarse reddish brown and dark grey flint gravel and cream shell fragments and fine to medium glauconitic sand. Dense, bluish grey mottled reddish brown slightly gravelly clayey SAND. Gravel is subrounded fine to medium flint. Stiff to very stiff, green mottled yellowish brown and reddish brown slightly gravelly sandy silty CLAY. Gravel comprises subangular to subrounded fine to coarse off-white, red, black and brown flint.
THANET FORMATION	45.12 to 36.97	40.62 to 33.68	Grey slightly clayey fine SAND with occasional shell fragments and dark grey staining.
SEAFORD CHALK FORMATION	33.97 to 25.78	Extent not proven	Off-white CHALK recovered as: off-white GRAVEL and COBBLES. Gravel and cobbles comprise angular fine to coarse flint and weak, medium density off-white chalk fragments. Moderately weak, high density white CHALK with occasional light grey staining and rare flint (<60mm). Fractures closely to medium spaced, horizontal, open, planar, rough, clean.

9. REFERENCES

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10. EXPLORATORY HOLE LOCATION PLAN