Hampshire Water Transfer and Water Recycling Project

6.2 Environmental Statement Vol II Appendix 11.2 Geotechnical and geo-environmental reports - 10 of 18 documents - Geotechnical and Geo-environmental Interpretative Report for Ground Investigation in Section M (Phase 2 and Phase 3B/3C) Addendum to Summary Report

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1 Introduction and Objectives

1.1 Background and Scheme Overview

Water for Life Hampshire (WfLH) is a programme being undertaken by Southern Water Services Limited (hereafter referred to as 'the Applicant') to address the sustainability objectives of reduced abstractions on Hampshire's two main rivers, the River Test and River Itchen and ensuring a resilient water supply for the Applicant's customers during times of drought. The Hampshire Water Transfer and Water Recycling Project (HWTWRP) (hereafter referred to as the 'Proposed Development') is the Strategic Resource Option project being delivered as part of the WfLH programme (Southern Water, 2024). An overview of the Proposed Development, at the time of this report production, is provided in the Applicant's HWTWRP Technical Document Technology Guide (Southern Water, 2024).

1.2 Terms of Reference

Strategic Solutions Partner (SSP) has been instructed by the Applicant as part of the Proposed Development, to produce a Geotechnical and Geo-environmental Interpretative Report for ground investigations (GI) completed for the construction of the proposed underground pipeline within the Draft order Limits (DoL). The Proposed Development has been divided into 12 Sections by the Applicant, these are referred to as Sections A to M (excluding I).

1.3 Ground Investigation Programme

The GI for the Proposed Development is being completed utilising a phased approach as shown in **Table 1.1~~Table 1.1~~**. This document reports the findings of the GI works completed during Phase 2 and Phase 3B/3C within Section M only.

Table 1.1: Ground investigation programme

GI Phase	Description
Phase 0	This, with Phases 1 and 3A, was completed between July 2022 and October 2023 by SOCOTEC for Clancy (Principal Contractor) and as specified by SSP (AECOM) primarily for the purpose of tunnel and shaft design (Sections B, C, D and M only) and comprised 11 boreholes.
Phase 1	This, with Phases 0 and 3A, was completed between July 2022 and October 2023 by SOCOTEC for Clancy (Principal Contractor) and as specified by SSP (AECOM) primarily for the purpose of tunnel and shaft design (Sections B, C, D, L and M only) and comprised 35 exploratory hole locations.
Phase 2	This is part of a wider phased GI conducted along the route between February 2023 and July 2023 by SOCOTEC for Clancy (Principal Contractor) and as specified by SSP primarily for the purpose of investigating areas for non-pipeline infrastructure, trenchless crossings and potential sources of contamination (PSC).
Phase 3A	This, with Phases 0 and 1, was completed between July 2022 and October 2023 by SOCOTEC for Clancy (Principal Contractor) and as specified by SSP (AECOM) primarily for the purpose of tunnel and shaft design (Sections B, C, D, L and M only) and comprised 14 exploratory hole locations.
Phase 3B/3C	This, with several Phase 2 GI locations was completed between May 2023 and May 2024 by SOCOTEC for Clancy (Principal Contractor) and as specified by SSP primarily for the purpose of investigating areas for non-pipeline infrastructure, trenchless crossings, PSCs and the linear route.

1.4 Phase 2 and Phase 3B/3C Section M Ground Investigation Objectives

The Phase 2 and Phase 3B/3C works in Section M investigated the following:

- Two locations associated with proposed launch/reception locations at the proposed trenchless crossing beneath an unnamed tributary of the River Itchen in the northern part of Section M (2M6507SA and 2M6508SA).
- Two locations associated with the linear route to prove the geology (3M6517HP and 3M6601HP).

Seven exploratory hole locations from the Phase 3A GI (BH505, BH506, BH507, BH507A, BH507B, BH507C and BH507D) were completed within Section M as part of the proposed shaft and tunnels GI, for the Otterbourne Tunnel. Borehole BH507 was completed within the former historical landfill (Bugle Farm Landfill, PSC 209) and potentially infilled land. The ground conditions and geoenvironmental testing are included in the Geo-environmental Interpretative Report for Ground Investigation at Proposed Tunnels and Shafts (Phase 1 and Phase 3A) (SSP, 2025) and are therefore not assessed herein from a geo-environmental perspective. The scope and objectives of the Phase 3A GI was to investigate proposed shaft and tunnel locations and did not determine the nature and extent of PSCs. Phase 3A exploratory hole logs have not been included or interpreted as it is outside the scope of this report. Phase 3A exploratory hole logs are presented in the Phase 3A Factual GI Report (SOCOTEC, 2024b).

Within the southern part of Section M, south of the River Itchen, several proposed investigation locations were not completed during Phase 2 and Phase 3B/3C GI due to land access issues. These included GI locations within areas of PSCs assessed to have a risk rating of Moderate/Low or higher as identified within HWTWRP Geotechnical and Geo-Environmental Desk Study Version 4 (SSP, 2024). A historical landfill (Bugle Farm Landfill, PSC 209), potentially infilled ponds and channels (PSC 206, 210, 215 and 216) and infilled land (worked ground and made ground) as recorded by the British Geological Survey (BGS) (PSC 437, 438) were present in this area.

Other PSCs identified within a 50m radius of the DoL in Section M were not investigated during Phase 2 and Phase 3B/3C. The proposed GI location at filter beds (PSC 220) was removed due to ground works at the time of the GI making the area inaccessible. Previous GIs have been completed at the Otterbourne Water Supply Works (WSW) (PSC 208). No GI was undertaken during Phase 2 and Phase 3B/3C at the request of the Applicant due to the risk of increased turbidity in groundwater from the drilling works.

1.5 Report Format

This report comprises both geotechnical and geo-environmental interpretation of data collated during the GI as outlined below:

Section 1 Introduction and report objectives.

Section 2 Description including the location and Site description.

Section 3 Summary of the GI's (SOCOTEC, 2024), (SOCOTEC, 2023), and (SOCOTEC, 2024a).

Section 4 Ground Model.

Section 5 GI results, data interpretation and geo-environmental risk assessment, and geo-environmental considerations for the outline proposed works.

Section 6 Development of the land contamination risk assessment model from the GI.

Section 7 Geotechnical Testing and Assessment including geotechnical summary tables and figures and design parameters.

Section 8 Geotechnical Considerations including hazard and mitigation table, discussions on ground conditions, foundation design, excavations, groundwater control, flotation, trenchless construction and concrete aggressivity.

Section 9 Conclusions.

Section 10 Recommendations based on the results of the GI.

This report provides a summary of encountered ground conditions, existing GI results, geotechnical and geo-environmental interpretation of analysis undertaken to inform design of potential future structures and pipeline, health and safety of construction and future ground workers (construction), and excavated materials (waste) management.

A land contamination risk assessment for other potential future receptors such as farmers/ farm workers or members of the public accessing and working within the Proposed Development is outside the scope of this report. Further ground investigation and human health risk assessment may be required to determine the risk to these, and any other identified potential future receptors, particularly in regard to appropriate excavated materials management (e.g. proposed reuse of soils).

Assessment of the GI data collected across the other Proposed Development Sections is included in the separate relevant sectional reports which are collated in one summary Geotechnical and Geo-environmental Interpretative report (Ref.710166-SWS-XX-XX-RP-GE-00100).

2 Section M Description

2.1 Location and Description

The Section M pipeline route is shown in the **Figures** section.

Section M extends from Highbridge Road (B3335) in the southeast under the River Itchen, railway line and then north towards Kiln Lane through predominantly arable fields, and beneath small watercourses terminating at Otterbourne WSW.

The majority of the approximate 2.2 km length of Section M ductile iron (DI) pipeline will be 1200 mm diameter.

The pipeline within Section M will be installed with a combination of open-cut and trenchless construction techniques.

Open-cut construction will be between 3 and 6 m below ground level (bgl) across arable fields and minor roads, while trenchless construction between 10.00 and 13.00m bgl under major roads and watercourses such as the River Itchen. Temporary launch and reception Shafts at the trenchless crossing locations will be excavated; launch shaft dimensions will range between 9.00 – 9.50 m diameter and reception Shafts will range between 5.00 – 5.40 m diameter.

Section M starts at an elevation of approximately 19 m Ordnance Datum (OD) at Highbridge Road (National Grid Reference (NGR) 446900E, 121623N) and ends on the southern side of Batsford Lane (446685E, 123242N) at an elevation of approximately 27 m OD, the maximum elevation along Section M.

3 Section M Ground Investigation

3.1 Rationale for Ground Investigation Locations

Four GI locations from Phase 1 (BH504, TP507, TP508 and TP509) investigation location in Section M were originally completed for a proposed shaft (up to 40.0m deep) for the construction of the Otterbourne Tunnel. These are located in a grass field to the south of Kiln Lane, west of the railway line.
The rationale for the Phase 2 and Phase 3B/3C GIs is presented in **Table 3.1~~Table 3.1~~.**

Table 3.1: Rationale for Locations in Section M

BH ID	Rationale for GI Location
BH504	These holes provide summary ground and groundwater conditions for which the geology and geotechnical results are incorporated into this report as additional information
TP507	
TP508	
TP509	
2M6507SA	These boreholes were required to confirm ground and groundwater conditions at proposed locations where a trenchless crossing beneath an unnamed watercourse between these two boreholes that would inform the launch and reception shaft design. Launch shaft is to be 10.0 m depth and the reception shaft 13.0 m deep.
2M6508SA	
3M6517HP	To confirm the geology along the linear route.
3M6601HP	

Deviations from scope
Within Section M, some locations were cancelled due to land access permissions, this affected (2M6500TP, 2M6502TP, 2M6504TP, 2M6501SA, 2M6503SA, 2M6505SA, 2M6506SA and 3M6519DS) which were locations originally supplied to the GI contractor to investigate PSCs prior to GI commencing (SSP, 2022) (SSP, 2023b) (SSP, 2023c).

3.2 Section M Ground Investigation

Phase 1 GI: A GI was carried out as part of Phase 1 at presented locations by SOCOTEC between 11th January 2023 and 15th February 2023.

Phase 2 GI: A GI was carried out for Phase 2 at selected locations across Section M of the proposed pipeline by SOCOTEC between 29th March 2023 and 5th April 2023.

Phase 3B/3C GI: A GI was carried out for Phase 3B/3C at selected locations across Section M of the proposed pipeline route by SOCOTEC on the 2nd May 2023 and 11th March 2024.

The GI scopes were specified in multiple Specifications by SSP (SSP, 2022) (SSP, 2023b) (SSP, 2023c) . The following exploratory holes were completed:

Phase 1:
- One borehole (BH504) by cable percussion and rotary core follow-on to 50.50 m bgl (Phase 1).
- Three machine excavated trial pits (TP507, TP508 and TP509) to 4.0 m bgl (Phase 1).

Phase 2:

- Two inspection pits (3M6517HP and 3M6601HP) hand dug to a depth of 1.20 m bgl (Phase 3B/3C).
- Two boreholes (2M6507SA and 2M6508SA) by cable percussion boring to a drilled depth of 20.0m and 20.45 m bgl respectively (Phase 2).

Phase 3B/3C:

- Two inspection pits (3M6517HP and 3M6601HP) hand dug to a depth of 1.20 m bgl (Phase 3B/3C).
- One borehole (BH504) by cable percussion and rotary core follow-on to 50.50 m bgl (Phase 1).
- Three machine excavated trial pits (TP507, TP508 and TP509) to 4.0 m bgl (Phase 1).

A plan showing the exploratory hole locations (including the four relevant Phase 1 exploratory holes) is presented in the **Figures** section. The scope of the GI also included: in-situ geotechnical tests, volatile headspace testing by photoionisation detector (PID), geotechnical and geo-environmental sampling and testing, falling head permeability testing and follow-up groundwater and gas monitoring.

The details of the GI, tests and laboratory analysis are presented in the SOCOTEC Ground Investigation Final Factual report (SOCOTEC, 2024), (SOCOTEC, 2023), and (SOCOTEC, 2024a). A description of GI locations is shown in **Table 3.2~~Table 3.2~~**.

Table 3.2: Description of GI Locations

GI Locations	National Grid Reference [1]	Location Description
BH504	446192, 122316	Located within a grass field to the south of Kiln Lane, west of the railway line. Investigations are approximately 1 km southeast of Otterbourne, Hampshire.
TP507	446168, 122320	
TP508	446183, 122323	
TP509	446176, 122310	
2M6507SA	446369, 123012	Located within a grass field to the north of Kiln Lane, on the southern side of an unnamed watercourse that flows eastwards into the River Itchen. The borehole is approximately 0.5 km east of Otterbourne, Hampshire.
2M6508SA	446510, 123140	Located within a grass field to the southwest of Batsford Lane, on the northern side of an unnamed watercourse that flows eastward into the River Itchen. The borehole is approximately 0.75 km northeast of Otterbourne, Hampshire.
3M6517HP	446315, 122612	Located within a grass field to the south of Kiln Lane. The hand pit is approximately 40 m east of Otterbourne, Hampshire.
3M6601HP	446329, 122866	Located within a grass field to the north of Kiln Lane. The hand pit is approximately 0.5 km east of Otterbourne, Hampshire.

[1] Provided in the Final factual GI reports (SOCOTEC, 2024), (SOCOTEC, 2023), and (SSP, 2025).

3.3 Exploratory Holes and Monitoring Well Installations

The exploratory hole locations and borehole logs for Phase 2 and Phase 3B/3C are presented in SOCOTEC Ground Investigation Reports (SOCOTEC, 2024), (SOCOTEC, 2023). Details of the Phase 1 exploratory hole logs are presented in the SOCOTEC Phase 1 Factual Report (SOCOTEC, 2024a) (SOCOTEC, 2024a).

Table 3.3~~Table 3.3~~ provides a summary of the locations and installation response zones. A 19mm standpipe piezometer was installed in 2M6507SA (1), whilst 50mm standpipes with gas taps were installed in 2M6507SA (2) and 2M6508SA (1). 50mm (1) and 38mm (2) standpipes were installed in BH504. A datalogger to record the depths to groundwater continuously was installed in monitoring well 2M6507SA (1) at 3.0m bgl on 20th June 2023 during the fourth groundwater monitoring event, and at the time of writing is still in operation. A plan showing the exploratory hole locations is presented in the **Figures** section.

Table 3.3: Summary of Groundwater and Ground Gas Monitoring

BH ID	Response Zones (m bgl)	Groundwater Monitoring Rounds	Gas Monitoring Rounds	Groundwater Samples Collected
BH504 (1)	12.0 – 17.60 (London Clay Formation)	13 No. 9 March 2023 to 10 November 2023	-	-
BH504 (2)	0.90 – 3.00 (River Terrace Deposits & London Clay Formation)	3 No. 9 March 2023 to 14 April 2023	9 No. 30 March 2023 to 5 October 2023	-
2M6507SA (1)	9.7-10.0 (Lambeth Group)	12 No. 18 April 2023 to 7 February 2024	No Monitoring	-
2M6507SA (2)	1.0-4.0 (River Terrace Deposits)	13 No. 18 April 2023 to 4 April 2024	13 No. 18 April 2023 to 4 April 2024	3 No. 20 July 2023, 14 September 2023, 9 January 2024
2M6508SA (1)	7.0-20.0 (Culver Chalk Formation)	12 No. 18 April 2023 to 7 February 2024	11 No. 18 April 2023 to 4 April 2024	5 No. 4 April 2023 (2 samples), 20 July 2023, 14 September, 9 January 2024

[1] A data logger was installed in borehole 2M6507SA (2) at 3.00 m bgl on 20th June 2023 (i.e., during the fourth monitoring visit). Groundwater logger data was reported between 19th July 2023 and 10th November 2023. Readings were taken every 15 minutes. Interpretation of data collected from data loggers installed in this monitoring well is outside the scope of this GIR and the monitoring data has not been provided with this report.

Response zone depths are taken from Table D1 in the SOCOTEC Phase 1 and 2 Ground Investigation Report (SOCOTEC, 2023), (SOCOTEC, 2024a) and Phase 3b/3c Ground Investigation Report (SOCOTEC, 2024).

3.4 Geo-Environmental Testing

Geo-environmental laboratory testing was scheduled by SSP on selected soil and groundwater samples recovered during the GI works. The testing was carried out by SOCOTEC at their UKAS-accredited environmental chemistry laboratory at Bretby, near Burton-on-Trent, in accordance with MCERTS accreditation (where applicable) test methods as stated within the laboratory test reports. The scope of testing is listed in **Table 3.4~~Table 3.4~~** and shows that several requested chemical analyses were not included in either AGS format or the Ground Investigation Report (SOCOTEC, 2024) and (SOCOTEC, 2023) at the time of report production.

Table 3.4: Summary of Geo-environmental Laboratory Tests

Exploratory Hole ID	Sample Depth (m)	Analysis Suites [1]								
		Soils				Soil Leachates (including Suite 3.0 Leachate Preparation)			Groundwaters	
		Suite 1.1 Made Ground	Suite 1.3 Natural	Suite 1.7 Pesticides	Suite 1.8 Herbicides	Suite 3.1 Standard leachate	Suite 3.6 Pesticides	Suite 3.7 Herbicides	Suite 3.1 Standard	Suite 3.9 Hydrogeology
2M6507SA	0.5		✓[2 3]			R			N/A (See below)	
	3.0		✓[2 3]			R				
	6.5		✓[2 3]							
2M6508SA	1.0		✓[2 3]			✓			N/A (see below)	
	3.2		✓[2 3]							
	5.0		✓[2 3]							
	11.0		✓[2 3]							
2M6507SA (2)									20/07/23 14/09/23 09/01/24	14/09/23 20/07/23 09/10/24
2M6508SA (1)									1.7m 04/04/23 4.97m 04/04/23 20/07/23 15/09/23 09/01/24	 20/07/23 15/09/23 09/01/24
3M6601HP	0.2		✓[2]						N/A	
	0.5									
3M6517HP	0.3		✓[2]	✓	✓	R	R	R		
	1.0	✓							N/A	

Summary based on laboratory results in SOCOTEC Ground Investigation Report (SOCOTEC, 2023), (SOCOTEC, 2024), AGS dataset and Schedules
[1] List of analytes included in each suite is presented in **Appendix B**.
[2] No nickel analysis included in metals suite
[3] GRO (C6-C10) completed but not requested
✓ Requested and completed.
R Requested and not received. Not received in either AGS format or Final Factual GI report due to lab instrumental error.
N/A Not applicable
Note: Boron concentration missing for 3M6517HP at 1.0m bgl due to an instrumental lab error.

3.5 Geotechnical Testing

Geotechnical testing was scheduled by SSP on selected soil samples recovered during the GI works. The testing was carried out by nominated UKAS-accredited geotechnical laboratories including: GEOLABS, near Watford, The Testing Lab (TTL) near Doncaster and Derwentside Environmental Testing Services Ltd (DETS) near Durham. Depending on the samples available, the testing comprised a combination of moisture content, Atterberg limits, density (linear), particle size distribution, unconsolidated undrained triaxial, compaction, chalk carbonate content, BRE testing, organic matter content and loss on ignition. The tests completed are presented in the SOCOTEC final factual reports (SOCOTEC, 2023) (SOCOTEC, 2024).

Similar suites of geotechnical analysis were completed for the relevant Phase 1 exploratory holes. The tests completed are presented in the SOCOTEC Phase 1 Ground Investigation final factual report (SOCOTEC, 2024b).

4 Ground Model

4.1 Geological Setting

Superficial deposits are present across Section M apart from lengths of pipeline to the north and south of Kiln Lane. From Highbridge Road in the southeast, superficial Alluvium and River Terrace Deposits are present at ground level, associated with deposition from the River Itchen. Superficial Alluvium and River Terrace Deposits are again present at the trenchless crossing, associated with deposition from the tributary, while Head Deposits are present in the far north of Section M at the connection with the Otterbourne WSW adjacent to Batsford Lane. Superficial Deposits extent is summarised in **Table 4.1~~Table 4.1~~**.

Table 4.1: Summary of Mapped Superficial Deposits at Ground Level

Chainages	Geology	Typical Description
35900 - 36360	River Terrace Deposits	Undifferentiated sand and gravel.
36360 - 36625	Alluvium	Clay, silt and sand, locally organic with gravel.
36625 - 36905	River Terrace Deposits	Undifferentiated sand and gravel.
36905 - 37000	Not present	-
37000 - 37100	River Terrace Deposits	Undifferentiated sand and gravel.
37100 - 37710	Not present	-
37710 - 37750	River Terrace Deposits	Undifferentiated sand and gravel.
37750 - 37835	Alluvium	Clay, silt and sand, locally organic with gravel.
37835 - 38070	River Terrace Deposits	Undifferentiated sand and gravel.
38070 - 38140	Head Deposits	Variable deposits of sandy silty clay, locally gravelly; chalky and flinty in dry valleys.

The chainages have been provided by the Applicant as of 12 March 2024 as part of the Summer 2024 Design Consultation Route.

These superficial deposits are underlain by bedrock of the London Clay Formation, Lambeth Group and White Chalk Subgroup. From Highbridge Road in the southeast, superficial deposits are underlain by the London Clay Formation. South of Kiln Lane the London Clay Formation is mapped at ground level and underlain by the Lambeth Group, which is found at ground level further north around Kiln Lane. The Lambeth Group is underlain by the White Chalk subgroup which underlies superficial deposits in the north of section M. Bedrck extents are summarised in **Table 4.2~~Table 4.2~~**.

Table 4.2: Summary of Mapped Bedrock at Ground Level

Chainages	Geology	Typical Description
35900 – 37260	London Clay	Silt, clay and sand
37260 - 37650	Lambeth Group - Sand	Mottled clay, locally sandy
37650 - 37820	Lambeth Group – Clay silt and sand	
37820 - 38140	White Chalk Subgroup	White chalk with flints

The chainages have been provided by the Applicant as of 12 March 2024 as part of the Summer 2024 Design Consultation Route.

Three historic boreholes were drilled along Section M (SU42SE30, SU42SE184 and BH-E SOCOTEC 2019). These progressed to between 3.50m and 20.0m bgl. Each borehole encountered varying thicknesses of Made Ground, Alluvium, Head Deposits and River Terrace Deposits with London Clay and White Chalk Subgroup bedrock. The boreholes generally agreed with the geological sequence anticipated from the geological mapping.

4.2 Section M Ground Investigation Results

4.2.1 Encountered Ground

A summary of the ground conditions encountered during the GI is provided in **Table 4.3**~~**Table 4.3**~~. Exploratory hole logs are presented in SOCOTEC's Phase 1 Ground Investigation Report (SOCOTEC, 2024a), SOCOTEC's Phase 2 Ground Investigation Report (SOCOTEC, 2023) and SOCOTEC's Phase 3B/3C Ground Investigation Report (SOCOTEC, 2024). Superficial deposits include Alluvium, Head Deposits, River Terrace Deposits. Bedrock comprises London Clay Formation, Lambeth Group and White Chalk Subgroup.

Chainages across the pipeline route for Section M are between 35900 and 38140.

The encountered ground conditions differed from mapping at several locations, as follows.

- Made Ground was encountered at TP509 but was not mapped.
- BH504, TP507, TP508 and TP509 are on the contact of River Terrace Deposits and London Clay, with all investigations encountering River Terrace Deposits underlain by the London Clay Formation.
- 2M6507SA was mapped as Lambeth Group being present at ground level but River Terrace Deposits were encountered.
- 2M6508SA is mapped with River Terrace Deposits at ground level, however Alluvium was found.
- 3M6517HP mapping indicated no superficial deposits with Lambeth Group at ground level, however Made Ground was encountered at ground level and underlain by Alluvium and Head.

Table 4.3: Summary of Encountered Ground Conditions for Section M Exploratory Holes

Exploratory Hole ID		BH504*	TP507*	TP508*	TP509*	3M6517HP	3M6601HP	2M6507SA	2M6508SA
Chainage (m)		36960	36960	36960	36960	37280	37540	37695	37880
Ground Level (m OD)		+24.01	+25.76	+24.39	+23.75	+22.70	+25.27	+26.15	+23.25
Strata	Typical Description	Depth range (m bgl)							
Topsoil	Brown clayey gravelly SAND with rootlets and cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine flint.	-	-	-	-	-	-	0.00 – 0.30	-
	Soft to firm dark brown sandy gravelly CLAY with rootles. Sand is fine to coarse. Gravel is subrounded fine to medium chert and brick.	-	0.00 – 0.25	0.00 – 0.35	-	-	0.00 – 0.25	-	0.00 – 0.30
	Soft dark brown sandy silty GRAVEL with rootlets. Sand is fine, Gravel is subangular to subrounded fine to coarse chert.	0.00 – 0.25	-	-	-	-	-	-	-
Made Ground	Soft dark brown sandy gravelly CLAY. Sand is medium. Gravel is of chert, chalk and brick.	-	-	-	0.00 – 0.36	0.00 – 0.48	-	-	-
Alluvium	Soft to firm orangish brown silty sandy gravelly CLAY. Sand is fine to medium. Gravel is subrounded fine extremely weak chalk.	-	-	-	-	0.48 – 0.65	-	-	0.30 – 2.55
Head	Soft brown sandy gravelly CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse chert.	-	-	-		0.65 – 1.20	-	-	-
River Terrace Deposits	Medium dense brown gravelly clayey SAND/ gravelly sandy clayey SILT. Sand is fine to coarse. Gravel is angular to subangular fine to medium flint.	-	-	-	-	-	-	0.30 - 5.70	2.55 – 4.50
	Soft to firm brown sandy gravelly silty CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse chert.	0.25 – 2.89	0.25 – 1.40^	0.35 – 1.40^	0.36 – 1.00^	-	-	-	-

Exploratory Hole ID		BH504*	TP507*	TP508*	TP509*	3M6517HP	3M6601HP	2M6507SA	2M6508SA
Chainage (m)		36960	36960	36960	36960	37280	37540	37695	37880
Ground Level (m OD)		+24.01	+25.76	+24.39	+23.75	+22.70	+25.27	+26.15	+23.25
Strata	**Typical Description**	**Depth range (m bgl)**							
London Clay Formation (Division D)	Stiff orangish brown grading to dark grey sandy gravelly silty CLAY with occasional shell fragments. Sand is medium. Gravel Is medium to coarse mudstone.	2.89 – 9.50	1.40 – 4.00	1.40 – 4.00	1.00 – 4.00	-	-	-	-
London Clay Formation (Division A)	Very dense grey glauconitic fine silty SAND with rare gravel. Sand is fine to medium. Gravel is angular to subangular fine to coarse sandstone.	9.50 – 30.80	-	-	-	-	-		
Lambeth Group	Firm to very stiff grey CLAY / silty sandy gravelly CLAY at base of strata. Gravel is angular to rounded fine to coarse flint.	30.80 – 35.00	-	-	-	-	0.25 – 1.20	5.70 – 14.10	-
	Grey glauconitic fine SAND with rare shell fragments.	35.00 - 40.30	-	-	-	-	-	-	-
White Chalk Subgroup	Yellow white and white CHALK recovered as gravelly SILT. Gravel is subangular to subrounded dine to medium extremely weak low-density chalk.	-	-	-	-	-	-	-	4.50 – 7.40
	White CHALK recovered as silty GRAVEL with rare subangular fragments of flint. Gravel is very weak to weak low to medium density subangular fine to coarse chalk.	40.30 – 40.60	-	-	-	-	-	14.10 – 15.00	7.40 – 17.45
	White CHALK recovered as sandy gravelly SILT. Gravel is extremely weak to very weak low density of chalk with rare flint.	-	-	-	-	-	-	15.00 – 20.00	17.45 – 20.45
	Weak high density white CHALK with rare small to large fragments of flint.	40.60 – 50.50	-	-	-	-	-	-	-
Depth of investigation (m bgl)			50.50	4.00	4.00	4.00	1.20	20.00	20.45

*BH504, TP507, TP508 and TP509 were completed in Phase 1 of Section M and are presented in this report.
^ Reclassified to River Terrace Deposits from the SOCOTEC logs.

4.2.2 Groundwater Levels

Groundwater monitoring took place in selected boreholes specified by SSP. Monitoring was carried out by SOCOTEC during and after the main fieldwork period. Table 4.4~~Table 4.4~~ summarises the groundwater strikes and groundwater level measurements.

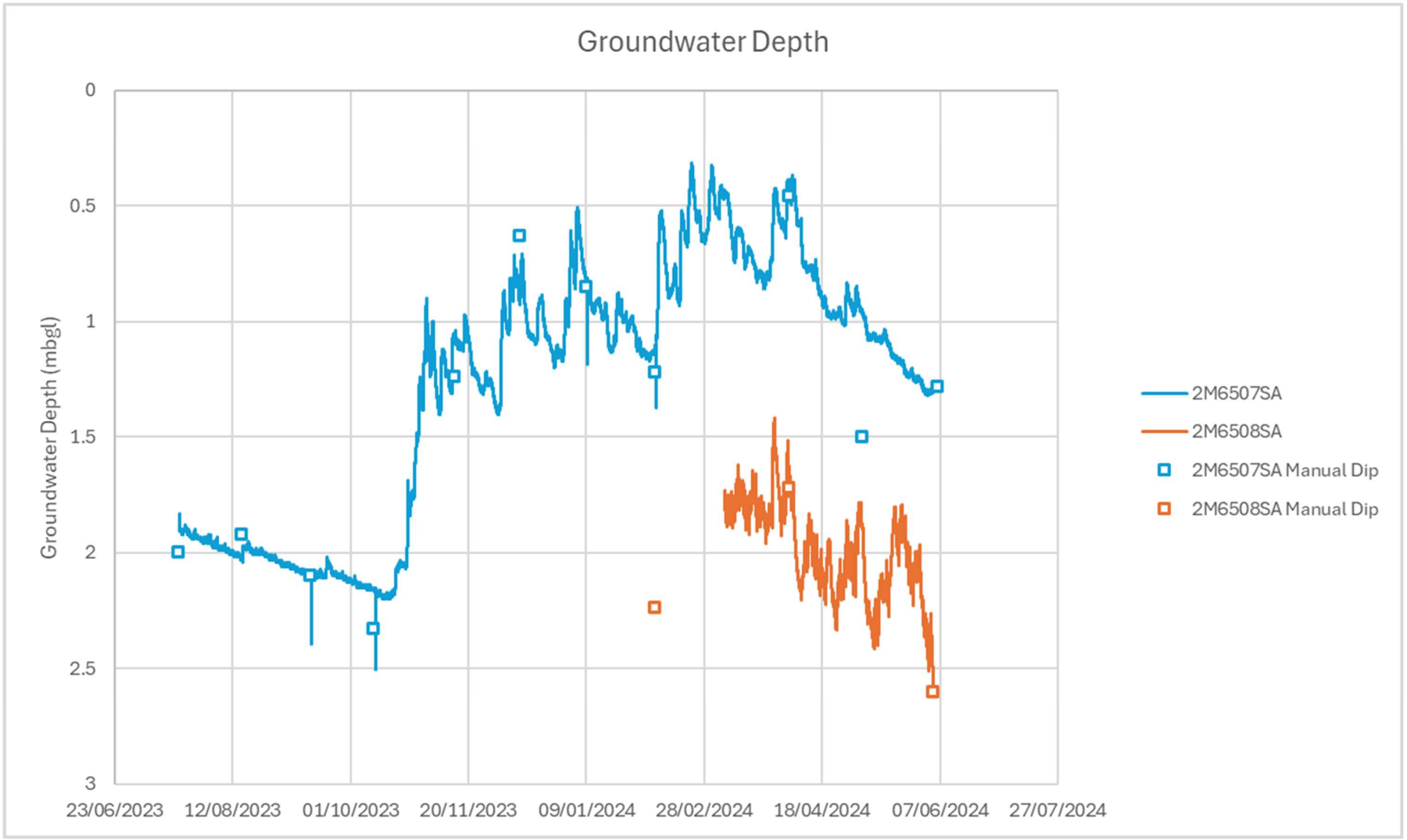
Table 4.4: Summary of Groundwater Strikes and Spot Monitoring Records

Exploratory Hole	Response zone (m bgl)	Strike During Drilling – Depth and Elevation (m OD)	Stratum Within Which Strike Was Recorded	Spot Monitoring – Depth and Elevation m bgl (m OD)	Data Logger – Minimum/ Maximum Depth and Elevation m bgl (m OD)
BH504 (1)	12.0 – 17.60	2.70	River Terrace Deposits	3.17 – 4.15 (+20.84 to 19.86)	-
BH504 (2)	0.90 – 3.00			1.17 to 2.31 (+20.84 to +21.70)	-
TP507	N/A	Not observed	-	-	-
TP508	N/A		-	-	-
TP509	N/A		-	-	-
2M6507SA (1)	9.70 – 10.00*	3.00 Rising to 1.89 14.00 Rising to 13.17 15.00 Rising to 3.34	River Terrace Deposits, Lambeth Group and White Chalk Subgroup	2.94 – 4.03 (+23.21 to +22.12)	-
2M6507SA (2)	1.00 – 4.00**			0.46 – 2.33 (+25.69 to 23.82)	0.32 – 2.50 (+23.65 to +25.83)
2M6508SA (1)	7.00 – 20.00	2.80 Rising to 1.70	River Terrace Deposits	1.72 – 2.60 (+21.53 to +20.65)	1.42 – 2.60 (+21.83 to +20.65)
		6.00 Rising to 4.97	White Chalk Subgroup		
3M6517HP	N/A	Not observed	-	-	-
3M6601HP	N/A			-	-

2M6507SA (2) – Standpipe Piezometer Installation. Data logger installed at 3.0 m, Baro logger installed at 0.30 m bgl.
*2M6507SA (1) is the 19mm standpipe piezometer
** 2M6507SA (2) is the 50mm standpipe

Graph 4.1~~Graph 4.1~~ shows the groundwater levels for selected Phase 2 boreholes at trenchless crossings across the proposed pipeline route within Section M. Graph 4.1~~Graph 4.1~~ is based on data (SOCOTEC, 2023) (SSP, 2023a) provided by SOCOTEC. 2M6508SA has a smaller monitoring period due to being installed at a later date. Further interpretation on the groundwater levels is not the focus of this GIR.

Graph 4.1: Datalogger groundwater levels for Section M Monitoring



4.2.3 Visual and/or Olfactory Contamination

There was no visual and/or olfactory evidence of contamination recorded on the exploratory hole logs in Section M.

5 Generic Quantitative Risk Assessment (GQRA)

This section assesses the soil, soil leachate and groundwater concentrations collected at the selected Phase 2 and Phase 3B/3C GI locations within Section M only[1].

In accordance with the guidance given in 'Land Contamination Risk Management' (LCRM) (Environment Agency, 2023) the results of the geo-environmental laboratory testing undertaken on the samples of soil and groundwater recovered during the 2023 and 2023/2024 SOCOTEC GI have been compared to current published generic assessment criteria (GAC) to identify potential hazards to the plausible receptors.

The eleven soil samples included one sample of Topsoil, one sample of Made Ground, one sample of Alluvium, three samples of River Terrace Deposits, one sample of Head deposits, two samples of Lambeth Group (Clay) and two samples of Chalk.

5.1 Soil Chemical Results

5.1.1 Assessment of Potential Risk to Human Health Receptors

There are no reported exceedances of the human health GAC (commercial land use). Details of the GAC used for screening are provided in **Appendix G**.

5.1.2 Notable Soil Contaminant Concentrations

GAC are not available for all determinands analysed. There were no concentrations which appear to be elevated compared to other chemical results recorded during the GI.

5.1.3 Soil Sample Deviations

Deviations arose due to the acceptable (holding) time between the sampling date and laboratory analysis being exceeded. Further details of the soil sample deviations are provided in **Appendix C**.

5.2 Soil Leachate and Groundwater Results

5.2.1 Comparison of Soil Leachate Results Against GAC

Of the three soil leachate (2:1 ratio) analysis requested, only one result has been reported - 2M6508SA from 1.0m (Alluvium). Concentrations were compared to the Drinking Water Inspectorate Drinking Water Standards guidance (2021), the withdrawn Water Supply (Water Quality) Regulations (1989) for petroleum hydrocarbons and Environmental Quality Standards (EQS). Details on the selection of water GAC are provided in **Appendix G**.

No contaminant concentrations detected in soil leachate exceeded the Drinking Water Standards (DWS) GAC. There are no TPH thresholds included in the Water Supply (Water Quality) guidance. Table 5.1~~Table 5.1~~ shows that TPH concentrations exceeded the TPH threshold value of 10 µg/l as presented within the Withdrawn Water Supply (Water Quality) Regulations 1989 which has been used for reference purposes; these

[1] Information regarding the intrusive works that were undertaken as part of the Phase 1 and Phase 3A ground investigation for tunnel and shaft design can be found in the Phase 1 / 3A Geo-environmental Interpretative Report (SSP, 2025).

thresholds are considered protective of human health. **Table 5.2** shows contaminant concentrations detected in soil leachate exceeding the Environmental Quality Standards (EQS).

Table 5.1: Soil Leachate Sample Exceedances of Withdrawn Water Supply (Water Quality) Regulations 1989

BH ID	Depth (m bgl)	Ground Conditions	Determinand	Concentration (µg/l)	GAC (µg/l)
2M6508SA	1.00	Alluvium	TPH	**<176***	10

* - Laboratory result was <176 ug/l. The method detection limit was <110. No detail was provided from the laboratory explaining the increase the detection limits. There is potential for the result to be an exceedance of the criteria.

Table 5.2: Soil Leachate Sample Exceedances of Freshwater EQS

BH ID	Depth (m bgl)	Ground Conditions	Determinand	Concentration (µg/l)	GAC(µg/l)
2M6508SA	1.00	Alluvium	Cadmium	**0.10**	0.08
			Copper	**3.00**	1.00

Further details on the selection of GAC protective of human health and aquatic ecosystems (controlled waters) are provided in **Appendix G.**

5.2.2 Comparisons of Groundwater Results Against GAC

Exceedances of the groundwater GAC are shown in **Table 5.3~~Table 5.3~~** and **Table 5.4~~Table 5.4~~.**

Table 5.3: Groundwater Exceedances of Withdrawn Water Supply (Water Quality) Regulations 1989

BH ID	Sampling Date and Depth (m bgl)	Determinand	Concentration (µg/l)	GAC (µg/l)
2M6507SA (2)	20/07/23	TPH	**140***	10
	09/01/24	TPH	**130**	10
2M6508SA (1)	04/04/23	TPH	**130***	10
	15/09/23	TPH	**70***	10

*Clean up not reported

Table 5.4: Groundwater Exceedances Freshwater EQS

BH ID	Sample Date and Depth (m bgl)	Determinand	Concentration (µg/l)	GAC (µg/l)
2M6507SA (2)	20/07/23	Chromium (VI)	**6.0**	3.4
	14/09/23	Anthracene	**0.80**	0.1
	09/01/24	Chromium (VI)	**5.0**	3.4
	09/01/24	Zinc	**20.0**	10.9
2M6508SA (1)	04/04/23 (1.7 m)	Fluoranthene	**0.02**	0.0063
		Benzo(g,h,i)perylene		0.0082
	04/04/23 (4.97 m)	Zinc	**24.0**	10.9
	20/07/23	Zinc	**17.0**	
	15/09/23	Zinc	**12.0**	

Groundwater sample deviations and determinands for which the method detection limit (MDL) exceeded the corresponding GAC are presented in **Appendix C**. It is noted that testing with a MDL lower than the GACs for the PAHs listed is typically not offered by standard commercial laboratories. For all determinands analysed, but not listed in the **Appendix C**, the MDLs were below the relevant GAC.

Further details on the selection of water assessment criteria protective of human health is provided in **Appendix G**.

5.3 Excavated Materials (Waste) Management

5.3.1 Hazardous Properties

Soil analytical results for the four soil samples (Phase 3b/3c) and seven soil samples (Phase 2) have been screened for hazardous properties as identified in Technical Guidance WM3 - Waste Classification – Guidance on the Classification and Assessment of Waste First Edition Version 1.2 (Environment Agency, 2021). These screens were carried out using Hazwasteonline™ (5TIWE-DPJCW-634HJ) (Hazwaste Online, 2024) and (TX7M4-BIOUY-0FPNO) (HazWasteOnline, 2024a). The reports with the results are provided in **Appendix E.**

The soil samples analysed showed no hazardous properties.

5.3.2 Waste Acceptance Criteria (WAC)

WAC testing was carried out for 3M6517HP at 1.00 m bgl (sandy gravel clay – HEAD deposits). The WAC results for the sample are non-hazardous hence, excavated materials can be offered to an inert landfill.

5.4 Ground Gas Monitoring

Ground gas monitoring between 18th April 2023 and 20th July 2023 are tabulated in SOCOTEC's Ground Investigation Report (SOCOTEC, 2024), the subsequent monitoring events are provided in AGS format and are also presented in **Appendix F**. The maximum peak concentrations are summarised in **Table 5.5~~Table 5.5~~**. Thirteen gas monitoring rounds were completed for 2M6507SA (2) and 11 monitoring rounds were completed for 2M6508SA (1) between 18th April 2023 to 4th April 2024.

For gas monitoring rounds on 18th April 2023, 11th May 2023, 9th January 2024 and 4th April 2024 within 2M6507SA (2) and all of the monitoring rounds within 2M6508SA (1) the groundwater level was above the top of the installation response zone (flooded). In view of the flooded well the gas data recorded during these dates are assessed as indicative as:

"The response zone of the gas monitoring standpipe should be wholly or partly above groundwater level to provide valid data... [and] gas standpipes with flooded response zones might exhibit measurements of elevated methane or carbon dioxide… due to dissolved gases or the presence of biodegradable material in the groundwater" (BS8485: 2015 + A1: 2019).

Generally, gas concentrations within these boreholes were low, though some low concentrations of oxygen and elevated concentrations of carbon dioxide were encountered.

Oxygen concentrations recorded during the 12-month monitoring programme in 2M6507SA (2) ranged between 4.2% and 21.2% with nine of the 13 monitoring occasions reporting a minimum oxygen concentration <19%. The minimum concentration (4.2 %) was recorded on 25th May 2023. Borehole 2M6507SA (2) is screened in the River Terrace Deposits. This borehole is close to the proposed location for a trenchless crossing. There are no identified PSCs within 50 m of this borehole.

A maximum carbon monoxide concentration was recorded in 2M6507SA (2) at 12 ppm during 18th April 2023, the remainder of the 12-month monitoring programme recorded concentrations ranging between <1 and 4 ppm. Similarly, a carbon monoxide concentration of 10 ppm was reported in 2M6508SA (1) during the same monitoring date with the remaining concentrations also ranging between <1 and 4 ppm.

5.4.1 Gas Thresholds

Maximum concentrations (minimum for oxygen) recorded in monitoring wells have been compared to the following gas threshold concentrations:

- BSI (The British Standards Institution) Health and Safety in tunnelling in the construction industry - Code of Practice [BS 6164:2019] (BSI, 2019).
- EH40/2005 (fourth edition 2020) Workplace Exposure Limits (WELs) (HSE, 2020).

Exceedances of these thresholds are shown in **Table 5.6~~Table 5.6~~** and the maximum (minimum for oxygen) recorded concentrations were compared to these thresholds.

Table 5.5: Ground Gas Monitoring Results Summary

Peak Gas Concentrations (minimum for Oxygen)									
Area	**Borehole**	**Response Zone and Stratum**	**CH_4 %vol**	**CO_2 %vol**	**O_2 %vol**	**CO ppm**	**H_2S ppm**	**VOC ppmv**	**Max Gas Flow Rate (pk) l/hr**
Open field (agricultural). Trenchless crossing – Unnamed tributary of the River Itchen	**2M6507SA (2)**	1.0-4.0 (River Terrace Deposits)	0.2	7.5	4.2	12.0	1.0	30.2	-5.7
	2M6508SA (1)	7.0-20.0 (Culver Chalk Formation)	0.1	0.8	15.8	10.0	1.0	0.7	2.0

CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds, ppmv - Part per Million Volume

Table 5.6: Exceedances of Gas Thresholds

Area	**BH ID**	**CH_4**	**CO_2**	**O_2**	**CO**	**H_2S**	**VOC**
Location / Substance (threshold)		**4.4% vol (LEL) to 17 % vol (UEL)**	**0.5 % vol (LTL) 1.5 % vol (STL)**	**<19% by volume**	**20 ppm (LTL) 100 ppm (STL)**	**5 ppm (LTL) 10 ppm (STL)**	**Approx. 10,000 ppmv (LEL)**
Open field (agricultural). Trenchless crossing – Unnamed tributary of the River Itchen	**2M6507SA (2)**	N/A	**Yes**	**Yes**	N/A	N/A	N/A
	2M6508SA (1)	N/A	**Yes (LTL only)**	**Yes**	N/A	N/A	N/A

LEL – Lower explosive limit, UEL – Upper explosive limit,
STL – Short Term Limit (15-minute reference period), LTL – Long Term Limit (8-hour reference period)
N/A – not applicable due to no exceedances

6 Land Contamination Risk Assessment Model

6.1 Approach and Outline Conceptual Site Model

The land contamination risk assessment presented in this section is a revised risk assessment. A summary of the guidance for the assessment of land contamination and the approach developed and adopted by SSP is presented in **Appendix G**. This revised risk assessment uses information collated as part of the Phase 2 and 3B/3C GI and builds on the existing preliminary risk assessment completed as part of the desk study. The revised risk assessment will allow for recommendations to be made based on the identification and assessment of potential contaminant linkages.

6.2 Potential Sources of Contamination

There were no PSCs identified in Section M west of the railway line within DoL with the exception of the Otterbourne water supply works and former filter beds. The two handpits, 3M6517HP and 3M6601HP were targeting the geology along the linear route. Boreholes 2M6507SA and 2M6508SA along Section M were at trenchless crossing locations.

The key results are as follows:

- The Phase 2 and Phase 3B/3C GI identified no exceedances of commercial GAC protective of human health within soil samples collected at these GI locations.
- Soil leachate concentrations of cadmium and copper exceeded EQS and TPH exceeded Withdrawn Water Supply (Water Quality) Regulations 1989 GAC for the one leachate sample tested.
- Groundwater samples exceeded the TPH withdrawn Water Supply (Water Quality) Regulations 1989 GAC and anthracene, fluoranthene, benzo(g,h,i)perylene, chromium (VI), and zinc exceeded the EQS.

The results as stated above are not associated with identified PSCs; therefore, there is potential for this to have been caused by off site sources.

6.3 Identification of Potential Contaminant Pathways

During and post construction works in Section M, the following potential pathways are considered:

- Dermal contact, ingestion and inhalation of dusts, fibres, gases and vapours.
- Gas and vapour migration through permeable materials/strata and accumulation in voids and below ground chambers/receptor pits.
- Surface water runoff from stockpiles to surface watercourses and migration through groundwater.
- Leaching through unsaturated soil to underlying groundwater.
- Migration of contamination through proposed pipe bedding.

6.4 Identification of Potential Contaminant Receptors

Based on the proposed construction works, end use and surrounding land uses, the following potential receptors previously identified in the desk study preliminary risk assessment have been further assessed following Phase 2 and 3B/3C GI data:

- Construction and maintenance workers.
- Future Site users (workers and maintenance workers).
- Adjacent land users.
- On Site existing and future property (buildings and below ground chambers / receptor pits).

- Surface water (River Itchen, a Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC)).
- Groundwater (Principal Aquifer and Secondary A Aquifers).

The proposed pipeline has not been included as a potential receptor to contaminants that could be present in soils or groundwaters because the pipe material selection is to be made during design to prevent impact from existing PSCs.

There are no proposed permanent buildings at the areas investigated in Phase 2 and 3B/3C of Section M DoL.

6.5 Risk Assessment

An evaluation of the above pollutant linkages has been used to undertake a qualitative risk assessment. The method of risk evaluation adopted is consistent with LCRM (Environment Agency, 2023a) and is being carried out in accordance with CIRIA C552 (CIRIA, 2001) using probability, consequence and risk classifications as shown in **Appendix I.**

Preliminary risk estimation is based on the evaluation of both desk study information collated for the Section route together with the Phase 2 and 3B/3C GI data.

Table 6.1~~Table 6.1~~ summarises the risk classification (without mitigation measures) for the Phase 2 GI location at the proposed trenchless crossing in Section M. The risk classicisation ratings are taken from the risk assessment tables (**Appendix H**). The table presents the risk classification for potential receptors of Moderate/Low or above. Where more than one pathway has been evaluated, the pathway with the highest risk rating is presented in **Table 6.1**. The detailed risk assessment table which contains information pertaining to probability and consequence can be found within **Appendix H**. Definitions for probability and consequence are in **Table 4** and **Table 5** of **Appendix I** (respectively).

No COCs were identified in Phase 3B/3C GI hand pit locations and therefore a risk assessment at these locations is not required.

Table 6.1: Summary of Risk Classification for Construction and Maintenance Activities for Areas Investigated in Section M

Location description	COCs encountered	Risk Classification (without mitigation measures) for Potential Receptors		
		Construction, maintenance workers and future Site users	On Site existing and future property	Groundwater and Surface Waters
Trenchless crossing at an unnamed tributary of the River Itchen. Open field (agricultural). GI locations 2M6507SA and 2M6508SA.	Soil leachable concentrations of cadmium and copper exceeded EQS and TPH exceeded Withdrawn Water Supply (Water Quality) Regulations 1989 GAC for the one leachate sample tested. Groundwater samples exceeded the TPH GAC, PAHs (anthracene, fluoranthene, benzo(g,h,i)perylene) and metals (chromium VI, zinc) exceeded the EQS. Carbon dioxide concentrations during monitoring exceeded STL and LTL workplace thresholds. Low oxygen levels were also encountered.	Moderate/Low	Moderate/Low	Moderate

6.6 Summary

The Phase 2 boreholes advanced within Section M only targeted the trenchless crossing in the north. There are no PSCs within 50m of this trenchless crossing location.

The Phase 3B/3C exploratory holes advanced within Section M targeted an open cut excavation in the north. There are no PSCs within 50m of this open cut location.

It should be noted that several PSCs in the south of Section M are located on the current DoL route; due to access restriction no Phase 2 and Phase 3B/3C proposed boreholes were able to target these, and it is possible subsequent phases of GI may target these in the future.

At this stage a risk cannot be determined for PSCs identified within Section M until further information is obtained. Other PSCs identified within a 50m radius of the proposed Section M DoL were not investigated during Phase 2 and 3B/3C GI. Risk Assessments for these PSCs are presented in the Desk Study (SSP, 2024).

7 Geotechnical Testing and Assessment

7.1 Geotechnical Testing and Assessment Summary Tables for Section M boreholes

Table 7.1~~Table 7.1~~ shows the varying geotechnical tests per strata specific to Section M.

Table 7.1: Geotechnical Testing and Assessment Summary for Section M

	Geotechnical Property																								
Strata	**Moisture (%)**			**Plasticity (%)**			**Particle Size Distribution (Average of values)**		**Triaxial Shear Strength (kPa)**				**SPT Results (uncorrected N value)**				**Uniaxial Compressive Strength, UCS (MPa)**	**Compaction – Max Dry Density (Mg/m³) (Optimum Moisture content, %)**			**Linear (Bulk) Density (kg/m³)**				
Alluvium	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	None				**Min**	**Av**	**Max**		Not Applicable	**Min**	**Av**	**Max**	None				
	12	17	23	22	23	23	**Cobbles**	0					7	11	14										
							Gravel :	6																	
							Sand :	17																	
							Silt :	36																	
							Clay	42																	
Total No. of tests	**2**			**2**			**1**		**0**				**2**				**0**	**0**			**0**				
River Terrace Deposits	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	(%)	None				**Min**	**Av**	**Max**		Not Applicable	**Min**	**Av**	**Max**	None				
	16	26	28	21	34	47	**Cobbles**	0					5	11	15			1.84 (13)	1.93 (11)	1.98 (9.4)					
							Gravel :	14																	
							Sand :	21																	
							Silt :	34																	
							Clay :	31																	
Total No. of tests	**8**			**7**			**9**		**0**				**9**				**0**	**3**			**0**				
London Clay Formation Division D	**Min**	**Av**	**Max**	**Min**	**Av**	**Max**	**Particle Size**	%	**Min**	**Av**	**Max**		**Min**	**Av**	**Max**		Not Applicable	None			**Min**	**Av**	**Max**		
	22	26	30	22	34	46	**Cobbles:**	0	69	160	250		24	24	24						2.08	2.12	2.16		
							Gravel :	0																	
							Sand :	4																	
							Silt :	53																	
							Clay :	43																	
Total No. of tests	**6**			**6**			**5**		**2**				**1**				**0**	**0**			**2**				
London Clay Formation Division A							**Particle Size**	%																	

Strata	Geotechnical Property																							
	Moisture (%)			Plasticity (%)			Particle Size Distribution (Average of values)		Triaxial Shear Strength (kPa)			SPT Results (uncorrected N value)			Uniaxial Compressive Strength, UCS (MPa)			Compaction – Max Dry Density (Mg/m^3) (Optimum Moisture content, %)			Linear (Bulk) Density (kg/m^3)		
	Min	Av	Max				Cobbles	0				Min	Av	Max	Not Applicable			None			None		
							Gravel :	1																
	24	25	26				Sand :	74				>50	>50	>50										
							Silt :	18																
							Clay :	7																
Total No. of tests	3			0			3		0			8			0			0			0		
Lambeth Group*	Min	Av	Max	Min	Av	Max	Particle Size	(%)	Min	Av	Max	Min	Av	Max	Not Applicable			Min	Av	Max	Min	Av	Max
							Cobbles	0															
							Gravel :	7															
	22	25	32	27	38	53	Sand :	39	74	124	180	20	38	>50				1.56 (23)	1.64 (18)	1.72 (13)	2.05	2.12	2.22
							Silt :	19															
							Clay:	35															
Total No. of tests	9			8			3		4			8			0			2			4		
White Chalk Subgroup*	Min	Av	Max	Min	Av	Max	Particle Size	(%)	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max
							Cobbles	None															
							Gravel :																
	21	26	31	6	9	17	Sand :		None			2	18	>50	1.9	2.8	4.0	None			1.93	2.01	2.1
							Silt :																
							Clay :																
Total No. of tests	13			7			0		0			22			5			0			6		

* For both Lambeth Group 4No.SPT's, White Chalk Subgroup 1No. SPT were a refusal and did not achieve a full 0.45m penetration depth due to hard material.

Table 7.2: Porosity and Additional Geochemical Testing

Geochemical Testing							
Geology	**Porosity**	**Chalk Carbonate Content**	**Organic Matter Content (%)**	**BRE SD1 values[1]**			
Alluvium	-	-	5.1	**Test type**	**Min**	**Max**	**Characteristic Value**
				Water soluble SO4 (mg/l)	Below limit of detection		
				Acid soluble SO4 (%)	0.01	0.01	0.01
				Total Sulphur (%)	Below limit of detection		
				Total Potential Sulphate (%)	Below limit of detection		
				pH	8.8	8.8	8.8
No. Tests	0	0	1	1			
River Terrace Deposits	-	-	0	**Test type**	**Min**	**Max**	**Characteristic Value**
				Water soluble SO4 (mg/l)	Below limit of detection		
				Acid soluble SO4 (%)	Below limit of detection.	0.01	0.01
				Total Sulphur (%)	Below limit of detection		
				pH	8.7	8.9	8.7
No. Tests	0	0	1	2			
London Clay Formation Division A	-	-	0	**Test type**	**Min**	**Max**	**Characteristic Value**
				Water soluble SO4 (mg/l)	110	110	<500
				Acid soluble SO4 (%)	0.02	0.14	0.14
				Total Sulphur (%)	0.04	0.04	0.04
				Total Potential Sulphate (%)	0.12	0.12	0.24 – 0.6
				pH	8	8.1	8
No. Tests	0	0	0	2			
London Clay Formation Division B	-	-	-	**Test type**	**Min**	**Max**	**Characteristic Value**
				Water soluble SO4 (mg/l)	10	120	<500
				Acid soluble SO4 (%)	0.21	1.1	1.1
				Total Sulphur (%)	0.15	1.38	1.38
				Total Potential Sulphate (%)	0.45	4.14	>2.4
				pH	7.1	8.2	7.1
No. Tests	0	0	0	3			
Lambeth Group	-	-	-	**Test type**	**Min**	**Max**	**Characteristic Value**
				Water soluble SO4 (mg/l)	Below limit of detection		<500
				Acid soluble SO4 (%)	Below limit of detection	0.23	0.23

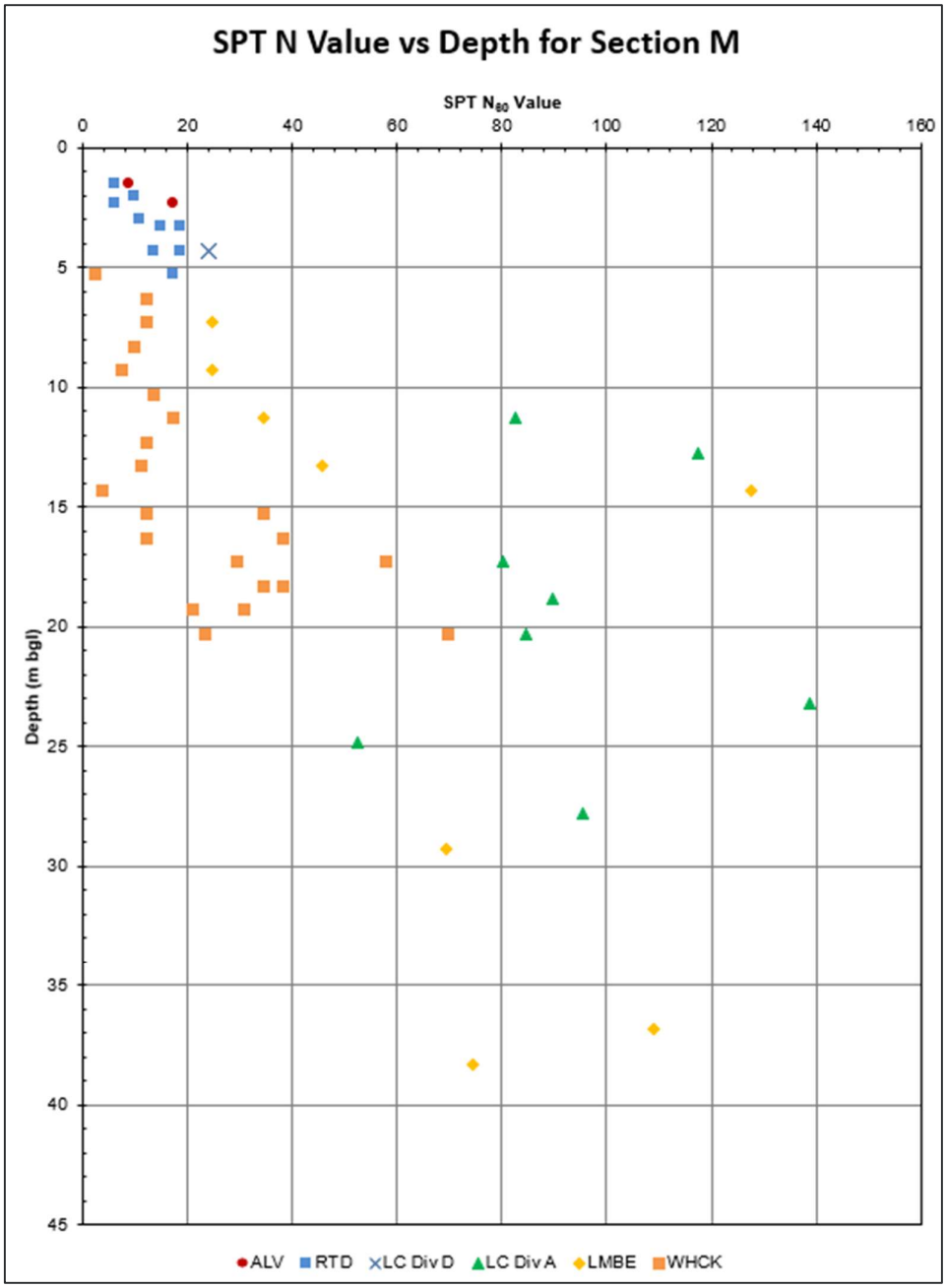
Geochemical Testing							
Geology	**Porosity**	**Chalk Carbonate Content**	**Organic Matter Content (%)**	**BRE SD1 values[1]**			
				Total Sulphur (%)	Below limit of detection	0.05	0.05
				Total Potential Sulphate (%)	Below limit of detection	0.15	<0.24
				pH	8.2	8.9	8.2
No. Tests	0	0	0	4			
White Chalk Subgroup	40%	23 – 44%	0	**Test type**	**Min**	**Max**	**Characteristic Value**
				Water soluble SO4 (mg/l)	Below limit of detection		<500
				Acid soluble SO4 (%)	0.02	0.03	0.03
				Total Sulphur (%)	0.01	0.03	0.03
				Total Potential Sulphate (%)	0.03	0.09	<0.24
				pH	8.8	9.6	8.8
No. Tests	6	2	3	6			

[1]Total Potential Sulphate is calculated from section *C5.1.2* (BRE, 2005)

7.2 Standard Penetration Test (SPT) vs Depth Relationship

Graph 7.1~~Graph 7.1~~ shows Alluvium, and London Clay Formation Division D do not show enough values to define a clear relationship between depth and SPT N values. White Chalk Subgroup shows a relatively consistent value to ~15m and then increases with depth, London Clay Formation Division A shows no relationship, while River Terrace Deposits and Lambeth Group show an increase in SPT N value with depth.

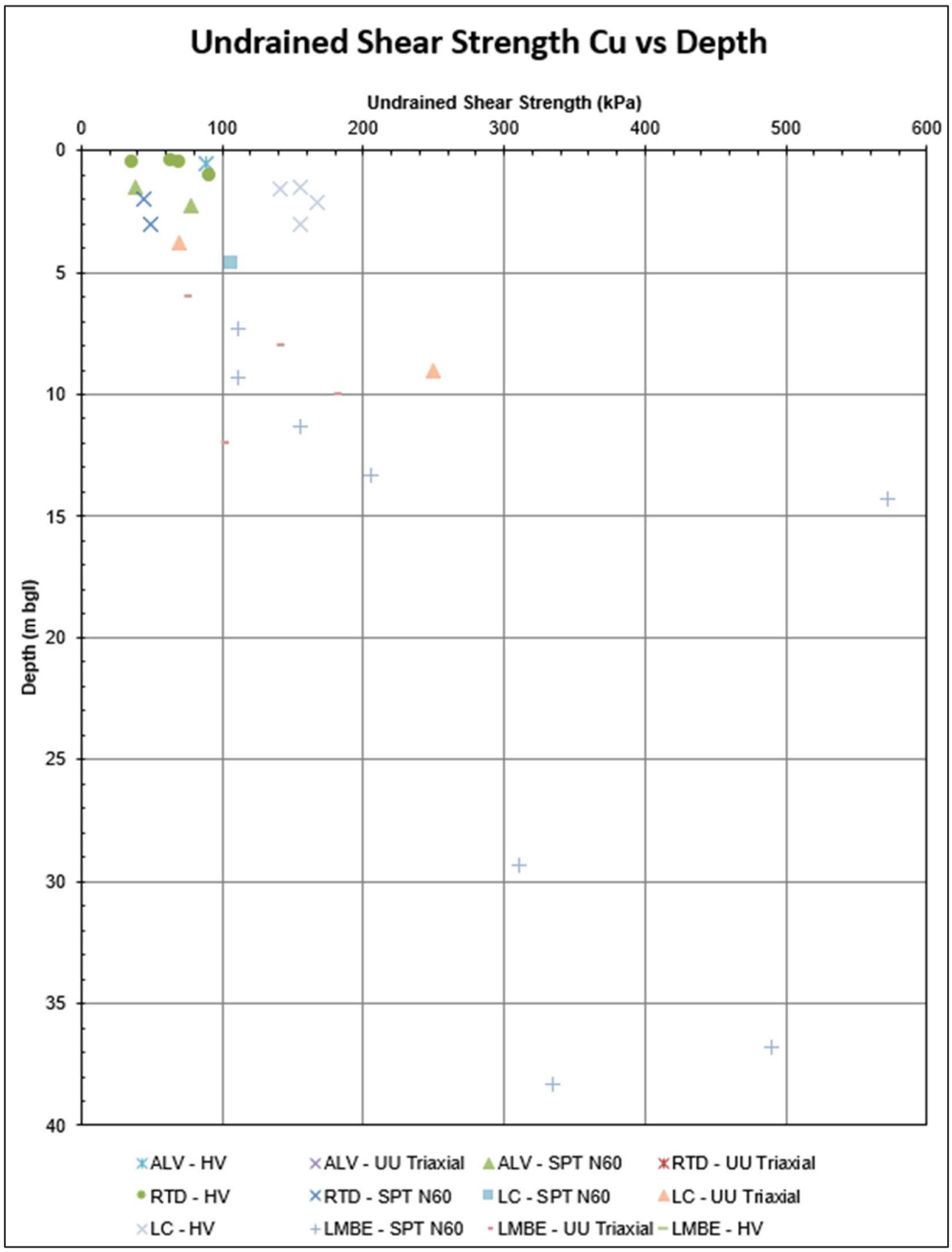
Graph 7.1: SPT vs Depth per strata for Section M boreholes.



7.3 Undrained Shear Strength C_u vs Depth Relationship

Graph 7.2~~Graph 7.2~~ shows that Alluvium, River Terrace Deposits and London Clay Division A and D does not enough values to define a clear relationship between depth and undrained shear strength, while Lambeth Group shows an increase in undrained shear strength with depth (however, C_u >300 is considered unrealistic and is due to extrapolation of SPT N values). The White Chalk Subgroup was not assessed for shear strength relationship due to the unreliability of SPT's in Chalk due to the presence of flint, fractures and fracture spacing.

Graph 7.2: Undrained Shear Strength Cu vs Depth per strata from Section M boreholes

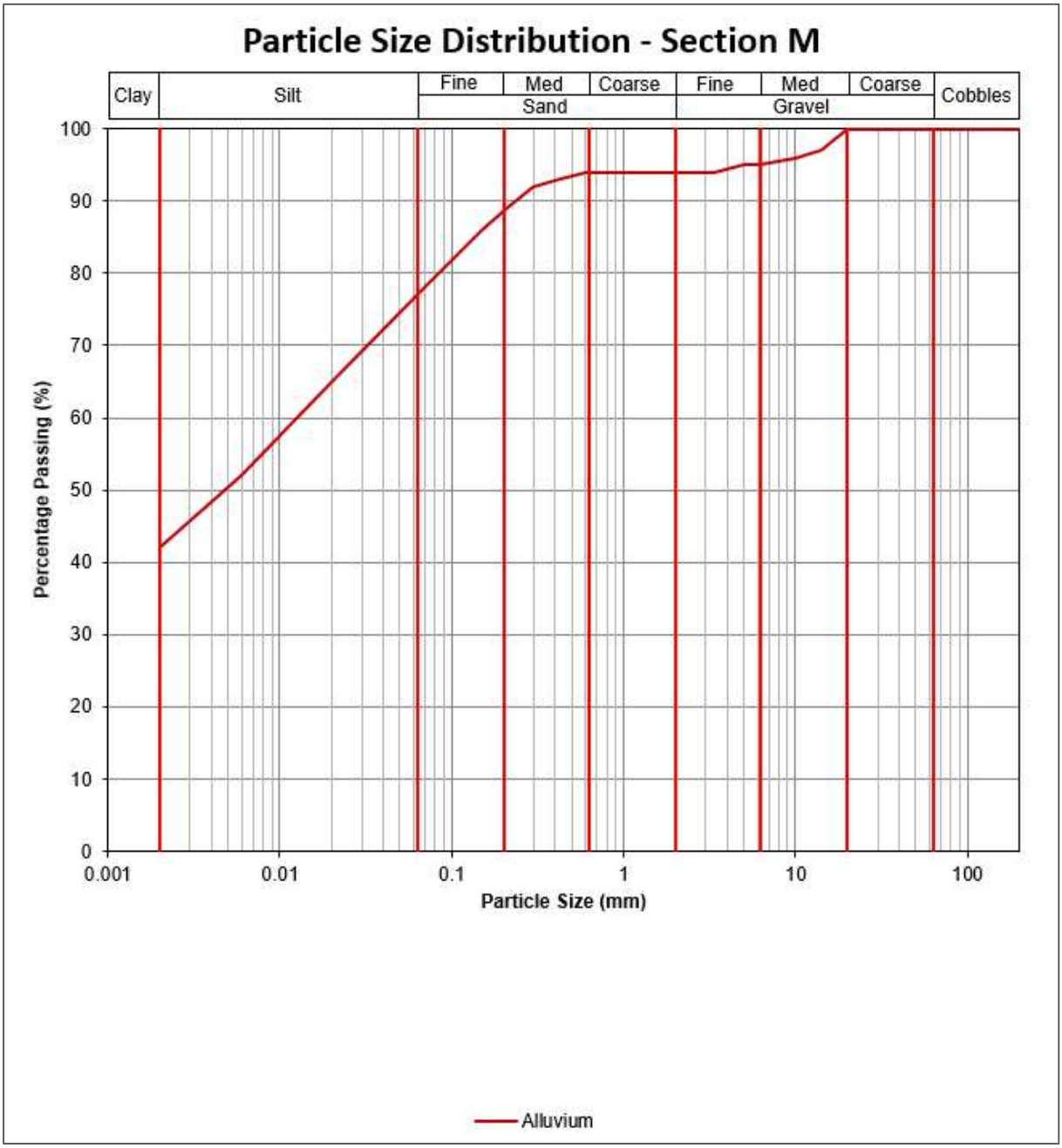


After Stroud (1975) where cu = f_1 x N60 where f_1 = 4.5

7.4 Particle Size Distribution

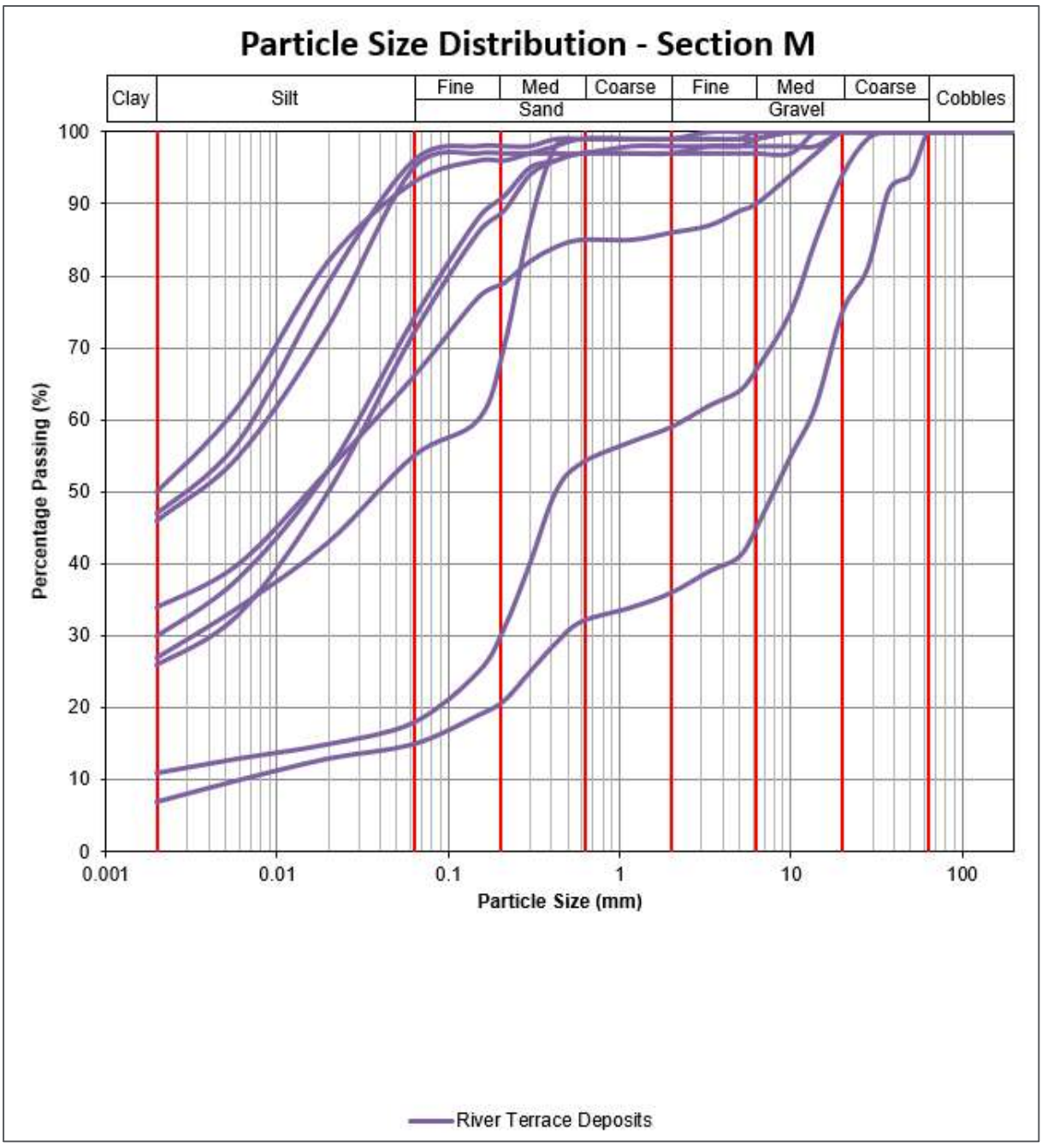
Graph 7.3~~Graph 7.3~~ shows Alluvium to fall within silt and clay particle size distribution.

Graph 7.3: Particle Size Distribution for Alluvium from Phase 1 and 2 Section M boreholes



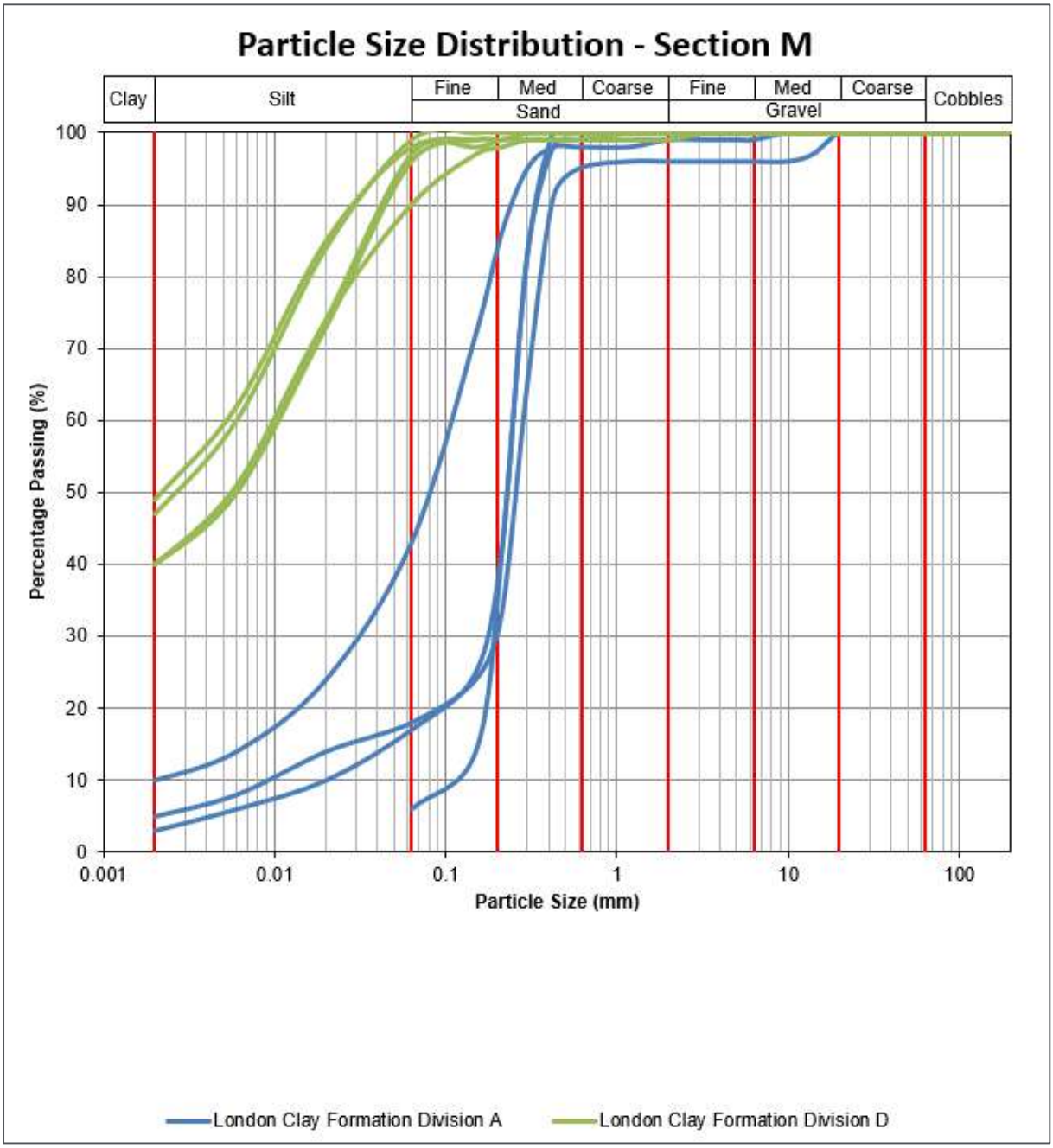
Graph 7.4~~Graph 7.4~~ shows River Terrace Deposits to be variable, falling within gravel, sand, silt and clay particle size distribution.

Graph 7.4: Particle Size Distribution of River Terrace Deposits from Phase 1 and 2 Section M boreholes



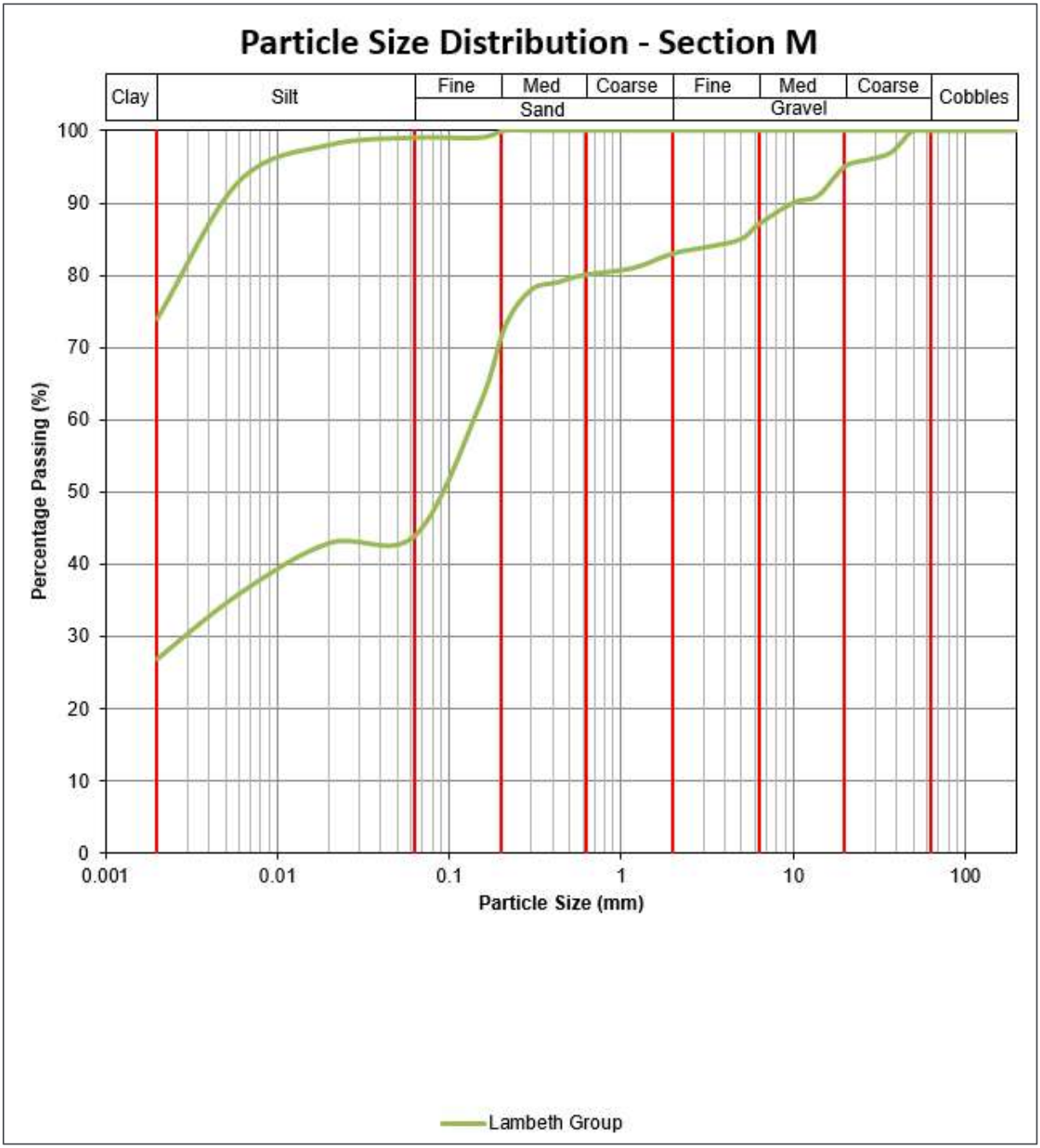
Graph 7.5~~Graph 7.5~~ shows London Clay Formation Division A to fall within sand particle size distribution for three results and for silty sand for one result. Division D falls within silt and clay particle size distribution.

Graph 7.5: Particle Size Distribution of London Clay Formation from Phase 1 and 2 Section M boreholes



Graph 7.6~~Graph 7.6~~ shows the Lambeth Group to fall within sand, silt and clay particle size distribution with up to 16% gravel.

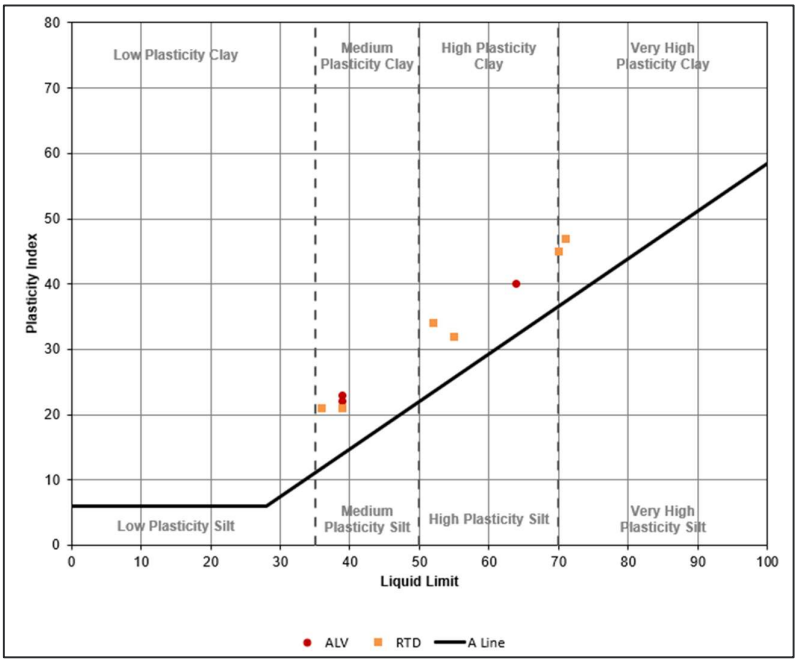
Graph 7.6: Particle Size Distribution of Lambeth Group from Phase 1 and 2 Section M boreholes



7.5 Plasticity

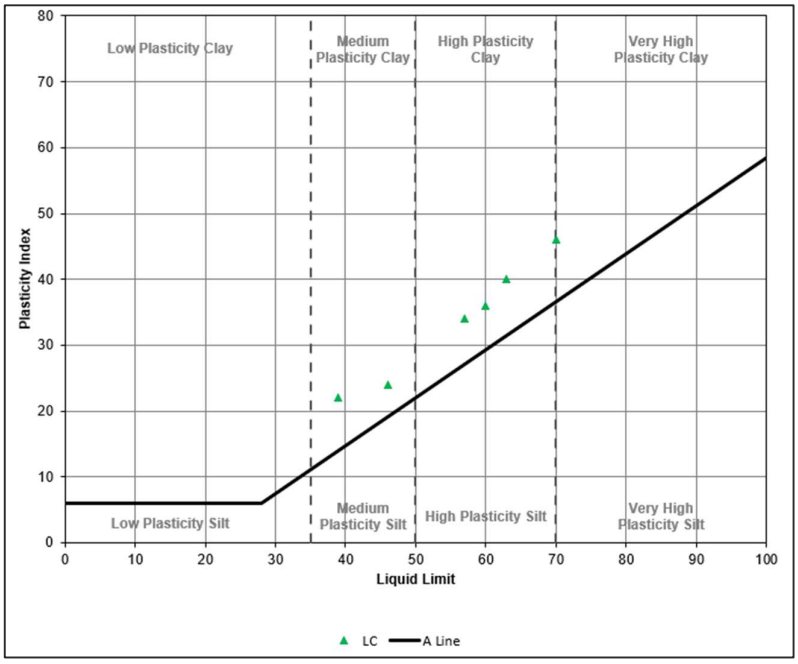
Graph 7.7~~Graph 7.7~~ shows Alluvium to be medium to high plasticity clay and River Deposits to be medium to very high plasticity clay (one plasticity test was undertaken within a coarse horizon of River Terrace Deposits, showing to be medium plasticity clay).

Graph 7.7: Plasticity across Alluvium and River Deposits from Phase 1 and 2 Section M boreholes



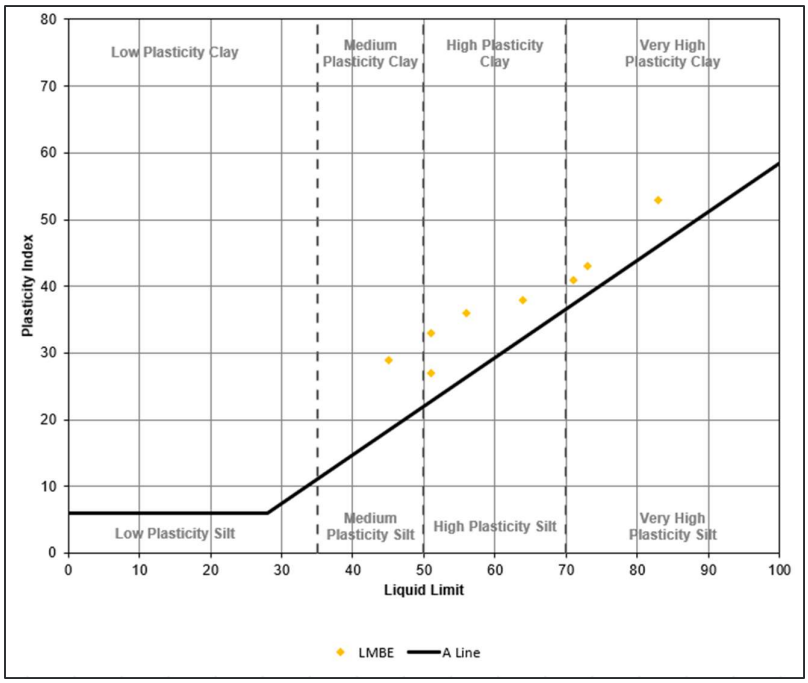
Graph 7.8~~Graph 7.8~~ shows the London Clay Formation Division D to be medium plasticity to high plasticity clay. Division A is non plastic and was not tested.

Graph 7.8: Plasticity of London Clay Formation Division D from Phase 1 and 2 Section M boreholes



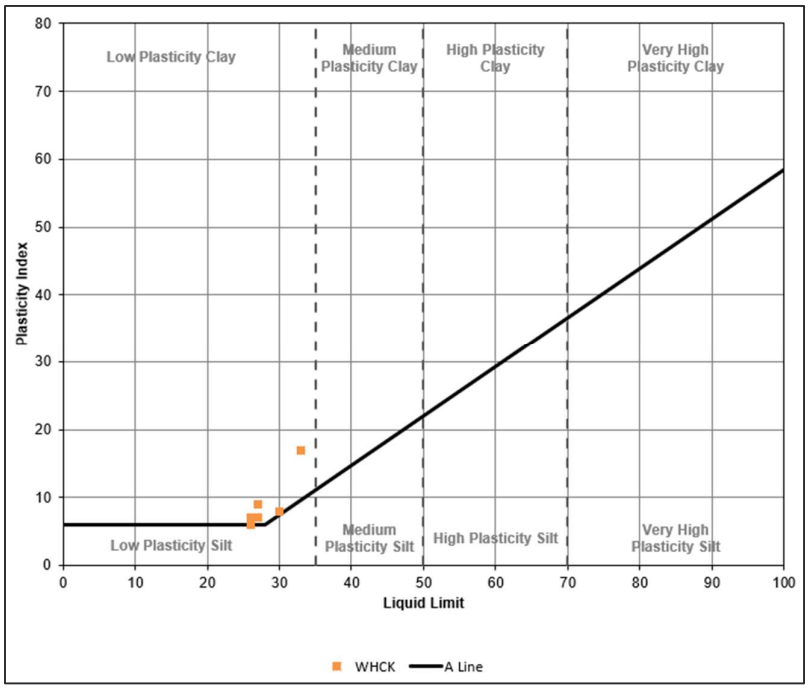
Graph 7.9~~Graph 7.9~~ shows the Lambeth Group to be medium to very high plasticity clay.

Graph 7.9: Plasticity of Lambeth Group in Section M



Graph 7.10~~Graph 7.10~~ shows the White Chak subgroup to class as a low plasticity clay.

Graph 7.10: Plasticity of White Chalk Subgroup in Section M



7.6 Geotechnical Design Parameters

Table 7.3: Geotechnical Design Parameters for Section M

	Geotechnical Design Parameters									
Strata	**Native Soil Modulus E'_3 (MN/m²) [a]**	**Elastic Modulus E_u [b2]**	**Bulk weight density γ (kN/m³) [c]**	**Constant angle of shearing resistance φ (°) [c]**	**Undrained Shear Strength C_u (kPa) [b1]**	**Coefficient of Volume Compressibility m_v (m²/MN) [b1]**	**Uniaxial Compressive Strength (MPa)**	**Concrete Aggressivity [d]**	**Earthworks [b2]**	**From PSD results Embedment corresponding From Table A.3 WIS 4-08-02 [e]**
Alluvium (ALV)	Soft to firm clay: 1.5	Short Term: 10-25 MPa Long Term: 7-20 MPa	15 – 20	Based on average plasticity result of 23%, φ = 25°	20	0.1	Not Applicable	DS-1 AC-1	1 V: 2.5H	Fine grained with less than 25% coarse grained material. Unsuitable for reuse.
Head Deposits (HEAD)	Firm clay: 3 - 4	Short Term: 5 MPa Long Term: 4 MPa	16 - 20	Not available for Section M, from nearby section20 - 25°	25 - 50	0.1 – 0.3	Not Applicable	Not available for Section M, from Section L: DS-1 AC-1	1 V: 2.5 – 3 H	Fine grained, liquid limit > 50% and more than 50% fines. Unsuitable for re-use
River Terrace Deposits (RTD)	Medium dense sand and / or gravel: 4	8-30 MPa	18 - 20	Based on 1 plasticity result of 22%, φ = 23°	Not Applicable	Not Applicable	Not Applicable	DS-1 AC-1	1 V: 2.5 – 3.0H	S2 - subject to further classification testing including liquid limit and PSD. Is a coarse-grained soil with more than 12% fines.
River Terrace Deposits (RTD)	Soft to firm clay: 1.5 - 4	Short Term: 2 - 12 Long Term: 1 - 8	15 - 20	Based on average plasticity result of 34%, φ = 23°	12 - 50	0.1 – 1.0	Not Applicable	DS-1 AC-1	1 V: 2.5H	Fine grained, liquid limit > 50% and more than 50% fines. Unsuitable for re-use
London Clay Formation Division D (LC)	Firm to very stiff clay: 6 - 10	Short Term: 5 - 50 MPa Long Term: 4 - 35 MPa	20 - 22	20 - 25°	50 - 100	0.1	0.07 – 0.34	DS-2 AC-2	1 V: 2.5H	Fine grained, liquid Limit > 50% with < 25% fines. Unsuitable for re-use
London Clay Formation Division A (LC)	Very dense sand: 10 - 15	25 – 50 MPa	20 - 22	30º	Not Applicable	Not Applicable	Not Applicable	DS-5 AC-5	1 V: 2.5 – 3.0H	S2 - subject to further classification testing including liquid limit and PSD. Is a coarse-grained soil with more than 12% fines.
Lambeth Group (LMBE)	Very stiff clay: 6	Short Term: 20 MPa Long Term: 15 MPa	20 - 22	Based on average plasticity result of 38%, φ = 22°	150	0.05	Not Applicable	DS-1 AC-1	1 V: 2.5H	Fine grained, liquid limit generally >50%. Unsuitable for re-use
White Chalk Subgroup	Silty Gravel / gravelly SILT and very weak rock >40	Elastic Modulus: Not Applicable. Secant Modulus, E_s: CIRIA Grade B2 medium density chalk: 1500 – 2000MN/m² [f]	20 - 23	34 - 39°	Not Applicable	Not Applicable	2.8	DS-1 AC-1	Based on the remoulded friction angle of 34° within CIRIA Grade Dc (structureless) chalk, typical stable batters of chalk fill slopes are expected to be up to around: 1 V : 2 H For structured chalk, CIRIA Grade B, typical stable batters of chalk fill expected to be up to: 1 V : 1 H	Imported granular sidefill materials S1, S2

[a] (BSI, 2020) Table 13, [b1] Laboratory testing presented in Table 7.1. (Tomlinson, 2001) Table 2.5,Table 2.11, Figure 2.33, Section 2.6.6, [b2]Laboratory Testing presented in Table 7.1. (Look, 2007) Table 11.7, Table 11.8, Figure 14.1, Table 14.10
[c] (BSI, 2015) Figure 2 and Section 4.3.1.3.5 & 4.3.1.4.8, [d] (BRE, 2005) Table C1, [e] (BSI, 2020) Table 24 of BS9295:2020 corresponds to Table A.3 from the Water Industry Specification for Bedding and Side fill Materials for buried pipelines WIS 4-08-02 February 1994: Issue 1 document.

For Head Deposits (HEAD), geotechnical design parameters are not derived from geotechnical results from Section M boreholes (not encountered during drilling). The nearest encountered HEAD from Phase 2 is within adjacent Section L to the southeast along the pipeline route. HEAD geotechnical design parameters will be taken from Section L results, the desk study Version 4 SSP, 2024), British Standards and published reference literature itemized above within the footnotes below **Table 7.4~~Table 7.4~~.**

7.7 Electrical Resistivity Testing

In situ apparent resistivity testing was undertaken at 3M6601HP, where Lambeth Group was recorded from 0.25 – 1.20 m bgl (hole terminated at 1.20 m bgl) the results are presented in **Table 7.4~~Table 7.4~~**.

Table 7.4: Electrical Resistivity Results for Section M

BH ID	Depth (m bgl)			
	4.0m	3.0	2.0	1.0
	Apparent Resistivity (mean) (Ω.m)			
3M6601HP	**90**	94	110	140

A characteristic apparent resistivity value of 10 Ωm should be taken, which indicates that the ground is highly aggressive towards ferrous metals.

7.8 Permeability Testing

Falling permeability testing was undertaken at 2L6011SR. The results are presented in **Table 7.5~~Table 7.5~~.**

Table 7.5: Falling head permeability testing results.

BH ID	Depth of Test (m bgl)	Test Type	Borehole / Standpipe	Permeability (k)	Strata
2M6508SA	7.00 – 20.45	Falling Head Permeability	Standpipe	1.4×10^{-6}	White Chalk Subgroup

8 Geotechnical Considerations

8.1 Ground Conditions

The ground conditions recorded at the GI locations are generally in line with geological mapping for the area.

- On the southern side of the crossing (Chainage 37690) River Terrace Deposits were encountered beneath Topsoil at 0.30 m, but were not recorded by BGS mapping, these deposits are underlain by Lambeth Group at 5.70 m which overlies White Chalk Subgroup at 14.10 m.
- The northern side (Chainage 37880) of the river Topsoil is underlain by Alluvium at 0.30 m; not mapped by BGS mapping. This is underlain by River Terrace Deposits at 2.55 m and White Chalk Subgroup bedrock at 4.50 m.
- To the south of Kiln Lane along a proposed open cut section of the pipeline (Chainage 37280), Topsoil is underlain by River Terrace Deposits at 0.25 and 0.35 m. This is underlain by London Clay Formation (Division D) from between 1.00 and 2.90 m. The London Clay Formation (Division A) underlies Division D at 9.50 m, Lambeth Group at 30.80 m and White Chalk Subgroup at 40.30 m.

Across Section M, superficial deposits including, Alluvium and River Terrace Deposits are present with London Clay Formation, Lambeth Group and White Chalk Subgroup bedrock underlying. Head Deposits were not encountered during drilling but may be encountered in the north of Section M at ground level.

The majority of the open cut trench will be in the London Clay Formation moving into the Lambeth Group heading in a northerly direction.

South of Kiln Lane the open cut trench will be constructed within solid geology of the London Clay Formation Division D; stiff sandy gravelly silty clay. Towards the north and Kiln Lane the London Clay Formation will grade to Division A, a very dense silty sand. Between Kiln Lane and the trenchless crossing, the open cut trench will be within firm to very stiff clay and glauconitic sand of the Lambeth Group.

The trenchless crossing at the River Itchen (Chainage 37695 – 37880) is adjacent to 2M6507SA and 2M6508SA are expected to be founded within the Lambeth Group and White Chalk Subgroup bedrock.

Further investigations are required to characterise ground conditions north of the trenchless crossing within Alluvium, River Terrace and Head Deposits.

8.2 Foundation Design

Open-cut pipeline sections are expected to be founded within all strata discussed within Section M and the ground will be capable of supporting all required plant. Cohesive Alluvium and River Terrace Deposits encountered prior to pipeline construction may potentially be removed due to low strength and granular imported fill placed beneath the pipeline.

For the approximate 2.2 km length of pipeline proposed across Section M; bearing resistance or settlement issues are not anticipated – the pipeline is expected to result in a net reduction in ground bearing pressure at formation level.

8.3 Shallow Excavation

8.3.1 Excavation

Shallow excavations for the proposed open-cut pipeline route are expected to be constructed between 3 m to 6 m bgl, within Alluvium and River Terrace superficial deposits, London Clay Formation, Lambeth Group and White Chalk Subgroup bedrock. Excavations are expected to be within the capability of conventional plant.

Full excavation support would likely be required in superficial deposits.

Where space permits (e.g. in open land), it may be possible to construct the shallow pipework within unsupported battered trenches though sides of the excavation may be prone to drying out and weathering could cause sides to slip if left open for long periods of time (CIRIA, 1992).

Shallow groundwater is anticipated, beneath which finer materials may be washed out resulting in reduced stability. Sand will be encountered beneath the groundwater table within granular deposits of the River Terrace Deposits, London Clay Formation (Division A) and Lambeth Group, and running sands may develop. Where excavations are proposed near existing structures (i.e. solar farm in the north), full temporary excavation support is recommended to mitigate unacceptable ground displacements.

8.3.2 Groundwater Control

Based on the GI records, groundwater is likely to enter excavations adjacent to 2M6507SA and 2M6508SA. Groundwater was encountered during drilling between 0.98 and 4.03 m bgl which is the river level at the adjacent tributary.

At the proposed River Itchen tributary trenchless crossing groundwater is expected to be encountered within River Terrace Deposits with further strikes within the White Chalk Subgroup. These groundwater entries are expected to be controllable by conventional sump pumping.

2M6507SA struck groundwater at 15.0 m rising to 3.34 m, indicating a high volume of sub-artesian water, however this is below proposed depth of construction.

Groundwater levels during monitoring were higher than those encountered during drilling; this should be considered prior to construction.

Control of groundwater will be required in granular deposits of the London Clay Formation and Lambeth Group. Further investigation will be necessary to establish whether well pointing and/or ejector wells will be necessary in these deposits.

8.4 Flotation

There were no instances of artesian groundwater conditions above ground level during investigation, but high groundwater levels were encountered as well as a sub artesian strike within the White Chalk Subgroup. Therefore, the pipeline should be designed based on groundwater at ground level and structures should be designed to resist flotation in all stages of temporary and permanent works.

8.5 Trenchless Construction

The Applicant has confirmed that pipejacking is the preferred method of trenchless construction across the proposed pipeline with the current trenchless crossing pipeline and shaft dimensions and depths. Launch shaft dimensions will range between 9.0 m – 9.5 m diameter and reception Shafts range between 5.0 m – 5.4 m diameter with a 700 mm – 800 mm diameter ductile iron (DI) pipe within a 1200 mm internal diameter pipe jack. Trenchless crossings are presumed to be driven west to east, so the launch Shafts are to be the westerly shafts.

The depths of the trenchless crossing of the tributary of the River Itchen (Chainage 37695 - 37880) are yet to be confirmed however, it is expected to be constructed at a maximum depth of between 10.0 m (launch shaft at northern side) and 13.0 m bgl (reception shaft at southern side), while a minimum of 2.5m under the lowest point of the river bed. It is expected that trenchless construction will be undertaken within Lambeth Group and White Chalk Subgroup.

Lambeth Group and White Chalk Subgroup are considered to be the appropriate materials for soft-ground tunnelling as they are generally self-supporting and of low permeability. Both open-face and closed face tunnelling methods are likely to be suitable though it should be noted however that gravelly clay may be present at the base of the Lambeth Group.

It is approximately 190 m between the two boreholes 2M6507SA and 2M6508SA, therefore, variable unexpected ground conditions may be encountered between the launch and reception shafts such as the depth of the alluvial channel at its deepest point (possibility of granular alluvial material being encountered). Such uncertainties could lead to face collapse if variable ground conditions are encountered. It is recommended that further intrusive investigation (i.e. cable percussion borehole with rotary core follow on) is completed between the two proposed Shafts.

Other issues that require further consideration include:

- The presence of flints within the River Terrace Deposits, Lambeth Group and White Chalk Subgroup getting caught on the string.
- The permeability may change if there is a transition between structureless and structured chalk (structureless chalk as noted would probably be of lower permeability), or alluvial material.
- Slurry pressures would need to be carefully controlled to ensure the bore remains stable whilst not over pressurizing (risking blow out of fluid at the surface).

8.6 Ground Aggressivity

8.6.1 Concrete

The results of the pH and sulphate tests (SO_4) undertaken on all strata on all natural ground material samples recovered present the following design sulphate class and aggressive chemical environment for concrete (ACEC) classes:

- Alluvium: DS-1 AC-1
- Head Deposits: DS-1 AC-1
- River Terrace Deposits: DS-1 AC-1
- London Clay Formation Division D: DS-2 AC-2
- London Clay Formation Division A: DS-5 AC-5
- Lambeth Group: DS-1 AC-1
- White Chalk Subgroup: DS-1 AC-1

8.6.2 Ferrous Metals

Strata across the proposed pipeline route has the potential to be aggressive towards ferrous metals.

Following guidance published by TRL (Eyre, D., & Lewis, D.A., 1987) if the ground has the below characteristics, it is considered aggressive towards ferrous metals:

- Characteristic apparent resistivity value of 10Ωm
- Organic content greater than 0.2%
- Plasticity index greater than 15
- Poorly drained area or groundwater above pipework level
- Moisture content greater than 20%
- pH greater than 6

- Soluble sulphate 500 to 1000mg/l
- The presence of aggressive compounds in Made Ground (e.g. cinder or coke).

Eyre and Lewis' (1987) Contractor Report has two soil corrosivity assessment methods; Table A1 and B1. These two assessments class Section M as aggressive (Table A1) and very aggressive (Table B1) respectively (Eyre, D., & Lewis, D.A., 1987).

8.7 Natural Cavities

Dissolution is a common weathering mechanism in chalk. Typical features associated with dissolution in chalk include an irregular interface with the cover material, downward tapering pipes infilled with compressible material and voids. If undetected, dissolution features pose a risk to construction through differential settlement or collapse.

The highest risk areas are generally found where surface water originates on Tertiary beds and soft water infiltrates through those into the chalk – e.g., the Lambeth Group overlying Chalk, though the overall risk is dependent not only on stratigraphic sequence but also on hydrogeological and geomorphological factors. The SHR_N (Subsidence Hazard Rating number) determined by the approach proposed by Edmonds would, at its worst case, be 580, indicating a high hazard category (i.e., statistically 22.8% solution features recorded in the natural cavity database occurred in at Sites with these characteristics, >466 solution features per 100km^2) (Edmonds, 2001).

Caution is advised when constructing the proposed pipeline in these areas to be mindful of potentially unrecorded, buried or unmapped cavities below ground affecting construction. Further details can be found within the desk study Section 3.2 produced by SSP (SSP, 2024) and the Groundsure Report (Groundsure, 2024).

It should be noted that no evidence of dissolution features was identified within the boreholes drilled in Section M.

8.8 Geotechnical Hazard Assessment

Table 8.1~~Table 8.1~~ summarises potential geotechnical hazards associated with the Site during and post construction.

Table 8.1: Potential Hazards

Hazard	Source of information/comment	Mitigation method
Unforeseen Ground Conditions	Project specific ground investigation undertaken in 2023 and 2024 to inform outline design. Trenchless bore collapse and uncontrolled ground settlement, very soft / loose material present that is inadequate for founding of pipework / chambers. Only 8 exploratory locations completed for Section M.	Exploratory holes have been undertaken at around 200 – 250 m intervals of the proposed pipeline route. The Applicant and Principal Contractor agreed on potential exploratory locations including a Site visit, reviewing utility drawings and geological maps. Where inadequate, additional appropriate exploratory holes to be constructed.
Groundwater	Lack of knowledge of groundwater conditions. Potentially result inappropriate/inadequate choice of dewatering techniques, excessive sump pumping causing settlement, unstable ground, inappropriate bore support and flotation	Ensure appropriate groundwater measurements and appropriate monitoring are undertaken. Groundwater levels are checked for boreholes 2M6507SA, 2M6508SA and BH504 throughout post-fieldwork monthly monitoring visits. Groundwater results should be reviewed over a minimum period of 6 months.
Trench collapse	Other sections within Phase 2 (Section E & K) fracture indices during rotary coring highlighting areas of assumed zones of core loss and instability. Probable high groundwater in granular deposits	When excavating, assess the degree of fracturing and structure as the excavation progresses in depth and lateral extent. Check to see if the excavation remains intact or blocky. If the ground becomes increasingly laminated and irregular, excavate in reduced thicknesses rather than larger blocks at a time to prevent the likelihood of collapse. Superficial deposits such as Head Deposits have relic shear surfaces, which may be within soft clay or loose sand may be encountered. Use vertical sided trench support: trench sheets or boxes, where required.

Hazard	Source of information/comment	Mitigation method
Excessive settlement of structures, pipe failure / bursts	Geological logs displaying strata to a maximum of 50 m BGL. Subsidence and hidden soft areas of ground previously not identified during the GI.	Ensure that proposed pipework avoids areas of unsuitable ground and buried structures where possible. If structures are within the route alignment, arrange with the Applicant and appropriate asset landowners that the impact of the proposed construction is reviewed, and appropriate mitigation undertaken. Ensure that the design includes for the use of appropriate groundwater control and excavation support methods to be employed for the encountered ground to minimise any impacts.
Unexploded ordnance (UXO) risk	Wider Site was impacted by bombing in WWII.	Preliminary Risk Assessments were conducted specific to each exploratory hole location to reduce the section-wide greater UXO risk. Detailed UXO assessment undertaken with the following findings (Zetica, 2024): ■ No significant sources of UXO hazard have been identified. ■ Proceed with works; however, a UXO awareness briefing is prudent for staff involved in excavations. LOW UXO hazard level is applied to Section M
Risk of concrete degradation, failure of concrete structures/ / ferrous materials and proposed DI pipe	BRE test results on all strata from the GI show the maximum available design sulphate class is DS5. The corresponding Aggressive Chemical Environment for Concrete (ACEC) is AC5. Potential for excessive corrosion of ductile iron.	Ensure that additional testing is carried out on future investigations across the pipeline route. Perform resistivity testing
Buried chalk cavities	Groundsure report showed Section M to contain buried chalk cavities that could impact construction.	Undertake electromagnetic (EM) surveys to detect the likely presence of chalk cavities/dissolution features followed by Electric Resistivity Tomography (ERT) surveys in areas where strategic structures are proposed (e.g. pumping station Sites). ERT will be able to determine potential chalk cavities based on high/low resistivity results indicating cavities filled with air or water that will impact any potential dewatering or imported granular fill to be required.

9 Conclusions

9.1 Geotechnical

Open-cut construction of the pipeline is likely to encounter River Terrace Deposits, Alluvium, London Clay Formation and Lambeth Group.

The trenchless crossing at the River Itchen tributary is expected to be founded within the Lambeth Group and White Chalk Subgroup bedrock. High water levels were encountered at the exploratory holes and groundwater control will be necessary.

Pipejacking is the proposed trenchless construction technique considered by the Applicant..

Across all encountered strata the design sulphate class and aggressive chemical environment for concrete varies. The worst-case design sulphate class is DS-5 and the worst case aggressive chemical environment for concrete (ACEC) class AC-5. No BRE testing was undertaken on Head Deposits within Section M and values from Section L have been used.

The majority of the open cut trench will be in the London Clay Formation and Lambeth Group, and excavated materials will be largely unsuitable for reuse from a geotechnical standpoint, however more testing is required to determine the extents of the London Clay Formation Division A and confirmation of its embedment class.

Granular River Terrace Deposits have an embedment class of S2, while cohesive deposits are unsuitable for reuse, both require further classification testing.

White Chalk Subgroup has an embedment class as S1 or S2 using granular sidefill materials.

All materials encountered in future investigations will require particle size distribution tests performed on samples across Section M to assess suitability for re-use.

All the strata in Section M (superficial and bedrock) are highly / very aggressive towards ferrous metals.

9.2 Geo-environmental

These conclusions are based on the data obtained during Phase 2 and Phase 3B/3C GI works. Geo-environmental assessment of data collected during Phase 1 and Phase 3A ground investigation for the proposed tunnels and shafts within Section M are presented in a separate Phase 1 / 3A GIR report (SSP, 2025).

Soil: There were no exceedances of commercial GAC protective of human health in the tested soil samples.

Leachate: Leachable concentrations of cadmium and copper exceeded EQS and TPH potentially exceeded the withdrawn Water Supply (Water Quality) Regulations 1989 GAC for the one leachate sample tested (2M6508SA).

Groundwater: TPH concentrations exceeding the GAC were recorded in both monitoring wells at the trenchless crossing (2M6507SA and 2M6508SA). Exceedances of the EQS for chromium (VI), zinc and anthracene were recorded in borehole 2M6507SA. Exceedances of the EQS for zinc and benzo(g,h,i)perylene and fluoranthene were recorded in borehole 2M6508SA. The source of these concentrations is unconfirmed.

An area recorded by the local council as infilled land (artificial) is located approximately 110 m northwest of borehole 2M6507SA and is within 250m of the DoL. It is possible for identified PSCs within surrounding area at this location to be impacting on groundwater, but with the limited data it is difficult to delineate sources.

Ground Gas: Carbon dioxide concentrations during monitoring exceeded STL and LTL workplace thresholds. Low oxygen levels were also recorded. Ground gas is unlikely to pose a risk within areas of Section M undergoing open cut excavations in the northern parts of Section M as any gas accumulated will quickly dissipate. Although there are no permanent building structures proposed for this area of the scheme, the ground gas data recorded at this location should be considered at the pre-construction phase as temporary deep excavations are planned as reception pits for the trenchless crossing beneath the tributary of the River Itchen.

Groundwater levels were recorded above the top of the installation response zone (flooded) during the first two rounds (18th April 2023, 11th May 2023, 9th January 2024 and 4th April 2024) within 2M6507SA and the one ground gas monitoring round for 2M6508SA therefore the data has been considered as indicative.

Risk Classification: Moderate risk to groundwater and surface water has been determined based on the presence of adjacent watercourses which may be in hydraulic continuity with groundwater beneath the area of the proposed trenchless crossing reception pits, and the presence of contaminants detected in groundwater and soil leachate samples. In addition, the watercourse in which the trenchless crossing is to be constructed beneath flows into the River Itchen, approximately 500m southeast. This is an ecological sensitive receptor designated as a SSSI and SAC.

Moderate/Low risks to human health of construction workers and future site users have been assessed for the trenchless crossing location based on potential exposure to identified contaminants in groundwater and potential for exposure to gases.

10 Recommendations

10.1 Geotechnical

Further Ground Investigation is recommended.
It is recommended that further GI works are completed to obtain ground conditions and geotechnical information as detailed below:

- BRE concrete aggressivity testing to be undertaken upon Head Deposits, currently no BRE testing has been conducted on Head Deposits within Section M.
- Further intrusive investigation (i.e. cable percussion borehole with rotary core follow on is completed between the two proposed shafts of the trenchless crossing of the tributary of the River Itchen.

Ground Preparation

A processing plant should be used on Site to screen out and remove the particles exceeding 40 mm within fine and coarse-grained soil across the pipeline. Only material with embedment class of S4 or less are recommended to be used for as – dug soils surrounding semi-rigid pipes or the proposed 1200 mm ductile iron pipeline across the route.

10.2 Geo-Environmental

Further Ground Investigation is recommended.

- In areas of the Proposed Development where there are currently data gaps from the Phase 2 and Phase 3B/3C GI, in both the northern area (PSC 220, Water Works – Filter Beds and PSC 208, Otterbourne WSW) and southern area (PSC 209, Landfill-Bugle Farm Landfill and infilled land, PSCs 209, 210, 215, 216, 437, 438 and 516) of Section M where PSCs within the DoL could not be investigated due to access restrictions. It is recommended that the contractor will assess PSCs not assessed by the GI and PSCs with a risk rating of Moderate/Low and higher (where additional information is needed) as part of their construction phase works to understand and comply with contaminated land, health and safety, waste classification and any other relevant guidance.
- Soil leachable, groundwater contaminant concentrations and ground gas exceedances were encountered in the Phase 2 ground investigation locations at one trenchless crossing location. Additional groundwater sampling and ground gas monitoring is recommended to provided further information on dewatering and ground gas mitigation measures during construction works.

Conduct additional geo-environmental monitoring during construction.
Recommendations for ground gas and groundwater monitoring/testing during the construction phase should be provided within the Construction Phase Environmental Management Plan. The ground gas data recorded at the trenchless crossing of the unnamed tributary of the River Itchen should be considered at the pre-construction phase in terms of risks to groundworkers in the planned launch/reception pits.

Watching Briefs

Watching briefs should be in place during construction. Groundworkers should remain vigilant throughout construction and should visual and/or olfactory indicators of contamination (including asbestos) be encountered, works should cease in that area and advice be sought from a suitably qualified geo-environmental professional.

Stockpile Management

Stockpile material must be well managed and kept on an area of hardstanding located down gradient of surface water drainage that may potentially discharge to a watercourse. It is recommended that any stockpiled material

is covered to prevent rainfall infiltration, run off, and leachate and dust generation. Stockpiles should be secured when not in use to prevent third party access.

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Figures

Appendices

Appendix A: Section M Desk Study Information specific to the GI Investigation

Table A1 summarises desk study information specific for the Phase 2 and 3B/3C GI areas in Section M. The information was used to develop the preliminary conceptual Site model (CSM) presented in the HWTWRP Geotechnical and Geo-environmental desk study Version 4 (SSP, 2024).

Table A1: Geo-environmental Desk Study Summary Information for Phase 2 and Phase 3B/3B GI Locations at Section M

		2M6507SA	2M6508SA	3M6517HP	3M6601HP
Geology	Superficial Deposits	River Terrace Deposits	Alluvium and River Terrace Deposits	None	None
	Bedrock Geology	Lambeth Group -Clay, silt, sand over Chalk		Lambeth Group – Sand over Chalk	Lambeth Group- Sand over Chalk
	Artificial Ground [1]	None			
Hydrogeology	Bedrock Aquifer Classification	Lambeth Group (Secondary A Aquifer) Chalk (Principal Aquifer)		Lambeth Group (Secondary A Aquifer) Chalk (Principal Aquifer)	Lambeth Group (Secondary A Aquifer) Chalk (Principal Aquifer)
	Superficial Aquifer Classification	Secondary A		N/A	N/A
	Source Protection Zones (SPZs)	Zone 1			
	Groundwater Abstractions [2]	178 m west	190m northwest	225 m west	300 m southwest; 320 m northeast
	Nitrate Vulnerable Zones (NVZs)	Hampshire Chalk (Groundwater) and Hamble Estuary Eutrophic			
Hydrology	Surface Watercourses	Unnamed tributary of the River Itchen		Unnamed tributaries of the Itchen are located approximately 175m east	Unnamed tributary of the Itchen is located approximately 200m east.
	Surface Water Abstractions [2]	River Itchen – 800 m southeast		Transfer between Sources- 670 m northeast	Potable Water Supply- 780m northeast and Transfer between Sources- 730 m east
	Risk for Rivers and the sea	Flood Zone 3		Flood Zone 1	
Site History	On Site and Surrounding Land	The earliest mapping from the late 1800s shows woodland, farmland or other undeveloped land this has largely remained unchanged for the trenchless crossing location. An unnamed tributary of the Itchen runs between the two borehole locations.		The earliest mapping from the late 1800s shows undeveloped land this has largely remained unchanged.	
Landfill Sites		None			
Pollution Incidents		There are no pollution incidents (category 1 or 2) within 50 m of the GI locations.			
Ecological Sensitivity (250m radius)	Sites of Special Scientific Interest (SSSIs), SSSI	None			
	Special Areas of Conservation (SAC),				
	Special Protection Areas (SPAs)				
	RAMSAR Site				
	National Nature Reserve (NNR)	South Downs National Park - 330 to 450 m east			
	Ancient Woodlands	Oakwood Copse		None	None
Preliminary Risk Assessment	Overall Risk Assessment Summary	PSCs greater than 50 m distance from trenchless crossing locations		PSCs greater than 50 m distance	

Notes:
[1] Artificial Made Ground as identified by the BGS
[2] Active groundwater and surface water abstractions within 1 km; surface waters up to 250m; artificial ground up to 250m. All distances are approximate.

Appendix B: Chemical Analysis List of Suites

Appendix C: Deviations Reported by the Analytical Laboratory

The Quality Control (QC) associated with the results of the following soil analysis did not wholly meet the QMS requirements, therefore the accreditation has been removed by the analytical lab. However, the laboratory has confidence in the performance of the method as a whole and the integrity of the data has not been significantly compromised:

- 2M6507SA 0.50 m, 3.00 m and 6.50 m: GRO (>C6-C10) Total and pH (2:5:1) exceeded holding times.
- 2M6508SA 1.00 m: 17 PAHs (inc. Coronene) by GCMS, Cyanide (Total and Free), Sulphide, TPH (>C6-C40) Total (Calc), BTEX & MTBE by GCMS exceeded holding time.
- 2M6508SA 1.70 m, 4.97 m water samples: Electrical conductivity, pH, Cyanide (Total and Free), Sulphide, TPH (>C6-C40) Total (Calc), BTEX & MTBE by GCMS exceeded holding time.
- 3M6601HP 1.00 m, pH and GRO (>C6-C10) total deviation present due to exceeded holding time.

A non-standard volume has been used for PAH analysis on the following groundwater samples which has resulted in a raised detection limit.

- 2M6507SA (20 July 2023) and 2M6508SA (20 July 2023)
- 2M6508SA (15 September 2023)

A non-standard volume has been used for PAH and TPH (C_{10}-C_{40}) analysis on the following groundwater samples which has resulted in a raised detection limit.

- 2M6507SA (14 September 2023)

Appendix D: Geo-Environmental Laboratory Analysis Summary Screening Tables

Appendix E: HazWasteOnline™ Reports

Appendix F: Ground Gas Monitoring

Table F1: Ground Gas Monitoring Results Summary for within each monitoring within 2M6507SA (2)

Monitoring Round Date	Peak Gas Concentrations (minimum for Oxygen)						Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv		
18 April 2023 *	<0.1	1	20.2	12	<1	0	-5.5	1023
11 May 2023*	<0.1	0	6.7	3	1	0	-0.4	1014
25 May 2023	<0.1	5.7	4.2	4	1	0.9	<0.1	1027
20 June 2023	<0.1	<0.1	15.2	2	1	0	-0.6	1024
20 July 2023	<0.1	6.7	13.6	1	<1	<0.1	<0.1	1013
16 August 2023	<0.1	3.8	14.9	1	1	0.2	<0.1	1018
14 September 2023	<0.1	6.7	9.3	<1	<1	0	<0.1	1017
11 October 2023	<0.1	7.5	9.0	<1	<1	0	<0.1	1010
14 November 2023	0.1	1.8	11.6	<1	<1	<0.1	-2.8	1001
12 December 2023	0.1	1.0	16.2	<1	<1	30.2	-5.7	993
9 January 2024	0.1	0.8	21.2	<1	<1	0.1	-0.1	1026
7 February 2024	0.2	1.9	20.4	<1	<1	0.6	<0.1	1009
4 April 2024	<0.1	<0.1	19.7	0	<10	<0.1	-4.0	1000

Notes:
CH_4 – Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds.
ppmv – Part per Million Volume
* Pump flow fail due to high water level. Unable to fully complete gas monitoring

Table F2: Ground Gas Monitoring Results Summary for 2M6508SA (1)

Monitoring Round Date	Peak Gas Concentrations (minimum for Oxygen)						Max Gas Flow Rate (pk) l/hr	Atmospheric Pressure (mbar)
	CH_4 %vol	CO_2 %vol	O_2 %vol	CO ppm	H_2S ppm	VOC ppmv		
18 April 2023	<0.1	0.1	15.8	10	<1	0.7	<0.1	1024
11 May 2023	<0.1	0.1	15.8	4	1	0.3	2	1014
25 May 2023	<0.1	0.1	20	2	1	<0.1	<0.1	1027
20 June 2023	<0.1	0.4	20.3	2	<1	<0.1	-0.9	1002
20 July 2023	<0.1	0.4	20.4	1	1	0.4	<0.1	1013
16 August 2023	<0.1	0.4	20.3	1	1	0.5	<0.1	1018
14 September 2023	<0.1	0.8	20.5	<1	<1	<0.1	-0.1	1024
11 October 2023	<0.1	0.8	20.9	<1	<1	<0.1	<0.1	1010
9 January 2024	0.1	0.7	16.4	<1	<1	0.2	-0.1	1026
7 February 2024	0.1	0.5	21.2	<1	<1	<0.1	<0.1	1008
4 April 2024	<0.1	<0.1	19.72	0	<10	<0.1	0	1004

Notes:
CH_4 - Methane, CO_2 – Carbon Dioxide, O_2 – Oxygen, CO – Carbon Monoxide, H_2S – Hydrogen Sulphide, VOC – Volatile Organic Compounds.
ppmv - Part per Million Volume

Appendix G: Guidance for the assessment of Land Contamination

Selection of Soil Assessment Criteria Protective of Human Health

Generic Assessment Criteria (GAC)

To evaluate potential risks to human health receptors, including future Site users, the soil analytical results have been assessed against the following Generic Assessment Criteria (GAC):

- Suitable for Use Values (S4ULs) for commercial land use (Nathanail et al, 2015) adopting a 1% soil organic matter (SOM) value.
- Lead was compared against the Defra Category 4 Screening Level (C4SL) for a commercial end use, (Defra, 2014) because a S4UL for lead has not been published, also adopting a 1% SOM value.
- Cyanide (free) was compared to the Society of Brownfield Risk Assessment (SoBRA) Acute Generic Risk Assessment criteria for assessing risks to human health from contaminants in soil (Society of Brownfield Risk Assessment (SoBRA), 2020) since there are currently no C4SLs or S4ULs for cyanide. The assessment criteria used evaluates potential for acute harm to a child by inhalation of free cyanide. This is a conservative assessment criterion used as generic assessment criteria as allows the criteria to be adjusted if the Site-specific conditions are suitable.

The GAC for a Commercial/industrial end-use have been selected as these are considered to be the most appropriate for the protection of construction workers undertaking the development and the maintenance workers who may undertake maintenance/operational work at these locations. The GAC have been generated assuming short exposure periods over a long timescale.

The GAC have been generated using assumptions regarding soil characteristics. Where the published GAC are dependent upon Soil Organic Matter (SOM), a value of 1% has been used to provide a conservative assessment. Consideration of the default soil properties used to generate the soil GAC for protection of human health is important as these influence the fate, transport and behaviour of contaminants.

- Soil type – the model default is set as Sandy Loam and assumes a dry and relatively porous soil. The default is considered sufficiently similar to the soils which are variably clayey/ sandy.
- pH – pH influences the cation exchange capacity and the portioning behaviour of a chemical between soil and water. The default is pH 7. The ground encountered have been found to have a pH of typically between 7.4 and 8.7.

Selection of Water Assessment Criteria Protective of Heman Health and Aquatic Eco-systems (Controlled Waters)

The Site is located over a Principal aquifer (Culver Chalk Formation) and within a groundwater source protection zone 1. Active groundwater abstractions for potable water supply are within 250m from the proposed trenchless crossing excavations. Superficial deposits comprising Alluvium and River Terrace deposits are present (Secondary A aquifers). An unnamed tributary of the River Itchen is present within 100m of the proposed trenchless crossing. The tributary flows towards the River Itchen (a designated SSSI and SAC) which is located approximately 500 m east.

To evaluate potential risks to human health and controlled waters receptors, the leachate analysis results (2:1) and groundwater analysis results were assessed against the following:

- UK Drinking Water Standards (DWS) [1]
- Freshwater Environmental Quality Standards (EQS) annual average (AA) concentrations and maximum allowable concentrations (MAC) used where there is no AA.
- In the absence of a TPH threshold within the Water Supply [2](Water Quality) Regs 2021, the value of 10 µg/l as presented within the withdrawn Water Supply (Water Quality) Regs 1989 has been used for reference purposes. These thresholds are considered protective of human health.
- In the absence of a EQS for total ammonia the total ammonia as N (i.e., ammoniacal nitrogen as N) standard for rivers in the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 has been used; assuming a good status.

When assessing ground condition data and the potential to harm Controlled Waters, SSP uses the approach presented in Groundwater Protection Policy and Practice (GP3) (EA, 2017).

Bioavailable Environmental Quality Standards (EQS)

Bioavailable Environmental Quality Standards (EQS) have been developed for UK Specific Pollutants copper, zinc and manganese and the EU priority substances lead and nickel. An EQS is the concentration of a chemical in the environment below which there is not expected to be an adverse effect on the specific endpoint being considered, e.g., the protection of aquatic life.

The bioavailability of a metal depends on a number of physico-chemical factors which govern both metal behaviour and the interactions of the toxic forms of the metals with a biological receptor.

The EQS bioavailable corresponds to the bioavailable fraction (BioF) of dissolved metal in a sample, as determined by the physico-chemical characteristics of the water and can be calculated using a biotic ligand model (BLM) or other calculation method. To assess compliance, the bioavailable fraction of dissolved metal can be compared to the EQS bioavailable. However, bioavailable metal is not the same metric as dissolved metal as only a fraction of the dissolved metal will usually be bioavailable.

It is very difficult to measure the bioavailable concentration of a metal directly. Biotic Ligand Models (BLMs) are a predictive tool that can take account of water quality parameters such as pH, and calcium to determine

[1] DWI (2021) Guidance on The Water Supply (Water Quality) Regulations 2016 (as amended) specific to PFOS and PFOA concentrations in drinking water DWI, January 2021.

the amount of bioavailable metal present. However, the complexity of the models, the runtime per sample, input data requirements and level of operator skill needed to interpret the model outputs mean that few regulatory organisations have adopted the full BLMs. The UK has developed simplified Metal Bioavailability Assessment Tool (M-BAT) for copper, zinc, nickel, and manganese.

Geo-environmental laboratory analyses required to generate Site-specific Predicted No Effect Concentrations (PNEC) suitable for the protection of the identified receptors has not been undertaken. On this basis, to provide a conservative assessment the results have been compared against the EQS for copper, zinc, manganese, lead and nickel without a correction for bioavailability.

Limit of Detection vs. Generic Assessment Criteria

Where the concentration of a determinand is below the limits of detection and the limits of detection are below the relevant threshold criterion, the concentrations recorded are not considered to present a hazard to human health or controlled waters.

Where the concentration of a determinand is below the limit of detection and the limit of detection is greater than the relevant threshold criterion, ultra-low analysis or further Detailed Quantitative Risk Assessment would be required to robustly conclude that these can be eliminated as hazards.

Appendix H: Risk Assessment Tables

Table H1: Contaminated Land Risk Assessment for Section M

Location		Trenchless Crossing of an unnamed tributary to the River Itchen				
Potential Source of Contamination	**Potential Contaminants of Concern**	**Potential Receptors**	**Potential Pathways**	**Potential Consequence of Pollutant Linkage**	**Probability of Pollutant Linkage**	**Risk (Without mitigation measures)**
Open field (agricultural). GI locations 2M6507SA and 2M6508SA. GI not targeting PSCs.	Made Ground nor any visual or olfactory evidence of contamination was encountered during the GI. No exceedances of the GAC protective of human health in soil samples collected were detected. Soil leachable concentrations of cadmium and copper exceeded EQS and TPH exceeded Withdrawn Water Supply (Water Quality) Regulations 1989 GAC for the one leachate sample tested. Groundwater samples exceeded the TPH GAC, PAHs (anthracene, fluoranthene, benzo(g,h,i)perylene) and metals (chromium VI, zinc) exceeded the EQS. Carbon dioxide concentrations during monitoring exceeded STL and LTL workplace thresholds. Low oxygen levels were also encountered.	**Construction, maintenance workers and future Site users:** Construction workers during open cut excavations/construction, maintenance workers during operation.	Direct dermal contact, ingestion and inhalation of dusts	Medium	Low Likelihood	Moderate/Low
			Inhalation of gases and vapours.	Medium	Low Likelihood	Moderate/Low
		Adjacent land users: Otterbourne WSW (current operation); Solar Panel Farm users > 50 m distance.	Direct dermal contact, ingestion and inhalation of dusts, gases and vapours during excavation works	Medium	Unlikely Disturbance of ground during excavation activities.	Low
		On Site existing and future infrastructure property (buildings and buried services): No current structures, possible below ground valves at trenchless crossing points.	Direct contact and gas migration / accumulation.	Medium	Low Likelihood Temporary reception pits, possible below ground valve chambers, potential for accumulation of ground gas that could migrate to these features.	Moderate/Low
		Surface water bodies/watercourses: A surface watercourse tributary of the River Itchen adjacent to trenchless crossing Site. River Itchen (approximately 500m southeast).	Surface water runoff from stockpiles and migration through groundwater.	Medium	Likely Excavations beneath this watercourse, groundwater is likely to be hydraulic continuity with the surface watercourse.	Moderate
		Groundwater 2M6507SA and 2M6508SA encountered Superficial deposits of River Terrace Deposits and Alluvium (Secondary A Aquifers). White Chalk (Principal Aquifer), encountered at 14.1m bgl within 2M6507SA and 4.5m bgl within 2M6508SA. Section M is within a Source Protection Zone I.	Leaching through unsaturated and saturated soil.	Medium	Likely Potentially high-water table (groundwater between 0.98 and 4.5m bgl).	Moderate
		Ecological receptors (flora and fauna): The River Itchen (SSSI and SAC) approximately 500 m east.	Plant uptake, direct contact, ingestion and inhalation of dusts, gases and vapours by animals.	Mild	Low Likelihood	Low

Appendix I: Risk Assessment Methodology