East Midlands Gateway
Phase 2 (EMG2)

Document DCO 6.14F/MCO 6.14F (Part 4 of 6)

ENVIRONMENTAL STATEMENT

Technical Appendices

Appendix 14F

Preliminary Sources Study Affecting National Highways

October 2025

14

The East Midlands Gateway Phase 2
and Highway Order 202X and The East Midlands Gateway
Rail Freight and Highway (Amendment) Order 202X

SEGRO.COM/SLPEMG2

SEGRO


STRATA
GEOTECHNICS
Project Name: M1 J23a-25
Project No: 230600
Date: 28/6/23
Box No: 3
Borehole No: BH18515
Depth (M)
From: 5.00 To: 6.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm


STRATA
GEOTECHNICS
Project Name: M1 J23a-25
Project No: 230600
Date: 28/6/23
Box No: 3
Borehole No: BH18515
Depth (M)
From: 6.00 To: 7.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm


STRATA
GEOTECHNICS
Project Name: M1-J23A-25
Project No: 230899
Date: 15/6/23
Box No:
Borehole No: BH1877S
Depth (M)
From: 1.20
To: 2.0


STRATA
GEOTECHNICS
Project Name: M1-J23A-25
Project No: 230599
Date: 15/6/23
Box No:
Borehole No: BH1877S
Depth (M)
From: 2.0
To: 3.0


STRATA
GEOTECHNICS
Project Name: M1 J23A-
Project No: 230600
Date: 14/6/23
Box No:
Borehole No: BH1896S
Depth (M)
From: 1.20
To: 2.0


STRATA
GEOTECHNICS
Project Name: M1 J23A-
Project No: 230600
Date: 14/6/23
Box No:
Borehole No: BH1896S
Depth (M) From: 4.0 To: 5.0


STRATA
GEOTECHNICS
Project Name: M1-J23A-25
Project No: 230599
Date: 15/6/23
Box No:
Borehole No: BH1896S
Depth (M)
From: 9.20
To 10.0


STRATA
GEOTECHNICS
Project Name: M1-J23A-25
Project No: 230600
Date: 19/6/23
Box No:
Borehole No: BH1912S
Depth (M) From: 2.00 To: 3.00


STRATA
GEOTECHNICS
Project Name: M1 J23a - J25
Project No: 230600
Date: 03/07/23
Box No:
Borehole No: BH 1937N
Depth (M)
From: 2.00 To: 3.00


STRATA
GEOTECHNICS
Project Name: M1 J23a - J25
Project No: 230600
Date: 03/07/23
Box No:
Borehole No: BH 1937N
Depth (M)
From: 3.0
To: 3.5


STRATA
GEOTECHNICS
Project Name: M1 J23a-J25
Project No: 230600
Date: 03/07/23
Box No:
Borehole No: BH 1937N
Depth (M)
From: 3.50 To: 4.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm


STRATA
GEOTECHNICS
Project Name: M1 J23a - J25
Project No: 230600
Date: 03/07/23
Box No:
Borehole No: BH 1937N
Depth (M)
From: 4.00 To: 5.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm


STRATA GEOTECHNICS
Project Name: M1 J23a - J25
Project No: 230600
Date: 03/07/23
Box No:
Borehole No: BH 1937N
Depth (M) From: 600 To: 700
100mm 200mm 300mm 400mm 500mm 600mm 700mm 800mm 900mm
BH 1937N 230600 M1 J23a - J25 B40V 03/07/23 70


STRATA
GEOTECHNICS
Project Name: M1 J23a – J25
Project No: 230600
CB02
Date: 04-7-2023
Box No:
Borehole No: BH1937N
Depth (M)
From: 7.00
To: 8.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm


CB02
STRATA
GEOTECHNICS
Project Name: M1 J23a – J25
Project No: 230600
Date: 04-7-2023
Box No:
Borehole No: BH1937N
Depth (M)
From: 8.00
To: 9.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm


STRATA
GEOTECHNICS
Project Name: M1 J23a – J25
Project No: 230600
CB02
Date: 04-7-2023
Box No:
Borehole No: BH1937N
Depth (M)
From: 9.00
To: 10.00
100mm
200mm
300mm
400mm
500mm
600mm
700mm
800mm
900mm

Annex K Contaminated Land Screening Tables

ACUTE GENERIC ASSESSMENT CRITERIA TABLES

											Sample Location	BH1877N
											Sampled Date	45079
											Base Depth (m)	0.5
Analyte Group	Analyte	Unit	SOBRA_AGAC_DERMAL_ADULT	SOBRA_AGAC_INHALATION_ADULT	SOBRA_AGAC_ORAL_ADULT	Number of Results	Number of Detects	Exceedance of SOBRA AGAC: Adult Dermal	Exceedance of SOBRA AGAC: Adult Inhalation	Exceedance of SOBRA AGAC: Adult Oral	Result	
UK&I-RA-(SO)-Asbes	Asbestos (Presence	none				4	0	0	0	0	< 0.0001 ND	
UK&I-RA-(SO)-Inorg	Cyanide (Free)	mg/kg		1400	2100	10	0	0	0	0	< 1	
UK&I-RA-(SO)-Metal	Arsenic	mg/kg		14000000	7000	10	10	0	0	0	2	
UK&I-RA-(SO)-Metal	Cadmium	mg/kg		3500000	12000	10	5	0	0	0	2.4	
UK&I-RA-(SO)-VOC	Benzene	mg/kg	79000000	370	4100	7	0	0	0	0	< 0.005	

Notes
AGAC - Acute Generic Assessment Criteria
SOBRA - Society of Brownfield Risk Assessment
(blank) - no assessment criteria available
None - No unit
% - Percentage
mg/kg - milligrams per kilogram

						BH1877N	BH1877N	BH1877S	BH1896S	BH1912S	BH1920N
						45079	45079	45092	45089	45097	45097
						1	1.7	2	1.7	2	
Analyte Group	Analyte	Unit	SOBRA_AGAC_DERMAL_ADULT	SOBRA_AGAC_INHALATION_ADULT	SOBRA_AGAC_ORAL_ADULT	Result	Result	Result	Result	Result	Result
UK&I-RA-(SO)-Asbes	Asbestos (Presence	none									< 0.0001 ND
UK&I-RA-(SO)-Inorg	Cyanide (Free)	mg/kg		1400	2100	< 1	< 1	< 1	< 1	< 1	< 1
UK&I-RA-(SO)-Metal	Arsenic	mg/kg		14000000	7000	6.4	5.6	6.3	6.8	7.6	9
UK&I-RA-(SO)-Metal	Cadmium	mg/kg		3500000	12000	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1
UK&I-RA-(SO)-VOC	Benzene	mg/kg	79000000	370	4100	< 0.005		< 0.005		< 0.005	< 0.005

Notes
AGAC - Acute Generic Assessment Criteria
SOBRA - Society of Brownfield Risk Assessment
(blank) - no assessment criteria available
None - No unit
% - Percentage
mg/kg - milligrams per kilogram

						BH1933S	BH1933S	BH1933S
						45071	45071	45071
						0.3	1	1.4
Analyte Group	Analyte	Unit	SOBRA_AGAC_DERMAL_ADULT	SOBRA_AGAC_INHALATION_ADULT	SOBRA_AGAC_ORAL_ADULT	Result	Result	Result
UK&I-RA-(SO)-Asbes	Asbestos (Presence	none				< 0.0001 ND	< 0.0001 ND	
UK&I-RA-(SO)-Inorg	Cyanide (Free)	mg/kg		1400	2100	< 1	< 1	< 1
UK&I-RA-(SO)-Metal	Arsenic	mg/kg		14000000	7000	2.6	2.4	4.4
UK&I-RA-(SO)-Metal	Cadmium	mg/kg		3500000	12000	2.1	3.5	0.4
UK&I-RA-(SO)-VOC	Benzene	mg/kg	79000000	370	4100	< 0.005	< 0.005	

Notes
AGAC - Acute Generic Assessment Criteria
SOBRA - Society of Brownfield Risk Assessment
(blank) - no assessment criteria available
None - No unit
% - Percentage
mg/kg - milligrams per kilogram

GENERIC ASSESSMENT CRITERIA TABLES

								BH1877N 02/06/2023 0.5	BH1933S 17/05/2023 1.5	BH1933S 18/05/2023 1.4	BH1933S 19/05/2023 1.3	BH1933S 20/05/2023 1.2	BH1933S 21/05/2023 1.1	BH1933S 22/05/2023 1.0	BH1933S 23/05/2023 1.1
Analyte Group	Analyte	Unit	Threshold	Threshold Source	Number of Results	Number of Detects	Number of Exceedances	Result	Result	Result	Result	Result	Result	Result	Result
UK&I-RA-(SO)-Asbestos	Asbestos (Presence of)	none			4	0	0	< 0.0001 ND						< 0.0001 ND	< 0.0001 ND
UK&I-RA-(SO)-Asbestos	Mass of Sample	kg			10	10	0	1.7	1.7	1	0.6	1	2	1.2	1.7
UK&I-RA-(SO)-Inorganics	Moisture, percent	%			10	10	0	0.39	11	14	13	19	13	10	1.2
UK&I-RA-(SO)-Inorganics	pH	pH UNITS			10	10	0	9.3	8.7	8.4	8.7	8.9	8.9	8.1	10.7
UK&I-RA-(SO)-Inorganics	Total Organic Carbon	%			10	7	0	0.2	0.4	0.3	0.3	< 0.1	0.2	2.5	< 0.1
UK&I-RA-(SO)-Inorganics	Cyanide (Free)	mg/kg			10	0	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
UK&I-RA-(SO)-Inorganics	Cyanide (Total)	mg/kg			10	0	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
UK&I-RA-(SO)-Metals	Antimony	mg/kg	7500	EIC	10	3	0	< 1	< 1	< 1	2.7	2.6	< 1	3.9	< 1
UK&I-RA-(SO)-Metals	Arsenic	mg/kg	640	C4SL	10	10	0	2	6.4	5.6	6.3	6.8	7.6	9	2.6
UK&I-RA-(SO)-Metals	Barium	mg/kg	22000	EIC	10	10	0	460	130	220	96	120	140	270	130
UK&I-RA-(SO)-Metals	Beryllium	mg/kg	12	S4UL	10	10	0	0.11	0.92	1.2	1.2	1.1	1.1	1.1	0.11
UK&I-RA-(SO)-Metals	Boron	mg/kg	240000	S4UL	10	8	0	< 0.2	0.3	< 0.2	0.5	0.4	0.2	0.8	0.2
UK&I-RA-(SO)-Metals	Cadmium	mg/kg	410	C4SL	10	5	0	2.4	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1	2.1
UK&I-RA-(SO)-Metals	Chromium, Hexavalent (Cr6+)	mg/kg	49	C4SL	10	0	0	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
UK&I-RA-(SO)-Metals	Chromium, Trivalent (Cr3+)	mg/kg	8600	S4UL	10	10	0	3.8	24	28	39	29	30	21	3.3
UK&I-RA-(SO)-Metals	Chromium	mg/kg	8600		10	10	0	3.8	24	28	39	30	30	23	3.4
UK&I-RA-(SO)-Metals	Copper	mg/kg	68000	S4UL	10	10	0	5.4	22	15	11	21	14	86	6.8
UK&I-RA-(SO)-Metals	Iron	mg/kg			10	10	0	3200	28000	31000	820	3500	34000	26000	2100
UK&I-RA-(SO)-Metals	Lead	mg/kg	2300	C4SL	10	10	0	12	9.5	8.4	6.7	10	10	99	29
UK&I-RA-(SO)-Metals	Manganese	mg/kg			10	10	0	170	580	380	660	500	590	860	130
UK&I-RA-(SO)-Metals	Mercury	mg/kg	1100	S4UL	10	0	0	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
UK&I-RA-(SO)-Metals	Molybdenum	mg/kg	17000	EIC	10	7	0	< 0.25	0.64	0.51	0.28	0.5	0.46	1.4	0.26
UK&I-RA-(SO)-Metals	Nickel	mg/kg	980	S4UL	10	10	0	4	26	27	35	28	27	20	4.2
UK&I-RA-(SO)-Metals	Selenium	mg/kg	12000	S4UL	10	0	0	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
UK&I-RA-(SO)-Metals	Vanadium	mg/kg	9000	S4UL	10	10	0	7.2	26	33	35	32	38	40	4.9
UK&I-RA-(SO)-Metals	Zinc	mg/kg	730000	S4UL	10	10	0	36	53	79	59	67	69	190	24
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C5-C6	mg/kg	3200	S4UL	7	0	0	< 0	< 0		< 0		< 0	< 0	< 0
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C6-C8	mg/kg	7800	S4UL	7	0	0	< 0	< 0		< 0		< 0	< 0	< 0
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C8-C10	mg/kg	2000	S4UL	7	0	0	< 0	< 0		< 0		< 0	< 0	< 0
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C10-C12	mg/kg	9700	S4UL	7	1	0	< 1	< 1		2.4		< 1	< 1	< 1
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C12-C16	mg/kg	59000	S4UL	7	2	0	< 2	< 2		5.4		4.3	< 2	< 2
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C16-C21	mg/kg	1600000	S4UL	7	1	0	< 8	< 8		12		< 8	< 8	< 8
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C21-C35	mg/kg	1600000	S4UL	7	2	0	< 8	< 8		35		< 8	16	< 8
UK&I-RA-(SO)-TPHCWG	TPH Aliphatic >C5-C35	mg/kg			7	3	0	< 10	< 10		54		12	18	< 10
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C5-C7	mg/kg	26000	S4UL	7	0	0	< 0	< 0		< 0		< 0	< 0	< 0
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C7-C8	mg/kg	56000	S4UL	7	0	0	< 0	< 0		< 0		< 0	< 0	< 0
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C8-C10	mg/kg	3500	S4UL	7	0	0	< 0	< 0		< 0		< 0	< 0	< 0
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C10-C12	mg/kg	16000	S4UL	7	0	0	< 1	< 1		< 1		< 1	< 1	< 1
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C12-C16	mg/kg	36000	S4UL	7	0	0	< 2	< 2		< 2		< 2	< 2	< 2
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C16-C21	mg/kg	28000	S4UL	7	0	0	< 10	< 10		< 10		< 10	< 10	< 10
UK&I-RA-(SO)-TPHCWG	TPH Aromatic >C21-C35	mg/kg	28000	S4UL	7	2	0	13	< 10		< 10		< 10	12	< 10
UK&I-RA-(SO)-Other TPH	TPH Aromatics > C6-C35	mg/kg			7	2	0	22	< 10		< 10		< 10	17	< 10
UK&I-RA-(SO)-VOC	Benzene	mg/kg	27	C4SL	7	0	0	< 0.005	< 0.005		< 0.005		< 0.005	< 0.005	< 0.005
UK&I-RA-(SO)-VOC	Toluene	mg/kg	56000	S4UL	7	0	0	< 0.005	< 0.005		< 0.005		< 0.005	< 0.005	< 0.005
UK&I-RA-(SO)-VOC	Ethylbenzene	mg/kg	5700	S4UL	7	0	0	< 0.005	< 0.005		< 0.005		< 0.005	< 0.005	< 0.005
UK&I-RA-(SO)-VOC	m & p-Xylene	mg/kg	5900	S4UL	7	0	0	< 0.005	< 0.005		< 0.005		< 0.005	< 0.005	< 0.005
UK&I-RA-(SO)-VOC	o-Xylene	mg/kg	6600	S4UL	7	0	0	< 0.005	< 0.005		< 0.005		< 0.005	< 0.005	< 0.005
UK&I-RA-(SO)-VOC	Methyl Tert-Butyl Ether	mg/kg	7900	EIC	7	0	0	< 0.005	< 0.005		< 0.005		< 0.005	< 0.005	< 0.005

Notes
GAC - Generic Assessment Criteria
(blank) - no assessment criteria available
None - No unit
% - Percentage
mg/kg - milligrams per kilogram

C4SL – DEFRA Category 4 Screening Levels for Assessment of Land Affected by Contamination
S4UL – LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment
EIC - EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment

				BH1933S 24/05/2023 1.2	BH1933S 25/05/2023 1.3
Analyte Group	Analyte	Unit	Threshold	Result	Result
UKBI-RA-(SO)-Asbestos	Asbestos (Presence of)	none		< 0.0001 ND	
UKBI-RA-(SO)-Asbestos	Mass of Sample	kg		1.7	1.8
UKBI-RA-(SO)-Inorganics	Moisture, percent	%		0.98	11
UKBI-RA-(SO)-Inorganics	pH	pH UNITS		9.6	9
UKBI-RA-(SO)-Inorganics	Total Organic Carbon	%		< 0.1	0.1
UKBI-RA-(SO)-Inorganics	Cyanide (Free)	mg/kg		< 1	< 1
UKBI-RA-(SO)-Inorganics	Cyanide (Total)	mg/kg		< 1	< 1
UKBI-RA-(SO)-Metals	Antimony	mg/kg	7500	< 1	< 1
UKBI-RA-(SO)-Metals	Arsenic	mg/kg	640	2.4	4.4
UKBI-RA-(SO)-Metals	Barium	mg/kg	22000	730	360
UKBI-RA-(SO)-Metals	Beryllium	mg/kg	12	0.19	0.93
UKBI-RA-(SO)-Metals	Boron	mg/kg	240000	0.2	0.3
UKBI-RA-(SO)-Metals	Cadmium	mg/kg	410	3.5	0.4
UKBI-RA-(SO)-Metals	Chromium, Hexavalent (Cr6+)	mg/kg	49	< 1.8	< 1.8
UKBI-RA-(SO)-Metals	Chromium, Trivalent (Cr3+)	mg/kg	8600	4.7	36
UKBI-RA-(SO)-Metals	Chromium	mg/kg	8600	4.8	37
UKBI-RA-(SO)-Metals	Copper	mg/kg	68000	16	14
UKBI-RA-(SO)-Metals	Iron	mg/kg		4800	32000
UKBI-RA-(SO)-Metals	Lead	mg/kg	2300	28	9.1
UKBI-RA-(SO)-Metals	Manganese	mg/kg		190	460
UKBI-RA-(SO)-Metals	Mercury	mg/kg	1100	< 0.3	< 0.3
UKBI-RA-(SO)-Metals	Molybdenum	mg/kg	17000	< 0.25	< 0.25
UKBI-RA-(SO)-Metals	Nickel	mg/kg	980	4.6	34
UKBI-RA-(SO)-Metals	Selenium	mg/kg	12000	< 1	< 1
UKBI-RA-(SO)-Metals	Vanadium	mg/kg	9000	7.7	33
UKBI-RA-(SO)-Metals	Zinc	mg/kg	730000	48	51
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C5-C6	mg/kg	3200	< 0	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C6-C8	mg/kg	7800	< 0	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C8-C10	mg/kg	2000	< 0	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C10-C12	mg/kg	9700	< 1	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C12-C16	mg/kg	59000	< 2	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C16-C21	mg/kg	1600000	< 8	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C21-C35	mg/kg	1600000	< 8	
UKBI-RA-(SO)-TPHCWG	TPH Aliphatic >C5-C35	mg/kg		< 10	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C5-C7	mg/kg	26000	< 0	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C7-C8	mg/kg	56000	< 0	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C8-C10	mg/kg	3500	< 0	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C10-C12	mg/kg	16000	< 1	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C12-C16	mg/kg	36000	< 2	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C16-C21	mg/kg	28000	< 10	
UKBI-RA-(SO)-TPHCWG	TPH Aromatic >C21-C35	mg/kg	28000	< 10	
UKBI-RA-(SO)-Other TPH	TPH Aromatics > C6-C35	mg/kg		< 10	
UKBI-RA-(SO)-VOC	Benzene	mg/kg	27	< 0.005	
UKBI-RA-(SO)-VOC	Toluene	mg/kg	56000	< 0.005	
UKBI-RA-(SO)-VOC	Ethylbenzene	mg/kg	5700	< 0.005	
UKBI-RA-(SO)-VOC	m & p-Xylene	mg/kg	5900	< 0.005	
UKBI-RA-(SO)-VOC	o-Xylene	mg/kg	6600	< 0.005	
UKBI-RA-(SO)-VOC	Methyl Tert-Butyl Ether	mg/kg	7900	< 0.005	

Notes
GAC - Generic Assessment Criteria
(blank) - no assessment criteria available
None - No unit
% - Percentage
mg/kg - milligrams per kilogram

C4SL – DEFRA Category 4 Screening Levels for Assessment of Land Affected by Contaminat
S4UL – LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment
EIC - EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment

Annex L ZETICA UXO Bomb Risk Maps

EA-SB-185/1

UNEXPLODED BOMB RISK MAP

zeticauxo

SITE LOCATION

Map Centre: 447265,333920



LEGEND

- **High:** Areas indicated as having a bombing density of 50 bombs per 1000acre or higher.
- **Moderate:** Areas indicated as having a bombing density of 15 to 49 bombs per 1000acre.
- **Low:** Areas indicated as having 15 bombs per 1000acre or less.

miltary | industry | UXO find
transport | dock | Luftwaffe targets
utilities | Bombing decoy | other

How to use your Unexploded Bomb (UXB) risk map?
The map indicates the potential for Unexploded Bombs (UXB) to be present as a result of World War Two (WWII) bombing.

You can incorporate the map into your preliminary risk assessment* for potential Unexploded Ordnance (UXO) for a site. Using this map, you can make an informed decision as to whether more in-depth detailed risk assessment* is necessary.

What do I do if my site is in a moderate or high risk area?
Generally, we recommend that a detailed UXO desk study and risk assessment is undertaken for sites in a moderate or high UXB risk area.

Similarly, if your site is near to a designated Luftwaffe target or bombing decoy then additional detailed research is recommended.

More often than not, this further detailed research will conclude that the potential for a significant UXO hazard to be present on your site is actually low.

Never plan site work or undertake a risk assessment using these maps alone. More detail is required, particularly where there may be a source of UXO from other military operations which are not reflected on these maps.

If my site is in a low risk area, do I need to do anything?
If both the map and other research confirms that there is a low potential for UXO to be present on your site then, subject to your own comfort and risk tolerance, works can proceed with no special precautions.

A low risk really means that there is no greater probability of encountering UXO than anywhere else in the UK.

If you are unsure whether other sources of UXO may be present, you can ask for one of our **pre-desk study assessments (PDSA)**

If I have any questions, who do I contact?

tel: **+44 (0) 1993 886682**

email: **uxo@zetica.com**

web: **www.zeticauxo.com**

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EA-NB-187/8 & SB-187/7

UNEXPLODED BOMB RISK MAP

zeticauxo

SITE LOCATION

Map Centre: 446862,330016



LEGEND

- **High:** Areas indicated as having a bombing density of 50 bombs per 1000acre or higher.
- **Moderate:** Areas indicated as having a bombing density of 15 to 49 bombs per 1000acre.
- **Low:** Areas indicated as having 15 bombs per 1000acre or less.

miltary | **industry** | **UXO find**
transport | **dock** | **Luftwaffe targets**
utilities | **Bombing decoy** | **other**

How to use your Unexploded Bomb (UXB) risk map?

The map indicates the potential for Unexploded Bombs (UXB) to be present as a result of World War Two (WWII) bombing.

You can incorporate the map into your preliminary risk assessment* for potential Unexploded Ordnance (UXO) for a site. Using this map, you can make an informed decision as to whether more in-depth detailed risk assessment* is necessary.

What do I do if my site is in a moderate or high risk area?

Generally, we recommend that a detailed UXO desk study and risk assessment is undertaken for sites in a moderate or high UXB risk area.

Similarly, if your site is near to a designated Luftwaffe target or bombing decoy then additional detailed research is recommended.

More often than not, this further detailed research will conclude that the potential for a significant UXO hazard to be present on your site is actually low.

Never plan site work or undertake a risk assessment using these maps alone. More detail is required, particularly where there may be a source of UXO from other military operations which are not reflected on these maps.

If my site is in a low risk area, do I need to do anything?

If both the map and other research confirms that there is a low potential for UXO to be present on your site then, subject to your own comfort and risk tolerance, works can proceed with no special precautions.

A low risk really means that there is no greater probability of encountering UXO than anywhere else in the UK.

If you are unsure whether other sources of UXO may be present, you can ask for one of our **pre-desk study assessments (PDSA)**

If I have any questions, who do I contact?

tel: **+44 (0) 1993 886682**

email: **uxo@zetica.com**

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EA-NB-190/2 & MS4-NB-190/5

UNEXPLODED BOMB RISK MAP

zeticaUXO

SITE LOCATION

Map Centre: 447546,327389



LEGEND

- **High:** Areas indicated as having a bombing density of 50 bombs per 1000acre or higher.
- **Moderate:** Areas indicated as having a bombing density of 15 to 49 bombs per 1000acre.
- **Low:** Areas indicated as having 15 bombs per 1000acre or less.

miltary | **industry** | **UXO find**
transport | **dock** | **Luftwaffe targets**
utilities | **Bombing decoy** | **other**

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EA-NB-192/0

UNEXPLODED BOMB RISK MAP

zeticauxo

SITE LOCATION

Map Centre: 446872,332634



LEGEND

- **High:** Areas indicated as having a bombing density of 50 bombs per 1000acre or higher.
- **Moderate:** Areas indicated as having a bombing density of 15 to 49 bombs per 1000acre.
- **Low:** Areas indicated as having 15 bombs per 1000acre or less.

- miltary
- industry
- UXO find
- transport
- dock
- Luftwaffe targets
- utilities
- Bombing decoy
- other

How to use your Unexploded Bomb (UXB) risk map?
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EA-SB-193/4

UNEXPLODED BOMB RISK MAP

zeticaUXO

SITE LOCATION

Map Centre: 447171,335387



LEGEND

- **High:** Areas indicated as having a bombing density of 50 bombs per 1000acre or higher.
- **Moderate:** Areas indicated as having a bombing density of 15 to 49 bombs per 1000acre.
- **Low:** Areas indicated as having 15 bombs per 1000acre or less.

miltary	industry	UXO find
transport	dock	Luftwaffe targets
utilities	Bombing decoy	other

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Annex M Series 600 Specification

M1 J23A TO J25

SERIES 600

EARTHWORKS

SPECIFICATION

Date: 27/02/24

Disclaimer: The listed deliverables have been prepared and issued in accordance with the provisions of the Smart Motorways Alliance Contract between the Alliance and National Highways. The Alliance Partners accept no third-party liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon these deliverables by anyone other than the Smart Motorways Partners or National Highways.

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Required Approvals

Name	Signature	Title	Date of Issue	Version

Contents:

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APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING ETC. OF EARTHWORKS MATERIALS

1. General

A schedule defining fill classes and acceptability limits for the fill materials required for this contract is given in Table 6/1 of this Appendix. If additional classes of material are required, then Table 6/1 shall be updated.

Unless described in this Appendix, other acceptability limits are as shown in Table 6/1 and 6/3 of the Specification for Highways Works (SHW) Series 600.

Unless described in this Appendix, the grading requirements for each class of fill are given in Table 6/2 and Table 6/5 of the Specification for Highways Works (SHW) Series 600.

The compaction requirements are given in Table 6/4 and Clause 612 of the SHW Series 600.

2. Fill acceptability and classification requirements

It is anticipated that all proposed earthworks fill material will be imported. The classification and confirmation of acceptability of the imported fill shall be carried out by the Contractor and shall satisfy the limits detailed in Table 6/1.

The Contractor is responsible for determining the acceptability and classification of materials at source and is responsible for preventing any deterioration of condition in transport and deposition. The minimum frequency of compliance tests shall be in accordance with Appendix 1/5 in Series 100 Specification (HE614830-WSP-HGN-P015_AL_ALLGENR-SP-CH-0001), with additional testing to be undertaken as agreed between the Contractor and the Designer's Geotechnical Advisor (DGA).

Where the DGA is of the opinion that the classification of the site arisings for reuse as fill, or imported material, have changed, the Contractor will be required to repeat the tests against Appendix 1/5 to ensure compliance.

For confirmation of chemical suitability of imported materials (not including secondary/recycled aggregates or clean virgin fill), testing is to be completed at source and be carried out and assessed against the limiting criteria provided in Specification Appendix 6/14 and 6/15. Source approval will comprise (as a minimum) 3 sets of the relevant test on each sub-class of material to be used in the Contract. Source approval tests will have to be within 6 months of the fill's proposed use and must be taken from the same area/quarry lift as the proposed fill.

The Contractor is to make all test result summaries available electronically for viewing, filtering/ querying and print out in a format to be agreed with the Client (provisionally Microsoft Excel format) and shall include the following information for each test:

- Unique Reference of test
- XYZ coordinates,
- Time,
- Date,
- Material description in accordance with BS 5930:2015+A1:2020 and test results as required by BS 1377-2:2022 + BS EN ISO 17892-1 to 12, Parts 1 to 9 (as applicable).

Each sample tested for geotechnical or chemical properties shall be visually described in accordance with BS EN ISO 14688-1:2002 and BS EN 14688-2:2004. Copies of these records

shall be submitted to the Designer's Geotechnical Advisor (DGA), [redacted] , within five working days.

Final compliance testing of the earthworks materials shall be made by the Contractor after deposition where end-product compaction is specified. However, where the properties of the materials change between excavation or deposition, or the material undergoes significant deterioration during compaction, further testing and sampling may be carried out at the point of deposition following agreement between the Contractor and the DGA where Method Compaction has been adopted. The DGA shall be informed of any change in properties of earthworks materials.

In situ density tests (sand replacement method in accordance with BS 1377 Part 9, clause 2.2 or 2.3 as appropriate or Nuclear Density Gauge (NDG) in accordance with BS1377 Part 9) to verify the required compaction for Class 6N material has been achieved, shall be undertaken as detailed in Table 1/5. Nuclear Density Gauge (NDG) shall be calibrated in accordance with BS1377 Part 9, Clause 2.5.5.3.1, with the additional requirement that the box depth for calibration test must be 1.5 times the max stone size.

In situ CBR value of cohesive subgrades (generally with strength in the range 2%<CBR<6%) may be assessed using a Dynamic Cone Penetrometer (i.e. DCP) as described in CS 229.

Testing using MCV equipment may be carried out on site for material acceptability where MCV limits have been specified in Table 6/1. When sources are confirmed, and actual test results received for each source, relationship testing will be carried out and subsequently MCV limits in Table 6/1 may be reset at that time. Any such proposals are to be agreed with the DGA.

Any Class U unacceptable material excavated, is to be removed from site or treated so that it complies with the Specification. Any proposal by the Contractor for processing of unacceptable fill into acceptable is to be agreed with the DGA.

3. Requirements for treatment/handling/disposal of material arisings from the works

It is anticipated that site won material will not be acceptable for earthworks fill and shall be processed or disposed of in an authorised facility in accordance with the Contractor's Materials Management Plan. Site won material may be processed for use as landscape fill subject to the requirements outlined in the Series 3000 Specification Appendices [redacted]

Any Class 1 material arising from the Works which is unacceptable solely by reason of moisture content and where the Contractor wishes to reuse such material, shall be treated by the Contractor by raising or lowering the moisture content to a level necessary to comply with the acceptable limits of the moisture content required in Appendix 6/1.

Where such material is unacceptable solely by reason of grading, the Contractor may break down the material to a size complying with the acceptable limits of the grading as stated in Table 6/1.

Specific requirements for processing unacceptable (Class U1) to acceptable material shall be determined by the Contractor. Where Class U1A and U1B unacceptable material is present at formation level, it shall be excavated and removed from site and replaced with either Class 1 or Class 6 granular fill as designated on the drawings.

Class U1B and U2 material can be processed to meet the limiting concentrations and acceptability limits of contaminants as set out in Specification Appendices 6/14 and 6/15. If it is not possible to process the Class U1B/U2 material to meet the limiting concentrations and acceptability limits of contaminants as set out in Specification Appendices 6/14 and 6/15, disposal of the materials off site will be required.

Earthworks materials created by demolition works are to be classified as Class U1A and be processed to meet the acceptability limits as set out in Specification Appendices 6/14 and 6/15.

As far as it is practical, the Contractor should process Class U1A demolition material into Selected Fill or General Fill.

The type, location and volume of any materials deemed hazardous which the Contractor wishes to process/treat to render the materials as non-hazardous is to be agreed with the Designer prior to commencement. The Contractor shall be responsible for obtaining all licences/permits to undertake these works, and the validation of the land utilised for such works to show that it is suitable for use following completion of the Works.

4. Groundwater

In accordance with Clause 601.15, all reasonable measures shall be taken to keep construction areas free of groundwater infiltration and the effects of weather. The Contractor shall maintain the stability of all excavations and ensure that the formation is protected from damage.

Where provided, all permanent drains are to be constructed ahead of excavation to formation level to prevent water ingress and softening of the ground.

Where a high-water table is identified within a proposed area of excavation, groundwater control measures may be required.

The Contractor shall allow and be responsible for the control of groundwater in all temporary excavations and in all temporary situations during the works. Pumping into existing watercourses or sewers shall only be permitted upon provision of a detailed method statement and its subsequent approval by the relevant authorities.

Pumping into existing watercourses or sewers shall only be permitted upon provision of a detailed method statement (considering turbidity and chemical requirements) and its subsequent approval by the relevant authorities.

Table 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements

Class	General Material Description	Typical Use	Permitted Constituents	Material Properties Required for Acceptability				Compaction Requirements (Clause 612)
				Property	Test in accordance with	Acceptable Limits within: Lower	Acceptable Limits within: Upper	
General granular fill 1A	Well graded granular material	General fill for earthworks with slope gradient equal or flatter than 1(v):2(h)	Any material, or combination of materials, other than material designated as Class 3 in the Contract. (Properties (i), (ii) and (iv) in next column, shall not apply to chalk). Recycled aggregate. Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9, and 10: P (natural aggregates); A (construction and demolition recycling industries); B1 (municipal incinerator bottom ash (MIBA)); D2 (air cooled blast furnace slag) D3 (basic oxygen furnace slag) D4 (electric arc furnace slag (EAF C)) E (non ferrous steel industry – except E2 molybdenum slag) G (mining and quarry industry)	(i) grading	BS 1377: Part 2 or BS EN 13242	Tab 6/2	Tab 6/2	Tab 6/4 Method 2
				(ii) uniformity coefficient	See Note 5	10	-	
				(iii) mc	BS 1377: Part 2 See Note 4	OMC-3%	OMC+1%	
				(iv) MCV	Clause 632	-	-	
				(v) IDD of chalk	Clause 634	-	-	
				(vi) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	Φ'= 36° c'= 0kPa	-	
Topsoil 5A	Topsoil, or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A in the Contract	(i) grading	BS 1377: Part 2 or BS EN 13242	Clause 618	Clause 618	-
Topsoil 5B	Imported topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-
Selected Granular Fill 6C	Selected uniformly graded granular material	Starter Layer	Natural gravel, natural sand, crushed gravel, crushed rock other than argillaceous rock, crushed concrete, chalk, well burnt colliery spoil, slag or any combination thereof. (Property (iii) in next column, shall not apply to chalk.) Recycled aggregate. Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN	(i) grading	BS 1377: Part 2 (On-site)	Tab 6/2	Tab 6/2	Tab 6/4 Method 3
					BS EN 933-2 (Imported onto site)	Tab 6/5	Tab 6/5	
				(ii) uniformity coefficient	See Note 5	-	10	

Class	General Material Description	Typical Use	Permitted Constituents	Material Properties Required for Acceptability				Compaction Requirements (Clause 612)
				Property	Test in accordance with	Acceptable Limits within: Lower	Acceptable Limits within: Upper	
			13242 from one or more of the following source codes, see Notes 8, 9, and 10: P (natural aggregates – except shale, siltstone or slate, see Note 7); A (construction and demolition recycling industries); D2 (air cooled blast furnace slag) D3 (basic oxygen furnace slag) D4 (electric arc furnace slag (EAF C)) G1 (red coal shale) G3 (pre-selected all-in from quarrying/mining)	(iii) plasticity index	BS 1377: Part 2	Non-plastic		
				(iv) Los Angeles	Clause 635	-	50	
				(v) mc	BS 1377: Part 2 See Note 4	Limits to be derived to achieve 95% of lab max dry density 2.5kg rammer	Limits to be derived to achieve 95% of lab max dry density 2.5kg rammer	
				(vi) effective angle of internal friction (φ') and effective cohesion (c')	Clause 636	-	-	
Selected Granular Fill 6F2		Capping	Any material, or combination of materials - including recycled aggregates with not more than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials contaminated with tar and tar bitumen binders, unburnt colliery spoil and argillaceous rock. Property (i) in the next column shall not apply to chalk. Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less. Where material in this Class is imported onto site it shall be classified as Class 6F5 and comply with the requirements for that material.	(i) grading	BS 1377: Part 2 (On site materials only)	Tab 6/2	Tab 6/2	Tab 6/4 Method 6
				(ii) optimum mc	BS 1377: Part 4 (vibrating hammer method)	-	-	
				(iii) mc	BS 1377: Part 2 See Note 4	OMC-3% (vibrating hammer)	OMC+1% (vibrating hammer)	
				(iv) Los Angeles coefficient	Clause 635	-	50	
				(v) Class Ra (asphalt) content	Clause 710	-	50%	
				(vi) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	2%	
6F3		Capping		(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	

Class	General Material Description	Typical Use	Permitted Constituents	Material Properties Required for Acceptability				Compaction Requirements (Clause 612)
				Property	Test in accordance with	Acceptable Limits within: Lower	Acceptable Limits within: Upper	
Selected Granular Fill	Selected granular material		Any material, or combination of materials with not less than 50% by mass of recycled bituminous plannings and granulated asphalt, but excluding materials contaminated with tar and tar-bitumen binders, unburnt colliery spoil and argillaceous rock. Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from the following source codes, see Notes 8, 9 and 10: A1 (reclaimed asphalt) A4 (mixed recycled aggregate) Aggregates from source code A4 shall contain at least 50% of constituents in Class Ra (bituminous materials).	(ii) optimum mc	BS 1377: Part 4 (vibrating hammer method)	-	-	Table 6/4 Method 6 (maximum thickness – 200mm)
				(iii) mc	BS 1377: Part 2	OMC-3% (vibrating hammer)	OMC+1% (vibrating hammer)	
				(iv) Class Ra (asphalt) content	Clause 710	-	50%	
				(v) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	10%	
Selected Granular Fill 6F5	Selected granular material (coarse grading) – imported on to the Site	Capping	Unbound mixture complying with BS EN 13285 containing aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10: P (natural aggregates – except chalk, shale, siltstone or slate, see Note 7) A2 (crushed concrete) A3 (crushed bricks, masonry) A4 (mixed recycled aggregate) B1 (municipal incinerator bottom ash (MIBA)) D2 (air cooled blast furnace slag) D3 (basic oxygen furnace slag) D4 (electric arc furnace slag (EAF C)) G (mining and quarry industry – except G2 (black coal shale))	(i) Size designation and overall grading category	BS EN 13285 – 0/80 and G_E	Tab 6/5	Tab 6/5	Tab 6/4 Method 6
				(ii) Maximum fines and oversize categories	BS EN 13285 – UF_{12} and OC_{75}	Tab 6/5	Tab 6/5	
				(iii) Los Angeles coefficient	BS EN 13242 – LA_{50}	-	50	
				(iv) Volume stability of blast furnace slag	BS EN 13242 – free from dicalcium silicate and iron disintegration	-	-	
				(v) Volume stability of steel	BS EN 13242 – V_5	-	-	

Class	General Material Description	Typical Use	Permitted Constituents	Material Properties Required for Acceptability				Compaction Requirements (Clause 612)
				Property	Test in accordance with	Acceptable Limits within: Lower	Acceptable Limits within: Upper	
			Aggregates from source code A4 shall contain not more than 50% of constituents in Class Ra (bituminous materials). Property (x) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(BOF) and EAF) slag				
				(vi) Other aggregate requirements	BS EN 13242 – Category NR (no requirement)	-	-	
				(vii) Laboratory dry density and optimum water content	BS EN 13285, Clause 5.3 – declared values	-	-	
				(viii) Water content	BS EN 1097-5	OMC-3% (vibrating hammer)	OMC+1% (vibrating hammer)	
				(ix) Class R_a (asphalt) content	Clause 710	-	50%	
				(x) bitumen content	BS EN 12697-1 or BS EN 12697-39	0	2.0%	
Selected Granular Fill 6N	Selected well graded granular materials	Fill to Structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt. Where material is imported onto site which is not 'as dug' it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10: P (natural aggregates – except shale, siltstone or slate, see Note 7) A2 (crushed concrete) A3 (crushed bricks, masonry) D2 (air cooled blast furnace slag) G1 (red coal shale).	(i) grading	BS 1377: Part 2 (On-site)	Tab 6/2	Tab 6/2	End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)
					BS EN 933-2 (Imported onto site)	Tab 6/5	Tab 6/5	
				(ii) uniformity coefficient	See Note 3	10	-	
				(iii) Los Angeles coefficient	Clause 635	-	40	
				(iv) undrained shear parameters (c and φ)	Clause 633	-	-	
				(v) effective angle of internal friction (φ') and	Clause 636	Φ'= 36° c'= 0kPa	-	

Class	General Material Description	Typical Use	Permitted Constituents	Material Properties Required for Acceptability				Compaction Requirements (Clause 612)
				Property	Test in accordance with	Acceptable Limits within: Lower	Acceptable Limits within: Upper	
				effective cohesion (c')				
				(vi) permeability	Clause 640	5×10^{-5} m/s	-	
				(vii) mc	BS 1377: Part 2 See Note 4	OMC -2% (vibrating hammer)	OMC +2% (vibrating hammer)	
				(viii) MCV	Clause 632	-	-	
				(ix) Slope stability test (where required in App 6/6)	Clause 610	-	-	
Misc Fill 8	Class 1 or Class 2 material	Lower trench fill	Not Used					

Footnotes to Table 6/1

1. **Tab = Table**
2. **Where BS EN 17892-4 is specified for grading, this shall mean BS EN 17892-4 or BS EN 933-1 as appropriate**
3. **Uniformity coefficient is defined as the ratio of the particle diameters D_{60} to D_{10} on the particle size distribution curve where:**
   D_{60} = particle diameter at which 60% of the soil by weight is finer
   D_{10} = particle diameter at which 10% of the soil by weight is finer
4. **Determination of the moisture content shall be made from that part of the material passing the 20mm BS sieve.**
5. **OMC = optimum moisture**
6. **Some of the standards given in the SHW have been superseded, Table 6/1 gives the most up to date standards in these instances.**
7. **Allowable moisture content values subject to review following receipt of source approval. To be advised by the Designer.**
8. **Where material source codes are referenced these are listed in Table 6/7.**
9. **Where materials are required to be aggregates conforming to BS EN 13242 materials certified as being compliant with BS EN 13285 are acceptable for use provided that they meet all the specification requirements and the Declaration of Performance for constituent parts to BS EN 13242 are provided to the Overseeing Organisation.**
10. **Materials shall comply with the current Environmental Regulations at the time of use. Reference shall be made to Annex ZA (informative) of BS EN 13242.**

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS

5. General

Historical reports such as the Ground Investigation Report (Amey Arup JV, 2016)), Geotechnical Design Report (Amey Arup JV, 2017) and Preliminary Sources Study Report (ARUP, 2004) describe moderate to slight potential sources of contamination along the scheme. However, the 2023 Strata Geotechnics ground investigation detected no visual or olfactory evidence in soils, no contaminants have been recorded above the human health GAC or AGAC, and no asbestos has been recorded.

Where suspicion of contamination has been identified in the historical reports, or on encountering potentially unacceptable or contaminated material in areas not identified in the report, a watching brief shall be immediately established, where a suitably experienced contaminated land professional shall be in attendance. If additional areas of contamination or unacceptable material are identified on site, this operation shall be extended to cover these areas.

6. Identification of Unacceptable Materials

Should Class U1B or U2 Materials be encountered during the works, a specialist environmental chemist (employed by the Contractor) shall satisfy themselves by chemical analysis, that the material is not Class U1B or U2 material or otherwise hazardous. If Class U1B or U2 materials are encountered on site, then works in that area shall immediately cease and the Contractor shall make all necessary arrangements for their safe handling and disposal after consultation with the Client, the appropriate Local Authority Contaminated Land Officer or Environment Agency and, if necessary, the Health and Safety Executive.

Any suspected contaminated materials identified during the works should be isolated and submitted for separate testing and assessment in order to determine the appropriate treatment for re-use or disposal route. If the Contractor has reason to believe that Class U1B or U2 material has been encountered, the Contractor shall immediately carry out tests to determine the nature and degree of contamination.

Testing must be carried out by an UKAS accredited laboratory using MCERTS accredited tests where available and applicable. One copy of the results must be submitted to the Client's Representative or specialist environmental chemist within five working days of such material being uncovered.

A Method Statement shall be submitted by the Contractor to the Designer detailing how any materials suspected of being Class U1B or U2 shall be sampled and tested. The Contractor shall also be responsible for the preparation of any additional method statements for dealing with wastes, hazardous materials, and contaminated ground, groundwater and surface water. All method statements shall be pre-agreed with the necessary environmental authority, e.g. the Environment Agency.

The Contractor shall be responsible for keeping records of the location, volumes, extent, nature (including a visual and olfactory assessment) and test results of all Class U1B and U2 materials encountered. The Contractor shall keep the Designer informed of the Class U1B and U2 encountered on a daily basis.

The presence of contamination and/or unacceptable waste materials may render otherwise suitable site-won material unacceptable for re-use within the scheme. Such material may be classified as either Class U1B or Class U2 as defined by Appendix 6/14 and 6/15 and defined in the Specification for Highway Works (SHW), Clause 601.

7. Excavation, Transport and Disposal of Unacceptable Materials

If material is suspected of being contaminated, Class U1B or U2 unacceptable material, then it shall be isolated and the Designer notified. Depending on the nature of the material, it shall either be left in-situ whilst classification is carried out or removed to a source-specific stockpile for subsequent classification testing. The Contractor shall carry out appropriate testing and physical assessment to classify the materials in accordance with the requirements of the Designer. Testing shall be in accordance with Appendices 1/5, 6/1 and 6/14 and 6/15.

The Contractor shall undertake the classification and necessary pre-treatment of all wastes and shall pay all fees in relation to its handling, haulage and disposal. The Contractor shall pay all landfill taxes at the rate prevailing at the time of disposal.

Material classed as unacceptable for re-use on-site shall only be disposed of, after agreement with the Designer and consultation with the appropriate Environmental Health Authority and if necessary, the Environment Agency.

Contaminated materials classified as U1B or U2 shall be sent off-site to an appropriately permitted waste disposal/treatment facility, unless re-used on site or off-site using the CL: AIRE Definition of Waste: Code of Practice. The transport of such material shall be managed in accordance with the requirement of the Duty of Care Regulations (Environmental Permitting 2016).

If applicable, the Contractor shall be responsible for registering the site as a producer of hazardous waste. Pre-notification of the movement of each consignment of Class U2 material shall be submitted for authorisation to the receiving local Environment Agency Office responsible for the disposal site, at least 3 working days before the transport of any consignment of Class U2 material. All Class U2 materials arising from site shall be deposited only at appropriately licensed waste disposal facilities. All wastes shall be handled and disposed of in accordance with the Environmental Protection (Duty of Care) Regulations 2003 and the accompanying Code of Practice.

Waste materials shall only be transported off site by a carrier registered under the Controlled Waste Registration of Carriers and Seizure of Vehicles Regulations (1991). Should the Contractor not possess the relevant licences for handling Class U2 material, including asbestos, they shall appoint a licensed subcontractor to handle the material.

Should the Contractor (likely to be designated as the waste ‘Producer’) need to handle, manage or reclaim materials that they consider not suitable under the WRAP Aggregates Protocol, a Permit can be obtained.

All open vehicles used for transporting wastes off-site shall be sheeted securely prior to leaving the site areas.

The Contractor shall ensure that waste soils, including contaminated made ground, are not taken off site on vehicle wheels. The Contractor shall agree suitable arrangements with the Environment Agency and Highways Authorities prior to commencement of works on site.

The Contractor shall be responsible for obtaining copies of all Waste Transfer Notes and Consignment Notes.

Works should be undertaken cognisant of the Site Waste Management Plan.

Potentially contaminated materials shall be handled and disposed of in accordance with the requirements of the Designer and appropriate Environment Agency guidance. Classification and disposal of contaminated material shall be in accordance with the Hazardous Waste Regulations (2005) and shall be the responsibility of the Contractor.

All operations in connection with classification and disposal of contaminated materials shall be in accordance with environmental regulations and shall take into account any special requirements and precautions as directed by the appropriate Environmental Authorities. The Designer shall be

kept fully informed by the Contractor of all licensing and permit agreements with and special requirements of the appropriate Authorities.

The Contractor shall provide the Designer with appropriate written evidence that waste material has been taken to a disposal site that is licensed to accept such waste materials.

The Contractor shall keep all records related the handling and disposal of waste for a minimum of six years.

8. Health and Safety Requirements

Material excavated and designated for disposal based on visual and olfactory evidence and/or chemical analysis shall be transported direct to the appropriate stockpile for necessary pre-treatment. The pre-treatment methodology shall be selected by the Contractor and approved by the Designer, based on the identified contaminants and concentrations together with the determined classification and cost-benefit analysis.

Wet materials shall be allowed to drain under controlled conditions i.e. without discharging to land or surface water, before disposal. The Contractor's health and safety measures shall incorporate all the issues identified in the appropriate method statements, risk assessments, health and safety plan(s), together with all the requirements of the various Health and Safety legislation and Codes of Practice to ensure that all appropriate facilities and personal protective equipment (PPE) are provided, used and maintained.

9. Health and Safety Implementation

The Contractor shall be responsible for ensuring that all work with Class U1B and U2 materials is carried out in accordance with all relevant Health and Safety legislation, including the Construction Design Management (CDM) Regulations, 2015. The primary duty under the Control of Substances Hazardous to Health (COSHH) Regulations 2017 is to prevent exposure to hazardous substances, but where this is not reasonably practicable, the requirement is to ensure that exposure is adequately controlled. Site-specific requirements for protection of the workforce shall be determined by discussion between the Contractor and the HSE as appropriate.

The Contractor shall be responsible for assessing whether the Control of Asbestos Regulations 2012 apply to any part of the works and, if they do, ensuring that the works comply with the Regulations.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

1. Drawings

The following Drawings detail the earthworks design for the Scheme:

General Arrangement Drawings:

Earthwork Type	Drawing Number (General Arrangement)
Earthwork Cutting Details	[redacted]
Earthwork Embankment Details	[redacted]
Earthwork At-Grade Details	[redacted]

Standard Detail Drawings:

Solution	Drawing Number (Standard Detail)
Earthworks - Typical Details	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0001
Modular Block Wall Typical Details Cuttings	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0002
Slab on End Typical Details	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0003
King Sheet Pile Wall Plan and Elevation Embankments	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0004
King Sheet Pile Wall Plan and Elevation Cuttings	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0005
King Sheet Pile Wall Typical Details Cuttings	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0006
King Sheet Pile Wall Typical Details Embankments	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0007
NEAR Modular Block Wall Plan and Elevation	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0008
Modular Block Wall Typical Details Embankments	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0009
Typical Detail Drawing (Soil Nails)	HE614830-JAC-HGT-P001_AL_ALLGENR-DE-CE-0010

2. Preparation and protection of formation

All topsoil, subsoil and tree roots shall be completely removed prior to the deposition of earthworks fill. Any loose or soft spots with an undrained shear strength less than 40kPa present at formation

level shall be excavated and replaced with acceptable material as shown on the drawings listed in Appendix 6/3.

3. Blasting

Blasting is not required or permitted as an alternative to normal excavation methods.

4. Cuttings

Soil cuttings shall be constructed with a gradient no steeper than 1(V):2(H) unless specified otherwise on the Contract Drawings.

Temporary cutting slopes should be formed at safe angles to ensure stability and safety of all operatives and plant and equipment, as well as ensuring the stability of the permanent works. All temporary slope or excavations shall be designed by the Contractors' temporary works designer. Temporary slopes may be formed as a series of steps with steeply cut faces. The height of each step and the width of each berm should be such that the required overall slope for the full height of the cutting is not exceeded. At the final stage of excavation, the steps are trimmed back to the final design profile.

All temporary slopes or excavations shall be designed by the Contractors' temporary works designer.

Any temporary undercutting at the toe of cutting slopes shall be adequately supported to prevent failure of the slope. Undercutting shall be kept free of standing water with dewatering, if required, to be controlled in a manner so as not to disturb the fines in adjacent soils.

Drainage trenches and trenches for other services at the toes of cutting slopes in soft cohesive soils shall be offset by a safe distance, agreed with the DGA and shall be excavated in a controlled manner as agreed with the DGA.

No soft materials were identified at design stage; but if encountered, isolated patches of soft (C_u<40kN/m^2), loose, fragmented and insecure material are to be excavated and re-filled by ramming in selected acceptable granular fill material. The exact locations of dig out and replacement shall be confirmed on site by the DGA following removal of the soil and measurement of the shear strength of the underlaying strata. The final depth of soft soils to be excavated prior to the placement of granular fill shall be agreed with the DGA.

During excavation for earthworks construction where soft clay is exposed, then strength measurements shall be made using hand shear vane apparatus (e.g. Geonor H-60), or similar device as agreed with the DGA.

Excavation shall be undertaken commencing from the top, progressing towards the toe of the slope.

Requirements for benching of the existing earthwork materials shall be in accordance with Clause 603.7 and Clause 608.12 of SHW and the construction drawings.

Cut slopes to be re-soiled as soon as practically possible to avoid damage from erosion. Measures to protect the cut surface from heavy rainfall shall be implemented if faces of cuttings are left exposed for an extended period.

Groundwater may be encountered within cut slopes and excavations, and this should be dealt with during construction using suitable groundwater control measures such as filter drains and sump pumps to draw down groundwater below the excavation, or coffer dams to exclude water from excavations. No requirement for permanent drainage in the form of counterfort drains on the cutting faces is anticipated at this time. Any areas of persistent seepage shall be reported to the Designer.

Where high water tables within proposed cut slopes are identified, groundwater control measures or otherwise may be introduced to assist in maintaining the long-term stability of these slopes.

Unless specific groundwater control measures are specified on the Earthwork General Arrangement Drawings, an observational approach will be adopted during the construction and/or maintenance period for other cutting slopes. If persistent seepages or instability presents itself, additional groundwater measures may be implemented and agreed by the Designer.

In areas of new cutting, where top of batter earthworks drainage is present such as ditches/channels or cut off drains, and where it is likely that new cutting works will remove/disrupt the existing drainage, then realignment and or replacement works as appropriate shall be undertaken to ensure continuity of the drainage runs and protection of the new cutting slopes from surface run off.

All cuttings shall be inspected by an appropriately qualified engineering geologist upon completion to assess whether ground conditions are the same as those assumed in the design.

5. Groundwater

All reasonable measures should be taken to keep construction areas free of groundwater infiltration and the effects of weather. The Contractor shall maintain the stability of all excavations and ensure that the formation is protected from damage.

Where necessary, localised dewatering in the form of sump and pump will be required during the excavation of foundations and cuttings and the Contractor should note the requirements of Clause 602.15.

A total abstraction value of 100 cubic metres per day has been agreed with the Environment Agency. The Contractor is responsible for obtaining all permits and/or licences required to undertake groundwater lowering and for treatment and/or disposal of said groundwater.

The Contractor shall allow and be responsible for the control of groundwater in all temporary excavations and in all temporary situations during the course of the works.

Pumping into existing watercourses or sewers shall only be permitted upon provision of a detailed method statement (taking into account turbidity and chemical requirements) and its subsequent approval by the relevant authorities.

The Contractor shall take all necessary measures to prevent any surface runoff from the construction works flowing directly into any of the watercourses, on the site. The Contractor shall provide measures to channel surface water runoff to specific discharge points where silt traps, screens and any other measures deemed necessary will be employed to prevent any excessive clouding of the watercourses.

6. Watercourses

The clearance of any minor watercourses or ditches encountered on site will be in accordance with Clause 606.2.

Any redundant watercourses and ditches encountered shall be drained and cleared in accordance with Clause 606. In addition, the watercourse / ditch will then be backfilled using a Class 1 material compacted in accordance with Table 6/1.

Any watercourses shall be protected from contamination by site materials.

No unauthorised discharges are to be made to any watercourses.

All culverts and outfalls are to be kept clear and unobstructed.

7. Embankments

In areas of embankment widening new fill slopes are to be constructed with a maximum slope gradient of 1(v):2.5(h) as shown on the construction drawings.

Embankments shall not at any stage of construction have side slopes steeper than indicated for the final earthworks outline. Any temporary increase in embankment width, to permit adequate compaction of side slopes and edges before trimming, shall not exceed 1.0 metre.

Where an embankment is constructed on any existing slope, the existing surface shall be benched. Maximum benching dimensions and minimum slope gradients are either shown on the drawings or as detailed within this Appendix section 1. The indicative benching shall follow similar guidelines as adopted in HE549339-ACM-HGT-ZZ_ZZ_ZZ_ZZ-TN-GE-0004 of the M6 J21a-J26 scheme, which states that a minimum offset of 1.2m shall be provided from the edge of the existing carriageway to the start of benching and avoid over excavation under the carriageway.

Placement and compaction of fill is to be undertaken beginning at the toe of the slope and progressing towards the crest.

Topsoil and pockets of soft-soil and loose rock shall be removed from beneath embankments. Soft materials for this Scheme are defined as cohesive soils with an undrained shear strength (C_u) less than 40kN/m^2.

No soft soils were identified at design stage, but if encountered at construction stage at the proposed formation/founding levels of embankments and structures, they are to be dug out and replaced as appropriate with Class 1A material below earthworks and Class 6N below structures. The exact locations of dig out and replacement shall be confirmed on site by the Designer following removal of the soil and measurement of the shear strength of the underlying strata. The final depth of soft soils to be excavated prior to the placement of granular fill shall be agreed with the Designer.

The Contractor shall take measures to ensure that the settlement of embankments shall be substantially complete before the road pavement shall be constructed.

During excavation for earthworks construction where soft clay is exposed, then strength measurements shall be made using hand shear vane apparatus (e.g. Geonor H-60), or similar device as agreed by Designer.

Where the Designer observes an extent or condition of soft ground greater than anticipated, and which cannot be effectively excavated and replaced, then probing and/or trial pitting may be required to define the extent and condition of this deeper soft ground. Sampling and testing from trial pits may involve in situ shear vane testing (e.g. Geonor H-10) with laboratory testing of retrieved samples. The extent of testing will be determined by the Designer.

Assessment of performance of earthworks found to be sited over unexpected soft ground, using the additional information collated above where available, will be determined by the Designer for the scheme. Where necessary the Designer will produce revised/alternative embankment design.

The Contractor shall remove, and where possible recycle into the Works, all redundant areas of existing road pavement from within the Site.

The mixing of acceptable and unacceptable materials shall not be permitted. Unacceptable materials Class U1A may be separated and conditioned to render it acceptable for inclusion as acceptable engineering fill.

8. Compaction

Compaction is required over the full width of embankment or between outer extremities of verges unless otherwise specified.

Compaction requirements shall be as detailed in Table 6/1, Clause 602 and Clause 612. The type and frequency of compliance testing of earthworks materials is detailed in Appendix 1/5.

To achieve end product compaction, sand replacement tests, in accordance with BS1377 Part 9, shall be undertaken at a minimum frequency of one test per 500m^3 per layer of compaction.

Should a nuclear density gauge (NDG) be employed to monitor in situ or compacted density, dry density or moisture content, the gauge shall have been calibrated to BS1377 Part 9 at a rate of one calibration box per material initially per gauge. Calibration shall be repeated using a ratio of 50 NDMs to one SRT.

The degree of compaction required for landscaping areas will be sufficient to remove large voids, avoid subsequent excessive settlement, ensure stability and to avoid over-compaction and excessive pore water pressure build-up. Landscaping is not intended to support foundations, fencing, or vehicles with the expectation of maintenance vehicles such as grass cutters.

Haul roads over embankments and through cuttings are to be of sufficient minimum thickness, including the surcharge, so that rutting is prevented which could lead to damage to the sub-grade or any services therein. All haul roads are to be adequately maintained during the construction period in order to ensure the above requirements are satisfied.

9. Profiles

The final profile shall be constructed in such a way as to ensure unrestricted drainage of water from the earthwork.

10. Disposal of material

Prior to commencing any excavation works, the Contractor shall inform the Client of the locations proposed for disposal of materials arising from the temporary and permanent works. The Contractor shall confirm that the proposed disposal sites have current licenses or consents to accept the excavated material.

APPENDIX 6/4: REQUIREMENTS FOR CLASS 3 MATERIAL

Not used

APPENDIX 6/5: GEOTEXTILES USED TO SEPARATE EARTHWORK MATERIALS

1. General

The specific requirements for the use of separating geotextiles are shown on the Standard Earthwork Embankment and Cutting detail drawings specified in Appendix 6/3, with this Appendix covering the general requirements only.

Geotextiles shall be manufactured from synthetic fibres and UV resistant. The geotextile shall be thermally bonded, or needle punched, non-woven and inert to all chemicals naturally found in soils and shall have no solvents at ambient temperature. It shall not be susceptible to hydrolysis, shall be resistant to aqueous solutions of salts, acids and alkalis and shall be non-biodegradable. It should have a certified design life/durability of at least 120 years under the conditions anticipated in the stipulated use.

The properties described in the table below shall be proved by the Manufacturers' Quality Assurance certification, which itself shall have been approved by an independent organisation.

Material Properties		
Mean tensile strength	10.0 kN/m min.	BS EN ISO 10319:2015
Mean tensile elongation	50 % min.	BS EN ISO 10319:2015
Mean CBR puncture resistance	1.50 kN min.	BS EN ISO 12236:2006
Mean AOS O_{90} pore size	50 – 300 µm	BS EN ISO 12956:2020
Permeability, 5 cm head	50 litres/m^2/sec min.	BS EN ISO 11058:2019
Durability		BS EN 13251 (Table 1, Annex B and Annex C)

Full test certificates for the proposed geotextile covering the requirements of Clause 609 and this Specification shall be submitted to the Designer at least two weeks prior to installation.

2. Geotextile Requirements

Adjacent sheets of the geotextiles shall be overlapped or joined according to the Manufacturers' recommendations and with a minimum overlap of 300mm, or other greater dimensions as recommended by the Manufacturers. Returns for anchorages and turn-ups at edges shall be according to the Manufacturers' recommendations and shall not be less than 500mm.

Geotextiles shall be supplied to site in an undamaged condition and shall not be damaged by site handling, whether supplied in the form of rolls or packages. The methods of supply and handling adopted shall ensure that; the geotextile is supplied dry and remains dry; the geotextile is protected from abrasion and damage; the geotextile is protected from contamination; and the geotextile is protected from exposure to sunlight (ultra-violet radiation in particular).

Items within consignments of geotextiles shall be supplied to site clearly marked with the name of the product and its grade or code number, in order that it shall easily be identified both before and after removal of any wrapping.

Wrapping provided shall not be removed before the geotextile is used.

The geotextiles shall at all times prior to placement be stored under cover and suitably protected from direct sunlight and water. Care shall be taken to ensure that the geotextile is not damaged during placement or during the deposition, spreading and levelling of the fill material.

The fabrication and installation shall be planned and implemented taking into account existing or diverted services and drainage works.

The layer or surface against which the geotextile is to be placed shall not have protrusions or sharp projects that are likely to damage the geotextile during installation or in service. It shall be free from stumps, stones or other large protrusions that could cause damage to the geotextile.

Fill (backfill) shall not be tipped directly onto the geotextile. Fill shall be carefully spread onto previously placed geotextile and shall be taken forward and placed by suitable plant with a bucket type that causes the recovering material to cascade onto the geotextile. Care shall be taken to avoid damage to the geotextile.

During placing and compaction of fill, care shall be taken to avoid displacing the geotextile. At overlaps, the top piece of geotextile shall be the first to be covered by fill and no fill shall be permitted to come between overlapping layers.

3. Compliance and Control Testing

Testing requirements are set out in Table 1/5. The Geotextile Manufacturers shall provide quality assured test data for the materials supplied to site.

Samples for testing in accordance with Clause 609 shall be taken in accordance with the prescriptions of BS EN 9862:2005 ‘Geosynthetics – Sampling and Preparation of Test Specimens'. The sampling report shall be sent with the samples to the test laboratory and a copy shall be delivered to the Designer within 3 days of the sampling.

Samples are to be retained by the Contractor for a minimum of 12 months.

Additional testing of geotextiles shall be undertaken as directed by the Designer when visual assessment raises concerns about the acceptability for intended use.

Appendix 6/6: Fill to structures and fill above structural foundations

1. General

Backfill to structures shall be Class 6N fill in accordance with Table 6/1, and as shown on the Standard Detail Drawings listed in Appendix 6/3.

The locations and extents of structural fill materials are shown on the individual structure drawings as listed below and on the relevant Standard Detail Drawings listed In Appendix 6/3.

General Arrangement Drawings:

Type	Drawing Number (General Arrangement)
CCTV Plunge pile MIDAS SVD Pad foundation EA-SB-193/4 King sheet pile wall	[redacted]

The Contractor shall satisfy himself that the proposed material is stable at the trimmed batters shown on the Drawings, as required in SHW Clause 610.6. If the Contractor proposes materials that cannot be trimmed to the batters indicated, shallower stable slopes shall be used.

The full-scale determination of stable slopes in accordance with Clause 610(6) is not required for this scheme.

Fill to structures to be in accordance with SHW Series 600 clause 610.

Compaction of fill to be in accordance with SHW Series 600 clause 612.

2. Foundation Formation

The Contractor shall inspect and record the founding strata to confirm that the ground conditions are as assumed in the design.

The formation shall be investigated by the Contractor, using the approved methods described below, for the presence and extent of any ‘soft spots’ (i.e. strength below that required by the design). Such ‘soft spots’ shall be removed and backfilled in accordance with Clause 604 and as directed by the Designer. Blinding layer shall be Class 6N fill as shown on the Drawings. The founding level of all foundations and the depth or extent of excavation of inadequate founding strata (“soft spots”) shall be subject to the inspection and acceptance of the Designer.

If the ground conditions (e.g. strata profile) and other conditions at formation (e.g. groundwater table) are not compatible with those presumed conditions indicated in the design, then excavation shall continue until such conditions are met or a suitable alternative formation as agreed with the Designer is met. The excavation shall be backfilled to the specified formation depth with Class 6N as shown on the drawings and as agreed with the Designer.

The following tests shall be carried out at formation level by the Contractor to confirm that the design assumptions have been satisfied:

- Cohesive Soils – by use of a hand shear vane test to prove that the cu (undrained shear strength) value at a depth of 0.2m below the excavated formation level is greater than 40kPa.
- Granular Soils – by use of a Mackintosh or dynamic probe to prove that the equivalent SPT ’N’ value is a minimum of 10 if no value is shown on the Drawings.

- Rock – the Designer shall confirm the presence of rock at founding level in their inspection report. If rock is located directly below foundations, a binding layer with Class 6N fill shall be spread to ensure an appropriate level of foundation.

Personnel trained in the use of the equipment shall undertake tests using suitably calibrated equipment. The tests referred to above shall be taken at representative locations across the formation (on a grid pattern, if necessary, at maximum of 10m centres throughout the foundation). Additional tests shall be undertaken at any apparent ‘soft spots’ (i.e., strength below that required by the design) identified visually. The locations, results and correlation for equipment used shall be recorded by the Contractor with the results.

Records of the inspections and testing and any subsequent remedial measures shall be submitted to the Designer for review, including the test locations, test values and calibrations of equipment.

Where blinding concrete is required, a concrete class ST1 shall be used, and the formation shall be blinded as soon as possible after excavation is complete (allowing for the inspections and investigations described).

The sides of excavations adjacent to the approach fills shall be provided with a benched transition slope to suit the conditions and in any case no steeper than 1v:1h.

In the presence of groundwater, the Contractor shall undertake the excavation works with adequate temporary dewatering measures. This shall ensure that the working area remains ‘dry’, i.e. without resulting in saturation of the material that is to be excavated, leading to loss of strength to the foundation layer or affecting the stability of slopes and excavation.

APPENDIX 6/7: SUB-FORMATION AND CAPPING AND PREPARATION AND SURFACE TREATMENT OF FORMATION

1. General

The requirements for sub-base and capping thicknesses are specified in the Series 700 Specification Doc. No. HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002. The design subgrade surface modulus values in Appendix 7/1 are the long-term surface moduli of the prepared subgrade at each EA.

Requirements for lateral extent of capping and sub-formation, sub-formation shaping and crossfalls are given on the pavement drawings and in the highway construction details.

The base of the formation shall fall towards the verge to ensure sub formation drainage. To ensure compliance with Clause 3.40 to 3.44 of the DMRB CD 225, where the existing subsurface drainage falls towards the widening, the formation level within the widening shall either match or be lower than the existing formation level as illustrated in Figure 3.45 of DMRB CD 225. The subbase thickness specified in Series 700 drawings and specification appendices shall be increased as necessary to meet this requirement.

2. Formation inspection and preparation

Preparation and surface treatment of the sub-formation, including tolerances, shall be in accordance with Clause 616 as for formation.

A suitably experienced ground engineering professional should conduct a formation inspection prior to laying capping and sub-base.

The inspection shall identify the sub-grade soil type as being cohesive if the fines content (material passing 0.063mm sieve) is greater than 15%, granular for soils with fines content of less than 5%, marginal granular material where the fines content is between 5% and 15%.

If at any time the sub-grade becomes softened, the sub-grade shall be stripped by at least 40mm to expose a competent sub-formation that shall be re-compacted. Where the sub-formation level is reduced in this manner, the pavement foundation construction thickness shall be increased with capping (or sub-base if appropriate).

Exposed areas of formation or sub-formation should be kept to a minimum and should be covered quickly to avoid deterioration due to inclement weather conditions.

In cuttings where excavations may encounter a competent rock mass, it will not be practical to excavate a flat surface owing to discontinuity alignment giving preferential excavation planes. In such cases, some over dig will be required followed by the placement of a ‘regulating layer’ comprising processed excavated material described in Clause 616.4.

The results of sub-grade inspections and in situ subgrade surface modulus testing shall be recorded by the Contractor as a formal part of the earthworks records and made available to the Designer within 24hrs of in-situ test completion.

Preparation of sub-formation shall be carried out only after installation of adequate sub-grade / sub-formation drainage that shall be fully operational. Adequate drainage shall be determined by the Contractor to suit the conditions encountered.

3. Determination of the Construction Subgrade Surface Modulus

The Contractor shall check that the Design Subgrade Surface Modulus values are satisfied on-site prior to commencing the pavement foundation construction for the proposed EA locations.

The minimum subgrade surface modulus shall be 30 MPa in accordance with the pavement design. The type and frequency of required in-situ construction subgrade surface modulus testing is specified in Clause 882 of SHW and Appendix 1/5 of Series 100 Specification.

In situ CBR value of cohesive subgrades (generally with strength in the range 2%<CBR<6%) may be assessed using a Dynamic Cone Penetrometer (i.e. DCP) as described in CS 229. The CBR values shall be converted to surface modulus in accordance with Clause 882 of SHW.

The Contractor shall inspect and undertake construction surface modulus testing (in accordance with Clause 882 of SHW) at the time of trimming sub-formation.

The construction surface modulus test data shall then be used by the Contractor and Designer to verify the design subgrade surface modulus (MPa) in accordance with Clause 882. This is required to verify the sub-base/capping thickness specified in Appendix 7/1.

Where the design surface modulus values are not achieved, the requirements set out in Clause 882 and the Series 700 specification appendices (HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002) shall be followed. The subgrade must be re-engineered in consultation with the Designer if the design subgrade surface modulus is less than 30 MPa.

4. Locations and surface level detail

The requirements for capping and/or sub-base layers and locations are indicated on the Series 700 Specification Appendices (ref. HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002) and Drawings.

5. Allowed Surface Tolerance

Preparation and surface treatment of the sub formation, including tolerances, shall be in accordance with Clause 616.

Pavement details shall be in accordance with Series 700 Specification Appendices and Drawings.

6. Permitted capping materials

Class 6F2 or 6F3 or 6F5 capping in accordance with Table 6/1 shall only be permitted for use as capping unless otherwise agreed in writing with the Project Manager.

Mixed combinations of Classes are not permitted.

Material stabilised by the use of cement and / or lime shall not be permitted.

7. Capping construction procedure

The method for constructing capping shall be as Clause 613.11 in cuttings and as Clause 613.12 on embankments and other areas of fill. Where the embankment sub formation lies below original ground level the construction of the capping shall be as Clause 613.11 (i).

The Contractor shall record the results of sub grade inspections, sampling, laboratory testing and in situ testing as a formal part of the earthworks records.

8. Demonstration areas

A demonstration area is not required.

9. Formation and Sub formation

The formation and sub formation shall fall towards the verge to ensure formation and sub formation drainage and avoiding adding additional water to drainage path in the existing foundation of the carriageway. To ensure compliance with Clause 3.40 to 3.44 of the DMRB CD 225, where the existing subsurface drainage falls towards the widening, the formation level within the widening shall either match or be lower than the existing formation level as illustrated in Figure 3.45 of DMRB CD 225. The subbase thickness specified in Series 700 drawings and specification appendices shall be increased as necessary to meet this requirement.

Materials used within 450mm of the designated final road surface shall not be frost susceptible.

10. Formation inspection and preparation

Preparation and surface treatment of the sub-formation, including tolerances, shall be in accordance with Clause 616 as for formation.

A suitably experienced ground engineering professional should conduct a formation inspection prior to laying capping and sub-base.

The inspection shall identify the sub-grade soil type as being cohesive if the fines content (material passing 0.063mm sieve) is greater than 15%, granular for soils with fines content of less than 5%, or marginal granular material where the fines content is between 5% and 15%.

If at any time the sub-grade becomes softened, the sub-grade shall be stripped by at least 40mm to expose a competent sub-formation that shall be re-compacted. Where the sub-formation level is reduced in this manner, the pavement foundation construction thickness shall be increased with capping (or sub-base if appropriate).

Exposed areas of formation or sub-formation should be kept to a minimum and should be covered quickly to avoid deterioration due to inclement weather conditions.

In cuttings where excavations may encounter a competent rock mass, it will not be practical to excavate a flat surface owing to discontinuity alignment giving preferential excavation planes. In such cases, some over-dig will be required followed by the placement of a ‘regulating layer’ comprising processed excavated material described in Clause 616.4.

The results of sub-grade inspections and in situ subgrade surface modulus testing shall be recorded by the Contractor as a formal part of the earthworks records and made available to the DGSR within 24hrs of in-situ test completion.

Preparation of sub-formation shall be carried out only after installation of adequate sub-grade / sub-formation drainage that shall be fully operational. Adequate drainage shall be determined by the Contractor to suit the conditions encountered.

11. In-situ validation

The Contractor must verify that the design subgrade surface modulus (SSM) is achieved at the surface of the subgrade prior to laying of the foundation in accordance the Series 700 Specification Appendices. The type and frequency of required in-situ construction subgrade surface modulus testing is specified in Clause 882 of SHW and Appendix 1/5 of Series 100 Specification.

Where the SSM values are not achieved, the requirements set out in Clause 882 and the Series 700 specification appendices shall be followed. The subgrade must also be re-engineered in consultation with the geotechnical engineer if the design subgrade surface modulus is less than 30 MPa.

APPENDIX 6/8: TOPSOILING

1. General

Topsoil and turf to be designated as Class 5A and 5B material is described in Appendix 6/1 and is required in the areas detailed on all relevant Series 600 scheme drawings as listed in Appendix 6/3, as well as all relevant Series 3000 scheme drawings.

Existing topsoil shall either be left in place:

- within all areas of tree and shrub planting to be retained; and
- within all areas of grassland to be retained as set out on the Site Clearance drawings (Refer to [redacted] alternatively stripped from all areas to be regraded, including cuttings embankments or other areas of fill for storage / reuse locally or stored for reuse.

The Contractor shall prevent topsoil from being compacted, becoming adulterated with subsoil, rubbish, stone or hardcore, being contaminated with petrol, lime, cement or other injurious substances. They will remove from site any adulterated or contaminated topsoil and replace it with approved imported topsoil as necessary.

Prior to topsoil stripping, vegetation clearance shall be undertaken in accordance with the Vegetation Clearance Drawings. All vegetation shall be fully removed prior to stripping and there shall be no woody material or chippings, or any other type of surface vegetation left on the surface prior to topsoil removal.

With the exception of topsoil within the canopy spread of vegetation not affected by the Works, the existing topsoil (and its seed bank) is to be stripped from all areas of cutting, areas of filling, haul roads, site compounds, beneath soil stockpiles and were noted on the scheme drawings. The material is to be retained and placed over the constructed profile of the permanent works.

Locations (if any) where existing vegetation is to be retained and hence topsoil left in place are detailed on the Vegetation Clearance drawings.

In addition to topsoil, subsoil is also required to be placed on finished earthworks slopes and verges. Subsoil comprises a medium capable of transmitting rainfall and storing moisture to enable deep rooting by plants. For details in respect to scarification techniques (if required) reference should be made to Clause 5.3 of Specification Appendix 30/4.

2. Soil Stripping and Storage

Topsoil shall be retained on the Site wherever possible. Where this is not possible or the material cannot be re-used on site, the necessary Waste Licence(s) and submitted to the Onsite Assembly Partner Environmental Manager (OSAP EM) prior to removal of any topsoil from the Site.

In advance of vegetation clearance and soil stripping operations commencing within 10 metres of a watercourse, appropriate control measures will be implemented to prevent contamination.

The Contractor shall strip topsoil on cutting and embankments to a minimum of 0.3m, in accordance with BS3882 and suitably stored on site (Good Practice guide for handling soils, MAFF, 2000). Subsoil will only be stockpiled separately in temporary works areas that are to be returned to the landowner for re-use. In all other areas, subsoil shall be excavated and used as general fill. The source of soil in each stockpile shall be recorded by the Contractor.

On completion of the topsoil/subsoil strip, the material shall be stockpiled as follows:

- Stockpiles shall not be located within the canopy spread of existing vegetation;

- Stockpiles shall not exceed 3m in height for topsoil and 5m height for subsoil;
- Side slopes shall not be steeper than 1v:1.5h;
- Tops of the stockpiles shall be profiled to shed rain water;
- Material shall not be stockpiled closer than 2m to the crest of any slope or temporary cutting;
- Excavation of soils from stockpiles shall be in accordance with Clause 618(3).

It is acknowledged that compliance with MCHW clause 618.3(i) will not always be possible. Waterlogged soil will not be permitted. Topsoil stockpiles shall be sealed and shaped to prevent excessive ingress of water. Where re-soiling after heavy rainfall is to be carried out for programme critical activities, topsoil shall be inspected by the Designer and agreed with the Contractor that it may be used.

Topsoil or other material shall not be stockpiled within the floodplain or within 10m of any a watercourse. Stockpiles shall be located so that the soils do not become waterlogged in wet weather. Silt fencing will be installed around the margins of topsoil mounds to minimise the risk of sediment-laden runoff reaching watercourses.

Soil stockpiles shall be kept free of annual and perennial weeds. Exposed stockpiles that are to remain for long periods will be seeded with a standard Rye Grass seed mix immediately upon completion and in suitable weather conditions to minimise soil erosion and reduce colonisation of weeds.

All Class 5A topsoil arising from the site, which conforms to the requirements set out in Table 6/1 is to be stored and used for the topsoiling works.

Site-won topsoil and underlying subsoil shall be tested and where results demonstrate that nutrient levels in the topsoil are not significantly more than in the subsoil and shall be considered suitable for re-use in areas of proposed species-rich grassland.

Class 5B material (imported topsoil to make up deficiencies on the Site) shall not be permitted unless no practicable alternative is available.

Imported topsoil shall be identified from a suitable source and tested in accordance with BS 3882 for soil texture/particle size analysis, stone content, pH value, nutrient content (N, P, K and Mg) and organic matter content.

The Contractor is to ensure that his method of excavation and temporary works do not render any existing topsoil unsuitable. If this occurs, the topsoil rendered unsuitable shall be replaced by the Contractor at his own cost.

Topsoil shall be stored and re-used as close to the donor site as possible.

Where required in contract specific Appendix 6/3, faces of cuttings which are to receive topsoil shall have one or more of the following measures carried out as appropriate:

- Be benched to retain topsoil as described in contract specific Appendix 6/3.
- Be harrowed to a depth of 50 mm. Such harrowing shall be carried out immediately prior to topsoiling, diagonally, at an angle between 5º to 45º to the line of the toe, measured on the plane of the slope.

3. Topsoil Placement

The depth of topsoil/subsoil (scarified fill/in situ soil) is determined in relation to the planting and seeding requirements of the finished earthworks slopes.

The indicative depths of topsoil/subsoil are shown in APPENDIX 3/8 of the Series 3000 specification [redacted] These proposals are

subject to change based on the outcome of soil testing and on further detailed design of the planting and seeding types.

Slopes steeper than 1:2.5 but less than 1:2 are required in most locations throughout the scheme as a result of land take issues and for these slopes topsoil thicknesses should be a maximum of 150mm.For slopes steeper than 1(v):2.0(h) scarification of the surface should not be undertaken and topsoil shall not be placed without the use of a topsoil retention geomat or 3D cellular confinement system, to be installed in accordance with the Manufacturers' Instructions.. Where a topsoil retention geomat or cellular confinement system is specified, only Class 5B general purpose topsoil material in accordance with Table 6/1 shall be used and instructions sought from the Designer in regards to planting/seeding requirements. Class 5B material shall be free from stones and sufficiently friable to allow placement without incurring of voids.

Topsoil, or imported topsoil, if required and permitted by the Overseeing Organisation, shall:

- be deposited and spread on all soft areas to be reinstated or planted, following completion of adjacent construction works, to achieve the following total depths for planting and seeding works:
- scrub woodland: 300mm
- species-rich grassland: should be finished with subsoil to ensure compliance with Major Project Instruction MPI-85-102020, or if permitted by the Overseeing Organisation, up to 100mm depth of low fertility topsoil as defined by BS3882.
- have stones and other debris with dimensions greater than 50mm equivalent diameter, removed and disposed of off-site.
- be graded to smooth contours, eliminating all mounds and depressions.

Topsoil and planting requirements are outlined in the Series 3000 specification appendices [redacted] and planting works drawings.

Topsoil, shall be deposited and spread on all areas to be planted, following completion of adjacent construction works, to achieve a depth of 300mm-450mm for scrub and woodland planting works.

- Areas of proposed species-rich grassland shall be finished with low fertility topsoil/subsoil to ensure compliance with Major Project Instruction MPI-85-102020 or up to 150mm depth of low fertility topsoil as agreed with OSAP EM.
- Topsoil to be used as backfill material for tree pits in accordance with Appendix 30/6.
- have stones and other debris with dimensions greater than 50mm equivalent diameter, removed and disposed of off-site; and
- Be graded to smooth contours, eliminating all mounds and depressions.

Topsoil to be used as backfill material for tree pits in accordance with Appendix 30/6. The total depth of the topsoil or subsoil areas are listed below:

- The thickness of topsoil or subsoil placed on new earthworks with gradients of 1(v):2(h) or steeper will be 150mm depth; and
- The thickness of topsoil or subsoil placed on new earthworks with gradients of 1(v):2(h) or shallower and verges will be 150mm depth for grass seeding and 300-450mm for planting (refer to Series 3000 Planting Works drawings).

APPENDIX 6/9: EARTHWORK ENVIRONMENTAL BUNDS, LANDSCAPE AREAS, STRENGTHENED EMBANKMENTS

1. Earthwork Environmental Bunds

Not used.

2. Landscape Areas

Where existing earthwork bunds are removed or modified for temporary work activities, they should be returned to their original profile **utilising BS 3882:2015 low fertility topsoil.**

3. Strengthened Embankments

Not used.

APPENDIX 6/10: GROUND ANCHORAGES, CRIB WALLING AND GABIONS

1. **Soil Nailing**

   Not used.

2. **Crib Walling**

   Not used.

3. **Gabions**

   Not used.

4. **Ground Anchorages**

   Not used.

APPENDIX 6/11: SWALLOW HOLES AND OTHER NATURALLY OCCURRING CAVITIES AND DISUSED MINE WORKINGS

No known voids or swallow holes have been identified on site. Naturally occurring cavities are not anticipated at the site; however, the Contractor shall immediately inform the Designer's Geotechnical Representative if such features are encountered.

The Contractor shall survey in the exact location of such features.
Subject to the assessment of the Designer's Geotechnical Representative, the course of action shall comprise careful trial excavations to identify the extent of the feature, followed by infilling as if the void comprised an excavated soft spot.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

Not used.

A watching brief should be maintained during topsoil strip/preparation of formation for embankments, and during excavation of the cuttings, to confirm ground conditions are consistent with the design assumptions. The Designer shall be immediately informed if any significant areas of soft, compressible, contaminated, waterlogged etc material is encountered.

The watching brief should also note the presence of any voids or features indicative of coal workings.

APPENDIX 6/13: GROUND IMPROVEMENT

Where superficial deposits and/or soft soils (cu<40kPa) are encountered at the proposed formation/founding levels of embankments and structures, they are to be dug out and replaced as appropriate with Class 1A material below earthworks and Class 6N below structures.

APPENDIX 6/14: LIMITING VALUES FOR POLLUTION OF CONTROLLED WATERS

1. Introduction

This appendix only applies to site won and imported materials, and not to secondary aggregates were used under a WRAP protocol, or virgin materials.

This appendix provides limiting values for contaminants in materials for the protection of controlled waters. Reference shall also be made to Appendix 6/15 for the protection of human health.

2. Reuse of Site Won Materials:

If contaminant concentrations in the soil leachate are above the limiting values presented in Table 6/14.1, then the material under consideration might pose an unacceptable risk to identified controlled waters receptors. Either the Contractor must seek an alternative source of material, which complies with these criteria, or the Contractor can undertake further site-specific risk assessment. This could be a qualitative assessment or detailed quantitative assessment to derive limiting values which are more specific to the end land-use and likely to be less conservative. Such limiting values would be specific to a particular material and may restrict where it could be placed. Any alteration to the limiting values would require approval from the regulatory bodies (Environment Agency and Local Authority Contaminated Land Officer).

All materials classified as Hazardous Wastes in accordance with Technical Guidance WM3 are automatically classified as unacceptable material Class U2, irrespective of the limiting values presented in Table 6/14.1.

Limiting values for pollution of controlled waters are presented in Table 6/14.1. These should be applied to 2:1 soil leachate eluant data in mg/l or µg/l, obtained using the BS EN 12457-1 methodology.

Material with soil leachate concentrations greater than the relevant limiting values presented in Table 6/14.1 shall be classified as Class U1B, or further site-specific risk assessment shall be undertaken to determine suitability for re-use. This may also require further consultation with the Environment Agency or Local Authority Contaminated Land Officer.

3. Explanation of Limiting Values

The limiting values in Table 6/14.1 represent a broad range of contaminants suitable for the assessment of most materials. However, should other contaminants (e.g. chlorinated solvents, volatile organic compounds, PCBs) be suspected to be present, then these should also be tested and assessed against limiting values, as advised by a specialist environmental chemist.

The limiting values presented in Table 6/14.1 are based on UK Drinking Water Standards (UK DWS) (sourced from The Water Supply (Water Quality) Regulations 2016, and 1989 if 2016 is not available), and World Health Organisation Drinking Water Standards (WHO DWS). Where DWS are unavailable determination of the limiting values are based on Environmental Quality Standards (EQS) for freshwater (sourced from The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015). Where limiting value concentrations are too low for most modern analytical methods to detect, the concentrations have been set at the laboratory limit of detection (LoD).

The limiting values were selected to be protective of the Groundwater Source Protection Zone (Zone III) and the Secondary A and B Aquifers underlying the scheme.

Determinand	Units	Screening Value (µg/l)	Source of screening value
Metals			
Aluminium	µg/l	200	UK Drinking Water Standards
Antimony	µg/l	5	UK Drinking Water Standards
Arsenic (dissolved)	µg/l	10	UK Drinking Water Standards
Barium (dissolved)	µg/l	700	WHO Drinking Water Quality Guideline Value
Boron (dissolved)	µg/l	1000	UK Drinking Water Standards
Cadmium (dissolved)	µg/l	5	UK Drinking Water Standards
Chromium (total dissolved)	µg/l	50	UK Drinking Water Standards
Chromium VI	µg/l	3.4	EQS
Chromium III	µg/l	4.7	EQS
Copper (dissolved)	µg/l	2000	UK Drinking Water Standards
Lead (dissolved)	µg/l	25	UK Drinking Water Standards
Iron	µg/l	200	UK Drinking Water Standards
Lead	µg/l	10	UK Drinking Water Standards
Magnesium	mg/l	50	UK Drinking Water Standards
Manganese	µg/l	50	UK Drinking Water Standards
Mercury	µg/l	1	UK Drinking Water Standards
Nickel (dissolved)	µg/l	20	UK Drinking Water Standards
Potassium	mg/l	12	UK Drinking Water Standards
Selenium (dissolved)	µg/l	10	UK Drinking Water Standards
Sodium	mg/l	200	UK Drinking Water Standards
Tin	µg/l	25	EQS
Vanadium	µg/l	201	EQS
Zinc (dissolved)	µg/l	3000	WHO Drinking Water Quality Guideline Value
Inorganics			
pH Value	µg/l	6.5-10	UK Drinking Water Standards
Total Cyanide	µg/l	50	UK Drinking Water Standards
Free Cyanide	µg/l	1	EQS
Chloride	mg/l	250	UK Drinking Water Standards
Ammoniacal Nitrogen as NH4	mg/l	0.5	UK DWS
Nitrate as NO3	µg/l	50000	UK Drinking Water Standards
Nitrite as NO2	µg/l	100	UK Drinking Water Standards
Organics – Polycyclic Aromatic Hydrocarbons			
Anthracene	µg/l	0.1	UK Drinking Water Standards
Benzo(a)pyrene	µg/l	0.01	UK Drinking Water Standards
Benzo(b)fluoranthene	µg/l	0.1	UK Drinking Water Standards

Determinand	Units	Screening Value (µg/l)	Source of screening value
Benzo(ghi)perylene	µg/l	0.1	UK Drinking Water Standards
Benzo(k)fluoranthene	µg/l	0.1	UK Drinking Water Standards
Indeno(123cd)pyrene	µg/l	0.1	UK Drinking Water Standards
Fluoranthene	µg/l	0.1	UK Drinking Water Standards
Naphthalene	µg/l	0.1	UK Drinking Water Standards
Organics - Other			
Total Petroleum Hydrocarbons (TPH CWG)	µg/l	10	UK Drinking Water Standards
Phenol	µg/l	0.5	UK Drinking Water Standards
Benzene	µg/l	1	UK Drinking Water Standards
Toluene	µg/l	700	WHO Drinking Water Quality Guideline Value
Ethyl benzene	µg/l	300	WHO Drinking Water Quality Guideline Value
Xylene	µg/l	500	WHO Drinking Water Quality Guideline Value

Notes

Freshwater EQS based on lowest surface water hardness range.

UK DWS based on sum of benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene.

4. Sampling and Analysis of Site Won Material:

Testing requirements shall be in accordance with Table 1/5. Where site won materials come from areas deemed to be potential sources of contamination or where significant variation in material composition is observed during construction, as compared to that encountered and assessed during the ground investigation, such as the presence of visual or olfactory indicators of contamination, further sampling, testing and risk assessment is required to determine the materials acceptability for re-use. The sampling frequency for such incidences will be determined by a specialist environmental chemist.

5. Imported Material:

Imported materials (primary or secondary) must be suitable for use and will therefore require assessment for contamination. Where adequate prior testing and assessment is not available, additional testing is required for initial comparison with the Limiting Values detailed in Table 6/14.1, prior to material importation to site. If Limiting Values are exceeded further risk assessment will be required to determine suitability for use.

It is recommended that where additional testing is required, the schedule of sampling and analysis, and limiting values, must be agreed in advance with a specialist environmental chemist prior to importation.

Certain secondary or recycled materials, such as pulverised fly ash or aggregates, may have been produced in accordance with a quality control protocol (e.g. WRAP), which provides evidence of the physical and chemical properties of the material. Where the use of these materials has been given prior approval by the Environment Agency, no further leachate testing is required.

Virgin materials, such as quarry aggregate, will not require leachate testing.

6. Classification of Material:

Variations in the acceptance of the material to be used within the scheme are at the Contractors own risk. If the Contractor intends to use material that does not fully comply with the requirements of Table 6/14.1, then a suitable risk assessment shall be undertaken in consultation with the Local Authority Contaminated Land Officer and/or Environment Agency. This risk assessment shall demonstrate that the potential for any harm to controlled water receptors using the non-compliant material is not significant.

APPENDIX 6/15: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

1. Introduction:

This appendix only applies to site won and imported materials, and not to secondary aggregates where used under a WRAP protocol, or virgin materials.

This appendix provides limiting values for contaminants in materials for the protective of human health. Reference shall also be made to Appendix 6/14 for the protection of controlled waters.

2. Reuse of Site Won Materials:

If contaminant concentrations in soils are above the limiting values presented in Table 6/15.1, then the material under consideration might pose an unacceptable risk to identified human health receptors. Either the Contractor must seek an alternative source of material, which complies with these criteria, or the Contractor can undertake further site-specific risk assessment. This could be a qualitative assessment or detailed quantitative assessment to derive limiting values which are more specific to the end land-use and likely to be less conservative. Such limiting values would be specific to a particular material and may restrict where it could be placed. Any alteration to the limiting values would require approval from the regulatory bodies (Environment Agency and Local Authority Contaminated Land Officer).

All materials classified as Hazardous Wastes in accordance with Technical Guidance WM3 are automatically classified as unacceptable material Class U2, irrespective of the limiting values presented in Table 6/15.1.

Material containing free phase oil or bulk Asbestos Containing Materials (ACMs) shall be automatically classified as unacceptable material Class U2 irrespective of the limiting values presented in Table 6/15.1.

Material with soil concentrations greater than the relevant limiting values presented in Table 6/15.1 shall be classified as Class U1B, or further site-specific risk assessment shall be undertaken to determine suitability for re-use. This may also require further consultation with the Environment Agency or Local Authority Contaminated Land Officer.

3. Explanation of Limiting Values

The limiting values in Table 6/15.1 represent a broad range of contaminants suitable for the assessment of most materials. However, should other contaminants (e.g. chlorinated solvents, volatile organic compounds, PCBs) be suspected to be present, then these should also be tested and assessed against limiting values, as advised by a specialist environmental chemist.

The classification of site won materials shall take into account the potential receptors and exposure pathways. The primary human health receptors associated with the proposed scheme are construction workers and future maintenance workers. The assessment of risks to human health shall therefore use Generic Assessment Criteria (GAC) based on a commercial/industrial end use. These are considered to be appropriate for site won materials to be re-used beneath any hardstanding or soft landscaping.

The limiting values presented in Table 6/15.1 are based on published assessment criteria in accordance with the following hierarchy:

- C4SL - Department for Environment, Food and Rural Affairs SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. 2014.
- S4UL - Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C. and Nathanail, J.F. The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham. 2015.

- EIC - EIC/AGS/CL:AIRE. Soil Generic Assessment Criteria for Human Health Risk Assessment. 2010.

The Soil Organic Matter (SOM) affects the GAC for some organic contaminants. The GAC are published for a range of standard SOM values (1%, 2.5% and 6%). In deriving the limiting values presented in Table 6/15.1, a SOM of 1% has been selected since these represent the most conservative values.

Chemical	Unit	Limiting Value	Source
Metals			
Antimony	mg/kg	7,500	EIC
Arsenic	mg/kg	640	C4SL
Barium	mg/kg	22,000	EIC
Beryllium	mg/kg	12	S4UL
Boron	mg/kg	240,000	S4UL
Cadmium	mg/kg	410	C4SL
Chromium (Total)	mg/kg	8,600	S4UL
Chromium (Hexavalent)	mg/kg	49	C4SL
Chromium (Trivalent)	mg/kg	8,600	S4UL
Copper	mg/kg	68,000	S4UL
Lead	mg/kg	2,300	C4SL
Methyl Mercury	mg/kg	320	S4UL
Elemental Mercury	mg/kg	58	S4UL
Inorganic Mercury	mg/kg	1,100	S4UL
Molybdenum	mg/kg	17,000	EIC
Nickel	mg/kg	980	S4UL
Zinc	mg/kg	730,000	S4UL
Selenium	mg/kg	12,000	S4UL
Vanadium	mg/kg	9,000	S4UL
Asbestos			
Asbestos	-	Limit of detection	-
Organics – Polycyclic Aromatic Hydrocarbons			
Acenaphthene	mg/kg	84,000	S4UL
Acenaphthylene	mg/kg	83,000	S4UL
Anthracene	mg/kg	520,000	S4UL
Benzo(a)anthracene	mg/kg	170	S4UL
Benzo(a)pyrene	mg/kg	77	C4SL
Benzo(b)fluoranthene	mg/kg	44	S4UL
Benzo(g,h,i)perylene	mg/kg	3,900	S4UL
Benzo(k)fluoranthene	mg/kg	1,200	S4UL
Chrysene	mg/kg	350	S4UL
Dibenzo(a,h)anthracene	mg/kg	3.5	S4UL

Chemical	Unit	Limiting Value	Source
Fluoranthene	mg/kg	23,000	S4UL
Fluorene	mg/kg	63,000	S4UL
Indeno(1,2,3-cd)pyrene	mg/kg	500	S4UL
Naphthalene	mg/kg	190	S4UL
Phenanthrene	mg/kg	22,000	S4UL
Pyrene	mg/kg	54,000	S4UL
Organics – Total Petroleum Hydrocarbons			
TPH Aliphatic EC>5-6	mg/kg	3,200	S4UL
TPH Aliphatic EC>6-8	mg/kg	7,800	S4UL
TPH Aliphatic EC>8-10	mg/kg	2,000	S4UL
TPH Aliphatic EC>10-12	mg/kg	9,700	S4UL
TPH Aliphatic EC>12-16	mg/kg	59,000	S4UL
TPH Aliphatic EC>16-35	mg/kg	3,200,000	S4UL
TPH Aliphatic EC>35-44	mg/kg	1,600,000	S4UL
TPH Aromatic EC>5-7	mg/kg	26,000	S4UL
TPH Aromatic EC>7-8	mg/kg	56,000	S4UL
TPH Aromatic EC>8-10	mg/kg	3,500	S4UL
TPH Aromatic EC>10-12	mg/kg	16,000	S4UL
TPH Aromatic EC>12-16	mg/kg	36,000	S4UL
TPH Aromatic EC>16-21	mg/kg	28,000	S4UL
TPH Aromatic EC>21-35	mg/kg	28,000	S4UL
TPH Aromatic EC>35-44	mg/kg	28,000	S4UL
Other organics			
Phenol	mg/kg	760	S4UL
Benzene	mg/kg	98	C4SL
Toluene	mg/kg	56,000	S4UL
Ethylbenzene	mg/kg	5,700	S4UL
o-Xylene	mg/kg	6,600	S4UL
m-xylene	mg/kg	5,900	S4UL
p-xylene	mg/kg	5,900	S4UL
MTBE	mg/kg	7,900	EIC

4. Sampling and Analysis of Site Won Material

Testing requirements shall be in accordance with Table 1/5. Where site won materials come from areas deemed to be potential sources of contamination (see App. 6/2) or where significant variation in material composition is observed during construction, as compared to that encountered and assessed during the ground investigation, such as the presence of visual or olfactory indicators of contamination, further sampling, testing and risk assessment is required to determine the materials acceptability for re-use. The sampling frequency for such incidences will be determined by a nominated environmental specialist environmental chemist.

5. Imported Material

Imported materials (primary or secondary) must be suitable for use and will therefore require assessment for contamination. Where adequate prior testing and assessment is not available, additional testing is required for initial comparison with the Limiting Values detailed in Table 6/15.1, prior to material importation to site. If Limiting Values are exceeded further risk assessment will be required to determine suitability for use.

It is recommended that where additional testing is required the schedule of sampling and analysis, and limiting values, must be agreed in advance with a nominated environmental specialist environmental chemist prior to importation.

Certain secondary or recycled materials, such as pulverised fly ash or aggregates, may have been produced in accordance with a quality control protocol (e.g. WRAP), which provides evidence of the physical and chemical properties of the material. Where the use of these materials has been given prior approval by the Environment Agency, no further testing is required.

Virgin materials, such as quarry aggregate, will not require testing.

6. Classification of Material

Variations in the acceptance of the material to be used within the scheme are at the Contractors own risk. If the Contractor intends to use material that does not fully comply with the requirements of the table above, then a suitable risk assessment shall be undertaken in consultation with the Local Authority Contaminated Land Officer and/or Environment Agency. This risk assessment shall demonstrate that the potential for any harm to human health receptors using the non-compliant material is not significant.

Annex N Series 1600 Specification

M1 J23A TO J25

SERIES 1600

PILING & EMBEDDED

RETAINING WALL

Date: 23/02/24

Disclaimer: The listed deliverables have been prepared and issued in accordance with the provisions of the Smart Motorways Alliance Contract between the Alliance and National Highways. The Alliance Partners accept no third-party liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon these deliverables by anyone other than the Smart Motorways Partners or National Highways.

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INTRODUCTION

This document contains the series 1600 numbered appendices for the scheme entitled 'National Emergency Area Retrofit (NEAR) - Package 1a - M1: J23a to J25. Piling shall be undertaken in accordance with:

- Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway
- Works (SHW), Series 1600
- SHW Notes for Guidance Series NG 1600,
- BS EN 1536:2010 Execution of Special Geotechnical Works - Bored Piles
- Specification for Piling and Embedded Retaining Walls 3rd Edition, Institution of Civil Engineers (SPERW, 2017)

Where appropriate, the specification has been amended to adopt the requirements of the third edition of the SPERW, 2017. This Series 1600 Specification is subject to a departure from standards (HE614830-WSP-HGT-P015_AL_ALLGENR-DF-GE-0001) to align the Specification with the requirements of SPERW, 2017 including requirements of BS EN 1536:2010, BS EN 12699:2015 & BS EN 12063:1999.
This specification has been prepared following discussion with the On-Site Assembly Partner. Table below shows substitute clauses of Series 1600 of SHW for this contract.

Clause Number	Title	Requirements
1601	General Requirements for Piling and Embedded Retaining Wall	SR 1601: Refer to Clause B1 of SPERW
1603	Bored Cast-in-Place Piles	SR 1603: Refer to Clause B3 of SPERW
1604	Bored Piles Constructed Using Continuous Flight Augers and Concrete or Grout Injection Through Hollow Auger Stems	SR 1604: Refer to Clause B4 of SPERW
1606	Steel Bearing Piles	SR 1606: Refer to Clause B8 of SPERW
1614	King Post Walls	SR 1614: Refer to Clause B13 of SPERW
1615	Steel Sheet Piling	SR 1615: Refer to Clause B14 of SPERW

APPENDIX 16/1: SPECIFICATION REQUIREMENTS FOR PILING AND EMBEDDED RETAINING WALLS

The clause numbers in the table below refer to ICE Specification for Piling and Embedded Retaining Walls Third Edition (SPERW). The general piling works shall be in accordance with SPERW Section B1, except where there is a conflict of requirements. In which case, these Specification Appendices shall take precedence.
Scheme specific requirements are presented below.

Clause Number	Title	Requirements
B1.1	Standards	Applies.
B1.2	Project Specification	Applies.
	(a) role of the contract administrator	National Highways NEC Project Manager will manage the contract on behalf of the Employer with the intention of achieving the Employer's objectives regarding budget, programme, quality/end-product brief. The Designers Geotechnical Advisor: [redacted] will provide technical support to the NEC PM.
	(b) location and description of the site	The scheme runs from J23a (Donington Park Junction) to J25 (Sandiacre Interchange) of the M1 for a length of approximately 11.6km. J23a is approx. NGR Easting: Northing 446895, 324788. J25 is approx. NGR Easting: Northing 447194, 335613.
	(c) nature of the Works	For the general nature of the works refer to the drawings submitted as part of the Geotechnical Design Report for Structures, Doc. No. HE614830-WSP-HGT-P015_AL_ALLGENR-RP-GE-0003. The piling works comprise the design and installation of piled foundations to gantries and ancillary minor structures' masts and retaining structures for the installation of retrofitted Emergency Areas (EAs) to support the widened mainline and the slip road earthworks. The piling works comprise plunge piles for CCTV masts and MIDAS, steel Helical Piles for one gantry location, planted foundations have been proposed for five SVD's and King Sheet Pile walls to widen the verge at respective EA locations.
	(d) working area	As per the Contract.
	(e) sequence of the Works and other works proceeding at the same time	Where appropriate, assumptions with respect to the sequencing of the Work have been made and these are presented by the drawings and documents listed in item B1.2(f). The sequence of the Works shall be determined by OSA Partner and shall be compatible with the assumptions presented (by the drawings and documents listed in item B1.2(f)). The Contractor shall submit their proposed sequence for review by the Overseeing Organisation at least 14 days before commencing the Works and in compliance with the Programme of Works.

Clause Number	Title	Requirements
	(f) contract drawings	King Sheet Pile walls: HE614830-WSP-SRW-P015_J25_B11GENR-DR-CB-0001 PTZ CCTV plunge pile foundations: HE614830-WSP-SMA-P015_AL_ALLGENR-DR-CB-0100 SVD pole and foundations: HE614830-WSP-SMA-P015_AL_ALLGENR-DR-CB-0200, HE614830-WSP-SMA-P015_AL_ALLGENR-DR-CB-0201 MIDAS RADAR Column Foundation Details: HE614830-WSP-SMA-P015_AL_ALLGENR-DR-CB-0400
	(g) construction tolerances	Refer to the requirements for the piling method.
	(h) submission of information (in addition to table B1.1)	The information which shall be submitted at the stated stages of the works contract is listed in Table B1.1 of the piling specification.
	(i) responsibility for design, including any division of this responsibility	Option 1 – DED (Digitally Enabled Design) provides the permanent works design. The Contractor shall be responsible for all temporary works design- Applicable to plunge piles, planted foundation and King Sheet Pile walls. Option 2 – Contractor (ScrewFast) provides design of Steel Helical piles.
	(j) design standards and criteria for the piles or walls including design life	The piles are designed in accordance with BS EN 1997-1, all relevant Eurocodes and associated National Annexes and for a design working life of 120 years. The Contractor is required to ensure that the method of working, and equipment is compatible with these design standards and relevant BS EN execution codes.
	(k) constraints on design including the need to verify design assumptions	The permanent works design for the King Sheet Pile wall includes an allowance for unplanned excavation up to 0.5m. Any temporary excavations in front of the wall shall be subject to a temporary works assessment carried out by the Contractor. Care should be taken so that the drainage pipeline passes through the space between the King Piles (i.e., under the intermediate piles).
	(l) working platform and commencing surface level	No additional requirements. The design of the working platform shall be the responsibility of the Contractor. For the gantry, the design of the working platform, Steel Helical piles and grillage shall be the responsibility of the ScrewFast. Refer also to item B1.2(e).
	(m) a schedule of representative actions (or specified working loads if applicable)	DED will provide design parameters, assumptions and loads together with local topographical and section information to allow the contractor to complete the detailed design of the retaining structure. Parameters provided by DED will be the scheme-wide parameters for the M1 J23a-25, derived from G230600 - M1 J23a-J25 - Factual Report - Rev001 and they must be reviewed for suitability of use at detailed design stage.

Clause Number	Title	Requirements
		The global stability of the slopes will remain the responsibility of DED.
	(n) pile or wall element dimensions	Refer to documents and drawings referenced in B1.2 (f).
	(o) preliminary piles and trial bores/drives /panels	Not applicable.
	(p) performance criteria for the structure to be supported on the piles or by the wall	Plunge piles of CCTV: Deflection limit at the top of mast – 20mm. King Sheet Pile Wall: Deflection limit at the top of wall - 75mm. Steel Helical piles of MS4 Gantry: Please refer to HE614830-VAE-SGY-P015_S2_ALLGENR-RP-CB-0001.
	(q) performance criteria for piles under test or wall elements during service (see Tables B1.2, B1.3)	Static load pile testing will be undertaken to the requirements of the ICE SPERW 3rd Edition, EN 1997-1 section 7.5 and in accordance with Appendix 16/9 of this Specification.
	(r) sampling and testing of materials (other than concrete)	Testing of materials shall be in accordance with Appendix 1/5.
	(s) permissible damage criteria for existing critical structures or services	No damage is permitted to neighbouring assets, structures, services and infrastructure. If the Contractor is of the opinion that by any means arising from the works neighbouring property may be damaged this shall be stated in his tender and the nature of the necessary protective or other temporary works described therein. The Contractor shall take due cognisance of the presence of Statutory Undertakers apparatus which is present along the scheme alignment and in some locations, will be near proposed piled foundations.
	(t) additional temporary works plant and duration of loading which the working platform should be designed	As per the Contract.
	(u) site datum and site grid	As per the Contract.
	(v) restrictions on permissible working hours	Refer to the Series 0000 and 0100 specification appendices.
	(w) restrictions on noise and vibration levels	Refer to the Series 0000 and 0100 specification appendices.
	(x) Site Investigation including geotechnical and geo-environmental information, and the need for further GI	For existing information refer to GISR HE614830-WSP-HGT-P015_AL_ALLGENR-RP-GE-0001. Proposed ground investigation has been conducted and recorded in G230600 - M1 J23a-J25 - Factual Report - Rev001

Clause Number	Title	Requirements
	(y) disposal of excavated material and trimmed excess pile and wall material	Refer to the Series 600 specification appendices. Spoil generated from the site will require disposal by the Contractor in accordance with the Waste (England and Wales) (Amendment) Regulations 2012 and the Environmental Permitting (England and Wales) Regulations 2016 and any other relevant statutory instrument and guidance. Sheet piles will require trimming where located on slopes, gradients, changes of direction and other similar situations. Where there are any specific driving issues, returns or proud sheet piles they are to be cut with care to give a high-quality finish, as per below: • Use a small cutting nozzle whilst burning, e.g. 1mm; • Grind the clutches only instead of burning; • Apply light grinding to the back face to remove any blow back. • Use a magnetic profile attachment to burn to to achieve a better line. Flame cutting tolerance of +/- 25mm of the given level.
	(z) other particular technical requirements	Unless specified otherwise within these Specification Appendices and/or on the Contract drawings, the Contractor is to select from the piling techniques permitted herein. Unless shown otherwise on the drawings capping beams are not required on sheet pile walls. The tops of the sheet piles are to be finished to leave a level surface without sharp or irregular edges with sharp points. Sheet piles are to be driven along the main back wall to exact level working with a horizontal laser line to achieve a neat and level finish with a tolerance of 50mm. See trimming requirements in B1.2 (y)
	(aa) special requirements for retaining walls	Refer to the Contract Drawings.
	(bb) loads on walls and excavation depths	Loads from the gantry and CCTV masts have been provided by DED (Structures Team) as follows: CCTV-Moment of 78.6 kNm and horizontal force of 9.95 kN at base [ULS] SVD- Moment of 1.32 kNm and horizontal force of 0.30 kN at base [ULS] MIDAS- Moment of 3.73 kNm and horizontal force of 0.86 kN at base [ULS] Loads from MS4 gantry as in HE614830-VAE-SGY-P015_S2_ALLGENR-RP-CB-0001
	(cc) details of surrounding structures, their	Refer to the OSA Partner Drawings.

Clause Number	Title	Requirements
	foundations and associated loadings	
	(dd) water retention function and degree of retention for retaining wall in both temporary and permanent conditions	Not required.
	(ee) design external groundwater level for the water retention system and for watertightness inspections	Not required.
	(ff) design water retention grade for permanent overall system and the role of the retaining wall as a system component	Not applicable.
	(gg) programme for watertightness inspections	Not required.
	(hh) permissible limits on ground movements during wall installation	No ground movements that cause damage to neighbouring structures/services during wall installation shall be permitted.
	(ii) details of surrounding services including distance, depth and permissible movement	Refer to the OSA Partner Drawings.
B1.3	Submission of information	Applies.
B1.4	Design	Option 1 – Employer provides the permanent works design.
B1.5	Materials	Applies.
B1.6	Safety	Applies.
B1.7	Ground Conditions	Applies.
B1.8	Installation Tolerance	Applies.
B1.9	Waterproofing of embedded walls	Not required.
B1.10	Construction Method	Applies.
B1.11	Construction Programme	Applies.
B1.12	Records	Applies.
B1.13	Nuisance and damage	Applies.
B1.14	Driving piles	Not applicable. Foundations for proposed PTZ CCTV masts and MIDAS shall comprise steel circular hollow sections plunged into 750mm diameter bores filled with concrete.

Clause Number	Title	Requirements
B1.15	Supervision and control of the works	Applies.
B1.16	Non-conformances	Applies.
B1.17	Trimming and cutting off piles and wall elements	Applies.
B1.18	Definitions	Applies.

APPENDIX 16/2: PRECAST REINFORCED AND PRESTRESSED CONCRETE PILES AND PRECAST REINFORCED CONCRETE SEGMENTAL PILES

Not used.

APPENDIX 16/3: BORED CAST-IN-PLACE PILES

The clause numbers in the table below refer to ICE Specification for Piling and Embedded Retaining Walls Third Edition (SPERW).
Bored Cast-in-Place Piles shall be in accordance with SPERW Section B3, except where there is a conflict of requirements. In which case, these Specification Appendices shall take precedence.
Scheme specific requirements are presented below.

Clause Number	Title	Requirements
B3.1	General	Applies. A bored pile is specified: Plunge Pile Foundations– see details in B3.2(g).
B3.2	Project Specification	Applies. The Project Specification is this document.
	(a) support fluid	Not permitted.
	(b) base or shaft grouting	Not required.
	(b) pile shaft and base inspection by closed-circuit television (CCTV) and or sampling/probing (see clause B3.5.8)	Not required.
	(d) details of permanent casings	Not required.
	(e) inspection of under-reams	Not required.
	(f) ribbed piles	Not required.
	(g) details of plunge columns	Plunge piles are to be 457mm and 168mm diameter steel circular hollow sections plunged in 750mm diameter bores filled with concrete. Refer to drawings HE614830-WSP-SMA-P015_AL_ALLGENR-DR-CB-0100, HE614830-WSP-SMA-P015_AL_ALLGENR-DR-CB-0400 for further details.
	(h) other particular technical requirements.	For requirements for structural concrete refer to Specification Appendices Series 1700.
B3.3	Materials	Applies.
B3.4	Construction tolerances	Applies.
B3.5	Construction processes	Applies.
B3.6	Records	Applies.

Piles with Permanent Casing

Permanent casing shall meet the requirements of item B18 of the ICE Specification for Piling and Embedded Retaining Walls Third Edition (SPERW) except where there is a conflict of requirements. In which case, these Specification Appendices shall take precedence.
Scheme specific requirements are presented below.

Clause Number	Title	Requirements
B18.1	General	Applies.
B18.2	Project Specification	Applies.
	(a) the type and particular description of the permanent casing method and/or coating to be used	Refer to the drawings presented in item B1.2(f).
	(b) the purpose of the permanent casing or coating	Not required
	(c) the numbers or other identification of piles to be sleeved or coated	Not required
	(d) the length of pile to be sleeved or coated	Not required for CCTV; temporary casing used for the installation of CCTV MIDAS to have Thin-Wall Sleeve (or similar) of 1.21m from finished ground level
	(e) preparatory pre-boring or other work necessary for proper application of the method	To be determined by the Contractor.
	(f) depth, diameter and means of ensuring temporary stability of any pre-boring where required	To be determined by the Contractor and in accordance with the drawings presented in item B1.2(f).
	(g) designated manufacturer's name and details where a proprietary product is required	No permanent works requirement.
	(h) whether any annulus surrounding the permanent casing is to be filled with grout or other suitable self-hardening fluid	No permanent works requirement.
	(i) details of any pile testing, or trial piles required to demonstrate the effectiveness of the method	Before the commencement of concreting, the Contractor shall demonstrate that an effective seal has been achieved.
	(j) other technical requirements	None.
B18.3	Bituminous or other coating materials	Not used.
B18.4	Permanent casing	Applies.

APPENDIX 16/4: BORED PILES CONSTRUCTED USING CONTINUOUS FLIGHT AUGERS AND CONCRETE OR GROUT INJECTION THROUGH HOLLOW AUGER STEMS

The clause numbers in the table below refer to ICE Specification for Piling and Embedded Retaining Walls Third Edition (SPERW).
CFA Piles shall be in accordance with SPERW Section B4, except where there is a conflict of requirements. In which case, these Specification Appendices shall take precedence.
Scheme specific requirements are presented below.

Clause Number	Title	Requirements
B4.1	General	• Applies
B4.2	Project Specification	Applies
	a) Permitted pile types	A 750mm diameter bored pile is specified: Plunge Pile Foundations– see details in B3.2(g).
	b) Whether a single splitting of augers shall be permitted	Not permitted.
	c) Whether concrete supply is to be controlled by pressure or volume (see clause B4.4.5.3)	By volume.
	d) Whether compressed air shall not be permitted to assist with boring	Not permitted.
	e) Other technical requirements	Monitoring records in text readable format to be made available to the Designer's Geotechnical Advisor within 24 hours of completion of the pile. The piling contractor is to submit to the Designer's Geotechnical Advisor commencement of piling works a proposal on how to complete a pile in the event of failure of part or all the rig instrumentation system at least 10 days prior to.

APPENDIX 16/5: DRIVEN CAST-IN-PLACE PILES

Not used.

APPENDIX 16/6: STEEL BEARING PILES

16.6 Requirements for steel helical piles

16.6.1 Grades of steel

The materials for steel helical piles shall comply with the following:

Shaft:
• BS EN 10210, BS EN 10219 or BS EN 10297-1
• Grade S355 J2H

Toe, Helix, Wing & Drive Plates:
• BS EN 10025
• Grade S355 J2

Bolts and Studs:
• BS 3692 and BS 4190
• Grade 8.8

16.6.2 Sections of proprietary types of pile

See site specific pile design or installation sheet.

16.6.3 Lengths of pile to be supplied and additional lengths

Pile design length, founding level, and helix configuration are designed on a site-specific basis. Information regarding site specific design length, levels and helical configuration can be found in the relevant site-specific pile design drawings.

Should they be required due to unexpected ground conditions or low installation torque readings, additional pile length(s) or alternative alterations to the pile design will be approved by appropriate ScrewFast design engineers and will be recorded on the site-specific installation sheet.

16.6.4 Types of pile shoe

The pile point is generally fitted with tungsten rock teeth to ease pile installation where anticipated ground conditions suggest the pile needs to penetrate into particularly dense material or where there is a possibility of in situ obstructions affecting the pile installation.

16.6.5 Surface preparation & types of coating

The pile sections below the aerobic zone (the majority of the pile) are self-colour and no surface preparation of the steel is required.

Those sections within the aerobic zone, and within zones that may be affected by residual salt contamination, are to be coated with Highways Agency approved Thixotropic bitumen paint ‘Dacrylate’ (HA item 141) or other similar approved, as per requirements of ScrewFast Foundations Specification Appendix 19.5.

Galvanising of pile sections in aerobic zone to BS EN ISO 1461 in accordance with requirements of ScrewFast Foundations Specification Appendix 19.5 may also be specified according to the site-specific design.

16.6.6 Thickness of primer and coats

The Highways Agency approved Thixotropic bitumen paint ‘Dacrylate’ (HA item 141) requires:
• Thixotropic bitumen (HA item 141) typical mean thickness 250 microns

16.6.7 Welding procedure and tests

Testing and inspection of fabrication welds shall be in accordance with Table 1 of BS EN 12699. All

procedures shall be in accordance with BS EN ISO 15607, BS EN ISO 15609-1, BS EN ISO 15613 and BS EN ISO 15614-1.

All welds shall be visually inspected to BS EN 970 and where quality is doubtful, be magnetic particle inspected (MPI) to BS EN ISO 9934.

16.6.8 Penetration or depth or founding level

A minimum depth of pile is to be installed in all cases in order to satisfy axial, lateral and bending resistance requirements as per the site-specific requirements. Any alterations to the design must be approved by a ScrewFast Foundations design engineer.

16.6.9 Torque requirements

The minimum required pile installation torque will be specified based on the individual pile design load and the site-specific ground strength profile. The torque will be specified on the individual site-specific installation sheets.

The pile installation torque must be recorded over the last meter of installation and the average over this meter must be more than the specified minimum required. Should the minimum torque not be achieved, then additional lengths should be added as per 16.6.3, or an alternative design may be required.

16.6.10 Preliminary piles

Undertaken, where applicable, in accordance with the ScrewFast Specification Appendix 16/9.

16.6.11 Uplift/lateral displacement trials

Undertaken, where applicable, in accordance with the ScrewFast Specification Appendix 16/9.

16.6.12 Rock augering

Where required to ease pile drivability in particularly dense material or in made ground, pre-boring the pile position with a rock auger will be used to remove or displace any obstructions in the ground. The rock auger diameter will be smaller than the helix diameter.

Pre-augering does not affect the pile capacity so long as the minimum required installation torque is achieved; since the helix diameter is generally much larger than the auger diameter the helix is always installed into undisturbed material.

16.6.13 Detailed requirements for driving records

The following will be recorded on the installation sheet(s) for each pile:

- Pile type (shaft diameter, wall thickness)
- Pile reference
- Design pile length including modular section type and quantity
- Installed pile length
- Design minimum torque, design predicted torque and maximum torque
- Installed average torque over last meter of installation
- Design helical configuration and installed helical configuration
- Design corrosion protection requirements
- Recorded groundwater levels
- The torque head used for the pile installation
- The installation date, the installers name and their SFF installer number
- The supervisor’s name and their SFF installer number
- SFF approval of the installation

Note: other information related to quality, installation tolerances, and documentation of design changes are recorded on a separate document.

APPENDIX 16/7: REDUCTION OF FRICTION ON PILES

Not used.

APPENDIX 16/8: NON-DESTRUCTIVE METHODS FOR TESTING PILES

Not used.

APPENDIX 16/9: STATIC LOAD TESTING OF PILES

1. Particular requirements for static load testing of piles

(a) Type of pile

This document refers to the Screwfast designed and installed Steel Helical piles. Each location is designed for site specific ground conditions and loads. Tests are to range across the span of the corridor project detailed in this report for which this appendix forms a part thereof, excluding Section 3. The pile testing is to be undertaken on Helical piles.

(b) Type of test

All testing of piles shall be maintained load testing. Vertical tests will be two stage testing while lateral tests are single stage only.
The location for these tests will be dependent on which foundation locations are installed first.
Number of vertical and lateral working pile tests to be undertaken to be agreed with the Overseeing Organisation or Engineer as and where required.

Load testing of piles shall be maintained load testing.

Unless otherwise recommended, the performance criteria for working piles tested for axial and lateral loads shall be as follows:

Load	Allowed Deflection (mm)
100% SWL (under load)	15mm
Residual (load released)	10mm
150% SWL (under load)	17mm
Residual (load released)	12mm

For preliminary piles the point of failure will be defined as the load stage where the rate of deflection increases for a maintained constant load.
Screwfast have a large quantity of successful pile testing (where settlement performance exceeds pile design predictions) with; in excess of 300 successful pile tests, scores of which have been undertaken on the National Highways projects and several successful National Highways project piles tests in the past several years alone (on M1 J13-16 and M6 J21a-26 projects).
It is common UK pile testing practice that at least one percent of locations will be tested. There is only one location. The total number of piles required will be confirmed after finalization of design by ScrewFast. Tentatively, 3 tests are proposed for site MS4 151/4 as follows; 1 compression, 1 tension and 1 lateral working pile tests to be undertaken. A test report will be prepared summarising the results and performance of the piles under all test loading conditions.

(c) Details of working pile tests

The general procedure of each vertical or lateral working pile test type is included in this document. All pile testing procedures will adhere to the National Highways' Specification for Highway Works (HA SHW) Clause 1609.33 and Table 16/6 and Institution of Civil Engineer's Specification for Piling and Embedded Retaining Walls, 3rd Edition (ICE SPERW) specifically section B17. No pile will be tested more than once to ensure the pile performance data is accurate and test conditions are repeatable.
Pile Testing Details

Working pile tests will be conducted on the project as and where required. The piles to be tested are intentionally left unspecified. In this way the test locations can be matched to the locations where construction constraints have been encountered or design changes have been necessary, or if any other issues arise. Tests on Helical piles can be adjusted as the outcome of other tests and construction practicalities develop and the quantity tests can change, within limits, depending on the confidence of the results. The vertical pile tests will be tested in two stages only as detailed in Table 1 and lateral, one stage as in Table 2.
Table 1 – Vertical Maintained Load Test

	Load	Minimum Time to Maintain Load	Elapsed Time (minutes)
Stage 1	25% DVL	30 minutes	30
	50% DVL	30 minutes	60
	75% DVL	30 minutes	90
	100% DVL	6 hours	450
	75% DVL	10 minutes	460
	50% DVL	10 minutes	470
	25% DVL	10 minutes	480
	Nominal 5kN	1 hour	540
Stage 2	100% DVL	1 hour	600
	100% DVL + 25% SWL	1 hour	660
	100% DVL + 50% SWL	6 hours	1020
	100% DVL + 25% SWL	10 minutes	1030
	100% DVL	10 minutes	1040
	75% DVL	10 minutes	1050
	50% DVL	10 minutes	1060
	25% DVL	10 minutes	1070
	Nominal 5kN	1 hour	1130

Table adapted from ICE SPERW 3rd B17.1

Table 2 – Lateral Maintained Load Test

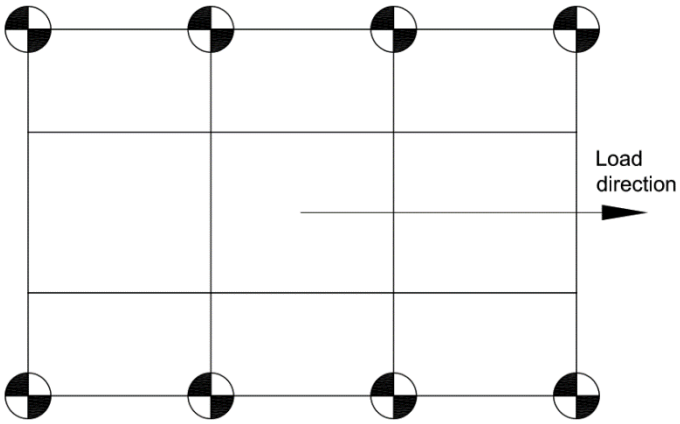
	Load	Minimum Time to Maintain Load	Elapsed Time (minutes)
Stage 1	Nominal 5kN	Start	0
	50% DVL	15 minutes	15
	100% DVL	60 minutes	75
	Nominal 5kN	15 minutes	90

Table adapted from ICE SPERW 3rd B17.3

Pile Testing Method

Vertical piles will be tested individually with a test beam, two reaction piles and a test pile. The Specified Working Load (SWL, similar to F_{rep} discussed below), Design Verification Load (DVL) and maximum test load shall be specified in the individual test documentation.
All lateral pile tests will be tested as a group. This is due to the steel grillage which connects all piles as a group creating a fixed head which works to act in unison against lateral forces.

The lateral working loads on the pile group is a combination of a moment force and a shear force. However, it is only practicable in testing to apply a shear load. Therefore, the DVL for each specific



lateral test will be determined from an iterative process to determine the shear load that results in the same predicted pile deflection, in the pile model as the combination of moment and shear on that same pile model. An illustrative example: where a pile group deflects 5mm under a combination of 70kN shear and 200kNm moment, an analysis may show that to achieve an equivalent deflection in the model under shear alone requires application of a 300kN load. Therefore, the DVL for this example would be 300kN.

The ICE SPERW defines DVL as the load which will be substituted for the SWL for the purpose of a test. In this case the unfactored load will be used as the DVL, so that the 100% DVL load increment will demonstrate pile displacement under the unfactored working load.

The ICE SPERW indicates that SWL is the unfactored load and that it is similar to the Representative Action (F_{rep}) defined in BS EN 1990 as $F_{rep} = \psi.F_{k.}$ If the unfactored load was used as both SWL and DVL for the testing, then the maximum test load would be 150% of the unfactored load. However, since the piles have been designed in accordance with Eurocode 0 and CD365, the characteristic loads (F_k) when multiplied by the appropriate partial factors (ψ) are less than 150% of the unfactored load. It is therefore considered inappropriate to use the unfactored load as the SWL. Accordingly, for the purposes of the testing, the value of SWL has been selected to ensure that the maximum test load of 100% DVL + 50% SWL is equal to the F_{rep} used for the designs, to ensure that the piles are tested to the precise design loads. Accidental loads, for which all piles have been designed, do not form part of the test loads combinations.

All testing shall be carried out in accordance with a Method Statement. The Method Statement will include details of the pile testing equipment, arrangement, form of test records and any temporary works required.

In all cases the loads applied shall be appropriate to the site-specific working pile, any temporary reaction piles required shall be designed by Screwfast Foundations and are subject to the same design conditions as all the other piles on the project. Any working piles used as reaction piles shall be monitored during static load testing. Working reaction piles shall not uplift/settle by more than half the specified permissible settlement of the test pile at working load. If a test pile is deemed to have failed the test load, then the Designer shall be notified, and the pile shall be re-designed based on the results of the pile tests.

Unless otherwise agreed, the performance criteria for working piles tested for axial loads shall be as shown in Table 3.

Table 3 – Pile Test Performance Criteria

Load	Measurable Criterion
Variable load only	5mm
100% DVL (under load)	10mm
Residual (load released)	-
100% DVL + 50% SWL (under load)	No excessive creep
Residual (load released)	-
Lateral load 100% DVL	Varies by gantry type

Note: "-" represents that a deflection limit was not specified. This is applied to *"Residual Load"* cases as there do not require a measurable deflection criterion

The allowable pile vertical deflection (settlement) is 10mm under DVL. As the grillage design assumes a spring stiffness value predicated on 5mm settlement under variable action then this is an additional settlement limit. This 5mm limit however is determined under the variable actions only. This is based on the National Highways Standard CD365 which states pre-camber in the gantry design accounts for the permanent action effects. Therefore, it is only the variable loads that account for the 5mm limit stated.

In order that testing stages do not have to be deviated from the testing standards the following method is proposed to make this determination with an illustrative example. If the test pile has a DVL of 100kN permanent and 70kN variable making it 170kN in total and the permanent and variable action split is 59/41. If, during the 170kN load stage, the pile settled by 8mm., then pile settlement under 70kN variable action is 8mm x 41% = 3.3mm. This test has passed because 8mm < 10mm, and 3.3mm < 5mm.

Deflection is to be recorded by four dial indicators set up on perpendicular axes on the test piles group and fixed to an independent datum frame with a tiltmeter affixed to the grillage at the centre point. The datum frame shall be set so that is out of the influence of the soil surrounding the loaded pile as per Section B17 of ICE SPERW, 3rd Edition. The lateral test is a direct measurement of the allowable displacement and rotation.

Ambient temperature will be monitored during testing. Should large temperature variations occur during testing, the deflections will be adjusted during reporting if temperature is deemed to have influenced the results.

The testing is to be completed by competent and experienced pile testing contractor. The applied load is to be monitored during load stages and pressure reapplied to that required for the stage should the hydraulic pressure fall. All such reapplications of pressure will be recorded.

The load test report shall include the following items in accordance with BS EN 1997-1:2004+A1:2013:

- A description of the site
- The ground conditions with reference to the ground investigation
- The pile type including details of the reaction piles
- Description of the loading and measuring apparatus and the reaction system
- Calibration documents for the load cells, the jacks and gauges.
- The installation records of the test piles
- Photographic records of the pile and the test site
- Test results in numerical form
- Time-displacement plots for each applied load when a step loading procedure is used
- Reasons for any departures from the above requirements

(d) Special materials to be used in construction of test piles where appropriate

None.

(e) Special construction detail requirements for test piles

All construction details shall be as per the requirements for a working pile.

(f) Special requirements for pile-testing equipment and arrangement

None.

(g) Pile installation criteria

As per the site-specific pile design installation.

(h) Time interval between pile installation and testing.
No time interval is necessary for helical pile testing as there is no concrete in the pile design.

(i) Removal of temporary works

Not applicable.

(j) Details of work to be carried out to the test pile cap or head at the completion of a test

None.

APPENDIX 16/10: DIAPHRAGM WALLS

Not used.

APPENDIX 16/11: HARD/HARD SECANT PILE WALLS

Not used.

APPENDIX 16/12: HARD/SOFT SECANT PILE WALLS

Not used.

APPENDIX 16/13: CONTIGUOUS BORED PILE WALLS

Not used.

APPENDIX 16/14: KING POST WALLS

Not used.

APPENDIX 16/15: STEEL SHEET PILES

The clause numbers in the table below refer to ICE Specification for Piling and Embedded Retaining Walls Third Edition (SPERW).
Steel Sheet Piles shall be in accordance with SPERW Section B14, except where there is a conflict of requirements. In which case, these Specification Appendices shall take precedence.
Scheme specific requirements are presented below.

Clause Number	Title	Requirements
B14.1	General	Applies. One embedded King Sheet Pile Wall is proposed in the following drawing: • HE614830-WSP-SRW-P015_J25_B11GENR-DR-CB-0001
B14.2	Project Specification	Applies
	(a) Penetration or depth or toe level	As per the drawings.
	(b) Methods of installation or extraction	No specific requirements. Pre-augering is anticipated and permitted.
	(c) Detailed requirements for piling records	As per SPERW (2017) requirements.
	(d) Grades of steel	As per the drawings.
	(e) grades of steel	As per the drawings.
	(f) section type and manufacturer's reference number; minimum, section modulus; second moment of inertia; web thickness	Not required.
	(g) types of coating	Not required.
	(h) thickness of primer and coats	Not required.
	(i) cathodic protection	Not required.
	(j) types of head and toe preparation	No particular requirements.
	(k) minimum length to be supplied	As required to meet design length and penetration shown in the drawings.
	(l) practical refusal for pile installation or extraction	As required to meet design length and penetration shown in drawings. Any deviation to be agreed with the Supervisor.
	(m) water-tightness performance requirement; basement	Not required.

Clause Number	Title	Requirements
	grade to BS 8102:1990 (BSI, 1990)	
	(n) interlock sealant or seal welds	Not required.
	(o) special piles, corners, etc.	As required to meet design geometry shown in drawings.
	(p) other particular technical requirements.	Refer Series 500 for Drainage.
B14.3	Materials and fabrication	Applies.
B14.4	Construction processes	Applies.
B14.5	Corrosion rates	Loss of section thickness due to corrosion over a 120-year design life has been considered. Refer to the scheme Combined PSSR-GISR-GDR document (HE614830-WSP-HGT-P015_AL_ALLGENR-RP-GE-0003) for further details.
B14.6	Welding procedures	Applies.
B14.7	Records	Applies.

Stage 2: Undertake pre-augering

1. Depth of pre-augering is to be determined by the sheet piling Contractor based on the existing/new borehole results but it should not be deeper than 1m above the design toe level of the sheet piles.
2. No water jetting is permitted.

APPENDIX 16/16: INTEGRITY TESTING OF WALL ELEMENTS

Not used.

APPENDIX 16/17: INSTRUMENTATION FOR PILES AND EMBEDDED WALLS

Not used.

APPENDIX 16/18: SUPPORT FLUID

Not used.

APPENDIX 16/19: HELICAL STEEL PILES

The clause numbers in the schedule below refer to ICE SPERW (2017). The general piling works shall be undertaken in accordance with ICE SPERW, 2017, Section B7. Where there is a conflict of requirements the specification appendices shall take precedence.

Clause Number	Title	Requirements
B7.1	General	Applies.
B7.2	Project Specification	Applies
	(a) penetration or depth or toe level	As per site specific design.
	(b) pre-drilling or other means of easing pile installation and any limitations	To BS 8004:2015 where required.
	(c) detailed requirements for installation records	Applies.
	(d) grades of steel	Shaft and helix • BS EN 10210 • Grade S355 J2H for shafts and S355 J2 for helices Bolts and studs • BS 15048 • Class 8.8 bolts with Class 10.9 nuts for galvanised bolts and Class 8.8 nuts for other Class 8.8 bolts • BS EN 14399-3 – Class 8.8/8 – HR – tZn with washers to BS EN 14399-5.
	(e) types of corrosion protection	As per NH 1900 series table 19/4C-G2b.
	(f) thickness of primer and coats	As per NH 1900 series table 19/4C-G2b.
	(g) adhesion tests	As per 1900 series and project specific RAM.
	(h) welding procedure – additional requirements to clause B7.6	Not required.
	(i) non-destructive testing of welds – additional requirements to clauses B7.6.2	Not required.
	(j) marking of piles – additional requirements to clause B7.4.2	Not required.
	(k) constraints on pile testing procedures	As per appendix 16/9.

Clause Number	Title	Requirements
	(l) other particular technical requirements.	Not required.
B7.3	Materials and fabrication	Applies.
B7.4	Construction processes	Applies.
B7.5	Protection against corrosion	Applies.
B7.6	Welding Procedures	Applies.
B7.7	Static load testing of helical piles	Applies.
B7.8	Records	Applies.

APPENDIX 19/5: GENERAL REQUIREMENTS FOR PROTECTION OF STEELWORK AGAINST CORROSION

19.5.1 Steelwork shall be designed to transfer the required working loads safely for the design life duration in the appropriate environmental conditions as per BS EN 1993-5 Section 4.

19.5.2 The sections of steelwork to be protected against corrosion and the details of the protection method shall be shown on the design fabrication drawings and detailed below.

19.5.3 The protective system shall include all required steelwork preparation, primers and all other coats.

19.5.4 The preparation of surfaces for the application of barrier or electrolytic systems shall be carried out safely by competent and appropriately trained personnel.

19.5.5 All work associated with surface preparation shall be undertaken inside a waterproof structure.
19.5.6 All surfaces to be coated shall be clean and dry and prepared as per the specific product requirements.

19.5.7 The method of application of protective systems shall comply with the manufacturer's instructions, including controls on limits of humidity.

19.5.8 All primary steelwork above ground and to a depth of 1m below ground level unless specifically indicated on drawing to be galvanised will be own colour and coated in a thixotropic bitumen protective system to 1900 Series specification.

19.5.9 The black bitumen protective system will be Dacrylate (Highways Agency item no. 141) or other similar approved product with typical mean dry thickness of 250 microns.

19.5.10 The nominal mean thickness of the finished protective coating and, if necessary, of each protective system shall be as specified in the relevant standard BS EN ISO 1461, BS EN ISO 12944 or other.

19.5.11 In no case shall any protective system be less than 75% of the nominal thickness. Each coat shall be applied after an interval that ensures proper hardening or curing of the previous coat in accordance with the manufacturer's instructions. The completed protective system shall be checked for thickness and electrical connectivity. Areas where the thickness is less than that specified shall receive additional treatment and areas where the connection is not sound shall receive remedial attention.

19.5.12 The finished protective system shall be smooth, of dense and uniform texture and free from sharp protuberances or pin holes. Areas of excessive sags, dimpling or curtaining shall be re-treated.

19.5.13 Galvanising where specified on fabrication drawing to be in accordance with BS EN ISO 1461 with minimum mean cover of 85 microns unless otherwise stated.

19.5.14 Sacrificial anode(s) where specified to be of suitable material, appropriately sized for the application, and adequately fixed to the steelwork.

19.5.15 All bolts above ground and to a depth of 2m below ground level shall be galvanised. All other bolts shall be zinc coated.

19.5.16 Surface soil which has been particularly contaminated by road salts should be removed and replaced by suitable compacted granular type 6N fill.

19.5.17 Any system damaged by subsequent processes or deterioration shall be removed and an approved manufacturers repair system used.

19.5.18 Where attachments are to be welded to the steelwork after installation, it is necessary to ensure that the coating system is removed and made good or replaced where appropriate.

See Bookmarks for contents of this report.

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06 Product Development & Production
Preconstruction and Construction services

Smart Motorways Programme

M1 Junction 23a to 25

Ground Investigation Report

HAGDMS Report No. 28929

Volume 1 of 4 – Title Page and Report Text

Issue 01 – February 2016

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This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

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Working on behalf of highways england

Document history

Amey Arup assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 389 pages including the cover.

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Executive summary

This Ground Investigation Report has been prepared in accordance with the proposal put forward in the Statement of Intent by Amey Arup Joint Venture in October 2015, it meets the requirements of Annex 10 of the Smart Motorway Programme Lot 1 Design Brief, Collaborative Delivery Framework (CDF) Scope, March 2014 as a deliverable for SGAR3/DF3 and the requirements of HD22/08 for the M1 Junction 23a to 25 SM Project. The Scheme is being delivered as part of the Highways England Smart Motorway Programme under Lot 1, Package Order No PC1 0004 and PC1 0005. This scheme forms part of Tranche 2 of a package of 12 schemes, in 6 tranches, being delivered as a single programme as part of the current SR13 Smart Motorways Operational Concepts Programme.

In 2005 a Preliminary Sources Study Report was completed by Arup for M1 widening works between Junctions 21 and 30. Following a ground investigation, a Preliminary Geotechnical Report was completed by Arup in 2007.

This Ground Investigation Report is an update to these reports, with identified geotechnical risks, ground model and historical ground investigation data being specific to the scheme extents only. Alongside an update to the desk study element of the scheme, a series of geotechnical hazard, superficial geology and solid geology plans are included with this report. The ground model for the site is diagrammatically represented by a long section of the scheme that includes generalised geological interpretations.

No additional intrusive ground investigation was undertaken to accompany this report as there is a large amount of historical ground investigation data exclusive to the scheme extents. A ‘Gap Filling’ ground investigation was recommended in the Statement of Intent, however, in light of additional data obtained in addition to what was included in the Arup Preliminary Geotechnical Report, this ‘Gap Filling’ ground investigation was no longer required for ground modelling purposes. ‘Just In Time’ ground investigation, is proposed as part of Design Fix 6, before construction works at the location of each proposed structure where it is considered that the preliminary ground model and detailed design at Design Fix 5 requires confirmation. In addition, ground investigation may be required to inform the ground model should widening works be undertaken at the Sawley rail underbridge or if a new emergency turnaround at Wilne Lane is developed

The ground conditions for the site include Made Ground associated with highway embankments, varying Superficial Deposits, notably those associated with the River Trent floodplain, overlying a weathered profile of the Mercia Mudstone Group. The ground model for the scheme extents has been divided into 3 sections, based on regional variations in lithology of the Mercia Mudstone Group, referred to as the ‘South Section’, ‘Central Section’ and ‘North Section’. For each of these sections, this report provides details on location, topography, geology, hydrology and hydrogeology.

Using historical ground investigation data, published literature and findings from the previously proposed M1 widening works; this Ground Investigation Report provides a summary of characteristic geotechnical properties and the derivation of generalised characteristic geotechnical parameters for the strata present within the scheme extents.

Characteristic geotechnical parameters will be re-assessed on a local-scale as part of future geotechnical design for each proposed geotechnical design location. Datasheets will be produced as part of future Design Fix stages for this scheme that detail site-specific ground models for each proposed design location.

Geotechnical design input will be required relevant to foundations, retaining solutions and earthworks design associated with gantries, Emergency Refuge Areas, areas of verge widening, minor structures such as CCTV cameras and signs together with the Sawley bridge widening and Wilne lane emergency turnaround areas should they be included in the scheme going forward.

An update to the geotechnical risk register presented in the Amey Arup Statement of Intent is included in this report.

1. Introduction

1.1. Scope and Objective of the Report

This Ground Investigation Report has been prepared in accordance with the proposal put forward in the Statement of Intent by Amey Arup Joint Venture in October 2015, the requirements of Annex 10 of the Smart Motorway Programme Lot 1 Brief as a deliverable for SGAR3/DF3 and the requirements of HD22/08 [Ref 1] for the M1 Junction 23a to 25 SM Project. The Scheme is being delivered as part of the Highways England Smart Motorway Programme under Lot 1, Package Order No PC1 0004 and PC1 0005. This scheme forms part of Tranche 2 of a package of 12 schemes, in 6 tranches, being delivered as a single programme as part of the current SR13 Smart Motorways Operational Concepts Programme.

In 2005, a Preliminary Sources Study Report (PSSR) was completed by Arup [Ref 2], in accordance with HD 22/02 [Ref 3], for M1 widening works between Junctions 21 and 30.

The PSSR [Ref 2] will be used as a basis for the geotechnical desk study element of this scheme and the issuing of a scheme specific PSSR was not considered necessary as outlined in the Statement of Intent (SoI) produced by AMAR in October 2015 [Ref 5]. However, an update of the desk study element of this scheme has been included in this GIR. Only information that has become available since the Arup PSSR [Ref 2] that is relevant to the scheme extents is included in this GIR.

Following a Ground Investigation (GI), a Preliminary Geotechnical Report was completed by Arup in 2007 [Ref 4]. The Arup Preliminary Geotechnical Report [Ref 4] used data for Junctions 21 to 30 of the M1. This GIR only includes the data for the scheme extents, i.e. Junctions 23a to 25, and contains relevant information (notably geotechnical data) that has become available since the issuing of the Arup Preliminary Geotechnical Report [Ref 4]. Characteristic geotechnical parameters were derived in the Arup Preliminary Geotechnical Report [Ref 4], and these are considered as part of this GIR for comparison; however, characteristic geotechnical parameters in this GIR are specific to the scheme extents and updated with information that has become available since the issuing of the report.

A Statement of Intent (SoI) [Ref 5] identified gaps in information related to the specific project requirements of the proposed scheme. The scope of a preliminary GI to fill in ‘gaps’ in ground condition information was reassessed as part of this GIR in light of the additional information and is not now considered necessary to build the ground model at this stage. This is described in more detail in Section 3. ‘Just in Time’ GI however will be required in certain locations to verify ground conditions used in design prior to construction works. Following the submission of this GIR, a Geotechnical Design Report (GDR) will be produced for the scheme extents that assesses the ground conditions at specific locations (such as gantries) and provides geotechnical design for earthworks, retaining and foundation solutions where required, including any ‘Just in Time’ GI.

This GIR provides an update to the Preliminary Geotechnical Report completed by Arup [Ref 4] and summarises the ground conditions and characteristic material properties based on the currently available geotechnical data specific to this scheme extents. An update to the geotechnical risk register produced as part of the SoI [Ref 5] is also included in this GIR.

1.2. Description of Project

This report relates to the Smart Motorway scheme on the M1 motorway between Junctions 23a (East Midlands Airport) and 25 (A52 Nottingham).

The M1 in the East Midlands is a key strategic route that carries high volumes of heavy goods and other vehicles between the conurbations in Leicestershire, Nottinghamshire, Derbyshire and beyond to South and West Yorkshire, with key links to the West Midlands and the South. The extents of the scheme are shown in Figure 1.

The proposed SMP scheme for M1 Junctions 23a to 25 includes the following elements:

- Smart Motorway infrastructure to enable hard shoulder running;
- Emergency Refuge Areas (ERAs);
- Lane specific signals and gateway gantries;
- Rigid concrete barrier in central reserve;
- Lighting;
- Pavement and drainage renewals;
- Environmental barrier;
- Tie-in to M1 J23 to 23a major maintenance renewals; and
- Tie-in to development of the proposed strategic rail freight terminal between junctions 24 and 24a.

It is considered that the scheme layout will be mainly dictated by operational requirements rather than geotechnical aspects.

A preliminary geotechnical schedule for the proposed new structure locations is included as Appendix A to this GIR (up to date based on proposed structure locations as of 7th February 2016).

1.3. Geotechnical Category of Project

In accordance with HD 22/08 [Ref 1] and BS EN 1997-1 [Ref 6], the scheme as a whole is considered to fall within Category 2.

2. Existing Information

This section provides an update to the information contained within the Arup PSSR [Ref 2] and only additional information is highlighted. For further information reference should be made to the Arup PSSR [Ref 2].

2.1. Topographical Maps

A LiDAR (light detecting and radar) survey has been completed for this scheme and therefore no further topographical surveys are envisaged. Upon review of the survey, it was considered that its coverage was sufficient for ground model derivation purposes.

2.2. Geological Maps and Memoirs

The British Geological Survey (BGS) Geological mapping available on the Highways Agency Geotechnical Data Management System (HAGDMS) [Ref 7] has been consulted, together with available BGS online Geoindex [Ref 8].

Since the issue of the PSSR by Arup [Ref 2], geological nomenclature has been updated by the BGS [Ref 8] across the entire scheme extents. The distribution of the superficial and solid geology of the site, based on the information from the BGS [Ref 8], is provided in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000006 to HA549342-AMAR-HGT-SWI-DR-CE-000015 in Appendix B. A summary of the superficial and solid geology of the site, based on the information from the BGS [Ref 8], is given in Tables 2-1 and 2-2 respectively below.

Table 2-1 – Superficial Geology Summary

Age	Group	Parent Unit	Unit
<0.012Ma (Holocene)	Superficial Deposits	Fluvial Deposits	ALLUVIUM
	Superficial Deposits	Fluvial Deposits	RIVER TERRACE DEPOSITS*
	Superficial Deposits	Mass Movement Deposits	HEAD
0.012 to 0.026Ma (Devensian)	Trent-Witham Catchments Subgroup	Trent Valley Formation (Glaciofluvial Deposits)	HEMINGTON MEMBER
			HOLME PIERREPONT SAND AND GRAVEL MEMBER
0.065 to 0.080Ma (Devensian)			BEESTON SAND AND GRAVEL MEMBER
0.128 to 0.195Ma (Wolstonian)			EGGINTON COMMON SAND AND GRAVEL MEMBER
0.424 to 0.478Ma (Anglian)			EAGLE MOOR SAND AND GRAVEL MEMBER
0.012 to 0.478Ma (Anglian)			GLACIOFLUVIAL DEPOSITS (undifferentiated)
0.424 to 0.478Ma (Anglian)	Albion Glacigenic Group	Wolston Formation (Glacial Deposits)	OADBY MEMBER

Notes
1. Geology is in chronostratigraphical order.
2. Ma = million years ago.
3. * River Terrace Deposits are not included in the 1:50,000 BGS maps, but are present in 1:10,000 BGS maps and are encountered in historical exploratory holes along the scheme extents.

Table 2-2 – Solid Geology Summary

Age	Group	Parent Unit	Unit
201.3 to 228Ma (Norian to Rhaetian)	Mercia Mudstone Group		BRANSCOMBE MUDSTONE FORMATION
228 to 235Ma (Carnian)			ARDEN SANDSTONE FORMATION
	Mercia Mudstone Group	Sidmouth Mudstone Formation	EDWALTON MEMBER
			COTGRAVE SANDSTONE MEMBER
235 to 242Ma (Ladinian)			DISEWORTH SANDSTONE
235 to 247.2Ma (Anisian to Ladinian)			GUNTHORPE MEMBER
242 to 251.2Ma (Olenekian to Anisian)	Mercia Mudstone Group		TARPORLEY SANDSTONE MEMBER
201.3 to 252.2Ma (Induan to Rhaetian)			MERCIA MUDSTONE GROUP (Undifferentiated)
252.2 to 424Ma (Induan to Anisian)	Sherwood Sandstone Group		BROMSGROVE SANDSTONE FORMATION

Notes
1. Geology is in chronostratigraphical order.
2. Ma = million years ago.

It is recorded on the available geological maps that geological faulting is present within the scheme extents. Geological faulting is particularly abundant within the area of Junction 23a. The general trend of faults is near perpendicular to the trend of the M1; the locations of the geological faults as recorded on HAGDMS [Ref 7] are shown in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000011 to HA549342-AMAR-HGT-SWI-DR-CE-000015 in Appendix B.

2.3. Geomorphology

The outlined geomorphology of the M1 route corridor from Junctions 22 to 26 within the Arup PSSR [Ref 2] details the geomorphology of the scheme extents.

2.4. Historical Maps and Aerial Photography

Historical mapping covering the entire site is contained in the Envirocheck report included in the Arup PSSR [Ref 2].

An aerial photographic survey was undertaken in 2004 as part of the study by Arup for the M1 widening works [Ref 2]. Historical aerial photography in combination with the 2004 aerial photography was assessed by Arup [Ref 2].

Since the Arup PSSR [Ref 2], the site has developed in some areas, with the following changes noted from historical maps and aerial photographs available from online sources [Ref 9]:

- Continued quarry activity for sands and gravels associated with the River Trent, particularly just north of Junction 24a. Extension to the quarry site evident in 2003 and backfilled by 2006;
- Widening works between Junctions 25 and 28 of the M1 complete by 2009;
- East Midlands International Airport runway extension complete by 2003; and
- Widening works associated with the A453, which meets the M1 at Junction 24 on the north-eastern side of the M1.

All known historical features with geotechnical relevance to the motorway corridor are noted on the geotechnical hazard plans which are included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000043 to HA549342-AMAR-HGT-SWI-DR-CE-000069 in Appendix B.

2.5. Records of Mines and Mineral Deposits

2.5.1. Coal Mining

As established in the SoI [Ref 5], based on the information available from the Coal Authority Online Interactive Map [Ref 10] and a review of HAGDMS [Ref 7], coal mining is not anticipated to be a geotechnical hazard for the scheme.

2.5.2. Non-Coal Mining

The site crosses an area where the quarrying of River Terrace Gravels associated with the River Trent for aggregate is currently active. The extents of the active gravel pits are shown in the geotechnical hazard plans (see Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000055 in Appendix B). The implications of these works on the programme are under consideration by the SMP Design Team and will be continually reviewed as the scheme progresses.

HAGDMS [Ref 7] was consulted for brine features and none are recorded within the scheme extents or the peripheral area. Subsidence due to dissolution features associated with brine was not considered as a risk in the Arup PSSR [Ref 2] or Preliminary Geotechnical Report and is not considered a risk to the proposed works [Ref 4].

2.6. Earthworks

2.6.1. Properties

A list of earthworks related to the scheme was produced as part of the PSSR [Ref 2]. Since 2005, the earthworks have been re-inspected and updated, as recorded in HAGDMS [Ref 7]. The earthworks within the scheme extents, as recorded in HAGDMS [Ref 7], are summarised in Appendix C of this report.

2.6.2. Condition

A summary of the geotechnical earthworks defects as currently recorded in HAGDMS [Ref 7] for the scheme extents is included in the SoI [Ref 5]. Defects of greater risk than ‘Low’ in accordance with HD 41/15 [Ref 11] were inspected to determine their current condition as part of a site walkover in October 2015. The geotechnical earthworks defects inspected are summarised in Table 2-3 below:

Table 2-3 – Geotechnical Earthworks Defects Update Summary

Defect Number	HAGDMS Description	Chainage	Carriageway	Length (m)
7_M1_42102_528723	Slope Bulge, Hydro Vegetation. "Slight slope bulge and backscarp with hydrophilic vegetation above brick box and drainage cover".	180010 to 180018	Northbound	8
7_M1_42105_528528	Dislocated Trees. "Slight hummocking of slope. Trees leaning slightly."	180930 to 180942	Northbound	12
7_M1_22152_535990	Slip. "Slip mid-slope approximately 15cm backscarp. 4m upslope from comms 1m high retaining wall."	193734 to 193781	Southbound	47
7_M1_22152_535991	"Comms retaining wall failure/collapse"	193811 to 193816	Southbound	5

Defect Number	HAGDMS Description	Chainage	Carriageway	Length (m)
7_M1_57726_536105	"No erosion protection matting over geogrid exposing geogrid structure and material free to erode."	194176 to 194185	Southbound	2
7_M1_57726_536107	"Erosion protection matting slipped down slope exposing geogrid structure and material free to erode."	194560 to 194563	Southbound	3
7_M1_57726_536108	"Erosion protection matting folded over exposing geogrid structure and material free to erode."	194575 to 194575	Southbound	1
7_M1_57726_458384	"Erosion protection matting no longer in existence allowing material free to erode."	194665 to 194665	Southbound	1

Representatives from the geotechnical team visited the site on 1st October 2015 to undertake a walkover assessment of the geotechnical defects noted above. Each defect was located and visually inspected to assess its current condition. Upon inspection it was clear that none of the present defects require immediate remedial action, nor are they likely to require preventative measures in the medium term. As such, no further assessment of these defects is considered necessary as part of this scheme in order to achieve the required 5 year post opening major asset renewal free period. It is therefore recommended, at this stage, that a future re-inspection of the identified defects is arranged as part of the ongoing maintenance programme provided by the Area 7 Managing Agent Contractor.

As part of the defect analysis a copy of the most recent GAMP for Area 7 was obtained and reviewed [Ref 12]. The GAMP [Ref 12] was reviewed to ascertain the extents of current works within the area; as well as to assess any programmed forthcoming works which may impact on the scheme. The GAMP [Ref 12] does not include any current or planned works that will impact on this scheme. In addition, Aone+ were contacted to determine whether any new findings relating to geotechnical assets were made since its issue; it was confirmed that no new geotechnical defects or proposed works had become apparent since it was issued.

2.7. Historical GIs

As part of an existing GI data collation exercise for this scheme, a preliminary GIR was produced by WSP in 2015 [Ref 13]. This report summarised the historical boreholes within the site extents available from the BGS GeoIndex [Ref 8] that were not available from HAGDMS [Ref 7].

As part of the same exercise, WSP also completed the conversion of existing historical borehole and geotechnical laboratory testing data into electronic format. The electronic records (Association of Geotechnical & Geoenvironmental Specialists (.ags) format) of historical GI data were subsequently available to download from HAGDMS [Ref 7].

HAGDMS [Ref 7] reports were not consulted as part of the WSP GIR [Ref 13], but have been reviewed by AMAR as part of this GIR to determine the extents of the existing GI factual and interpretative reports available for the scheme. Reports that were not available (or only partially available) for consultation at the time of the 2005 PSSR [Ref 2], but are available now, are reviewed below.

A spatial ‘gap’ analysis of missing geotechnical data for the site extents was undertaken as part of the SoI [Ref 5] to determine where GI was required to inform a complete site-wide ground model. The ’gap filling’ GI requirement is discussed further in Section 3 of this GIR and was revised on the basis of additional boreholes available from the BGS [Ref 8], which are included as Appendix D to this GIR. Additional GI information that has become available since the issue of the Arup PSSR [Ref 2] and Preliminary Geotechnical Report [Ref 4], are summarised below:

- **Carl Bro Aquaterra Ltd, September 1999, M1 Junction 25 Bostock's Lane Sandiacre, Environmental Site Evaluation [Ref 14] / WSP Environmental Ltd, October 1999, M1 Junction 25 Bostock's Lane Sandiacre, Ground Investigation Factual Report [Ref 15]**
  - These reports present the results of an environmental site investigation carried out at a vacant proposed development plot on Bostock's Lane, Sandiacre, immediately northwest of Junction 25.
  - The fieldwork comprised the excavation of 10 trial pits
- **Geotechnics, September 2000, Ground Investigation at Leicester Control Offices Area MIDAS and MS3, Ground Investigation Factual Report [Ref 16]**
  - This is a factual GI report for investigative works undertaken at the site of proposed MS3 cantilever gantry foundations and superstructures on the M1, M6 and M69 motorways.
  - This investigation included fieldwork between Junctions 24 and 25 of the M1; however, no borehole location drawings or grid references were provided, therefore the locations of the boreholes were not determinable.
- **Fugro, March 2006, M1 Widening Junctions 21 to 30 Contract 1 (Junctions 22-23, 25-28), Preliminary Ground Investigation Factual Report [Ref 17]**
  - A site investigation was carried out between 4th July 2005 and 9th September 2005 by Fugro on the instructions and under the supervision of Arup, acting on behalf of the Highways Agency, between Junctions 22 and 23 and Junctions 25 to 28 of the M1.
  - This is a factual report of the investigation for the motorway widening from dual three lane to dual four lane.
  - Only 2 rotary boreholes located immediately north of Junction 25 were relevant to this GIR.
- **Scott Wilson Ltd, September 2006, M1 1Mile Advance Direction Signs – Phase 4, Geotechnical Report [Ref 18]**
  - Scott Wilson Ltd were commissioned by AMScott to provide geotechnical advice on the installation of 2 advance direction signs (ADS) on the M1 at the approach to Junction 24a, near Castle Donington.
  - This is a geotechnical report that includes the findings of a GI as well as geotechnical interpretation and analysis.
  - 2 trial pits were undertaken at the location of the ADS on 26th June 2006.
- **Fugro, January 2007, M1 Widening Junction 21 to 30 Contract 1 Phase 2A, Factual Report on Ground Investigation [Ref 19]**
  - On the instructions and under the supervision of Arup, acting on behalf of the Highways Agency, a site investigation was carried out by Fugro between Junctions 25 and 26 of the M1 between 24th July 2006 and 1st December 2006.
  - The sitework comprised 40 cable percussion boreholes, 27 rotary cored boreholes, 48 trial pits, 14 observation pits and 37 dynamic probeholes.
  - Of these boreholes and pits, there were 3 trial pits, 9 dynamic probeholes, 2 observation pits, 4 cable percussion boreholes, 4 rotary cored boreholes and 5 combined cable percussion and rotary cored boreholes of relevance to this GIR.
- **Geotechnics, May 2007, A453 Widening, M1 Junction 24 to A52 Nottingham (Flood Compensation Areas), Ground Investigation Factual Report [Ref 20]**
  - A geotechnical and geoenvironmental investigation was undertaken by Geotechnics Ltd at the site of the proposed A453 Widening Scheme, from M1 Junction 24 to A52, Nottingham between 30th March 2007 and 13th April 2007. The investigation was carried out to the instructions of White Young Green (WYG) on behalf of Laing O'Rourke Infrastructures Limited. 28 window sample boreholes were undertaken, 4 of those were relevant to the proposed M1 SMP for Junctions 23a to 25.
- **Fugro, June 2007, M1 Widening Junction 21 to 30 Contract 2 Preliminary, Factual Report on Ground Investigation [Ref 21]**
  - On the instructions and under the supervision of Arup, acting on behalf of the Highways Agency, a site investigation was carried out by Fugro between Junctions 21 and 30 of the M1 between 22nd August 2006 and 5th February 2007. The sitework comprised 103 cable percussion boreholes, 81 rotary core boreholes, 31 trial pits and 2 hand dug observation pits. Of these boreholes and pits, those that were relevant to the proposed M1 SMP for Junctions 23a to 25, comprised 25 trial pits, no hand dug observation pits, 30 cable percussion boreholes, 7 rotary cored boreholes and 2 combined cable percussion and rotary cored boreholes.
- **WSP, April 2015, Smart Motorways Programme – British Geological Survey Exploratory Holes, Super Midland M1 Junction 23a to Junction 25, Ground Investigation Report [Ref 13]**
  - A report was created by WSP as part of the SMP data collection exercise for the M1 Junction 23a to 25.

- The report contains the exploratory holes identified within 30m of the highway boundary for the scheme, available only via the BGS [Ref 8] and not included in any report currently available on HAGDMS [Ref 7]. Only 6 boreholes are attached to this report.

In addition, a GDR has become available since the issuing of the Arup Preliminary Geotechnical Report [Ref 4]; this GDR is summarised below:

- **MVM Joint Venture, August 2009, M1 Widening Junction 21 – 30 Contract 1 Junctions 25 to 28, Geotechnical Design Report [Ref 22]**
  - MVM Joint Venture (Morgan Est, Vinci and Sir Robert McAlpine as Constructors and Gifford-WSP (GWSP) as Designers) were awarded the widening scheme of the M1 between Junctions 25 and 28 in January 2007 by the Highways Agency.
  - The Contract involved the design and construction of the widening of the existing motorway by the addition of one lane on each side within the existing land take.
  - The subsequent report was to take forward the Arup Preliminary Geotechnical Report [Ref 4], to update the report in the light of the Main Phase 2 GI's, to manage the geotechnical risks of the Contract and to set down the methodology and design of the geotechnical aspects of the project.

2.8. Consultation with Statutory Bodies and Agencies

The Multi-Agency Geographic Information for the Countryside (MAGIC), Environment Agency (EA) and English Heritage websites [Ref 23, 24 and 25 respectively] were consulted as part of an environmental assessment of this scheme. The following information includes only information of which is additional to the information available for the site included in the Arup PSSR [Ref 2] for M1 widening works completed by Arup [Ref 2].

2.8.1. Local Nature Reserves

A Local Nature Reserve (LNR), recorded as 'Stony Clouds', is located approximately 2km north of Junction 25 around the extremity of the proposed works east of Erewash Valley Golf Course. Due to the proximity of this LNR, a detailed environmental assessment by suitably qualified personnel may be required before construction works commence. Additional LNR's relevant to the scheme extents are outlined in the PSSR by Arup [Ref 2].

2.8.2. Further Land-Based Designations

The site does not lie within 1km or less of any of the following statutory or non-statutory land-based designations:

- Areas of Outstanding Natural Beauty;
- National Parks;
- Ramsar Sites;
- Special Areas of Conservation;
- Special Protection Areas;
- Biosphere Reserves; or
- RSPB (Royal Society for the Protection of Birds) Reserves.

2.8.3. Landfills

No current or historic landfills have been identified within 500m of the site that were not already recorded in the PSSR for the M1 widening completed by Arup [Ref 2].

2.8.4. Pollution Incidents

4 pollution incidents were recorded within 1km of the scheme, but not within the scheme extents. These pollution incidents were located 500 to 900m from the site around Junctions 24 and 24a and included

general biodegradable materials and wastes (impact to water), atmospheric pollutants (impact to air) and agricultural materials and wastes (impact to land). These pollution incidents are not expected to have implications on the proposed works.

2.9. Flood Records

2.9.1. Environment Agency

The EA website [Ref 24] was consulted to determine the status of groundwater resources along the route. The aquifer designations of strata located within the scheme extents are summarised in Table 2-4 below:

Table 2-4 – 'South Section' Aquifer Designation Summary

Stratum	Aquifer Designation
Superficial Deposits	
Alluvium	Secondary A
Head	Secondary (undifferentiated)
Glaciofluvial Deposits	Secondary A
Glacial Till	Unproductive
Bedrock Deposits	
Mercia Mudstone Group (mudstone and siltstone members)	Secondary B
Mercia Mudstone Group (sandstone members)	Secondary A
Bromsgrove Sandstone Formation	Principal

Notes
1. Principal Aquifer = layers of rock or drift deposits that have high intergranular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
2. Secondary A = permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.
3. Secondary B = predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
4. Secondary (undifferentiated) = has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

The scheme extents are not within a Groundwater Source Protection Zone (GSPZ).

The probability of flooding across the scheme extents, as outlined by the EA [Ref 24] was not included within the Arup PSSR [Ref 2]. Table 2-5 summarises the flood risk for the scheme extents, as recorded by the EA [Ref 24].

Table 2-5 – Identified Areas of Flood Risks as defined by the EA [Ref 24]

Area	Flood Risk
J23a and south	Mainly Very Low Risk. High Risk associated with Long Whatton Brook
North of J23a, South of J24	Very Low Risk

Area	Flood Risk
J24	J24 and southwards is at Very Low Risk. North of J24 the area is at Medium Risk
J24a	Mainly High Risk area from River Trent and associated water bodies in the vicinity
North of J24a and South of Wilne Lane	Mainly High Risk area from River Trent and associated water bodies in the vicinity
North of Wilne Lane and south of J25	Mainly Low Risk area from Wilne Lane to A6005 (Derby Road). North of A6005 (Derby Road) is a Very Low Risk area. Medium to High Risk associated with Golden Brook, Breaston Fields Farm and Church Wilne Reservoir
J25 and north	Very Low Risk area

Notes
1. Very low risk = this area has a chance of flooding of less than 1 in 1000 years (<0.15%).
2. Low risk = this area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%).
3. Medium risk = this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).
4. High risk = this area has a chance of flooding of greater than 1 in 30 (>3.3%).

These areas of noted flood risk are represented on a geotechnical hazard plan included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000043 to HA549342-AMAR-HGT-SWI-DR-CE-000069 in Appendix B. This geotechnical hazard plan is an updated version of the hazard plan produced in the Arup PSSR [Ref 2].

2.9.2. Environmental Study Report [Ref 26]

A comprehensive flood risk assessment has been undertaken as part of an environmental study for this scheme by the AMAR Landscape and Environment team as part of Design Fix 3 [Ref 26]. Findings from the flood risk assessment included:

- Design Fix 2 design included earthwork changes that have the potential of affecting the hydraulic characteristics within the floodplain associated with the River Trent and its tributaries.
- These earthwork changes have to be assessed in comparison to known flood levels for the River Trent, Lockington Brook and Hemington Brook, while additional flood level data is also required for the Golden Brook and the watercourse located to the north of Junction 23a.
- In advance of undertaking this comparison, consultation is also required with the EA and the consultancy body responsible for undertaking the hydraulic analysis related to the proposed rail depot between Junctions 24 and 24a to clarify the understanding of their analysis in relation to the Lockington Brook.
- The drainage strategy required at this Design Fix outlines that the proposed works must not allow any additional surface water runoff into receiving watercourses up to the 1% + climate change rainfall event as a result of the additional hardstanding being created. This has to be balanced with the need for the highway not to flood below the 5 year return period storm event.
- Implementation of the strategy as a design will have to be undertaken so that the principles are applied at all locations. Any concessions have the potential to increase flood risk in a very sensitive location. Therefore, the AMAR drainage team will have to be prepared to implement innovative techniques in conjunction with Highways England and their maintenance partners to ensure the goals of the drainage strategy can be applied.
- There are no changes in floodplain area that would require a DCO process.

The anticipated flood levels, as defined by a separate study of flood risk for the scheme by BWB, are as shown in Table 2-6 below:

Table 2-6 – Projected Flood Levels [Ref 26]

Chainage	Projected Flood Level*	Comments
East side of motorway		
Ch 185900 to Ch 186060	30.56m Above Ordnance Datum (AOD)	Lockington and Hemington Brook
Ch 186100 to Ch 186200		
Ch 186700 to Ch187000	30.52m AOD	
Ch 187200 to Ch188600	30.85 to 31.07m AOD	River Trent floodplain. Flood level gradually rises as alignment of M1 moves to the north
Ch 188600 to Ch 189920	32.3m AOD	River Trent floodplain. Flood level to be confirmed when EA data obtained
Ch 190120 to Ch 190380		
Ch 190380 to Ch 191380		Golden Brook floodplain. River Trent flood level of 32.3m applied until EA data is received
West side of motorway		
Ch 185900 to Ch 186540	32.3m AOD	River Trent floodplain
Ch 187200 to Ch 188600	30.85 to 31.9m AOD	River Trent floodplain. Flood level gradually rises as alignment of M1 moves to the north
Ch 188600 to Ch189850	32.3m AOD	River Trent Floodplain. Flood level to be confirmed when EA data obtained
Ch 190380 to Ch191380		Golden Brook floodplain. River Trent flood level of 32.3m applied until EA data is received

Notes
1. * = 1 in 100 year with increase for climate change flood event.

Additional information that was observed in the Environmental Study Report [Ref 26] pertained to the ecology of the area. It has been noted that 2 badger setts have been identified within close proximity of the M1 carriageway; at present these setts are situated more than 30m away from any proposed new gantry locations (as of Design Fix 3). However, one of these setts is likely to be impacted upon by the proposed works because the footprint of the works area encroaches within 10m of the sett. Exact details of the location of these badger setts currently remain confidential in accordance with standard practice approach.

Also identified was the presence of Great Crested Newts (GCN) as identified by an eDNA test carried out in 2015. 'Pond 10' housing the GCN is situated 271m to the east of proposed new Gantry Ref. 305 and 90m south of Gantry Ref. 306. It has been suggested that a full population survey of GCN in the area is carried out in Design Fix 4 when further mitigation recommendations can be made.

The invasive species of Himalayan Balsam has also been identified in 2 locations within the scheme extents.

A review of English Heritage assets was also undertaken by the AMAR Landscape and Environment Team as part of the Environmental Study Report [Ref 26]. 30 assets were identified in the peripheral area surrounding the scheme extents; however upon assessment none of these assets were deemed to be in a location that would be adversely affected by the proposed works and have been assessed to have only a slight or neutral impact.

2.10. Other Relevant Information

2.10.1. East Midlands International Airport

East Midlands International Airport lies approximately 200m west of the motorway at Castle Donington and is served by Junctions 23A and 24. The airport is unlikely to be a geotechnical constraint to the scheme, unless land-take is required. This will be further considered by AMAR as the scheme progresses. Runway lighting exists within the central reserve and the hard shoulder currently and any constraints their cause will be assessed by AMAR going forward.

2.10.2. Rail Freight Terminal

At the time of writing, the Rail Freight Terminal scheme at Junctions 24 and 24a has been approved at DCO (Development Consent Order). Scheme proposals, where they interact with the SMP scheme, are included in the hazard plan drawings (Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000043 to HA549342-AMAR-HGT-SWI-DR-CE-000069) in Appendix B.

It is known that there is currently an ongoing GI for the proposed rail freight terminal between Junctions 23a and 24a of the M1. The information from this GI, if provided, will be reviewed and the ground model updated accordingly.

The scheme proposals include new slip roads joining the M1 at Junctions 24 and 24a. It is currently understood that the rail freight terminal contract will include the design of the slip roads, however the location of slip roads may have an impact on the positioning of some proposed structures (such as gantries) within the SMP scheme. This development may mean that proposed locations for specific elements of the SMP construction works, such as gantries and ERAs, could move. Should specific locations alter significantly then new ground model and geotechnical design may be required. To inform a new ground model, it may be necessary to undertake GI to obtain suitable geotechnical data for design purposes as part of a preliminary GI before the ‘Just in Time’ GI.

3. Field and Laboratory Studies

3.1. Walkover Survey

3.1.1. Previous Walkover Surveys

A walkover survey of the identified geotechnical defects was undertaken by AMAR as part of Design Fix 2, as detailed in the SoI [Ref 5]. The walkover survey determined that the identified 'Medium' risk defects (in accordance with HD 41/15 [Ref 11] recorded on HAGDMS [Ref 7]) would not need to be considered as they did not represent a 5 year maintenance issue.

3.1.2. Proposed Walkover Surveys

Further walkover surveys will be required prior to detailed design at Design Fix 5, prior to early GI works associated with the Sawley bridge widening or the Wilne Lane emergency turnaround and prior to proposed 'Just in Time' GI to be undertaken as part of Design Fix 6 prior to construction works. These walkover surveys will have particular focus on the suitability of proposed exploratory hole locations and a visual survey of the proposed structure and ERA locations and alter visual assessment of geotechnical design locations.

3.2. Historical GIs

Historical GIs relevant to the scheme extents are outlined in the SoI [Ref 5] and in Section 2 of this GIR. The findings from these GIs are reviewed as part of Section 4 and 5 of this GIR.

3.3. Proposed GI

A 'Gap Filling' GI was proposed within the SoI [Ref 5] to inform the ground model for the scheme extents at locations where existing geotechnical data was considered insufficient. Since the issue of the Arup Geotechnical Report [Ref 4], additional geotechnical data has become available from the reports in Section 2.7 and since the issue of the SoI [Ref 5] additional borehole data has become available from the BGS Geoindex [Ref 8].

On review of the additional data, in the areas considered in the SoI [Ref 5] to lack sufficient data with which to build the preliminary ground model, it is considered that no 'Gap Filling' GI is required, 'Gap Filling' GI would be required however at Sawley rail overbridge which was noted in the SoI [Ref 5] and the Wilne Lane turnaround which is a recent development and insufficient data is considered to be available to produce a suitable ground model for design purposes.

Design will be undertaken on the basis of the preliminary ground model undertaken and presented in this GIR. Where design is undertaken on information that is considered to be spatially close, 'Just in Time' GI may not be required. GI will only be undertaken where the design has been undertaken on an assumed ground model and no boreholes are considered close enough to the structure or where the geotechnical design is GI critical (e.g. helical piles)

The 'Just in Time' GI fieldwork is to be undertaken as part of Design Fix 6 in accordance with BS EN 1997-2:2007 Eurocode – Geotechnical Design – Part 2 [Ref 27] and BS 5930:2015 Code of Practice for site investigations [Ref 28].

The 'Just in Time' GI will be used to confirm the geotechnical model and parameters assumed for design, as outlined in the GIR. The final 'Just in Time' GI strategy and specification will be produced as part of the forthcoming GDR at Design Fix 4. It is anticipated that combined percussive sampling and rotary coring drilling rigs will be specified

Once the final positions of structures are confirmed, the GI specification for the 'Just in Time' GI will be refined at Design Fix 6. The 'Just in Time' GI will be supervised by a geotechnical engineer with full

knowledge of the assumed ground model from the GDR. If any unexpected ground conditions are identified, re-design may be required.

3.3.1. In Situ Testing

In-situ Standard Penetration Tests (SPTs) are to be carried out at regular intervals in boreholes in accordance with BS 1377-9:1990 Methods of test for Soils for civil engineering purposes – Part 9: In-situ tests [Ref 29].

3.3.2. Proposed Laboratory Investigations

The following geotechnical and chemical laboratory tests are anticipated to be undertaken as part of the 'Just in Time' GI in Design Fix 6 on recovered soil/rock samples:

- Natural moisture content (NMC) tests in accordance with BS 1377-2:1990 Classification tests [Ref 30];
- Particle size distribution (PSD) tests in accordance with BS 1377-2:1990 Classification tests [Ref 30]; and
- BRE (Building Research Establishment) full suite tests in accordance with BS 1377-3 Chemical and electro-chemical tests [Ref 31] and BRE CP2/79 Sulphate and acid attack on concrete in the ground [Ref 32].

4. Ground Summary

4.1. General

The scheme has been split into 3 sections based on general variations in solid geology, as identified from information available from the BGS [Ref 8]. These sections are referred to as the 'South Section', 'Central Section' and 'North Section'. The ground model for these sections is summarised in the following sections. Chainages for each of these sections are summarised below:

- 'South Section' – chainages Ch179500 to Ch184750 (5.25km);
- 'Central Section' – chainages Ch184750 to Ch191530 (6.78km); and
- 'North Section' – chainages Ch191530 to Ch195800 (4.45km).

An interpreted geological long section for the scheme extents is produced as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000016 to HA549342-AMAR-HGT-SWI-DR-CE-000042 in Appendix B of this GIR.

In addition to the generalised ground models, AMAR are developing detailed datasheets for each geotechnical design element. These datasheets develop a site specific ground model at each location based on the overall model provided in this GIR. Should structure locations be amended, this will allow a single datasheet to be updated rather than the GIR in its entirety. Datasheets will be included within the GDR, which will be developed as part of Design Fixes 4 to 6. Datasheets will also be updated after completion of the 'Just in Time' GI and any amended datasheets will be incorporated in the Geotechnical Feedback Report (GFR) in Design Fix 6.

4.2. 'South Section'

4.2.1. Location

The 'South Section' can be found between chainages Ch179500 and Ch184750 (5.25km); this section includes Junction 23a.

4.2.2. Topography and Land-use

The main features for the 'South Section' are shown in the Geotechnical Hazard Plans, included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000043 to HA549342-AMAR-HGT-SWI-DR-CE-000051 in Appendix B. Along the 'South Section', the landscape to the east is rural with scattered farms and small residential areas (such as Long Whatton and Diseworth), but the west side is dominated by the East Midlands Airport (between chainages Ch183600 and Ch184200) north of Junction 23a and some associated buildings. Junction 23a of the M1 is located within the 'South Section', where the A42 joins the M1.

A LiDAR survey was undertaken for this scheme, which is used for the scheme drawings in Appendix B. Based on this LiDAR survey, the following changes in elevation of the road level are recorded in the 'South Section' (progressing from south to north within the extents of the 'South Section' only):

- Fall from 76m AOD to 47m AOD from chainage Ch179500 to Ch181400 (1.90km);
- Rise from 47m AOD to 78m AOD from chainage Ch181400 to Ch182900 (1.50km);
- Fall from 78m AOD to 70m AOD from chainage Ch182900 to Ch183200 (0.30km);
- Rise from 70m AOD to 77m AOD from chainage Ch183200 to Ch183700 (0.50km); and
- Fall from 77m AOD to 46m AOD from chainage Ch183700 to Ch184750 (1.05km).

Road level elevations are plotted on the long sections included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000016 to HA549342-AMAR-HGT-SWI-DR-CE-000024 for the 'South Section' in Appendix B.

Earthworks associated with the M1 vary spatially across the 'South Section'; these trends are summarised in Table 4-1 below (further earthwork details are included in Appendix C):

Table 4-1 – 'South Section' Earthworks Summary

Chainage	Earthwork	Maximum Height (m)	Maximum Gradient (°)
Ch179500 to Ch179730 (0.23km)	Embankments	5.8	27
Ch179730 to Ch180400 (0.67km)	Cuttings	6.1	30
Ch180400 to Ch180640 (0.24km)	Embankments	6.0	30
Ch180640 to Ch181120 (0.48km)	Cuttings	15.0	30
Ch181120 to Ch181800 (0.68km)	Embankments	6.1	27
Ch181800 to Ch183000 (1.20km)	Cuttings	7.4	30
Ch183000 to Ch183450 (0.45km)	Embankments	11.7	30
Ch183450 to Ch184600 (1.15km)	Cuttings	11.4	27
Ch184600 to Ch184750 (0.15km)	At Grade	0	0

Notes
1. Earthworks details are based on survey information from HAGDMS [Ref 7].

4.2.3. Made Ground

Made Ground is largely encountered in the 'South Section' of the scheme as either road construction materials or Embankment Fill in areas of embankment. Thicknesses of Made Ground vary depending on location within a cutting (solely road construction) or upon an embankment. Other areas of Made Ground within this section, for which only little information is currently known are noted in the Arup PSSR [Ref 2] and are included in the hazard plans included in Appendix B and summarised in Table 4-2 below:

Table 4-2 – Identified Areas of Made Ground other than road construction or Embankment Fill for the 'South Section'

Chainage	Description	Source	Drawing Reference
Ch182520 to Ch182590 (0.07km)	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000048
Ch182710 to Ch182780 (0.07km)	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000048
Ch183200 to Ch183220 (0.02km)	2m of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000049
Ch183580 to Ch183600 (0.02km)	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000049
Ch183790 to Ch183810 (0.02km)	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000050
Ch184000 to Ch184080 (0.08km) Northbound only	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000050
Ch184030 to Ch184120 (0.09km) Southbound only	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000050
Ch184080 to Ch184130 (0.05km) Northbound only	2m of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000050
Ch184120 to Ch184170 (0.05km) Southbound only	2m of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000050

These areas of Made Ground appear to be associated with excavation and replacement of unsuitable material prior to motorway construction. Limited information is available on their extent, thickness and composition.

The majority of the Embankment Fill is considered to have been locally sourced from cuttings in the Mercia Mudstone Group. Historical road improvement works may have resulted in some local variations in the Embankment Fill, particularly under embankment shoulders.

Road construction materials generally comprise bitumen hardstanding of the road surface, aggregate and general imported granular fill.

Table 4-3 below summarises the identified thicknesses of Embankment Fill encountered from historical borehole logs for the 'South Section':

Table 4-3 – 'South Section' Embankment Fill Summary

Chainage	Unit	Approximate Thickness (m)
Ch179400 to Ch179500 (0.10km)	Embankment Fill	6
Ch179500 to Ch179700 (0.20km)	Embankment Fill	1-2
Ch180330 to Ch180630 (0.30km)	Embankment Fill	0-8
Ch181150 to Ch181770 (0.62km)	Embankment Fill	0-10
Ch182910 to Ch183460 (0.55km)	Embankment Fill	0-10

4.2.4. Superficial Geology

The Superficial Deposits within the 'South Section', as recorded by the available GI data are summarised in Table 4-4 below. These are in general accordance with the data available from the BGS [Ref 8].

Table 4-4 – 'South Section' Superficial Geology Summary

Chainage	Unit	Approximate Thickness (m)
Ch179400 to Ch179950 (0.55km)	Glacial Till	8-9
Ch179950 to Ch180160 (0.21km)	Glacial Till	0-8
Ch181300 to Ch181530 (0.23km)	Alluvium	0-2.5
Ch181300 to Ch181480 (0.18km)	Glacial Till	0-2

Superficial geology for the 'South Section' is presented in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000006 and HA549342-AMAR-HGT-SWI-DR-CE-000007 in Appendix B.

4.2.5. Solid Geology

The solid geology across the scheme extents comprises the Mercia Mudstone Group with varying proportions of mudstone, siltstone and sandstone bands. The 'South Section' comprises highly variable proportions of mudstone, siltstone and sandstone.

The solid geology as identified by the available data for the 'South Section' are summarised in Table 4-5 below.

Table 4-5 – 'South Section' Solid Geology Summary

Chainage	Unit	Approximate Depth to top of stratum (m bgl)
Ch179400 to Ch179950 (0.55km)	Mercia Mudstone Group	9-14
Ch179950 to Ch180150 (0.20km)	Mercia Mudstone Group	0-9
Ch180150 to Ch180330 (0.18km)	Mercia Mudstone Group	0
Ch180330 to Ch180630 (0.30km)	Mercia Mudstone Group	0-7
Ch180630 to Ch181150 (0.52km)	Mercia Mudstone Group	0
Ch181150 to Ch181300 (0.15km)	Mercia Mudstone Group	0-9
Ch181300 to Ch181530 (0.23km)	Mercia Mudstone Group	8-14
Ch181530 to Ch181770 (0.24km)	Mercia Mudstone Group	0-8
Ch181770 to Ch182910 (1.14km)	Mercia Mudstone Group	0
Ch182910 to Ch183460 (0.55km)	Mercia Mudstone Group	0-11
Ch193460 to Ch184600 (1.14km)	Mercia Mudstone Group	0-5
Ch184600 to Ch184800 (0.20km)	Bromsgrove Sandstone Formation	0-5

Solid geology for the 'South Section' is presented in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000011 and HA549342-AMAR-HGT-SWI-DR-CE-000012 in Appendix B.

4.2.6. Hydrology

The 'South Section' contains the hydrological catchment of Long Whatton Brook between chainages Ch179500 and Ch182500, and of the River Trent northwards from chainage Ch182500. Watercourses, ponds, bridges and culverts are shown on the Geotechnical Hazard Plans, included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000043 to HA549342-AMAR-HGT-SWI-DR-CE-000051 for the 'South Section' in Appendix B.

The Long Whatton Brook, and its tributary Diseworth Brook, pass under the motorway in two culverts at chainages Ch181600 shortly before their confluence. The catchment is relatively steep, draining from west to east toward the Soar Valley, and is primarily rural in composition. Between Junctions 23A and 24, the M1 lies partially in a small sub-catchment, which drains from west to east towards the Soar Valley, and partially within the catchment of the River Trent. A projected 1 in 100 year (with climate change factored) flood level of 32.3m AOD is derived by AMAR in the Environmental Study Report [Ref 26] for the River Trent floodplain in this area.

4.2.7. Hydrogeology

Groundwater strikes and subsequent monitoring data is included in some historical boreholes within the scheme extents. Groundwater information is shown in the long sections included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000016 to HA549342-AMAR-HGT-SWI-DR-CE-000024 for the 'South Section' in Appendix B. Groundwater is discussed further in Section 5.5.

4.3. 'Central Section'

4.3.1. Location

The 'Central Section' can be found between chainages Ch184750 and Ch191530 (6.78km); this section includes both Junctions 24 and 24a.

4.3.2. Topography and Landuse

The main features for the 'Central Section' are shown in the Geotechnical Hazard Plans, included as Drawing sequence 49342-AMAR-HGT-SWI-DR-CE-000051 to HA549342-AMAR-HGT-SWI-DR-CE-000063 in Appendix B. The land use along the 'Central Section' is dominantly rural with scattered farms and contains Junctions 24 and 24a of the M1, which provide links to the A6 in the south and the A50 in the north.

From chainage Ch187400 to Ch188500 there are landfills on both sides of the motorway, which started as pits for gravel extraction and were subsequently backfilled with pulverised fuel ash and spoil from the construction of the motorway. On the west side, just south of the River Trent there is another former gravel pit, now a recreational lake. The motorway crosses the valley bottom on two viaducts with an embankment between them. The river used to have oxbow lakes in this area, which were filled in 1956. An overhead electricity line crosses the motorway at chainage ch187250.

Between chainages Ch189800 and Ch190100 the motorway passes a large water treatment plant on the west side with an associated reservoir just outside the band of interest, otherwise there is mainly agricultural land apart from some residential properties. On the east side residential areas of Long Eaton border the M1 for 4km up to Junction 25.

A LiDAR survey was undertaken for this scheme, which is used for the drawings in Appendix B. Based on this LiDAR survey, the following changes in elevation of the road level are recorded in the 'Central Section' (progressing from south to north within the extents of the 'Central Section' only):

- Fall from 46m AOD to 34m AOD from chainage Ch184750 to Ch185600 (0.85km);
- No change in elevation, remains at 34m AOD, from chainage Ch185350 to Ch186680 (1.33km); and
- Minor undulations between 30m AOD and 40m AOD from chainage Ch186680 to Ch191530 (4.85km).

Road level elevations are plotted on the long sections included as Drawing sequence 49342-AMAR-HGT-SWI-DR-CE-000024 to HA549342-AMAR-HGT-SWI-DR-CE-000036 for the 'Central Section' in Appendix B.

Earthworks associated with the M1 vary spatially across the 'Central Section'; these trends are summarised in Table 4-6 below (further earthwork details are included in Appendix C):

Table 4-6 – 'Central Section' Earthworks Summary

Chainage	Earthwork	Maximum Height (m)	Maximum Gradient (°)
Ch184750 to Ch184800 (0.05km)	At Grade	0	0
Ch184800 to Ch188600 (3.80km)	Embankments	8.6	30
Ch188600 to Ch188800 (0.20km)	None (overbridge/viaduct)	N/A	N/A
Ch188800 to Ch189000 (0.20km)	Embankments	5.1	20
Ch189000 to Ch189200 (0.20km)	None (overbridge)	N/A	N/A
Ch189200 to Ch189350 (0.15km)	Embankments	5.5	22
Ch189350 to Ch189530 (0.18km)	None (overbridge)	N/A	N/A
Ch189530 to Ch190700 (1.17km)	Embankments	10.1	24
Ch190700 to Ch191380 (0.68km) Northbound carriageway side only	At Grade	0	0
Ch190700 to Ch191530 (0.83km) Southbound carriageway side only	Embankments	4.6	25
Ch191380 to Ch191530 (0.15km) Northbound carriageway side only	Bund	6.8	24

Notes
1. Earthworks details are based on survey information from HAGDMS [Ref 7].

4.3.3. Made Ground

Made Ground is largely encountered in the 'Central Section' of the scheme as either road construction materials or Embankment Fill in areas of embankment. Thicknesses of Made Ground vary depending on location within a cutting (solely road construction) or upon an embankment. Other areas of Made Ground within this section, for which only little information is currently known are noted in the Arup PSSR [Ref 2] and are included in the hazard plans included in Appendix B of this GIR and summarised in Table 4-7 below:

Table 4-7 – Identified Areas of Made Ground other than road construction or Embankment Fill for the 'Central Section'

Chainage	Description	Source	Drawing Reference
Ch184850 to Ch184940 (0.09km)	600mm of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000052
Ch185870 to Ch185920 (0.05km)	2m of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000053
Ch185920 to Ch186000 (0.08km)	3m of unsuitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000053
Ch186120 to Ch186460 (0.34km)	Site of old ponds infilled with refuse prior to motorway construction. 4m of refuse material and suitable material removed below formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000054
Ch188280 to Ch188580 (0.30km)	Sand trenches at 6m centres beneath embankment	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000057 and HA549342-AMAR-HGT-SWI-DR-CE-000058
Ch188810 to Ch188900 (0.09km) and Ch188930 to Ch188980 (0.05km) Northbound only	Peat removed beneath embankment and backfilled with bedrock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000058
Ch189410 and Ch189500 Northbound only	Unknown filled ground. Former stream dating back to 1955.	Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000059
Ch189100 to Ch189140 (0.04km) and Ch189330 to Ch189390 (0.06km)	Infilled oxbow lake. Dating back to 1956	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000059
Ch190670 to Ch190930 (0.26km) Southbound only	Unknown filled ground. Former pond	Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000061
Ch191180 to Ch191450 (0.27km)	Sand trenches beneath embankment topped with 1m of imported rock. Former stream	Travers Morgan and Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000062

These areas of Made Ground appear to be associated with excavation and replacement of unsuitable material prior to motorway construction. Limited information is available on their extent, thickness and composition.

The majority of Embankment Fill is considered to have been locally sourced from cut of the Mercia Mudstone Group. Historical road improvement works may mean that some layers of Embankment Fill differ, particularly under embankment shoulders.

Road construction materials generally comprise bitumen hardstanding of the road surface, aggregate and general imported granular fill.

Table 4-8 below summarises the identified thicknesses of Embankment Fill encountered from historical borehole logs for the 'Central Section':

Table 4-8 – 'Central Section' Embankment Fill Summary

Chainage	Unit	Approximate Thickness (m)
Ch184750 to Ch185170 (0.42km)	Embankment Fill	0-5
Ch185170 to Ch185720 (0.55km)	Embankment Fill	1
Ch185720 to Ch191510 (5.79km)	Embankment Fill	1-9

4.3.4. Superficial Geology

The Mercia Mudstone Group is overlain by Superficial Deposits within the 'Central Section', as recorded by the BGS [Ref 8] and confirmed by the available GI data. These Superficial deposits are summarised in Table 4-9 below.

Table 4-9 – 'Central Section' Superficial Geology Summary

Chainage	Unit	Approximate Thickness (m)
Ch185200 to Ch191530 (6.33km)	Glaciofluvial Deposits	0-9
Ch188420 to Ch189210 (0.79km)	River Terrace Deposits	0-7
Ch188610 to Ch188670 (0.06km)	Alluvium	0-2
Ch189350 to Ch189480 (0.13km)	River Terrace Deposits	1
Ch189360 to Ch189470 (0.11km)	Alluvium	3
Ch190770 to Ch190870 (0.10km)	Alluvium	2

Superficial geology for the 'Central Section' is presented in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000007 to HA549342-AMAR-HGT-SWI-DR-CE-000009 in Appendix B.

4.3.5. Solid Geology

The ground model for the 'Central Section' can be generalised based on the solid geology recorded by the BGS [Ref 8] and this is confirmed by the available GI data. Solid geology across the scheme extents comprises the Mercia Mudstone Group with varying proportions of mudstone, siltstone and sandstone bands. The 'Central Section' generally comprises mudstone and siltstone with minor bands of sandstone.

The solid geology as identified by the available data for the 'Central Section' is summarised in Table 4-10 below.

Table 4-10 – 'Central Section' Solid Geology Summary

Chainage	Unit	Approximate Depth to top of stratum (m bgl)
Ch184750 to Ch185820 (1.07km)	Mercia Mudstone Group	1-5
Ch185820 to Ch186700 (0.8km)	Mercia Mudstone Group	5-9
Ch186700 to Ch191400 (4.70km)	Mercia Mudstone Group	8-17
Ch191400 to Ch191530 (0.13km)	Mercia Mudstone Group	5-10

Solid geology for the 'Central Section' is presented in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000012 to HA549342-AMAR-HGT-SWI-DR-CE-000014 in Appendix B.

4.3.6. Hydrology

The 'Central Section' contains the hydrological catchment of the River Trent between chainages Ch1847500 and Ch190000, and of Golden Brook/River Erewash northwards from chainage Ch190000. Watercourses, ponds, bridges and culverts are shown on the Geotechnical Hazard Plans, included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000051 to HA549342-AMAR-HGT-SWI-DR-CE-000063 for the 'Central Section' in Appendix B.

Between Junctions 24 and 25, the M1 lies wholly within the catchment of the River Trent. The confluence of the River Trent, the River Derwent and the Trent and Mersey Canal lies approximately 700m upstream of the existing M1 crossing of the Trent. The combined catchment areas of the Trent and Derwent are in the order of 5,580km^2 upstream of the M1 crossing. The existing river flows in the Trent are controlled by a system of locks and weirs, with high bank full flows at Sawley. In the vicinity of the M1, the Trent valley floodplain is approximately 2.4km wide and is subject to recurrent flooding.

Details of the River Erewash catchment are included in Section 4.2.7 of this GIR.

4.3.7. Hydrogeology

Groundwater strikes and subsequent monitoring data is included in some historical boreholes within the scheme extents. Groundwater information is shown in the long sections included as Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000024 to HA549342-AMAR-HGT-SWI-DR-CE-000036 for the 'Central Section' in Appendix B GIR. Groundwater is discussed further in Section 5.5.

4.4. 'North Section'

4.4.1. Location

The 'North Section' can be found between chainages Ch191530 and Ch195800 (4.45km); this section includes Junction 25.

4.4.2. Topography and Landuse

The main features for the 'North Section' are shown in the Geotechnical Hazard Plans, included as Drawing sequence 49342-AMAR-HGT-SWI-DR-CE-000063 to HA549342-AMAR-HGT-SWI-DR-CE-000069 in Appendix B. The landscape along the 'North Section' is open and flat, dominated by the very wide valley of the River Trent. The land use is mainly agricultural, with the M1 passing the towns of Sawley and Long Eaton on the east and the village of Breaston on the west.

A LiDAR survey has been undertaken for this scheme, which is used for the drawings in Appendix B. Based on this LiDAR survey, the following changes in elevation of the road level are recorded in the 'North Section' (progressing from south to north within the extents of the 'North Section' only):

- Flat at 34m AOD from Ch191530 to Ch191750 (0.22km);
- Rise from 34m AOD to 72m AOD from chainage Ch191750 to Ch195100 (3.35km); and
- Fall from 72m AOD to 60m AOD from chainage Ch195100 to Ch195800 (0.70km).

Road level elevations are plotted on the long sections included as Drawing sequence 49342-AMAR-HGT-SWI-DR-CE-000036 to HA549342-AMAR-HGT-SWI-DR-CE-000042 for the 'North Section' in Appendix B.

Earthworks associated with the M1 vary across the 'North Section'; these variations are summarised in Table 4-11 below (further earthwork details are included in Appendix C):

Table 4-11 – 'North Section' Earthworks Summary

Chainage	Earthwork	Maximum Height (m)	Maximum Gradient (°)
Ch191380 to Ch191630 (0.25km) Northbound only	Bund	6.8	24
Ch191530 to Ch191630 (0.10km) Southbound only	Cutting	4.7	22
Ch191630 to Ch192000 (0.37km) Northbound only	Cutting	3.0	20
Ch191630 to Ch192000 (0.37km) Southbound only	At Grade	0	0
Ch192000 to Ch192900 (0.90km)	Embankments	7.5	29
Ch192900 to Ch194800 (1.90km)	Cuttings	15.8	33
Ch194800 to Ch194910 (0.11km) Northbound only	Cutting	9.7	25
Ch194800 to Ch194910 (0.11km) Southbound only	Embankment	2.6	36
Ch194910 to Ch195600 (0.69km)	Cuttings	11.8	44
Ch195600 to Ch195700 (0.10km) Northbound only	At Grade	0	0
Ch195700 to Ch195800 (0.10km) Northbound only	Embankment	13.6	29
Ch195600 to Ch195800 (0.20km)	Cutting	14.1	44

Notes
1. Earthworks details are based on survey information from HAGDMS [Ref 7].

4.4.3. Made Ground

Made Ground is largely encountered in the 'North Section' of the scheme as either road construction materials or Embankment Fill in areas of embankment. Thicknesses of Made Ground vary depending on location within a cutting (solely road construction) or upon an embankment. Other areas of Made Ground within this section, for which only little information is currently known are noted in the Arup PSSR [Ref 2] and are included in the hazard plans included in Appendix B of this GIR and summarised in Table 4-12 below:

Table 4-12 – Identified Areas of Made Ground other than road construction or Embankment Fill for the 'North Section'

Chainage	Description	Source	Drawing Reference
Ch191690 to Ch191870 (0.18km)	Rock fill at formation level	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000063
Ch191920 Southbound only	Unknown filled ground. Former stream	Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000063
Ch192050 to Ch192080 (0.03km)	Boulder clay at formation level removed and filled with imported rock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000064
Ch192660 to Ch192710 (0.05km)	Disused Derby canal cleared out and backfilled with suitable material	Travers Morgan and Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000065

Chainage	Description	Source	Drawing Reference
Ch193640 Northbound only	Unknown filled ground mainly under Junction 25. Dating back to 1956	Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000066
Ch193170 to Ch193250 (0.08km) Southbound only	Old pond. Unknown backfill	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000066
Ch193360 to Ch193440 (0.08km) Northbound only	600mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000066
Ch193980 to Ch194250 (27km)	300mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan and Erewash Borough Council	HA549342-AMAR-HGT-SWI-DR-CE-000067
Ch194400 to Ch194430 (0.03km)	300mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000068
Ch194940 to Ch194990 (0.05km)	300mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000068
Ch195010 to Ch195030 (0.02km)	300mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000069
Ch195170 to Ch195210 (0.04km)	300mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan	HA549342-AMAR-HGT-SWI-DR-CE-000069

These areas of Made Ground appear to be associated with excavation and replacement of unsuitable material prior to motorway construction. Limited information is available on their extent, thickness and composition.

The majority of Embankment Fill are considered to have been locally sourced from cut of the Mercia Mudstone Group. Historical road improvement works may mean that some layers of Embankment Fill differ, particularly under embankment shoulders.

Road construction materials generally comprise bitumen hardstanding of the road surface, aggregate and general imported granular fill.

Table 4-13 below summarises the identified thicknesses of Embankment Fill encountered from historical borehole logs for the ‘North Section’:

Table 4-13 – ‘North Section’ Embankment Fill Summary

Chainage	Unit	Approximate Thickness (m)
Ch191940 to Ch192910 (0.97km)	Embankment Fill	1-6

4.4.4. Superficial Geology

The Mercia Mudstone Group is overlain by Superficial Deposits within the ‘North Section’, as recorded by the BGS [Ref 8] and confirmed by the available GI data. These Superficial deposits are summarised in Table 4-14 below:

Table 4-14 – 'North Section' Superficial Geology Summary

Chainage	Unit	Approximate Thickness (m)
Ch191530 to Ch192600 (1.07km)	Glaciofluvial Deposits	3-5
Ch192490 to Ch192900 (0.41km)	Head Deposits	0-6

Superficial geology for the 'North Section' is presented in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000009 and HA549342-AMAR-HGT-SWI-DR-CE-000010 in Appendix B.

4.4.5. Solid Geology

The ground model for the 'North Section' can be generalised based on the solid geology recorded by the BGS [Ref 8] and has been confirmed by the available GI data. Solid geology across the scheme extents comprises the Mercia Mudstone Group with varying proportions of mudstone, siltstone and sandstone bands. The 'North Section' generally comprises interbedded mudstone, siltstone and sandstone.

The solid geology as identified by the available data for the 'North Section' are summarised in Table 4-15 below.

Table 4-15 – 'North Section' Solid Geology Summary

Chainage	Unit	Approximate Depth to top of stratum (m bgl)
Ch191530 to Ch192000 (0.47km)	Mercia Mudstone Group	3-5
Ch192000 to Ch192300 (0.30km)	Mercia Mudstone Group	5-10
Ch192300 to Ch192700 (0.40km)	Mercia Mudstone Group	10-12
Ch192700 to Ch192900 (0.20km)	Mercia Mudstone Group	0-10
Ch192900 to Ch195800 (2.90km)	Mercia Mudstone Group	0

Solid geology for the 'North Section' is presented in Drawing sequence HA549342-AMAR-HGT-SWI-DR-CE-000014 and HA549342-AMAR-HGT-SWI-DR-CE-000015 in Appendix B

4.4.6. Hydrology

Between Junctions 25 and 26, the M1 lies partially in the northern extremities of the Trent catchment but is primarily within the catchment of Golden Brook, which flows eastward into the River Erewash. Watercourse, ponds, bridges and culverts are shown on the Geotechnical Hazard Plans, included as Drawing sequence 49342-AMAR-HGT-SWI-DR-CE-000063 to HA549342-AMAR-HGT-SWI-DR-CE-000069 for the 'North Section' in Appendix B.

The River Erewash flows from north to south and is traversed by the M1 just to the north of Stanton Gate. Within the Erewash valley the M1 also crosses the Erewash Canal and the Nottingham Canal. The catchment is highly urbanised and as such probably exhibits a rapid runoff response to rainfall. Flooding of the Erewash has been recorded in the vicinity of the existing M1 crossing of the floodplain.

4.4.7. Hydrogeology

Groundwater strikes and subsequent monitoring data is included in some historical boreholes within the scheme extents. Groundwater information is shown in the long sections included as Drawing sequence 49342-AMAR-HGT-SWI-DR-CE-000036 to HA549342-AMAR-HGT-SWI-DR-CE-000042 for the 'North Section' in Appendix B. Groundwater is discussed in more detail in Section 5.5.

5. Ground Conditions and Material Parameters

5.1. General

5.1.1. Geotechnical Parameters for Design

This chapter discusses the selection of characteristic material properties and the derivation of Characteristic material parameters based on available information taken from published sources and from information contained within the Arup Preliminary Geotechnical Report [Ref 4]. Only historical GI data from the Arup Preliminary Geotechnical Report [Ref 4] that is sourced from within the scheme extents is used as part of this study. In addition, further historical GI data from the BGS Geoindex [Ref 8] and HAGDMS [Ref 7] has become available since the issue of the Arup Preliminary Geotechnical Report [Ref 4] and these are also used as part of this GIR to supplement the Arup data.

Where practicable material parameters derived for this scheme extent have been compared to those defined in the Arup Preliminary Geotechnical Report [Ref 4].

The following sections detail the characteristic materials properties for the strata outlined in Section 4 of this GIR for the scheme extents.

In addition to the scheme wide characteristic ground model developed within this GIR, AMAR will produce standalone datasheets for each proposed structure/ERA location which will develop a site specific ground model based on the overall model provided in this GIR. Datasheets will also be updated after completion of any 'Just in Time' GI and incorporated in the GFR where any relevant significant changes are made.

According to existing geological data, the Bromsgrove Sandstone Formation underlies a very limited section of the M1 motorway corridor between CH184600 and CH184800. Based on the geotechnical data currently available it has not been possible to distinguish the Bromsgrove Sandstone Formation from the interbedded sandstone bands of the Mercia Mudstone Group in this location. Therefore, given the limited extents of the Bromsgrove Sandstone Formation, no characteristic parameters or properties have been derived for this material.

5.1.2. Laboratory Testing

In general, a large amount of classification testing results and in-situ tests (SPTs), as well as some strength and compressibility testing (triaxial, shear box and consolidation tests) has been identified in addition to the data utilised in the Arup Preliminary Geotechnical Report [Ref 4]. Data outside the scheme extents was removed and new data added so it was considered that parameters needed to be re-assessed against the Arup Preliminary Geotechnical Report [Ref 4].

5.2. Made Ground

5.2.1. General

Made Ground is largely encountered across the scheme as either road construction or Embankment Fill, but is also noted in Section 4 to be present as unspecified fill beneath embankments. For the purposes of the general ground model for the site in this GIR, only Embankment Fill is considered further. Identified areas of unspecified Made Ground under embankments should be considered locally where structures such as gantries or ERAs are proposed as part of datasheets prepared in Design Fix 4. Made Ground other than Embankment Fill will not have characteristic geotechnical parameters derived as part of this GIR. 'Just in

Time' GI will likely be required at locations where Made Ground with limited information is recorded. Determination of ground conditions and material properties of Embankment Fill is based only on materials recovered from boreholes within the highways boundary.

5.2.2. Embankment Fill

5.2.2.1. Description

Embankment Fill has been identified up to 9.40m thick and generally comprises brown grey firm and stiff silty/sandy CLAY with some gravels, and reflects the source geology in the cuttings along the route (i.e. Mercia Mudstone Group). Exploratory hole CP1061, located at chainage Ch 181296 (in the 'South Section'), is where the maximum Embankment Fill thickness of 9.40m is recorded; however, embankments with thicknesses up to 15.8m are recorded to be present within the scheme extents on HAGDMS [Ref 7]. Coarse materials underlying Embankment Fill may be present locally where historical excavation has taken place.

5.2.2.2. Classification

Results of classification tests on samples of Embankment Fill are presented below in Table 5-1.

Table 5-1 – Embankment Fill Atterberg Limit Test Results

	NMC (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Number of tests	78	66	66	66
Range	2.0-31.3	21-49	10-28	8-31
Average	15	33	16	17

The recorded NMC values show a wide variation, as expected for Embankment Fill materials. No correlation with depth is evident from the NMC plot in Figure 5-1-1 for Embankment Fill.

The plasticity chart shown in Figure 5-1-3 shows that the material can generally be classified as clay of low to medium plasticity with most tests showing low plasticity. The majority of tests plot above the A-line; 2 tests fell under the A-line indicating intermediate plasticity silt. The plasticity index falls within the range for weathered Mercia Mudstone (of which the Embankment Fill is considered likely to comprise) of 10-35% as presented in Hobbs et al. (2002) [Ref 33] and in CIRIA 181 [Ref 34]. A characteristic plasticity index for Embankment Fill is considered to be 17%.

PSD curves, plotted in Figure 5-1-4 reflect the heterogeneity of the material sizes, ranging from coarse gravel to clay. However, based on sample descriptions, it is considered that the materials represent a well graded fine grained general fill containing larger gravel and cobble size particles that represent Mercia Mudstone material broken up in the compaction process. 2 PSD tests have coarser fraction results than the majority of Embankment Fill materials encountered; it is possible that these samples represent infilled excavations undertaken during motorway construction, however this has not been confirmed.

No bulk unit weight tests were undertaken within Embankment Fill within the scheme extents. The BS 8002:2015 [Ref 35] suggested value for characteristic bulk density of fine grained material above the groundwater table is between 17kN/m^3 and 20kN/m^3. Guidance in CIRIA C570 [Ref 36] for a Mercia Mudstone – III/IV gives a unit weight range of 18-21kN/m^3; the majority of Embankment Fill is likely to comprise Mercia Mudstone – III/IV. Given that the Embankment Fill is considered to represent reworked Mercia Mudstone and will have been compacted to a low voids ratio during construction, a characteristic unit weight of 21kN/m^3 is suggested.

5.2.2.3. Strength

The results of 113 SPTs for Embankment Fill are shown in Figure 5-1-6. Of these SPTs, 10 tests met refusal, the results of these have been extrapolated to full penetration in Figure 5-1-6. N values range from 5 to 150 (capping extrapolated results at 150), although for the majority of samples, N values tend to fall in the range of 10 to 40. The average SPT N value (with extrapolated results capped at 150) was 30 however a characteristic N value is considered to be 15-20.

The undrained shear strength (c_u) of the Embankment Fill has been calculated after the correlation in CIRIA Report 143 [Ref 37] using the relationship outlined by Stroud [Ref 38]:

$$c_u = f_1 N$$

c_u values are plotted for Embankment Fill in Figure 5-1-7. Deriving f_1 using the characteristic plasticity index for the Embankment Fill gives an f_1 value of 6.0; however, it is considered that the resultant cu values using this correlation are uncharacteristically high for this stratum.

No hand shear vane (HSV) results were available for Embankment Fill within the scheme extents.

Forty seven undrained triaxial tests were undertaken in Embankment Fill within the scheme extents, the results of which are plotted in Figure 5-1-6. c_u ranged from 30 to 210kN/m^2, with an average of 110kN/m^2.

Based on the above values for Embankment Fill, the c_u range between 30 and 240 with a characteristic value of 100kN/m^2. This should be reviewed locally for each design location.

One shear box test was carried out in the Embankment Fill, as shown in Figure 5-1-9. Results for the shear box test gave an angle of internal friction (ϕ') of 36.5° and a drained cohesion (c') of 3.0kN/m^2. Given the limited number of test results, this is not considered representative of this stratum as a whole. For Embankment Fill a c' of 0kN/m^2 is considered characteristic for the stratum as a conservative assumption.

From the characteristic plasticity index of 17%, the ϕ' for Embankment Fill as estimated based on Table 2 in BS 8002:2015 [Ref 35] is 27°. Guidance in Hobbs et al. [Ref 33] for weathered Mercia Mudstone (of which the Embankment Fill is anticipated to comprise) gives a range for ϕ' of 25-42°.

The value of ϕ' should be location-specific to each embankment for geotechnical design, however a characteristic ϕ' for Embankment Fill is considered to be 27°.

5.2.2.4. Stiffness

Undrained and drained Poisson's ratio (v_u and v' respectively) can be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. A clay gives a v_u of 0.5 and a v' of 0.1-0.3, in accordance with this guidance. A v_u of 0.5 and a v' of 0.2 is considered characteristic of the Embankment Fill.

Undrained Young's modulus (E_u) can be derived using correlations between SPT N values and lithological description in Bowles (1988) [Ref 40]. For a fine grained material:

$$E_u = 300 (N + 6) \text{ kN/m}^2$$

For a characteristic SPT N value of 20, E_u is calculated to be 7.8MN/m^2.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for both drained (E') and undrained (E_u) Young's modulus based on typical lithological description. For a stiff clay, E_u is 10-20MN/m^2 and E' is 5-15MN/m^2.

E' can be derived for a fine grained material using correlation with v and E_u, as shown by Wroth (1972) [Ref 41]:

$$E' = 2/3 (1 + v) E_u$$

Using this correlation and the characteristic E_u and v values, E' is calculated to be 6.2MN/m^2.

5.2.2.5. Compressibility

Four undisturbed samples of Embankment Fill were tested for one dimensional consolidation in historical GIs; the samples tested were taken at depths ranging between 3.20 and 7.65m bgl from different embankments along the scheme extents. Results show that compressibility of this type of material is highly variable and settlement characteristics are dependent on depth and location.

Figure 5-1-8 shows the void ratio plotted against the applied pressures; the coefficient of compressibility (m_v), for a stress range of 50 to 3200kN/m^2, varied from 0.001 to 0.248m^2/MN (average 0.068m^2/MN). This range is indicative of stratum with very low to medium compressibility, as determined by guidance in Tomlinson [Ref 42].

Correlation between m_v and SPT N values is presented in Stroud [Ref 38] based on the following equation:

$$m_v = 1 / (f_2 \times N)$$

The constant f_2 varies with plasticity index of the material. In accordance with Stroud [Ref 38] f_2 is approximately 0.60 for an average plasticity index of 17%. Therefore, the characteristic m_v of the Embankment Fill using the characteristic SPT N value of 15-20 and this correlation is approximately 0.083m^2/MN. This value is indicative of stratum with low compressibility (Tomlinson [Ref 42]).

The coefficient of consolidation (c_v) also showed a high variability with results that ranged from 3.62 to 21.99m^2/yr and an average of 10.71m^2/yr considered to be typical of the stratum.

5.2.2.6. Soil Chemistry

Embankment Fill soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-2 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-2 below. 5 pH tests were undertaken that ranged from 7.14 to 8.31; these results are used to derive DS and ACEC Classes below.

Table 5-2 – Embankment Fill Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	3	26-91	DS-1	AC-1
	Groundwater	SO4 mg/l	5	410-810	DS-2	AC-2
	Total potential sulphate	SO4 %	13	0.024-0.551	DS-2	AC-2
pH		-	5	7.14 - 8.31	-	-

Based on these results, classifications of DS-2 and AC-2 for Embankment Fill are derived. However, based on the assumption that Embankment Fill comprises engineered Mercia Mudstone from local cuttings, it is possible that higher classifications will be required as it is noted in BRE Special Digest 1 [Ref 43] that Mercia Mudstone is a stratum likely to have high sulphate concentrations. It may be required that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.2.2.7. Potentially Contaminated Land

Assessment of the potential for contaminated land within the scheme extents was undertaken as part of the Geotechnical Report completed by Arup [Ref 4]. Past and current land uses were reviewed to determine potential pollutants and receptors and none of the sites identified for potential contamination within the scheme extents were assessed as having severe ground contamination effects. Some sites however were assessed as moderate risk or slight risk; therefore a targeted GI was undertaken to identify and/or confirm areas of potential contamination. The findings of the review of the GI for each potentially contaminated site are summarised in Table 5-3 below:

Table 5-3 – Findings of the Review of the Potentially Contaminated Sites

Site	Chainage	Activity Type	Initial Significance Criteria	Reviewed Significance Criteria
Hemington Gravel Pit	Ch187400 to Ch 188550	Landfill	Moderate	Slight
Lockington Grounds Farm	Ch187400 to Ch 188550	Landfill	Moderate	Slight
Sawley Cut	Ch188520 to Ch188840	Commercial	Slight	Slight
Church Wilne Water Treatment Works	Ch189750 to Ch190150	Landfill	Slight	Slight

These potentially contaminated sites are all located off site; therefore, given that there will be no landuse change, the reviewed significance risk is slight. No additional contamination GI is required for these identified locations. There is no mention of potential contaminated land issues within the Environmental Study Report prepared by AMAR for this scheme [Ref 26].

It is possible that contaminated ground exists that has not been detected by the work undertaken to date. Existing contamination test results will be consulted as part of a contaminated land risk assessment in the GDR for site works and an assessment for potential off-site disposal of arisings. The results of all future investigation work should be reviewed and any evidence of contaminated ground investigated further. Site procedures and method statements should include measures to detect and mitigate the effects of contaminated ground both within and outside the potentially contaminated locations identified.

5.3. Superficial Deposits

5.3.1. General

Fluvial Deposits are present in the floodplains of the River Trent and Erewash (chainages Ch184990 to Ch192700 and Ch196600 to Ch197700 respectively) and localised close to smaller watercourses. Glaciofluvial Deposits (of the Trent Valley Formation) and Head Deposits are generally located in close proximity to Fluvial Deposits. Glacial Till (known locally as the Oadby Member) is present towards the southern end of the scheme extents only. The Superficial Deposits have been further subdivided into Alluvium, Head, Glaciofluvial Deposits, Glacial Till and River Terrace Deposits.

5.3.2. Alluvium

5.3.2.1. Description

Alluvium was encountered in historical GIs within the floodplain of the River Trent and particularly within proximity of streams and brooks that pass under the motorway within the scheme extents. Generally, Alluvium

was of limited occurrence across the scheme extents, and therefore only limited test results were available. Alluvium was encountered below Topsoil or Embankment Fill on both sides of the Trent Valley between Junctions 24a and 25 of the M1. These deposits generally have limited thickness which ranges from 0.10m to 3.66m (1.0m average) and are generally described as very soft to firm mottled orange/brown and green/grey silty or sandy CLAY. Alluvium is recorded as present at depths that range from 0.15 to 7.90m bgl.

5.3.2.2. Classification

Results from classification tests are presented in Table 5-4 below:

Table 5-4 – Alluvium Atterberg Limit Test Results

	NMC (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Number of tests	9	3	3	3
Range	8-49	34-62	15-37	19-32
Average	23	51	27	24

NMC for Alluvium is recorded as variable, which is consistent with soft/saturated sometimes organic materials, as shown in Figures 5-2-1 and 5-2-2.

Only 3 plasticity index values were available for Alluvium, the results are shown in Figure 5-2-3. The plasticity chart shows the variability of the Alluvium between the 3 samples recording low clay plasticity, high clay plasticity and high silt plasticity. The average plasticity is shown to be 24% however a plasticity index of 20% is considered to be characteristic of the Alluvium.

Only 3 PSD tests were available for Alluvium, as shown in Figure 5-2-4. The PSD curves show the Alluvium to largely comprise clay and silt with some fine sand-sized particles.

No bulk unit weight tests were undertaken within Alluvium within the scheme extents. A characteristic value for bulk unit weight for Alluvium of 20kN/m^3 is considered suitable. There is no correlation for a well sorted material such as Alluvium in BS 8002:2015 [Ref 35] for comparison. The bulk unit weight derived by Arup in the Preliminary Geotechnical Report [Ref 4] was 20kN/m^3 and this is considered to be characteristic.

5.3.2.3. Strength

Two SPT tests were carried out in Alluvium; these are presented in Figure 5-2-6. The recorded N values were 28 and 36. It is considered that a value of 32 for N is characteristic of the strata, although this is based on a limited volume of data so is used with caution and it is possible that the SPT tests have been influenced by underlying gravels.

The c_u of Alluvium has been calculated after the correlation in Stroud [Ref 38] using the relationship:

$$c_u = f_1 N$$

The constant f_1 varies with plasticity index of the material. f_1 for an average plasticity index of 24% is approximately 5.0. The calculated c_u values are 140 and 180kN/m^2. These derived values are considered to be excessively high for the nature of the stratum and recorded descriptions thereof and may be a result of obstruction.

Two HSV results were available for Alluvium within the scheme extents; these were 22 and 24kN/m^2.

One undrained triaxial test was undertaken in the Alluvium, the result of which was 64kN/m^2.

Although higher values have been derived from limited SPT data, based on the available testing, a c_u of 30-50kN/m^2 is considered more appropriate as a characteristic value of the stratum as a whole.

All c_u values derived for the Alluvium are presented in Figure 5-2-7.

For fine grained Alluvium a c' of 0kN/m^2 is chosen as a conservative assumption in the absence of relevant geotechnical data.

From the plasticity index the ϕ' for the Alluvium has been estimated based on Table 2 in BS 8002:2015 [Ref 35] and a range of ϕ' of 24° to 26° is determined with a 25° considered characteristic of the stratum.

5.3.2.4. Stiffness

v_u and v' can be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. A clay gives a v_u of 0.5 and a v' of 0.1-0.3, in accordance with this guidance. A v_u of 0.5 and a v' of 0.2 is considered characteristic of Alluvium.

E_u can be derived using correlations between SPT N values and lithological description in Bowles [Ref 40]; however, as the SPT N values are not representative of the strata, this correlation is not used for Alluvium.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for both E' and E_u based on typical lithological description. For a soft clay, E_u is 2-6MN/m^2 and E' is 1-4MN/m^2. Based on these guidelines, it is considered that an E_u of 4MN/m^2 and an E' of 3MN/m^2 are characteristic of the Alluvium.

5.3.2.5. Compressibility

One sample of Alluvium was tested for one dimensional consolidation; the sample tested was taken at a depth of 1.52m bgl with stress ranges from 27 to 858kN/m^2. Results are given in Figure 5-2-8; m_v was in the range of 0.160 to 2.150m^2/MN which represents the high variability in compressibility which is characteristic of Alluvium. This range is indicative of stratum with medium to very high compressibility, as determined by guidance in Tomlinson [Ref 42].

No c_v values were recorded in historical GI data for Alluvium.

Correlation between m_v and SPT N values is presented in Stroud [Ref 38], however the SPT N values for Alluvium are not considered to be characteristic of the stratum; therefore this correlation is not used.

5.3.2.6. Soil Chemistry

Alluvium soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-5 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-5 below. No pH tests were available for Alluvium; however it is still possible to derived DS and ACEC classes based solely on sulphate testing.

Table 5-5 – Alluvium Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	0	-	-	-
	Groundwater	SO4 mg/l	0	-	-	-
	Total potential sulphate	SO4 %	1	0.012	DS-1	AC-1s
pH		-	5	0	-	-

Based on these results, classifications of DS-1 and AC-1s for Alluvium are derived; however this is based on a single test result on a highly variable stratum. It is required that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.3.3. River Terrace Deposits

5.3.3.1. Description

River Terrace Deposits are encountered at ground level or below Topsoil, Made Ground/Embankment Fill or Alluvium at several locations on both sides of the Trent Valley between Junctions 24a and 25 of the M1.

They were generally described as medium dense to dense brown fine to coarse Sand and Gravel, often with some clay and encountered at depths that range from 0.20 to 16.60m bgl. River Terrace Deposit thicknesses ranged from 0.30m to 8.90m (3.98m average).

5.3.3.2. Classification

Ten NMC tests for River Terrace Deposits gave values that were variable, which is typical for fluvial deposits recovered from below the water table, as shown in Figures 5-3-1 and 5-3-2. NMC ranged from 4-14% with an average of 10%.

PSD curves show a group of poorly graded materials, mainly composed of medium-grained gravels or sometimes fine-grained sand, generally with little fines content. PSD plots for River Terrace Deposits are presented as Figure 5-3-4.

No bulk unit weight tests were undertaken within River Terrace Deposits within the scheme extents. BS 8002:2015 [Ref 35] has a suggested value for characteristic bulk density of dense gravels above the groundwater table between 18kN/m^3 and 21kN/m^3. A unit weight of 20kN/m^2 is therefore considered characteristic of the River Terrace Deposits.

5.3.3.3. Strength

Ninety three SPT tests were carried out in River Terrace Deposits; these are presented in Figure 5-3-6. The recorded N values ranged from 4 to 600 (capping results at 150). The SPT N values are considered to largely belong within the range of 10-50 with 30 being the characteristic value. Due to its variability, River Terrace Deposits should be reviewed for each design element.

ϕ' derived in the Arup Preliminary Geotechnical Report [Ref 4] for River Terrace Deposits was 30-42°.

ϕ' for the coarse grained materials of the River Terrace Deposits can be estimated using Table 1 in BS 8002:2015 [Ref 35]. Based on a siliceous sand and gravel with fines content <15%, with rounded to well-rounded particles, which is evenly graded and dense, a ϕ' of 38° can be derived.

ϕ' can also be derived using SPT N values, as demonstrated by Peck (1974) [Ref 44]. Using the range of recorded N values, a ϕ' of 28° to 44° is derived. Using a characteristic N value of 30, a ϕ' of approximately 38° is derived. As such a ϕ' value of 38° is considered to be characteristic of the stratum.

5.3.3.4. Stiffness

E' can be derived using correlations between SPT N values and lithological description in Bowles [Ref 40]. For a gravelly sand:

$$E' = 1200 (N + 6) \text{ kN/m}^2$$

For a characteristic SPT N value of 30, E' is calculated to be 43MN/m^2.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for E' based on typical lithological description. For a dense sand, E' is 30-100MN/m^2.

It is anticipated that an E' of 43MN/m^2 is characteristic of the River Terrace Deposits. Stiffness properties should be reviewed locally for each design element due to the variability of the River Terrace Deposits.

v' can also be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. A dense sand gives a v' of 0.3-0.4, in accordance with this guidance. A v' of 0.35 is considered characteristic of River Terrace Deposits.

5.3.3.5. Soil Chemistry

River Terrace Deposits soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-6 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-6 below. 1 pH test was undertaken, with a result of 7.5; this result is used to derive DS and ACEC Classes below.

Table 5-6 – River Terrace Deposits Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	1	2000	DS-3	AC-3
	Groundwater	SO4 mg/l	0	-	-	-
	Total potential sulphate	SO4 %	0	-	-	-
pH		-	1	7.5	-	-

Based on these results, classifications of DS-3 and AC-3 for River Terrace Deposits are derived; however this is based on a single test result on a highly variable stratum and could be misleadingly high. It is recommended that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.3.4. Head

5.3.4.1. Description

Head Deposits are encountered at several locations in the River Trent Valley between Junctions 24a and 25 and associated with Black Brook south of Junction 23a of the M1.

They were generally described as firm to stiff mottled grey and brown sandy silty CLAY with some fine to medium gravel bands and encountered at depths that range from ground level to a maximum of 10.60m bgl. Head Deposit thicknesses ranged from 0.31m to 4.10m (1.53m average).

5.3.4.2. Classification

Results from classification tests are presented in Table 5-7 below:

Table 5-7 – Head Atterberg Limit Test Results

	NMC (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Number of tests	8	4	4	4
Range	8-24	26-57	13-25	12-32
Average	16	41	17	23

NMC for Head Deposits are recorded as generally highly variable, which is typical for mass movement deposits, as shown in Figures 5-4-1 and 5-4-2.

Figure 5-4-3 shows plasticity index values for 6 samples of Head Deposits; results show the materials to range between low and high plasticity clay. The average plasticity index is 23%, however from the plots the characteristic plasticity index is considered to be 20%.

Four PSD tests were undertaken with Head Deposits, as shown in Figure 5-4-4. PSD curves show the material to be well-graded with similar proportions of clay-, silt- and sand-sized particles (with 1 sample yielding medium-sized gravels).

No bulk unit weight tests were undertaken within Head Deposits within the scheme extents. There is no correlation for a well-graded material such as Head Deposits in BS 8002:2015 [Ref 35]. A bulk unit weight of 20kN/m^3 is considered to be suitable for Head Deposits found within the scheme extents.

5.3.4.3. Strength

Four SPT tests were carried out in Head Deposits; these are presented in Figure 5-4-6. The recorded N values ranged from 10 to 23, showed no noticeable correlation with depth.

The c_u of Head Deposits has been calculated after the correlation in Stroud [Ref 38] using the relationship:

$$c_u = f_1 N$$

The constant f_1 varies with plasticity index of the material. f_1 for a characteristic plasticity index of 20% is 5.0, giving a calculated c_u range of 50 to 115kN/m^2.

No HSV results were available for Head Deposits within the scheme extents.

Four undrained triaxial tests were undertaken in the Head Deposits within a single borehole. The results ranged from 103 to 121kN/m^2 and had an average of 117kN/m^2, with 3 of these tests producing the same value of 121kN/m^2.

Based on the above values, a c_u of 100kN/m^2 is considered characteristic of the stratum. Although confirmed from the available testing results, this value should be used with caution given the inherent variability of Head deposits and reassessed on a location specific basis..

All c_u values derived for the Head Deposits are presented in Figure 5-4-7.

For Head Deposits a c' of 0kN/m^2 is considered characteristic of the stratum given that no data relating to c' is currently available for Head Deposits.

From the plasticity index the ϕ' for the Head Deposits has been estimated based on Table 2 in BS 8002:2015 [Ref 35]. Using this correlation a ϕ' of 24° to 28° is derived with a 27° considered characteristic of the stratum.

5.3.4.4. Stiffness

v_u and v' can also be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. A clay gives a v_u of 0.5 and a v' of 0.1-0.3, in accordance with this guidance. A v_u of 0.5 and a v' of 0.2 is considered characteristic of Head Deposits.

E_u can be derived using correlations between SPT N values and lithological description in Bowles [Ref 40]. For a clayey or sandy silt:

$$E_u = 300 (N + 6) \text{ kN/m}^2$$

E_u has a calculated range of 4.8 to 8.7MN/m^3 and has a characteristic value of 7.8MN/m^3.

E' can be derived for a fine grained material using correlation with v and E_u, as shown by Wroth (1972) [Ref 41]:

$$E' = 2/3 (1 + v) E_u$$

Using this correlation and the characteristic E_u and v values, E' is calculated to be 6.2MN/m^2.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for both E' and E_u based on typical lithological description. For a firm to stiff clay, E_u is 5-20MN/m^2 and E' is 3-15MN/m^2.

Based on these guidelines, it is anticipated that an E_u of 7.8MN/m^2 and an E' of 6.2MN/m^2 are characteristic of Head Deposits.

5.3.4.5. Compressibility

No consolidation test data was available for Head Deposits within historical GIs for the scheme extents.

Correlation between m_v and SPT N values is presented in Stroud [Ref 38] based on the following equation:

$$m_v = 1 / (f_2 \times N)$$

The constant f_2 varies with plasticity index of the material. In accordance with Stroud [Ref 38] f_2 is approximately 0.5 for a characteristic plasticity index of 20%. Therefore, the characteristic m_v of Head Deposits range between 0.09 and 0.20m^2/MN with a characteristic value of 0.10m^2/MN. This value is indicative of stratum with medium compressibility (Tomlinson [Ref 42]).

No historical GI data for c_v was available for Head Deposits.

5.3.4.6. Soil Chemistry

Head Deposits soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-8 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-8 below. 1 pH test was undertaken, with a result of 7.8; this result is used to derive DS and ACEC Classes below.

Table 5-8 – Head Deposits Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	0	-	-	-
	Groundwater	SO4 mg/l	1	89	DS-1	AC-1
	Total potential sulphate	SO4 %	5	0.036*	DS-1	AC-1
pH		-	1	1	7.8	-

Notes

1. * All 5 tests produced the same result.

Based on these results, classifications of DS-1 and AC-1 for Head Deposits are derived; however this is based on limited test results on a highly variable stratum. It is recommended that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.3.5. Glaciofluvial Deposits (undifferentiated of the Trent Valley Formation)

5.3.5.1. Description

Glaciofluvial Deposits of the Trent Valley Formation can be subdivided into several geological members. However, for the purpose of the ground model for this scheme, it is considered appropriate to keep the Trent Valley Formation undifferentiated from its subdivision members to avoid unnecessary over complication.

Glaciofluvial Deposits are often found within subglacial channels intimately associated with Glacial Till and are encountered sporadically across the scheme extents and specifically within former courses of the River Trent (between chainages Ch188950 and Ch191200).

These deposits are mainly irregular masses of clay, sand and gravel deposited by melt-water streams associated with ice-sheets. They are typically described as loose to dense red brown clayey fine to coarse Sand and/or Gravel and were encountered at depths that ranged from ground level to 15.24m bgl. Some Glaciofluvial Deposits were recovered as dominantly clay or dominantly gravel grain size with highly variable thicknesses; therefore the Glaciofluvial Deposits should be considered as lithologically highly variable. Where recovered as a fine grained deposit, the material generally comprised firm to stiff clay. These deposits had recorded thicknesses that ranged from 0.25m to 8.69m (3.72m average).

Given the variable nature of the material, characteristic properties have been determined for the coarse and fine grained elements of the strata. The datasheets provided within the GDR will provide more information of the composition of this strata, if identified, at specific locations and the characteristic values used will need toi be assessed at this location specific level.

5.3.5.2. Classification

Results from classification tests are presented in Table 5-9 below:

Table 5-9 – Glaciofluvial Deposits Atterberg Limit Test Results

	NMC (%) (Fine and coarse grained samples)	Liquid Limit (%) (Fine grained samples only)	Plastic Limit (%) (Fine grained samples only)	Plasticity Index (%) (Fine grained samples only)
Number of tests	36	12	12	12
Range	2-39	20-65	11-33	5-32
Average	13	36	19	17

NMC for Glaciofluvial Deposits are recorded as generally highly variable, which is typical for Glaciofluvial Deposits, as shown in Figures 5-5-1 and 5-5-2.

The plasticity chart shows plasticity index values for the fine grained component of the Glaciofluvial Deposits to generally comprise a variable low to high plasticity clay. However, 2 results show a silt plasticity below the A-line (1 result is low plasticity and the other is very high plasticity). It is considered that a plasticity index of 18% is characteristic of the Glaciofluvial Deposits when they are recovered as fine grained materials.

PSD tests show a highly variable material, although in general it can be ascertained that particles sizes are medium-grained sand to medium-grained gravel. The results of these PSD tests are presented as Figure 5-5-4.

No bulk unit weight tests were undertaken within Glaciofluvial Deposits within the scheme extents. BS 8002:2015 [Ref 35] has a suggested value for characteristic bulk density of dense sands or gravels above the groundwater table of between 18kN/m^3 and 21kN/m^3. A characteristic bulk unit weight of 21kN/m^3 is considered appropriate for both the fine grained and coarse grained materials of the Glaciofluvial Deposits encountered within the scheme extents.

5.3.5.3. Strength

SPT tests were carried out in Glaciofluvial Deposits; the results of which are presented in Figure 5-5-6. 264 SPTs were undertaken in the coarse grained materials and 14 were undertaken in the fine grained materials.

The recorded N values for the fine grained materials ranged from 13 to 158 and for the coarse grained materials from 14 to 264; values >150 have been removed from the data plots as unrepresentative of the data as a whole. A general increase with depth is shown in the SPT N plots for both the fine and coarse grained components. For fine grained components the N value can be seen to increase with depth at a rate of 5 + 5z (z = m bgl). For the coarse grained components the N value characteristically ranges between 10 and 40 with a general increase with depth. Glaciofluvial Deposits are locally variable and therefore characteristic values should be reviewed locally for each design element.

For the fine grained component of the Glaciofluvial Deposits, the c_u results are plotted in Figure 5-5-7. These values are calculated after the correlation in Stroud [Ref 38] using the following relationship only for SPTs undertaken within fine grained materials:

$$c_u = f_1 N$$

The constant f_1 varies with plasticity index of the material. f_1 for a characteristic plasticity index of 18% is 5.5. The calculated c_u values increase with depth at a rate of 27.5 + 27.5z kN/m^2 in line with the SPTs for the fine grained components and the minimum is 28kN/m^2 and the maximum is 355kN/m^2.

One HSV test results was undertaken within a fine grained sample of Glaciofluvial Deposits at a depth of 1.1m bgl and had a result of 164kN/m^2. This value is considered to be uncharacteristically high for this stratum.

Ten undrained triaxial tests were undertaken in the fine grained Glaciofluvial Deposits. The results ranged from 38 to 106kN/m^2 and had an average of 60kN/m^2.

Overall for the fine grained components c_u results range from 28 to 355kN/m2 with a characteristic value of 100kN/m^2 increasing with depth as shown by 27.5 + 27.5z..

Seven shear box tests were carried out in Glaciofluvial Deposits, as shown in Figure 5-5-9. Results for the shear box tests gave ϕ' that ranged from 33.8° to 48.1° (average 39.0°) and a c' of 0kN/m^2 for the coarse grained element.

From the plasticity index the ϕ' for the fine grained component of the Glaciofluvial Deposits has been estimated based on Table 2 in BS 8002:2015 [Ref 35]. The ϕ' obtained has a range of 24° to 27°; a typical value of 26° is considered to be characteristic of the fine grained component of the Glaciofluvial Deposits.

For Glaciofluvial Deposits a c' of 0kN/m^2 is considered characteristic of the stratum.

ϕ' for the coarse grained component of the Glaciofluvial Deposits can be estimated using Table 1 in BS 8002:2015 [Ref 35]. Based on a siliceous sand and gravel with fines content <15%, with rounded to well-rounded particles, which is evenly graded and dense, the ϕ' is 38°.

ϕ' can be derived for coarse grained materials using SPT N values, as demonstrated by Peck (1974) [Ref 44]. Using characteristic SPT N values, a conservative ϕ' of 38° is derived; and this is considered to be characteristic of the stratum as a whole.

5.3.5.4. Stiffness

Due to the inherent variability of the Glaciofluvial Deposits, characteristic stiffness parameters have been considered for both the fine grained and coarse grained components of the stratum. Geotechnical parameters for this stratum should be reviewed locally for each design element.

v_u and v' can be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. For the coarse grained Glaciofluvial Deposits, v' for a dense sand is 0.15-0.30. For the fine grained Glaciofluvial Deposits, based on a clay, v_u is 0.50 and v' is 0.10-0.30.

E_u and E' can be derived using correlations between SPT N values and lithological description in Bowles [Ref 40]. For the coarse grained horizons of the Glaciofluvial Deposits, E' can be derived using:

$$E' = 1200 (N + 6) \text{ kN/m}^2$$

For the characteristic SPT N range of 10-40 for the coarse grained materials, E' is calculated to be 19.2 to 55.2MN/m^2.

For the fine grained horizons of the Glaciofluvial Deposits, E_u can be derived using Bowles [Ref 40] using:

$$E_u = 300 (N + 6) \text{ kN/m}^2$$

For the characteristic SPT N value increase in depth of 5 + 5z for the fine grained materials, E_u is calculated to be 3.3 to 21.3kN/m^2.

E' can be derived for a fine grained material using correlation with v and E_u, as shown by Wroth (1972) [Ref 41]:

$$E' = 2/3 (1 + v) E_u$$

Using this correlation and the characteristic E_u and v values, E' is calculated to be 2.6 to 17.0MN/m^2.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for both E' and E_u based on typical lithological description. For the coarse grained horizons of the Glaciofluvial Deposits, E' (based on a dense sand) is typically 30-100MN/m^2. For the fine grained horizons, E_u (based on a firm to stiff clay) is typically 5-20MN/m^2 and E' (also based on a firm to stiff clay) is 3-15MN/m^2.

Considering the above derived ranges and values for characteristic stiffness parameters, the following is considered characteristic of the stratum:

- For coarse grained component of the Glaciofluvial Deposits, E' = 19.2 to 55.2MN/m^2 and v' = 0.25
- For fine grained component of the Glaciofluvial Deposits, E_u = 3.3 to 20.0MN/m^2, E' = 2.6-17.0MN/m^2, v_u = 0.50 and v' = 0.20.

5.3.5.5. Compressibility

Three consolidation tests in fine grained horizons of the Glaciofluvial Deposits were carried out during historical GIs; the results are plotted in Figure 5-5-8. The tests were undertaken at depths of 6.45, 10.4 and 12.8m bgl at a stress range of 100 to 3200kN/m^2.

Recorded m_v varied between 0.001 and 0.483m^2/MN (average 0.067m^2/MN) and c_v was 2.83 to 25.44m^2/yr (average 12.75m^2/yr). These tests were only undertaken within the fine grained materials. This range is indicative of stratum with very low to high compressibility, as determined by guidance in Tomlinson [Ref 42].

Correlation between m_v and SPT N values is presented in Stroud [Ref 38] based on the following equation:

$$m_v = 1 / (f_2 \times N)$$

The constant f_2 varies with plasticity index of the material. In accordance with Stroud [Ref 38] f_2 is approximately 0.55 for characteristic plasticity index of 18%. Therefore, the characteristic m_v of Glaciofluvial Deposits using the increase in SPT N value with depth is 0.03 to 0.36m^2/MN for fine grained materials.

Based on test results, a typical c_v of 12.75m^2/yr is characteristic of the fine grained materials of the Glaciofluvial Deposits.

5.3.5.6. Soil Chemistry

Glaciofluvial Deposits soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-10 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-10 below. 17 pH tests were undertaken, with results of 6.0-8.25; this result is used to derive DS and ACEC Classes below.

Table 5-10 – Glaciofluvial Deposits Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	1	10	DS-1	AC-2z
	Groundwater	SO4 mg/l	16	144-1462	DS-3	AC-3z
	Total potential sulphate	SO4 %	22	0.012-0.372	DS-2	AC-3z
pH		-	1	17	6.0-8.25	-

Based on these results, classifications of DS-3 and AC-3z for Glaciofluvial Deposits are derived. It may be the case that the chemistry of the Mercia Mudstone has influenced the aggressivity of Glaciofluvial Deposits.

5.3.6. Glacial Till (Oadby Member)

5.3.6.1. Description

Glacial deposits have been identified to occur at isolated locations within the scheme extents, mainly restricted to localised topographic highs and in valley bottoms, underlying more recent Alluvium and River Terrace Deposits.

They were generally described as firm to stiff brown sometimes grey silty or gravelly CLAY and encountered at depths that range from 0.20 to 13.10m bgl. Glacial Till thicknesses ranged from 0.15m to 10.60m (4.13m average).

5.3.6.2. Classification

Results from classification tests are presented in Table 5-11 below:

Table 5-11 – Glacial Till Atterberg Limit Test Results

	NMC (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Number of tests	52	17	17	31
Range	8-25	23-48	9-21	14-29
Average	15	36	16	20

NMC for Glacial Till results are variable, which is typical for glacial deposits, as shown in Figures 5-6-1 and 5-6-2.

The plasticity chart is presented in Figure 5-6-3, which shows a low to medium plasticity clay that is more consistent in classification than other superficial deposits encountered within the scheme extents. It is considered that the average plasticity index of 20% is characteristic of Glacial Till.

Five PSD tests were undertaken in the Glacial Till, as shown in Figure 5-6-4. The PSD curves show the materials to be both well-graded and highly variable with particle sizes including quantities of clay, silt, sand and gravel all recorded.

Bulk unit weight test results for Glacial Till are shown in Figure 5-6-5. These 3 tests gave results of 20.4, 20.7 and 21.5kN/m^3. There is no correlation for a well-graded material such as Glacial Till in BS 8002:2015 [Ref 35] but given the characteristic results a value of 21kN/m^3 is considered characteristic of Glacial Till.

5.3.6.3. Strength

Twelve SPT tests were carried out in Glacial Till; these are presented in Figure 5-6-6. The recorded N values ranged from 10 to 97, showed an increase with depth and had an average of 34. Typically, the plot shows an increase in N value with depth, following an approximate trend of (with z = depth from top of stratum)):

$$N = 5 + 7z$$

The c_u of Glacial Till has been calculated after the correlation in Stroud [Ref 38] using the relationship:

$$c_u = f_1 N$$

The constant f_1 varies with plasticity index of the material. f_1 for a characteristic plasticity index of 20% is approximately 5.0. The calculated c_u values based on the increase in N value range between 25 and 445kN/m^2.

One HSV test was undertaken within the Glacial Till, the result of which was 35kN/m^2. This test was undertaken at shallow depth (1.0m bgl) within locally softer material and therefore is not considered representative of the stratum as a whole.

Twenty six undrained triaxial tests were undertaken in the Glacial Till. The results ranged from 75 to 414kN/m^2 with an average of 253kN/m^2.

c_u values derived for Glacial Till are presented in Figure 5-6-7.

Based on the above values, an increase of c_u with depth is considered characteristic; however, due to the variability of Glacial Till, a review of c_u should be undertaken for each design element. Generally c_u ranges between 50 and 300kN/m^2.

For Glacial Till a c' of 0kN/m^2 is considered characteristic of the stratum given that no data relating to c' is currently available for Glacial Till.

From the plasticity index the ϕ' for Glacial Till has been estimated based on Table 2 in BS 8002:2015 [Ref 35]. The ϕ' obtained from this correlation ranges between 24° and 27° with 26° considered characteristic of this stratum.

5.3.6.4. Stiffness

v_u and v' can be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. A clay gives a v_u of 0.5 and a v' of 0.1-0.3, in accordance with this guidance. A v_u of 0.5 and a v' of 0.2 is therefore considered characteristic of Glacial Till.

E_u can be derived using correlations between SPT N values and lithological description in Bowles [Ref 40]. For a clayey or sandy silt, E_u = 300 (N + 6) kN/m^2. Based on the increase in N value with depth, E_u is calculated to be 3.3-5.4MN/m^2.

E' can be derived for a fine grained material using correlation with v and E_u, as shown by Wroth (1972) [Ref 41]:

$$E' = 2/3 (1 + v) E_u$$

Using this correlation and the characteristic E_u and v values, E' is 2.64 to 4.32MN/m^2.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for both E' and E_u based on typical lithological description. For a firm to stiff clay, E_u is 5-20MN/m^2 and E' is 3-15MN/m^2.

Based on these guidelines, it is anticipated that the above increases in E_u and E' with depth are characteristic of the Glacial Till.

5.3.6.5. Compressibility

One consolidation test of the Glacial Till was carried out during a historical GI; the results are plotted in Figure 5-6-8. The test was undertaken at a depth of 3.0m bgl at a stress range of 75 to 430kN/m^2. The test results were incomplete and therefore no m_v or c_v values were derived.

Correlation between m_v and SPT N values is presented in Stroud [Ref 38] based on the following equation:

$$m_v = 1 / (f_2 \times N)$$

The constant f_2 varies with plasticity index of the material. In accordance with Tomlinson [Ref 42] f_2 is approximately 0.55 for an average plasticity index of 20%. The characteristic m_v of Glacial Till is, based on the increase in SPT with depth, calculated to range between 0.02 and 0.36m^2/MN.

It is anticipated that the Glacial Till has mainly low to medium compressibility, although this can vary locally.

5.3.6.6. Soil Chemistry

Glacial Till soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-12 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-12 below. No pH tests were available for Glacial Till; however it is still possible to derived DS and ACEC classes based solely on sulphate testing.

Table 5-12 – Glacial Till Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	1	72	DS-1	AC-1s
	Groundwater	SO4 mg/l	0	-	-	-
	Total potential sulphate	SO4 %	0	-	-	-
pH		-	1	0	-	-

Based on these results, classifications of DS-1 and AC-1s for Glacial Till are derived; however this is based on a single test result on a highly variable stratum. It is considered, given the low aggressivity of the Glacial Till deposits that the concrete classification in areas where this material is present, will be determined by the classification of other bearing strata.

5.4. Solid Geology

5.4.1. General

The Mercia Mudstone Group is the bedrock encountered across the entire scheme extents, with varying degrees of weathering profile. The various geological members of the Sidmouth Mudstone Formation (of the Mercia Mudstone Group) recorded by the BGS to be present along the scheme extents are typically interbedded layers of mudstone, siltstone and sandstone, with mudstone becoming generally more prevalent towards the north of the site.

Mercia Mudstone underlies Superficial Deposits where they are present across the scheme extents, but also outcrops at ground level at some locations.

The Mercia Mudstone is subdivided into the following groups for the following sections of this GIR. These subdivisions are based on engineering significance rather than geological nomenclature for the purposes of the ground model.

- Mercia Mudstone – III/IV*;
- Mercia Mudstone – I/II*;
- Mercia Mudstone – Siltstone; and
- Mercia Mudstone – Sandstone.

* Roman numerals represent weathering Grade after CIRIA C570 [Ref 36] where IV represents partially or fully weathered, III and II represents partially weathered and I represents unweathered.

In general more highly weathered Mercia Mudstone was found closer to the ground level. However, there are large variations in the thickness of each of the weathering grades encountered and it should be noted that not every exploratory hole which encountered Mercia Mudstone encountered the full sequence of weathering

grades. Weathering to a variable depth and preferential weathering along joints is characteristic of the Mercia Mudstone, i.e. one borehole may penetrate from weathered to intact material and back again.

Given the variability of the weathering profile of the Mercia Mudstone Group along the scheme extents further assessment of the ground model and characteristic parameters should be undertaken on a location specific basis and be provided within the datasheets in the GDR.

5.4.2. Mercia Mudstone – III/IV

5.4.2.1. Description

Mercia Mudstone – III/IV was generally encountered as a firm to very stiff red brown locally mottled grey green slightly gravelly/slightly sandy to sandy Clay/Silt, sometimes with lithorelicts of mudstone and siltstone along with pockets of grey green sandy silt. In some boreholes the material was encountered as a very weak Mudstone, recovered as subangular and subrounded fine to coarse gravel sized fragments in a clay matrix. It was proved to a maximum thickness of 18.60m (4.59m average) and to a depth of up to 25.45m bgl. The historical exploratory hole that encountered this maximum thickness was 'HIS0022', located at chainage Ch191676.

5.4.2.2. Classification

Results from classification tests are presented in Table 5-13 below:

Table 5-13 – Mercia Mudstone – III/IV Atterberg Limit Test Results

	NMC (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Number of tests	253	158	159	157
Range	6-41	18-55	14-35	2-37
Average	18	34	20	14

NMC for Mercia Mudstone – III/IV is recorded as being extremely variable, as shown in Figures 5-7-1 and 5-7-2, with an average of 18% calculated. Guidance in Hobbs et al. [Ref 33] and CIRIA 181 [Ref 39] for weathered Mercia Mudstone gives a range of natural NMC of 12-40%, which correlates well with the recorded results.

The plasticity chart is presented in Figure 5-7-3, which shows a generally low to medium plasticity clay (some Mercia Mudstone – III samples plotted as high plasticity clay); with a plasticity index range of 8-37% and characteristic value of 14%. Some samples plotted were below the A-line and showed a low plasticity silt; these generally belonged to samples of Mercia Mudstone – IV. Guidance in Hobbs et al. [Ref 33] and CIRIA 181 [Ref 34] for weathered Mercia Mudstone gives a range of plasticity index of 10-35%. This stratum is locally variable and therefore parameters should be reviewed locally for each design location.

PSD tests carried out in Mercia Mudstone – III and IV samples are presented in Figure 5-7-4. Results generally indicated that particles are mostly silt-sized often accompanied by clay- and sand-sized particles.

Bulk unit weight tends to increase with depth, as shown in Figure 5-7-5. 8 tests were undertaken with results that ranged from 19.7 to 22.1kN/m^3 with a characteristic value of 21kN/m^3. BS 8002:2015 [Ref 35] has a suggested value for characteristic bulk density of high c_u clay above the groundwater table of between 18kN/m^3 and 22kN/m^3. A range for bulk unit weight for Mercia Mudstone – III/IV is given in CIRIA C570 [Ref 36] as 18-23kN/m^3. A characteristic unit weight of 21kN/m^3 is therefore considered suitable for Mercia Mudstone – III/IV.

5.4.2.3. Strength

Three hundred and twenty two SPT tests were carried out in Mercia Mudstone – III/IV; these are presented in Figure 5-7-6. The presence of intact mudstone in a weathered matrix leads to a wide scatter of results with N>150 results occurring at all depths; tests that met refusal have been extrapolated. A lower bound range of the results is characteristic of the stratum and it generally is in the range of 10-60 for 0-10m bgl, and 30-100 for >10m bgl.

The c_u of the Mercia Mudstone – III/IV has been calculated after the correlation in Stroud [Ref 38] using the relationship:

$$c_u = f_1 N$$

The constant f_1 varies with plasticity index of the material. According to the CIRIA document C570 [Ref 36] the widely used f_1 for Mercia Mudstone is a factor of 5.0. c_u values based on this are plotted for Mercia Mudstone – III/IV in Figure 5-7-7 and range between 35 and 1875kN/m^2.

Four HSV results were available for Mercia Mudstone – III/IV within the scheme extents, the results ranged from 49 to 104kN/m^2 with a characteristic value of 90kN/m^2. These in situ tests were undertaken at shallow depth and therefore are likely to represent more heavily weathered horizons of the Mercia Mudstone – III/IV.

A range of c_u for weathered Mercia Mudstone is given in CIRIA 181 [Ref 34] of 70-200kN/m^2.

One hundred and sixty six undrained triaxial tests were undertaken, recorded c_u values ranged from 21-696kN/m^2 with an average of 180kN/m^2; these upper bound results are considered to be erroneous.

Based on the above values for Mercia Mudstone – III/IV, a c_u range of 50 to 200kN/m^2 is considered characteristic for the stratum.

Correlation between stiffness of fine grained soils and a c_u of approximately 100kN/m^2 in Tomlinson [Ref 42] gives a classification of ‘firm to stiff’ for this stratum.

One shear box test was carried out in the Mercia Mudstone – III/IV, as shown in Figure 5-1-9. Results for the shear box test gave a ϕ' of 64.0° and a c’ of 11.0kN/m^2. c’ obtained from CIRIA C570 [Ref 36] is <20 for Mercia Mudstone – III/IV. These values are considered to be uncharacteristically high for the stratum as a whole and are therefore discounted. For Mercia Mudstone – III/IV a characteristic c’ of 2.0kN/m^2 is considered appropriate.

From the plasticity index the ϕ' for Mercia Mudstone – III/IV has been estimated based on Table 2 in BS 8002:2015 [Ref 35]. The ϕ' obtained has a value of 29°.

The ϕ' derived for Mercia Mudstone – III/IV in CIRIA C570 [Ref 36] was 25 to 33° for Mercia Mudstone – IV and 32 to 42° for Mercia Mudstone – III. A ϕ' of 30° for Mercia Mudstone – III/IV is therefore considered characteristic of the stratum.

5.4.2.4. Stiffness

v_u and v’ can be derived using guidance in CIRIA 103 [Ref 39] for typical lithological descriptions. A clay gives a v_u of 0.5 and a v’ of 0.1-0.3, in accordance with this guidance. A v_u of 0.5 and a v’ of 0.2 is characteristic of Mercia Mudstone – III/IV.

Eu can be derived using correlations between SPT N values and lithological description in Bowles [Ref 40]. For a clayey silt:

$$E_u = 300\ (N + 6)\ kN/m^2.$$

E_u is calculated to be 10.8MN/m^3 for 0-10m bgl and 16.8MN/m^3 for >10m bgl.

E' can be derived for a fine grained material using correlation with v and E_u, as shown by Wroth (1972) [Ref 41]:

$$E' = 2/3 (1 + v) E_u$$

Using this correlation and the characteristic E_u and v values, E' is calculated to be 8.6MN/m^2 for 0-10m bgl and 13.4MN/m^2 for >10m bgl.

Guidance in CIRIA 103 [Ref 39] gives a generalised range for both E' and E_u based on typical lithological description. For a firm to stiff clay, E_u is 5-20MN/m^2 and E' is 3-15MN/m^2.

It is anticipated that an E_u of 10.8MN/m^2 for 0-10m bgl and 16.8MN/m^2 for >10m bgl are characteristic with E' values of 8.6MN/m^2 for 0-10m bgl and 13.4MN/m^2 for >10m bgl.

5.4.2.5. Compressibility

Thirteen consolidation tests of the Mercia Mudstone – III/IV were carried out during historical GIs; the results are plotted in Figure 5-7-8. The tests were undertaken at depths of 1.50 to 8.80m bgl at stress ranges of 25 to 1600kN/m^2. Recorded m_v values ranged from 0.008 to 0.310m^2/MN (average 0.082m^2/MN) and c_v ranged from 0.62 to 44.23m^2/yr (average 15.89m^2/yr). This range is indicative of stratum with very low to high compressibility, as determined by guidance in Tomlinson [Ref 42].

Correlation between m_v and SPT N values is presented in Stroud [Ref 38] based on the following equation:

$$m_v = 1 / (f_2 \times N)$$

The constant f_2 varies with plasticity index of the material. In accordance with Stroud [Ref 38] f_2 is approximately 0.55 for a characteristic plasticity index of 14%. m_v is calculated to be 0.060m^2/MN for 0-10m bgl and 0.036m^2/MN for >10m bgl.

On the basis of the available data it is considered that 0.06m^2/MN for 0-10m bgl and 0.04m^2/MN are characteristic mv values for Mercia Mudstone – III/IV. These values correlate as a stratum with very low compressibility (Tomlinson [Ref 42]).

5.4.2.6. Soil Chemistry

Mercia Mudstone – III/IV soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-14 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-14 below. 22 pH tests were undertaken, with results of 6.7-8.3; this result is used to derive DS and ACEC Classes below.

Table 5-14 – Mercia Mudstone – III/IV Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	15	12-84	DS-1	AC-1
	Groundwater	SO4 mg/l	20	0.12-924	DS-2	AC-2
	Total potential sulphate	SO4 %	100	0.008-0.348	DS-2	AC-1
pH		-	1	22	6.7-8.3	-

Based on these results, classifications of DS-2 and AC-2 for Mercia Mudstone – III/IV are derived. However, it is possible that higher classifications will be required as it is noted in BRE Special Digest 1 [Ref 43] that Mercia Mudstone is a stratum likely to have high sulphate concentrations. It is recommended that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.4.3. Mercia Mudstone – I/II

5.4.3.1. Description

Mercia Mudstone – I/II was described as a moderately to highly weathered mudstone. Highly weathered materials were recovered as coarse subangular and subrounded gravel sized fragments of very weak red brown and grey green mottled mudstone. Unweathered materials were described as moderately weak and weak red brown mudstone with closely to widely spaced very thin and thin beds of moderately strong light grey green siltstone and fine grained sandstone.

Mercia Mudstone – I/II was usually encountered below Mercia Mudstone – III/IV or at shallower depths in some cuttings. These deposits were proved to a maximum thickness of 20.10m (5.15m average) and to a depth of up to 30.55m bgl.

5.4.3.2. Classification

One hundred and one NMC tests were available in the historical GI data for Mercia Mudstone – I/II; these are shown in Figures 5-8-1 and 5-8-2, with a range of 6-24% and an average of 13%. Guidance in CIRIA C570 [Ref 36] and C181 [Ref 34] for Mercia Mudstone – I/II gives a range for natural NMC of 5-15%.

One No bulk unit weight test was undertaken within Mercia Mudstone – I/II within the scheme extents and gave a result of 20kN/m^3. A range for bulk unit weight for Mercia Mudstone – I/II is given in CIRIA C570 [Ref 36] as 22-24.5kN/m^3. Guidance in Hobbs et al. [Ref 33] for unweathered Mercia Mudstone also gives a typical value for bulk density of 24.8kN/m^3. A typical bulk unit weight of 22kN/m^3 is therefore considered characteristic for Mercia Mudstone – I/II.

5.4.3.3. Strength

Unconfined Compressive Strength (UCS) tests and point load tests were carried out on rock samples in historical GIs within the scheme extents for Mercia Mudstone – I/II; these test results can be used to determine characteristic strength parameters for intact rock. Results for UCS and point load index are plotted in Figures 5-8-10 and 5-8-11 respectively for Mercia Mudstone – I/II.

Three UCS tests were carried out at depths of 15.56 to 21.48m bgl and gave a UCS values of 1.90 to 3.54MN/m^2.

Twenty six point load tests were undertaken at depths of 4.40 to 25m bgl and gave corrected point load indices that ranged from 0.17 to 1.05MN/m^2. Using published BGS correlation data for Mercia Mudstone from Hobbs et. al [Ref 33] the point load test results have been converted to a UCS result using the correlation factor of 15.7. Using this correlation, the point load index results give a range of UCS values of 2.67 to 16.49MN/m^2 with an average of 5.64MN/m^2. Point load test results are lower than anticipated for the Mercia Mudstone, this may be because of the presence of localised bedding planes.

It is considered that a UCS of 4.0MN/m^2 is characteristic of Mercia Mudstone I/II encountered within the scheme extents. This typical value of UCS correlates to a weak rock strength, in accordance with BS 5930:2015 [Ref 35] and is therefore considered appropriate.

5.4.3.4. Stiffness

Within Hobbs et al. [Ref 33] Mercia Mudstone – I/II has a typical E of 250MN/m^2 and a range of 100-1200MN/m^2 and a characteristic value for E of 250MN/m^2 is therefore considered characteristic for the Mercia Mudstone – I/II.

Generalised values of v for different soil/rock types are given in Tomlinson [Ref 42]. For rocks a v of 0.20 is considered suitable.

5.4.3.5. Soil Chemistry

Mercia Mudstone – I/II soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-15 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-15 below. 3 pH tests were undertaken, with results of 7.0-7.6; this result is used to derive DS and ACEC Classes below.

Table 5-15 – Mercia Mudstone – I/II Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	2	12-60	DS-1	AC-1
	Groundwater	SO4 mg/l	3	0.12-1356	DS-2	AC-2
	Total potential sulphate	SO4 %	9	0.003-0.024	DS-1	AC-1
pH		-	1	3	7.0-7.6	-

Based on these results, classifications of DS-2 and AC-2 for Mercia Mudstone – I/II are derived. It noted in BRE Special Digest 1 [Ref 43] that only the weathered zone (generally the upper 2-10m) of the Mercia Mudstone is likely to have a significant quantity of sulphates present; therefore high levels of sulphates may not be present in the Mercia Mudstone – I/II. It is recommended that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.4.4. Mercia Mudstone – Siltstone

5.4.4.1. Description

Intact siltstone rock bands were encountered throughout the Mercia Mudstone, with a maximum recorded thicknesses of 24.70m (5.13m average) and at a maximum depth of 26.10m bgl. Intact siltstone rock bands were typically recovered as slightly to moderately weathered laminated to thinly bedded brown grey weak to moderately weak SILTSTONE. Siltstone of the Mercia Mudstone Group was generally encountered below Mercia Mudstone – III/IV or at shallower depths in some cuttings.

5.4.4.2. Classification

Twenty two NMC test results were available for Mercia Mudstone – Siltstone, these are plotted in Figures 5-8-1 and 5-8-2 and do not show any distinguishable change with depth. The results range from 8-34% and have an average of 15%. This correlates with the range of NMC for unweathered Mercia Mudstone given in Hobbs et al. [Ref 33] and CIRIA 181 [Ref 34] which is 5-15%.

No bulk unit weight tests were undertaken within Mercia Mudstone – Siltstone within the scheme extents. A range for bulk unit weight for Mercia Mudstone – I/II (mudstone and siltstone not differentiated) is given in

CIRIA C570 [Ref 36] as 22-24.5kN/m^3. A characteristic bulk unit weight of 22kN/m^3 is therefore considered appropriate for Mercia Mudstone – Siltstone.

5.4.4.3. Strength

UCS tests and point load tests were carried out on rock samples in historical GIs within the scheme extents for Mercia Mudstone – Siltstone; these test results can be used to determine characteristic strength parameters for intact rock. Results for UCS and point load index are plotted in Figures 5-8-10 and 5-8-11 respectively for Mercia Mudstone – Siltstone.

Seventy two UCS tests were carried out at depths of 3.97 to 19.62m bgl and gave a UCS of 0.24 to 168MN/m^2 with an average of 9.39MN/m^2 and most results plotting between 1 and 5MN/m^2.

Seventy five point load tests were undertaken at depths of 3.97 to 19.62m bgl and gave corrected point load indices that ranged from 0.01 to 7.00MN/m^2. Hobbs et. al [Ref 33] suggest a correlation factor of 15.7 for converting point load test to UCS values. Using this correlation, the point load index results give a range of UCS values of 0.16 to 109.90MN/m^2 and an average of 6.05MN/m^2.

It is considered that a UCS of 5.0MN/m^2 is characteristic of Mercia Mudstone – Siltstone encountered within the scheme extents. This typical value of UCS correlates to a weak rock strength, in accordance with BS 5930:2015 [Ref 35] and is therefore considered appropriate.

5.4.4.4. Stiffness

Typical engineering properties of Mercia Mudstone are published in Hobbs et al. [Ref 33] and CIRIA C181 [Ref 34]. Within Hobbs et al. [Ref 33] unweathered Mercia Mudstone has a typical E of 250MN/m^2 and a range of 100-1200MN/m^2 and CIRIA C181 [Ref 34] has a E of 2830MN/m^2 for unweathered Mercia Mudstone.

E can be derived for intact rock mass using the following correlation from Tomlinson [Ref 42], where j is average joint spacing (assumed 0.1) and M_r is modulus ratio (150 assumed for a cemented siltstone as a conservative assumption):

$$E = j \times M_r \times UCS \text{ MN/m}^2$$

Based on this correlation, an E of 75MN/m^2 is estimated for siltstone.

E ranges from 75 to 2830MN/m^2 for Mercia Mudstone – I/II.

Generalised values of v for different soil/rock types are given in Tomlinson [Ref 42]. For rocks a v of 0.20 is considered suitable.

5.4.4.5. Soil Chemistry

Mercia Mudstone – Siltstone soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-16 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-16 below. No pH tests were available for Mercia Mudstone – Siltstone; however it is still possible to derived DS and ACEC classes based solely on sulphate testing.

Table 5-16 – Mercia Mudstone – Siltstone Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	1	12	DS-1	AC-1s
	Groundwater	SO4 mg/l	0	-	-	-
	Total potential sulphate	SO4 %	0	-	-	-
pH		-	1	0	-	-

Based on these results, classifications of DS-1 and AC-1s for Mercia Mudstone – Siltstone are derived; however this is based on a single test result and therefore does not account for any variability within the stratum. It is recommended that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.4.5. Mercia Mudstone – Sandstone

5.4.5.1. Description

Intact sandstone rock bands were encountered occasionally within the Mercia Mudstone, with a maximum recorded thicknesses of 16.00m (3.79m average) and at a maximum depth of 25.93m bgl. Intact sandstone rock bands were typically recovered as moderately weathered laminated to thinly bedded grey green weak to moderately strong SANDSTONE. Sandstone of the Mercia Mudstone Group was generally encountered below Mercia Mudstone – III/IV or at shallower depths in some cuttings.

5.4.5.2. Classification

Seven NMC tests were available for Mercia Mudstone – Sandstone, of which when plotted generally do not show any distinguishable change with depth, as shown in Figures 5-8-1 and 5-8-2, with a range of 13-21% and an average of 17%.

No bulk unit weight tests were undertaken within Mercia Mudstone – Sandstone within the scheme extents. The characteristic value for bulk unit weight for these materials based on generalised published literature for sandstones is considered to be 21kN/m^3.

5.4.5.3. Strength

UCS tests and point load tests were carried out on rock samples in historical GIs within the scheme extents for Mercia Mudstone – Sandstone; these test results can be used to determine characteristic strength parameters for intact rock. Results for UCS and point load index are plotted in Figures 5-8-10 and 5-8-11 respectively for Mercia Mudstone – Sandstone.

Four UCS tests were carried out at depths of 5.10 to 20.47m bgl and gave a UCS of 3.40 to 16.71MN/m^2 with an average of 10.27MN/m^2.

Twelve point load tests were undertaken at depths of 5.10 to 25.00m bgl and gave corrected point load indices that ranged from 0.30 to 0.83MN/m^2. Using published correlation data for sandstone from Bieniawski [Ref 45], point load test results have been converted to a UCS result using the correlation factor of 23.9. Using this correlation, the point load index results give a range of UCS values of 7.21 to 19.81MN/m^2 and an average of 11.92MN/m^2.

It is considered that a UCS of 10MN/m^2 is characteristic of Mercia Mudstone – Sandstone. This typical value of UCS correlates to a weak rock strength, in accordance with BS 5930:2015 [Ref 35].

5.4.5.4. Stiffness

E can be derived for intact rock mass using the following correlation from Tomlinson [Ref 42], where j is average joint spacing (assumed 0.1) and M_r is modulus ratio (150 for a poorly cemented sandstone as a conservative assumption):

$$E = j \times M_r \times UCS\ MN/m^2$$

Based on this correlation, an E of 180MN/m^2 is estimated for sandstone.

Generalised values of v for different soil/rock types are given in Tomlinson [Ref 42]. For rocks a v of 0.20 is considered suitable.

5.4.5.5. Soil Chemistry

Mercia Mudstone – Sandstone soil and groundwater samples were historically tested for pH and sulphate. Results for these tests are summarised in Table 5-17 below. The assessment of the aggressivity of ground conditions is carried out in accordance with BRE Special Digest 1 [Ref 43]. DS and ACEC classification for brownfield locations with mobile water is given based on the chemical testing results worst-case scenario in Table 5-17 below. 3 pH tests were undertaken, with results of 7.2-7.5; this result is used to derive DS and ACEC Classes below.

Table 5-17 – Mercia Mudstone – Sandstone Chemical Testing Summary

Determinand	Test Type	Units	Number of Tests	Results	DS Class	ACEC Class
Sulphate	2:1 water/soil extract	SO4 mg/l	0	-	-	-
	Groundwater	SO4 mg/l	3	264-1644	DS-3	AC-3
	Total potential sulphate	SO4 %	0	-	-	-
pH		-	1	3	7.2-7.5	-

Based on these results, classifications of DS-3 and AC-3 for Mercia Mudstone – Sandstone are derived. Given the limited quantitiy of testing it is recommended that chemical testing is undertaken at locations where proposed new concrete-based structures are to be constructed as ground conditions will vary on a local scale.

5.5. Groundwater

Water strikes recorded during historical exploratory are presented in Table 5-18 below:

Table 5-18 – Historical Water Strikes Summary

Borehole	Stratum	Water Strike (m bgl)	Time Elapsed	Water Level (m bgl)
SK42NE426	Embankment Fill	1.20	20mins	1.05
SK42NE395		1.40	20mins	1.28
SK42NE382		3.85	Not recorded	4.00
SK42NE399		4.50	20mins	4.48
SK42NE396		6.80	20mins	6.50
SK42SE19	Alluvium	1.98	20mins	1.52
SK43SE14	River Terrace Deposits	0.91	1week	0.91
SK43SE9		1.22	15hours	0.61

Borehole	Stratum	Water Strike (m bgl)	Time Elapsed	Water Level (m bgl)
SK43SE12		1.37	6days	0.46
SK43SE13		1.52	5days	0.01
SK43SE15		1.98	4.5hrs	1.60
SK42NE390		2.00	20mins	1.73
SK42NE383		2.60	20mins	2.05
SK43SE25		2.74	1day	1.52
SK42NE73		3.50	20mins	1.70
SK43SE17		3.96	14hrs	0.76
SK42NE137		4.00	20mins	3.65
SK42NE397		4.40	20mins	4.10
SK42NE76		5.40	20mins	4.90
SK42NE382		9.45	Not recorded	11.00
HIS0026	Head Deposits	1.52	Not recorded	1.22
HIS0023		1.98	Not recorded	1.52
SK42NE13	Glaciofluvial Deposits	1.37	20mins	0.91
SK42NE384		1.50	20mins	1.40
HIS0015		1.52	Not recorded	1.22
SK43SE16		1.52	20mins	1.52
SK43SE18		1.52	4days	0.69
SK43SE8		1.52	3days	0.30
SK43SE284		1.70	Not recorded	1.70
SK43SE86		1.70	20mins	1.40
HIS0014		1.83	Not recorded	1.83
HIS0018		1.83	Not recorded	1.22
SK43SE26		1.83	20mins	1.37
HIS0013		1.91	Not recorded	2.44
SK43SE21		2.13	2days	0.61
SK42NE389		2.40	20mins	1.70
SK43SE22		2.44	38hrs	0.76
SK43SE20		2.44	22hrs	1.07
SK42NE12		2.74	20mins	2.74
HIS0017		3.05	Not recorded	1.22
HIS0025		3.05	Not recorded	2.13
SK42NE11		3.05	20mins	3.05
SK42NE419*		3.20	20mins	2.60
HIS0001		3.35	Not recorded	1.83
SK42NE387		3.60	20mins	3.40
SK42NE385		4.50	20mins	4.38
CP1111		4.60	20mins	3.10
SK42NE402		9.50	10mins	9.10

Borehole	Stratum	Water Strike (m bgl)	Time Elapsed	Water Level (m bgl)
HIS0036	Mercia Mudstone – III/IV	1.83	Not recorded	0.00
HIS0027		2.74	Not recorded	0.30
SK42NE61		3.00	20mins	2.00
SK42NE5		3.05	20mins	2.29
SK42SE20		3.20	20mins	1.68
HIS0032		3.51	Not recorded	2.13
SK42NE74		3.80	20mins	3.80
HIS0030		3.81	Not recorded	2.44
SK42NE55		3.85	20mins	3.80
SK42NE10		3.96	20mins	3.96
SK42SE14		4.27	20mins	3.20
SK42SE23		4.27	20mins	4.27
HIS0039		4.42	Not recorded	3.35
SK42NE4		4.42	20mins	2.29
SK43SE16		4.52	46hrs	1.14
HIS0035		4.57	Not recorded	3.05
SK42NE3		4.57	20mins	4.57
SK42SE18		4.57	20mins	4.57
SK42NE6		4.57	20mins	4.57
SK42NE7		4.57	20mins	4.57
SK42NE56		5.25	20mins	3.25
SK42SE90		5.30	20mins	3.60
HIS0006		6.40	Not recorded	1.68
SK43SE88		7.75	20mins	1.00
RC1064	Mercia Mudstone I/II	8.00	20mins	7.41

Shallow perched groundwater is occasionally present within Embankment Fill and Superficial Deposits. Few identifiable groundwater strikes are recorded across the scheme extents, suggesting that shallow groundwater conditions are not a prevalent feature of the site. It is considered that the main water table is found at depth within the Mercia Mudstone, with localised perched water being present at various shallower depths. Groundwater conditions should be assessed on a location specific basis.

5.6. Summary of Characteristic Geotechnical Parameters

The characteristic material properties and geotechnical parameters given in Table 5-19 and 5-20 below are summarised from the preceding Sections 5.2 to 5.4. It is advised that Table 5-19 and 5-20 are read in conjunction with the rest of the report, and is not used in isolation. For design, a re-assessment of characteristic parameters for particular locations is necessary, taking into account data from proximal GI. Re-assessment of characteristic parameters for particular locations will be included in updated datasheets as part of Design Fix 4 for proposed structure locations in the scheme.

Table 5-19 – Characteristic Material Properties Summary

Stratum	γ (kN/m^3)	NMC (%)	LL (%)	PL (%)	PI (%)	SPT N
Embankment Fill	21	2-31 (15)	21-49 (33)	10-28 (16)	8-31 (17)	10-40 (15-20)
Alluvium	20	8-49 (23)	34-62 (51)	15-37 (27)	19-32 (20)	28-36* (32)
River Terrace Deposits	20	4-14 (10)	-	-	-	10-50 (30)
Head Deposits	20	8-24 (16)	26-57 (41)	13-25 (17)	12-32 (23)	10-23 (20)
Glaciofluvial Deposits (fine grained materials)	21	2-39 (13)	20-65 (36)	11-33 (19)	5-32 (17)	5+5z
Glaciofluvial Deposits (coarse grained materials)			-	-	-	10-40
Glacial Till	21	8-25 (15)	23-48 (36)	9-21 (16)	14-29 (20)	5+7z
Mercia Mudstone – III/IV	21	6-41 (18)	18-55 (34)	14-35 (20)	2-37 (14)	30 (0-10m bgl) 50 (>10m bgl)
Mercia Mudstone – I/II	22	6-24 (13)	-	-	-	-
Mercia Mudstone – Siltstone	22	8-34 (15)	-	-	-	-
Mercia Mudstone – Sandstone	21	13-21 (17)	-	-	-	-

Notes
1. Typical ranges are given with characteristic values in brackets.
2. z = metres below top of stratum.
3. * = Refer to text. Considered uncharacteristic of Alluvum.
4. This table is to be read in conjunction with the report text and should not be used in isolation.
5. Characteristic properties should be re-assessed on a site-specific basis for datasheets at proposed structure locations.
6. γ = bulk density; PI = plasticity index; SPT = Standard Penetration Test.
7. Some strata had limited data available, in particular Alluvium, Head Deposits and unweathered Mercia Mudstone.

Table 5-20 – Characteristic Geotechnical Parameters Summary

Stratum	c_u (kN/m^2)	c' (kN/m^2)	ϕ' (°)	m_v (m^2/MN)	c_v (m^2/yr)	E_u (MN/m^2)	E' (MN/m^2)	E	v_u	v'	v	UCS (MN/m^2)	BRE Class
Embankment Fill	30-240 (100)	0	25-42 (27)	0.01-0.25 (0.08)	3.6-22.0 (10.7)	10-20 (7.8)	5-15 (6.2)	-	0.50	0.10-0.30 (0.20)	-	-	DS-2 AC-2
Alluvium	22-180 (30-50)	0	24-26 (25)	0.16-2.15	*	2.0-6.0 (4.0)	1.0-4.0 (3.0)	-	0.50	0.10-0.30 (0.20)	-	-	DS-1 AC-1s
River Terrace Deposits	-	-	28-44 (38)	-	-	-	30-100 (43)	-	-	0.30-0.40 (0.35)	-	-	DS-3 AC-3
Head Deposits	50-121 (100)	0	24-28 (27)	0.09-0.20 (0.10)	*	4.8-20.0 (7.8)	3-15 (6.2)	-	0.50	0.10-0.30 (0.20)	-	-	DS-1 AC-1
Glaciofluvial Deposits (fine grained materials)	28-355	0	24-27 (26)	0.03-0.36	2.8-25.4 (12.8)	3.3-20.0	2.6-15.0	-	0.50	0.10-0.30 (0.20)	-	-	DS-3 AC-3
Glaciofluvial Deposits (coarse grained materials)	-	-	38	-	-	-	19.2-55.2	-	-	0.15-0.30 (0.25)	-		
Glacial Till	50-300	0	24-27 (26)	0.02-0.36	*	3.3-5.4	2.6-4.3	-	0.50	0.10-0.30 (0.20)	-	-	DC-1 AC-1s
Mercia Mudstone – III/IV (0-10m bgl)	50-200	2	25-42 (30)	0.01-0.31 (0.06)	0.62-44.23 (15.9)	5-20 (10.8)	3-15 (8.6)	-	0.50	0.10-0.30 (0.20)	-	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)				0.01-0.31 (0.04)		5-20 (16.8)	3-15 (13.4)	-			-		
Mercia Mudstone – I/II	-	-	-	-	-	-	-	100-2830 (250)	-	-	0.20	1.9-16.5 (4.0)	DS-2 AC-2
Mercia Mudstone – Siltstone	-	-	-	-	-	-	-	75-2830 (75)	-	-	0.20	0.16-109.9 (5.0)	DS-1 AC-1s

Stratum	c_u (kN/m^2)	c' (kN/m^2)	ϕ' (°)	m_v (m^2/MN)	c_v (m^2/yr)	E_u (MN/m^2)	E' (MN/m^2)	E	v_u	v'	v	UCS (MN/m^2)	BRE Class
Mercia Mudstone – Sandstone	-	-	-	-	-	-	-	180	-	-	0.20	3.40-19.81 (10.0)	DS-3 AC-3

Notes
1. Typical ranges are given with characteristic values in brackets.
2. * = No historical consolidation test data was available for this stratum.
3. z = metres below top of stratum.
4. This table is to be read in conjunction with the report text and should not be used in isolation. The above characteristic parameters are an interpretation of the findings from historical GI data (where data was available) for the scheme extents.
5. Characteristic parameters should be re-assessed on a site-specific basis for datasheets at proposed structure locations.
6. c_u = undrained shear strength; c' = drained cohesion; ϕ' = drained angle of friction; m_v = coefficient of compressibility; c_v = coefficient of consolidation; E_u = undrained Young's modulus; E' = drained Young's modulus; v_u = undrained Poisson's ratio; v' = drained Poisson's ratio; UCS = unconfined compressive strength; and BRE Class = derived from BRE SD1 [Ref 43].

6. Geotechnical Risk Register

A review of the geotechnical and environmental risks associated with the proposed works has been undertaken. The risks have been evaluated using a risk evaluation matrix as presented below in Table 6-1. Reference has been made to Part 3 of HD 41/15 'Maintenance of Highway Geotechnical Assets' [Ref 11] as part of the risk assessment process.

Table 6-1 – Risk Rating Criteria

Likelihood (L)		Severity (S)			=	Risk (R)					
% Likelihood							Likelihood				
		Time, Cost, SHE, Reputation					1	2	3	4	5
Almost Certain	5	Negligible Impact	1	E.g. Programme, budget, commercial sensitivity, SHE risks and reputation	Severity	5	5	10	15	20	25
Probable	4	Client and Contract strained	2			4	4	8	12	16	20
Possible	3	Client dissatisfaction and damage to Amey relationships	3			3	3	6	9	12	15
Unlikely	2	Threat to future schemes and Client/business relationships	4			2	2	4	6	8	10
Negligible	1	Threat to contract credibility	5			1	1	2	3	4	5

Risk Ratings

1 to 5 Green Risk is negligible or of otherwise low severity (green) and shall be set aside for further consideration.

5 to 12 Amber Risk is unacceptable (red or amber) and shall be subject to further analysis and evaluation.

12 to 25 Red Risk is unacceptable (red or amber) and shall be subject to further analysis and evaluation.

The risk register, detailed below in Table 6-2, lists the anticipated geotechnical and environmental hazards associated with the works and the potential consequences of those hazards. The risk before control of the hazard has been assessed quantitatively as has the anticipated risk following the proposed response to each hazard.

Table 6-2 – Geotechnical Risk Register

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
A – Slopes and Earthworks									
A1	Existing steep slopes on or adjacent to scheme leading to slope failure	Instability, surface deformation, structural damage	3	4	12	Undertake preliminary earthworks inspection and monitoring. Ensure construction design includes specification and implementation of stabilisation methods where required.	1	4	4
A2	Gradient on site – insufficient land available for widening – retaining walls or earthworks required	Increased cost of scheme, impact on structure layout	4	4	16	Review structure locations and land required. Design of suitable retaining structures where space is limited.	2	4	8
A3	Cut material generated unsuitable as fill or insufficient in volume – imported fill required, removal of material off-site required	Increased cost of scheme	3	4	12	If insufficient existing information, then undertake GI at required structure locations to determine ground conditions and suitability of soils for re-use. Design retaining structures to minimise requirement for imported materials.	2	4	8
A4	Slope instability instigated by temporary works and loading the crest of existing highway embankments.	Damage to structures, highway, infrastructure and adjoining properties.	3	4	12	Assess stability of all slopes likely to be affected by the works and design the structures accordingly.	1	4	4

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
A5	Areas of previous minor instability within embankments identified in HAGDMS [Ref 7] records.	Re-activation of previous instability due to disturbance of adjacent ground during construction or loading crest of embankments. Damage to structures, highway, infrastructure and adjoining properties.	3	4	12	Existing available reports pertaining to previous areas of instability will be reviewed. A walkover assessment/inspection has been undertaken of the defects.	2	4	8
B – Foundations and Substructures									
B1	Loose or compressible soils at shallow depth – unstable ground unsuitable for shallow foundations	Instability of excavations. Excessive settlements/bearing capacity failure. Requirement for deep foundations. Increased cost of scheme	3	4	12	Undertake 'Just in time' GI and laboratory testing at required structure location if insufficient data currently available. Design appropriate foundation solutions for ground conditions present.	3	1	3
B2	Hard ground at shallow depth – difficulty in achieving adequate depth for foundation construction	Requirement for heavy duty machinery to excavate shallow bedrock to enable foundation construction. Potential requirement for re-design during construction	4	3	12	Undertake 'Just in time' GI and laboratory testing to determine ground conditions if insufficient data currently available. Design appropriate foundation solutions for ground conditions present.	2	3	6
B3	Adjacent Structures – works affecting existing foundations, services, off-site structures	Damage to existing foundations. Damage to services and endangering road users. Damage to adjacent structures. Increased cost of scheme	3	5	15	Investigate locations of existing foundations and re-use if possible. Locate all services prior to commencement of works. Design to avoid impact on existing foundations, services and adjacent structures.	2	5	10

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
B4	Aggressive ground chemistry – attack on buried concrete leading to reduced strength of foundations	Failure of foundations, damage to structures. Risk to road users. Increased cost to scheme to repair/replace	4	3	12	Undertake additional chemical testing in accordance with BRE-SD1 [Ref 43] during 'just in time' GI if insufficient data is available to provide concrete classification. Use appropriate concrete design in construction.	2	3	6
B5	Orientations of discontinuities/joints/faults etc. in bedrock not favourable to shallow foundation design and temporary works slopes.	Stability of temporary works compromised. Founding stratum failure or deformation in excess of structure serviceability limits resulting in structure/infrastructure damage. Disruption to construction owing to unforeseen ground conditions. Delays to programme and increased costs.	4	4	16	A site specific 'just in time' ground investigation will be undertaken at key sites to determine rock mass characteristics if required.	2	4	12
C – Pavement Construction									
C1	Soft and compressible near surface soil – Low CBR due to soft formation. Settlement of buried services infrastructure	Pavement deformation. Damage to services. Increased cost to repair	3	3	9	Ensure CBR testing undertaken, if required, as part of any additional GI works. Design pavement accordingly. Consider alternative solutions/routes for services.	2	3	6
C2	Hard ground at shallow depth – difficulty in excavation of service trenches	Requirement for heavy duty machinery to excavate service trenches. Increase cost to scheme	3	3	9	Consider alternative solution/routes for services.	2	3	6
C3	Frost susceptible soils resulting in frost heave	Pavement deformation / damage to buried services	3	2	6	Undertake design appropriate to ground conditions present.	2	2	4

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
D – Drainage and Flooding									
D1	Shallow groundwater	Dewatering required during construction. Risks to foundations due to uplift	3	3	9	Inspections of slopes for seepages to be carried out during investigation/walkover visit. Undertake appropriate design based on groundwater conditions present.	2	3	6
D2	Low ground and local watercourses resulting in localised flooding	Requirement for flood protection. Increased cost to development	3	4	12	Establish locations of watercourses adjacent to the site and determine local groundwater regime. Undertake appropriate design based on surface water conditions. Undertake slope design considering flood conditions.	2	4	8
D3	Low permeability strata leading to ineffective soakaway	Alternative drainage design required	4	2	8	Design drainage according to ground conditions encountered.	2	2	4
D4	Motorway crosses major river or watercourse and/or aquifer	Pollution of major river or watercourse or aquifer during works	3	4	12	AMAR Landscape and Environment completed Environment Study Report [Ref 26]. Pertinent surface water courses identified and contingency measures to be specified by the Environment team.	1	4	4
D5	Reduction in floodplain area due to earthwork widening	Earthwork changes have the potential of affecting the hydraulic characteristics within the floodplain associated with the River Trent and its tributaries. Flood plain compensation may be required. Increased cost and programme for liaison with EA.	4	4	16	Earthwork changes to be assessed in comparison to known flood levels and alternative solutions shall be considered. Early liaison with EA to determine if compensation areas are required.	2	4	8

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
D6	Locations within areas of high flooding risk.	Flooding of sites affecting temporary works. Disruption to construction owing to flood events. Delays to programme and increased costs.	4	3	12	Contractor to be aware of weather conditions and Environment Agency adverse weather warnings. Contractor to plan temporary works to avoid working in adverse weather conditions. Contractor to plan emergency procedures for flooding events. Residual risks for management by the contractor and site staff to be notified via Designer's Risk Assessment.	2	3	6
D7	High groundwater vulnerability.	Contamination of aquifer and water supply during construction and during operational life of the road.	3	4	12	High groundwater vulnerability areas were researched it was found that the scheme extents are not within a GSPZ.	1	1	1
D8	Proximity to surface water features (watercourses and water pools)	Falls in the water, risk of drowning/injury/death to site workers.	4	5	20	Contractor to design works area to restrict access of site staff to watercourses. Emergency procedures in place for falls in water. Residual risks for management by the contractor and site staff to be notified via Designers Risk Assessment.	2	5	10
E – Mining/Underground Voids									
E1	Solution features/natural cavities leading to unstable ground	Surface deformation, damage to structures. Risk to road users. Repairs required leading to increased cost to development. Reviewed as part of GIR and considered to be low risk.	1	4	4	Undertake GI to determine ground conditions where information is absent.	1	4	4

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
E2	Collapse of mine shafts/abandoned mine workings	Surface deformation, damage to structures. Risk to road users. Repairs required leading to increased cost to development. Reviewed as part of GIR and considered to be low risk.	1	4	4	Research into the local area has been undertaken and it was concluded that mine workings are not considered to be a significant risk.	1	4	4
F – Temporary Works/Construction Issues									
F1	Buried Services encountered during excavations	Health and safety risk – harm to workers/road users. Suspension of road signage. Increased cost to repair	3	5	15	Obtain all services plans for the route and ensure all services are identified and marked out prior to commencement of any intrusive site works. Inspection pits to be dug before commencement of any exploratory holes.	2	5	10
F2	Contaminated Ground	Health and safety risk to site workers/road users. Increased cost to dispose of material off site. Delay and increase in cost to development	3	4	12	Undertake contaminated land risk assessment and waste acceptance assessment as part of the geotechnical design.	2	4	8
F3	Environmental Noise Barrier	Constraints shown in the Environmental Study Report [Ref 26] that could limit the feasibility of new barriers. Lack of available verge width for new barriers resulting in verge build out and embankment widening. Cost and programme implications.	3	4	12	Obtain the extended environmental study and identified areas of constraints to modify the design. Obtain required barrier locations at early stage and assess requirements for embankment widening.	2	4	8

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
G – Insufficient Geotechnical Data									
G1	Insufficient GI and/or laboratory testing for design (notably at Wilne Lane turnaround and Sawley rail underbridge)	Stratigraphy and materials not as expected. Unforeseen ground conditions. Inappropriate design solutions. Re-design may be required with cost and programme implications	5	3	15	Completed gap analysis of currently available information and given significant volumes of available geotechnical data, a general ground model for the scheme extents has been derived. Plan to undertake 'Just in time' GI where required at specified locations of proposed elements. Location specific GI at Wilne Lane and Sawley rail underbridge also required.	3	3	9
G2	Delay in undertaking 'Just in time' GI	GI may be required for large majority of the new structures (once the location is identified) and design may need to be revised. Cost and programme delays due to delays in verification of design.	3	4	12	Once proposed elements are finalised for location specifics, 'Just in Time' GI will be undertaken before construction works. To prevent delays, a GI specification will be completed and comprehensive planning will be undertaken to ensure sufficient resources are available for the GI.	2	4	8
H – Construction Phase									
H1	Unknown/variable ground and groundwater conditions.	Founding stratum failure or deformation in excess of structure serviceability limits resulting in structure/infrastructure damage. Disruption to construction owing to unforeseen ground conditions. Re-design required.	4	4	16	The ground conditions at each proposed structure will be established from existing data in this GIR which is to be supplemented by a location specific 'Just in Time' GI were insufficient data is currently available.	2	4	8

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
H2	Services	Conflict with proposed new construction, damage during construction works, delays to construction and additional costs, risk of injury/death to construction personnel.	5	5	25	Existing services have been identified Inspection pits and slit trenches in high risk areas should be undertaken to locate and identify known services.	1	5	5
H3	Highway traffic	Injury/death to site workers/members of the public.	5	5	25	Traffic management will be implemented during 'just in time' ground investigation and construction. All site personnel to be briefed on the residual risks.	2	5	10
H4	Narrow verge width at the embankment crests.	Difficult/restricted access for plant/machinery. Increased risk of slips/falls. Increased risk of damage to equipment and risk to human health.	5	3	15	The potential for minor variations in locations to avoid areas of restricted access/working area.	4	3	12

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Smart Motorways Programme

M1 Junction 23a to 25

Ground Investigation Report

HAGDMS Report No. 28929

Volume 2 of 4 – Figures and Appendix A

Issue 01 – February 2016

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

Figures

The results of in-situ and laboratory tests carried out in historical GIs are presented graphically in figures 5-1-1 to 5-8-11. The following figure numbering convention has been adopted for this GIR:

Figure A-B-C where:

A = Report Section Code (i.e. '5')

B = Material Code

1 = Embankment Fill

2 = Alluvium

3 = River Terrace Deposits

4 = Head Deposits

5 = Glaciofluvial Deposits

6 = Glacial Till

7 = Mercia Mudstone – III/IV

8 = Mercia Mudstone – I/II/Siltstone/Sandstone

C = Test Code

1 = NMC

2 = Atterberg Limits and NMC

3 = Plasticity Chart

4 = PSD

5 = Unit Weight

6 = SPT Uncorrected N Values

7 = Undrained Shear Strength

8 = One Dimensional Consolidation

9 = Drained Shear Strength (Shear Box)

10 = Unconfined Compressive Strength (rock)

11 = Point Load (rock)

For example Figure 5-1-1 shows the NMC plot for Embankment Fill material. These figures are used to help derive characteristic parameters, of which are explored further in this chapter. Figures attached to this GIR are summarised below:

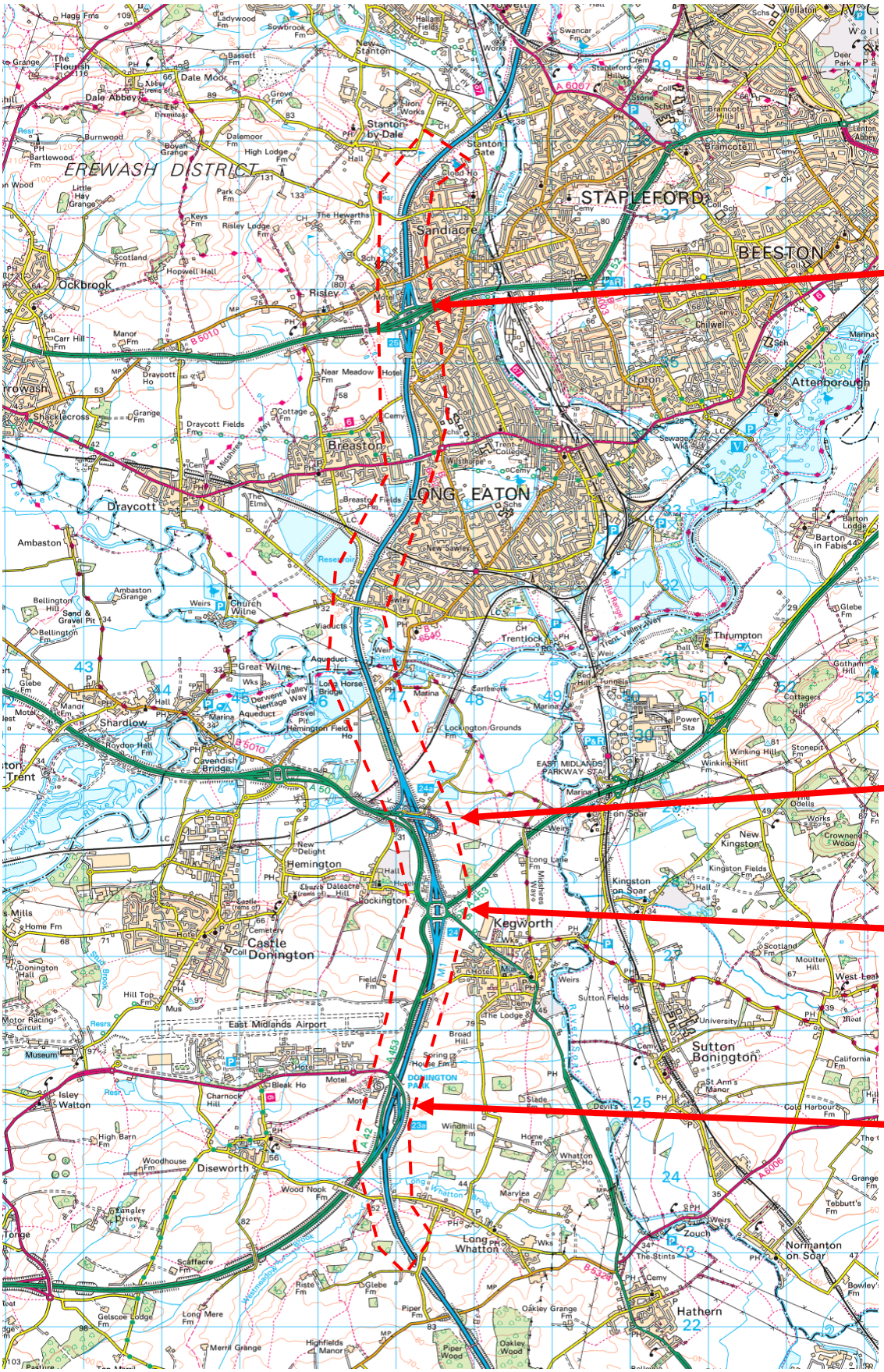
Summary of Figures

	Material	Made Ground Embankment Fill	Alluvium	River Terrace Deposits	Head	Glaciofluvial Deposits	Glacial Till	Mercia Mudstone – III/IV	Mercia Mudstone – I/II/Siltstone/ Sandstone
Plot Number	Material ID ("X")	1	2	3	4	5	6	7	8
5-X-1	NMC	X	X	X	X	X	X	X	X
5-X-2	Atterberg Limits and NMC	X	X	-	X	X	X	X	-
5-X-3	Plasticity Chart	X	X	-	X	X	X	X	-
5-X-4	PSD	X	X	X	X	X	X	X	-
5-X-5	Unit Weight	-	-	-	-	-	X	X	X
5-X-6	SPT Uncorrected N Values	X	X	X	X	X	X	X	-
5-X-7	Undrained Shear Strength	X	X	-	X	X	X	X	-
5-X-8	One Dimensional Consolidation	X	X	-	-	X	X	X	X
5-X-9	Drained Shear Strength (Shear Box)	X	-	-	-	X	-	X	-
5-X-10	Unconfined Compressive Strength (rock)	-	-	-	-	-	-	-	X
5-X-11	Point Load (rock)	-	-	-	-	-	-	-	X

In addition to the above, there is also a Site Location Plan included as Figure 1.

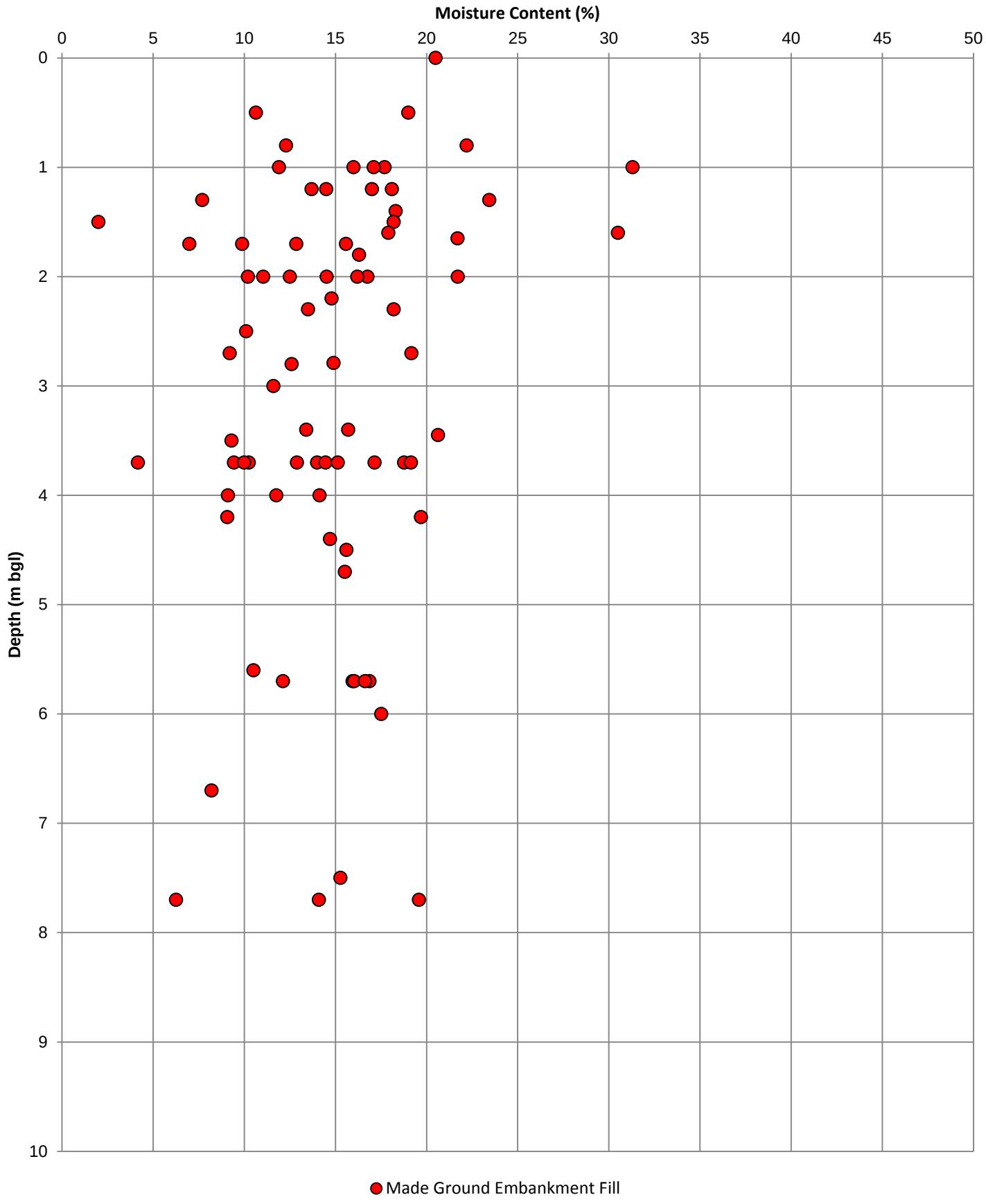
Site Location Plan

Project ID: **COCDFL1SMP01**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **1**	


J25
J24a
J24
J23a
Key:
Scheme
EREWASH DISTRICT
STAPLEFORD
BEESTON
Sandiacre
Risley
Ockbrook
Breaston
LONG EATON
Draycott
Ambaston
Shardlow
Great Wilne
Hemington
Castle Donington
Kegworth
Sutton Bonington
Diseworth
Long Whatton
Hathern
Attenborough
Thrumpton
Kingston on Soar
Normanton on Soar
East Midlands Airport
Isley Walton
Stanton by Dale
Dale Abbey
Trentlock
Lockington Grounds
Cavendish Bridge
Derwent Mouth
Long Horse Bridge
Aqueduct
Matina
Marina
Weirs
Viaducts
Trent Valley Way
Derwent Valley Way
Church Wilne
Ambaston Grange
Draycott Fields Fm
Near Meadow Hotel
Shackelcross
Carr Hill Fm
Manor Fm
Hopwell Hall
Scotland Fm
Risley Lodge Fm
The Hewarths Fm
Keys Fm
Park Fm
Dalemoor Fm
High Lodge Fm
Boyan Grange
Burnwood
Bartlewood Fm
Little Hay Grange
The Flourish
Dale Moor
Grove Fm
Stanton Gate
Old Ho
Stanton Works
Lion Works
Stanton Hall
Swancar Fm
Stapleford Hall
Bramcote
Bramcote Hills
Chilwell
Toton
Trent College
Wilsthorpe
Barton in Fabis
Barton Lodge
Glebe Fm
Gotham Hill
Cottagers
Stonepit Fm
Winking Hill
Power Sta
Sewage Wks
Odelis Works
Crowneno Wood
New Kingston
Kingston Fields Fm
Long Lane Fm
Midshires Way
Sutton Fields Ho
Moulter Hill
West Leake
Scotland Fm
California Fm
St Ann's Manor
Cold Harbours Fm
Tebbutt's Fm
Zouch
The Stints
Bowley Fm
Oakley Grange Fm
Oakley Wood
Piper Wood
Highfields Manor
Merril Grange
Long Mere Fm
Gelscoe Lodge
Scaffacre Fm
Langley Priory
Woodhouse Fm
High Barn Fm
Charnock Hill
Bleak Ho
Windmill Fm
Home Fm
Whatton Ho
Marylea Fm
Wood Nook Fm
Riste Fm
Glebe Fm
Piper Fm
Hill Top Fm
Field Fm
Spring House Fm
Broad Hill
Slade
Devil's
Motor Racing Circuit
Museum
Donington Hall
Home Fm
Castle Donington
Cemetery
Church
Hemington Fields Ho
New Delight
Bockington
Roydon Hall Fm
Shardlow Hall
Marina
Aqueduct
Great Wilne
Church Wilne
Weirs
Sand & Gravel Pit
Bellington Hill
Bellington Fm
Ambaston Grange
Draycott Ho
Draycott Fields Fm
Grange Fm
Cottage Fm

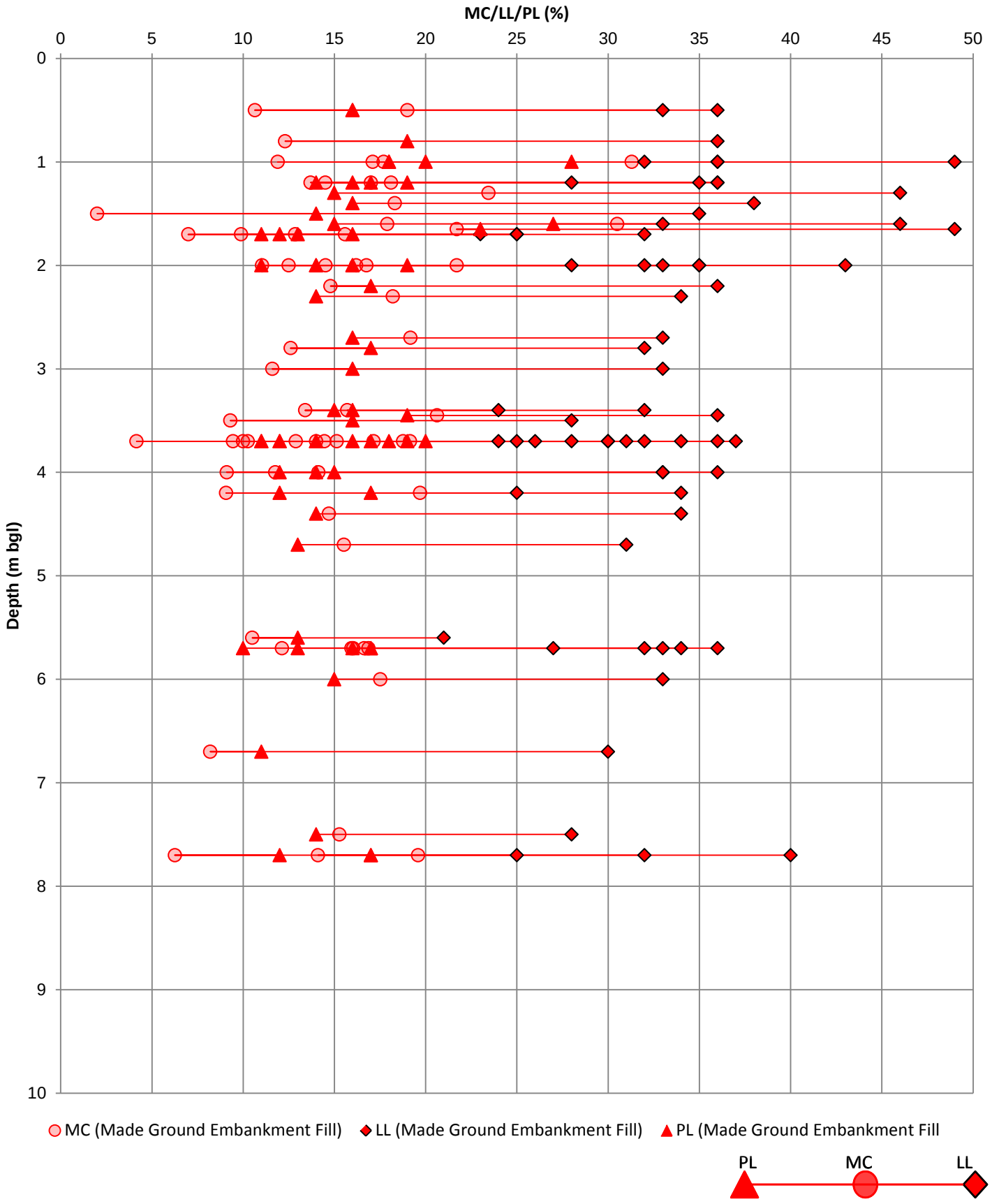
Made Ground Embankment Fill - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-1**	



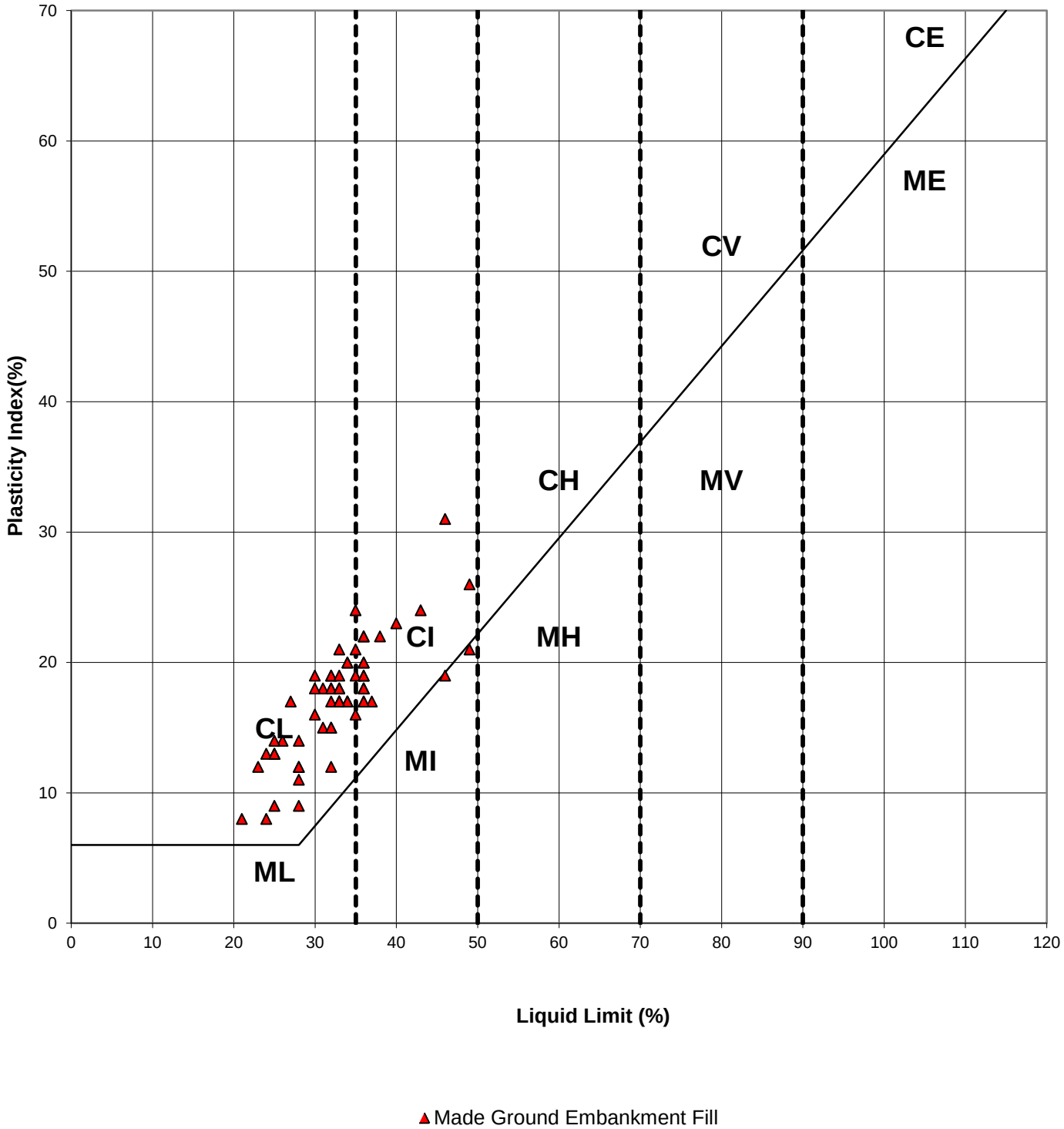
Made Ground Embankment Fill - Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-2**	



Made Ground Embankment Fill - A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-3**	

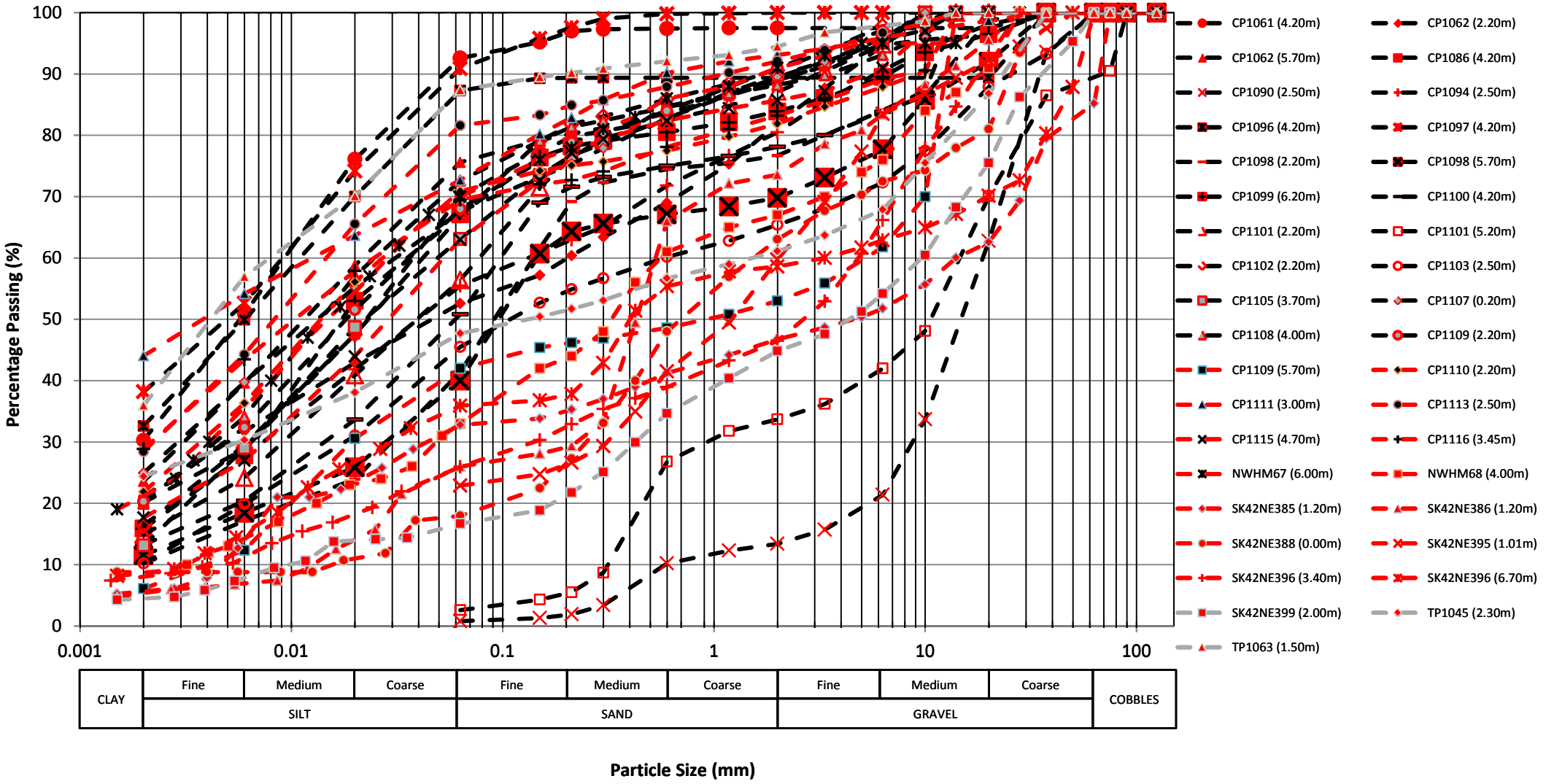


Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

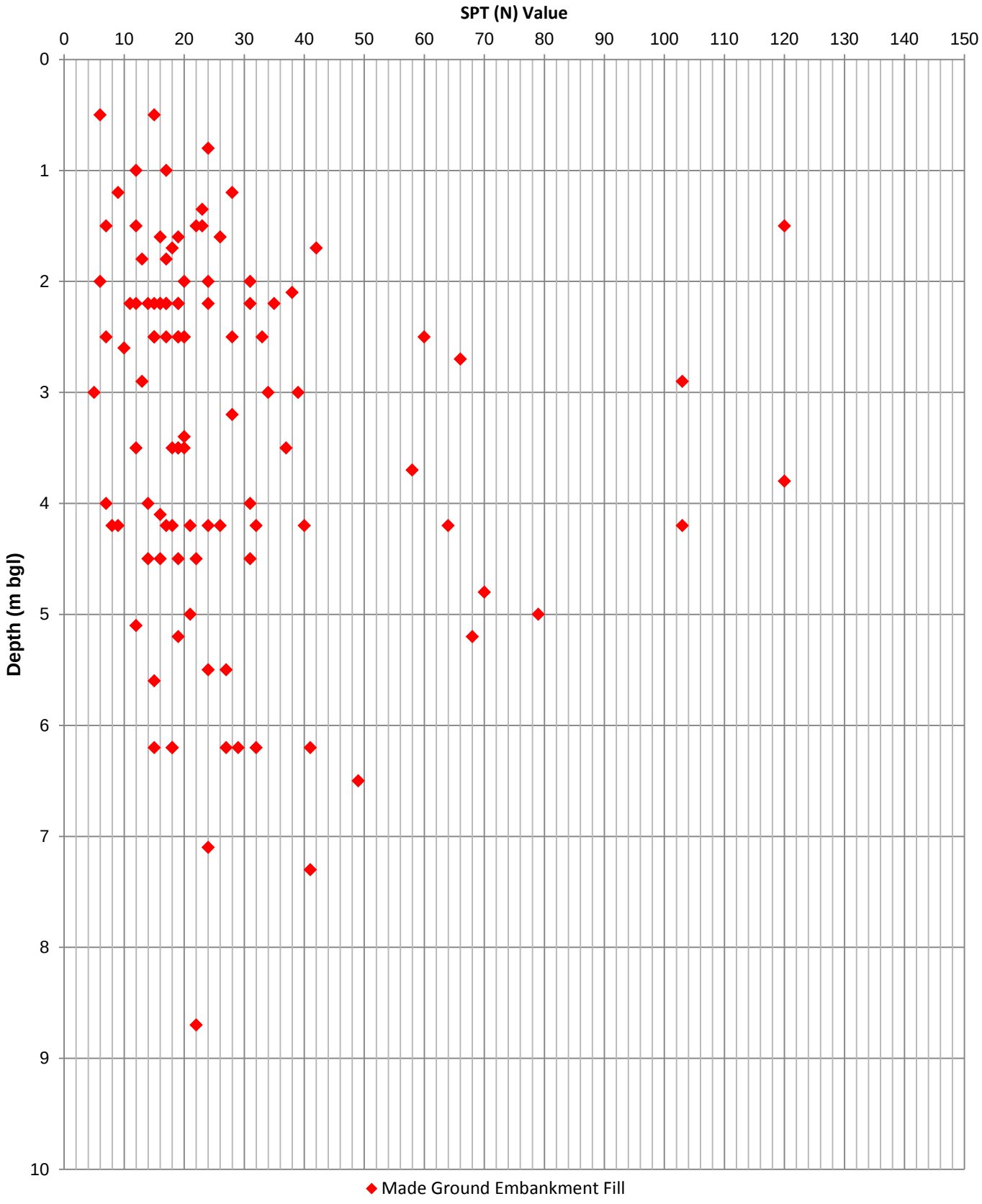
Made Ground Embankment Fill - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-4**	



Made Ground Embankment Fill - SPT N Value vs Depth

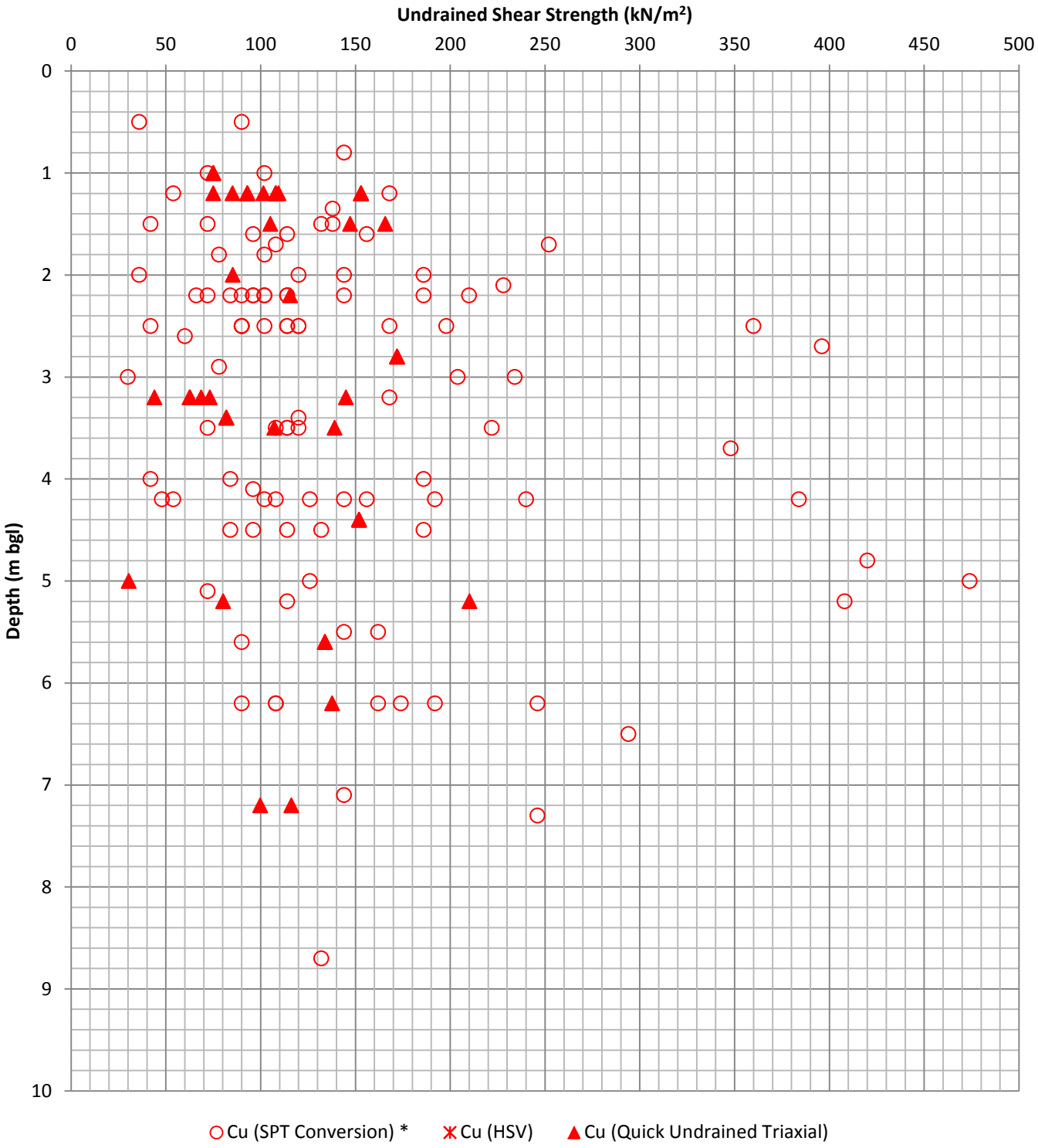
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-6**	



Extrapolated SPT (N) Values >150 have not been shown

Made Ground Embankment Fill - Undrained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-7**	



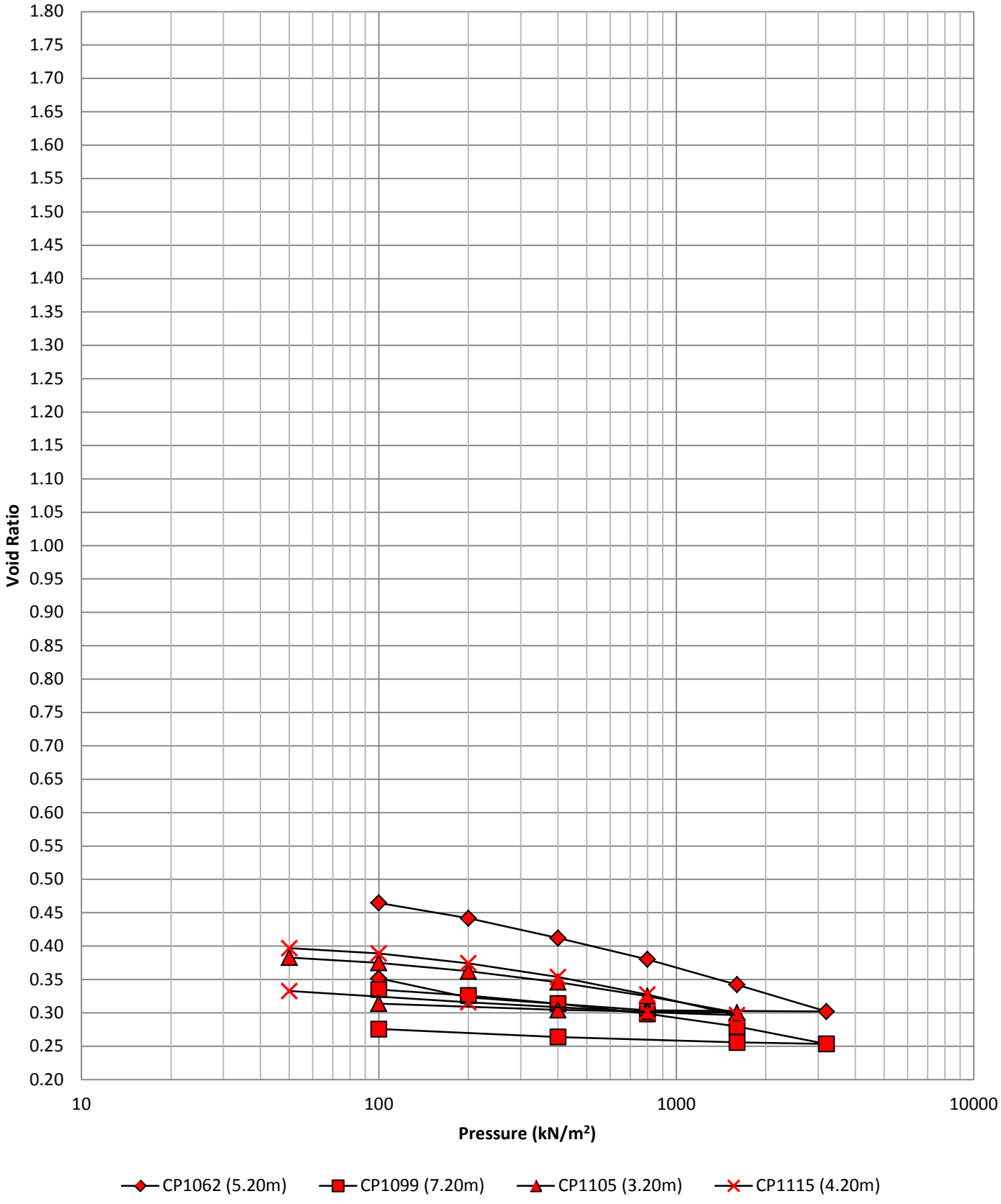
Average PI = 17 Assumed *f*1 = 6**

*Stroud, M. A., The Standard Penetration Test in Insensitive Clays and Soft Rocks, Proceedings of the European Symposium on Penetration Testing, **2**, 367-375, 1975.

10 No. Cu values derived from SPT N Values fall beyond the limits of this chart with results ranging from 618 - 4500 kPa

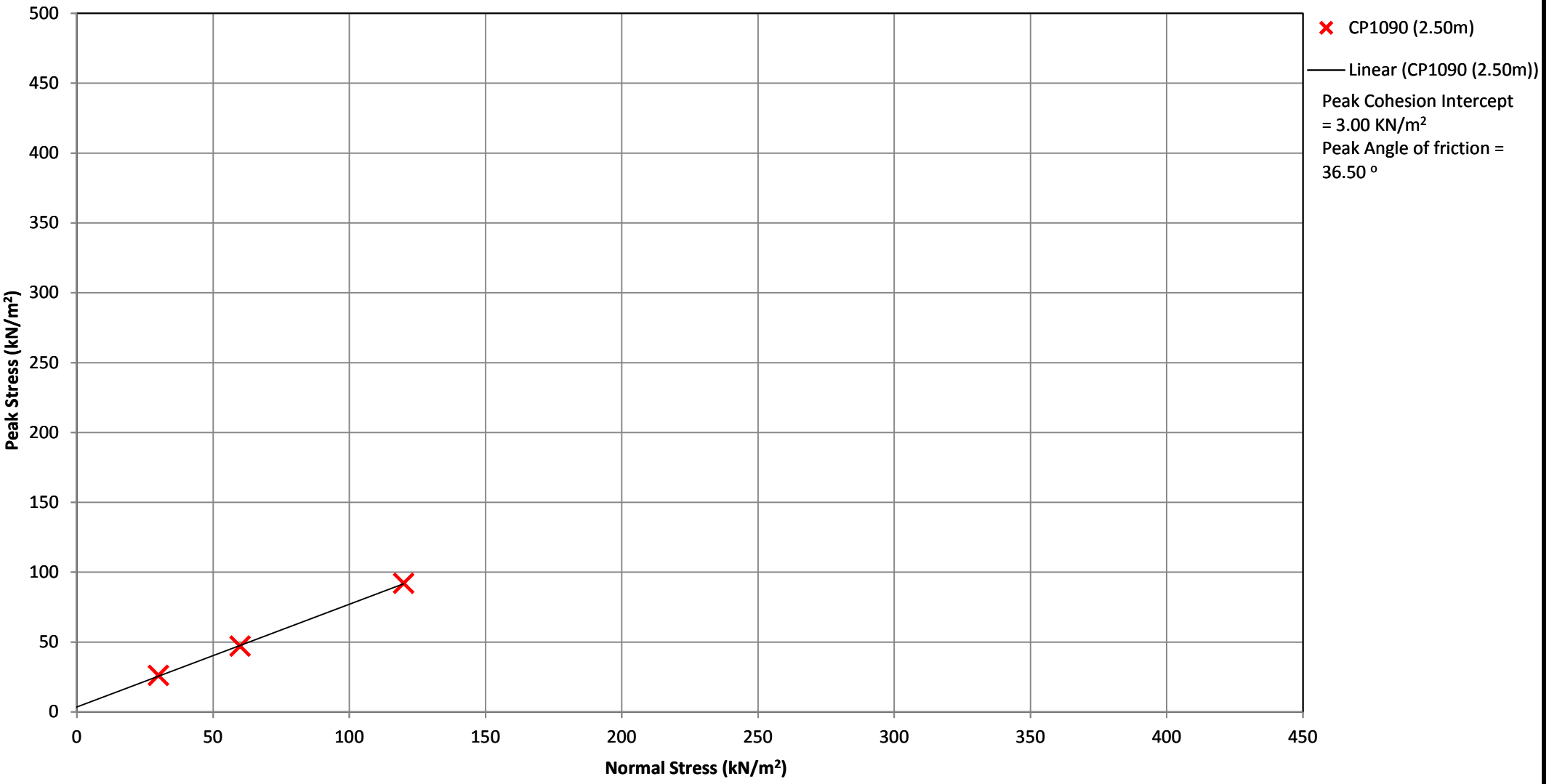
Made Ground Embankment Fill - One Dimensional Consolidation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-8**	



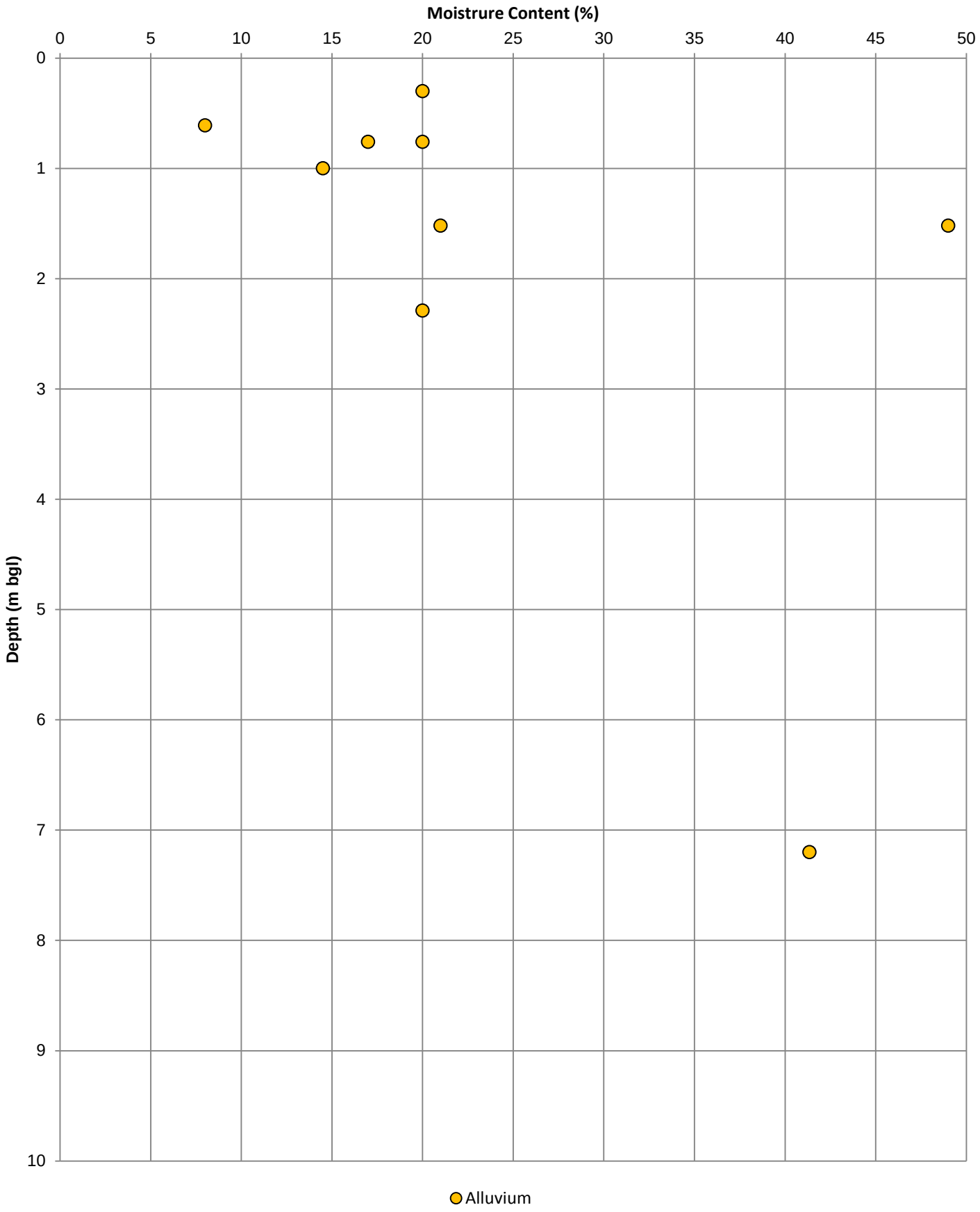
Made Ground Embankment Fill - Drained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-1-9**	



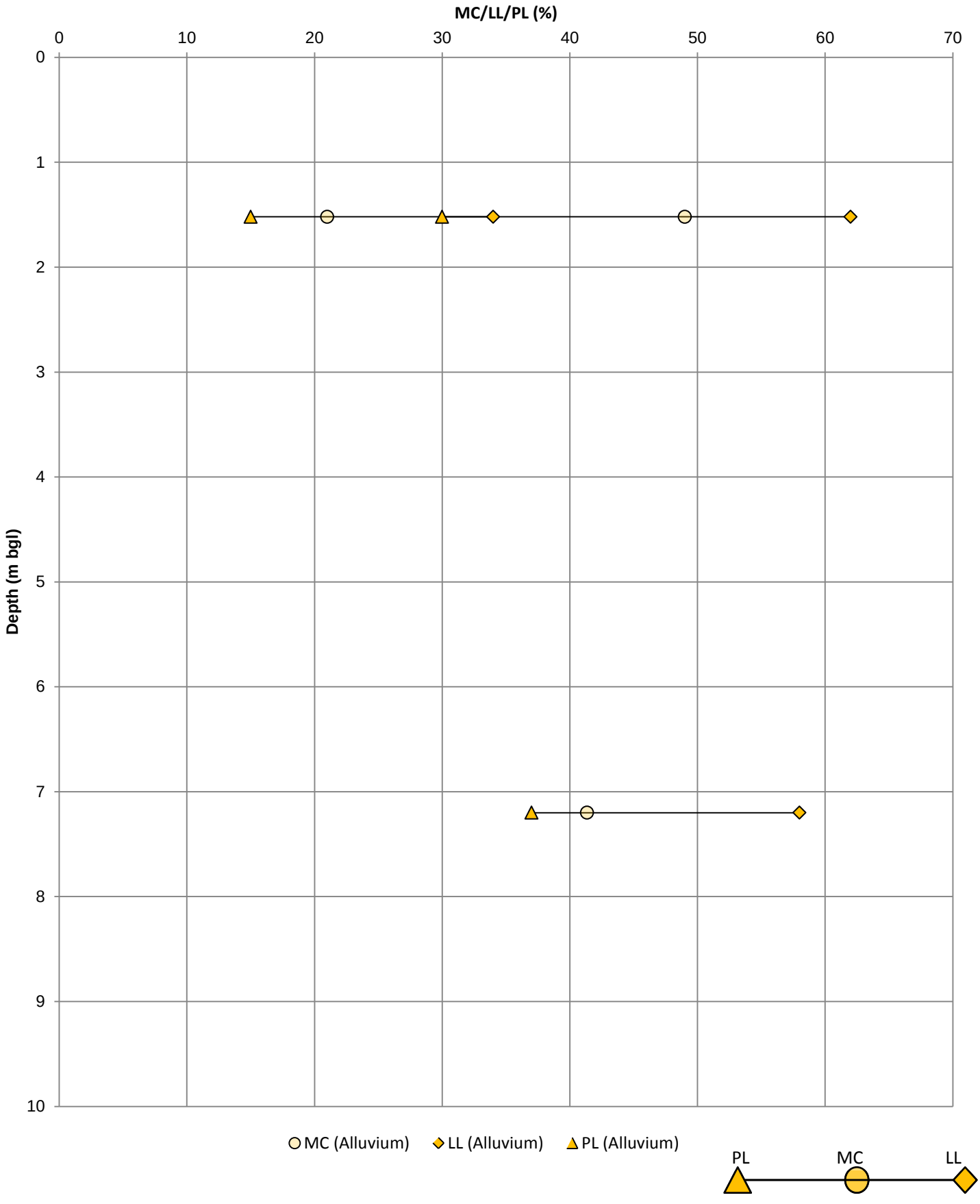
Alluvium - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-1**	



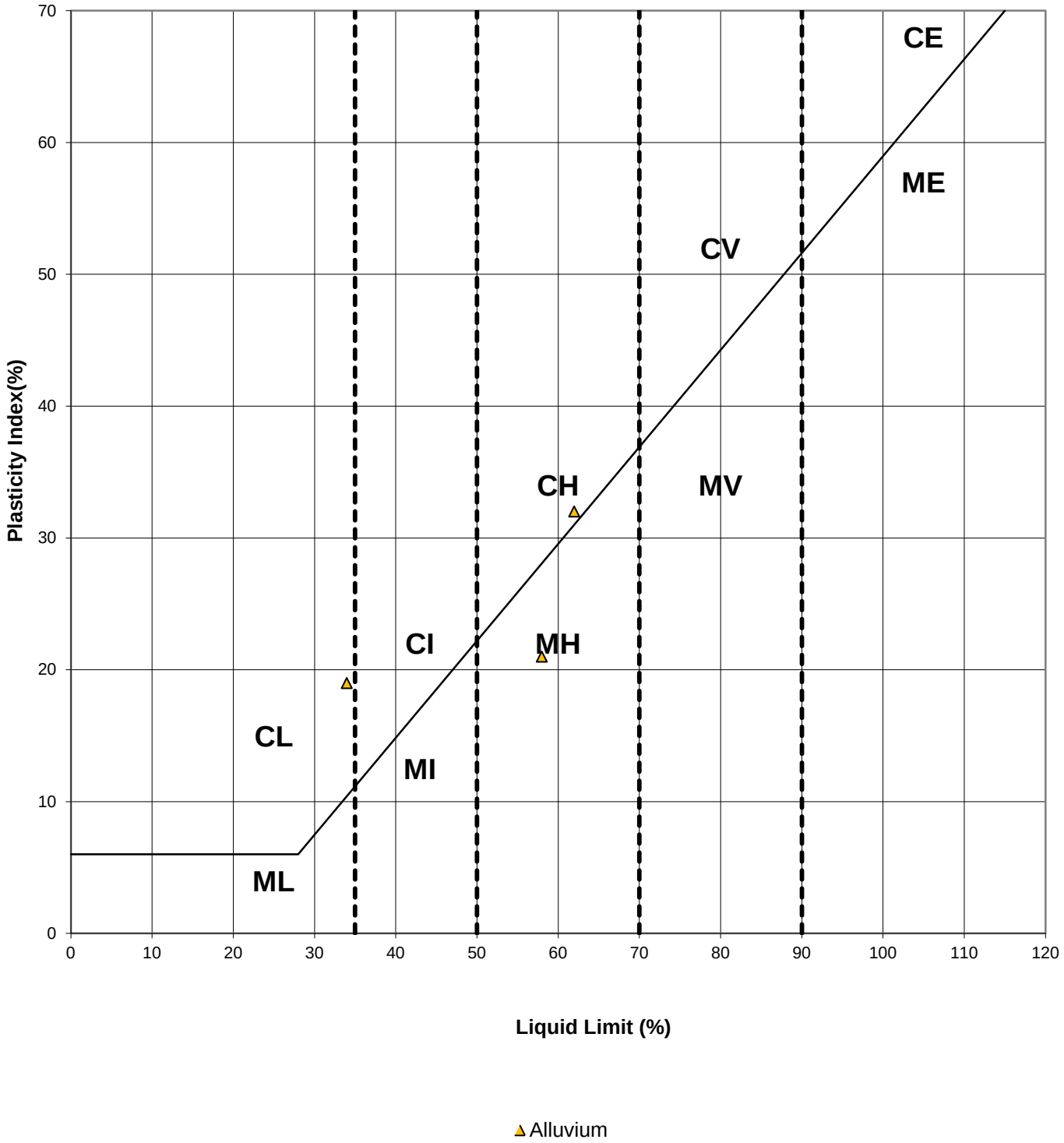
Alluvium - Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-2**	



Alluvium - A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-3**	

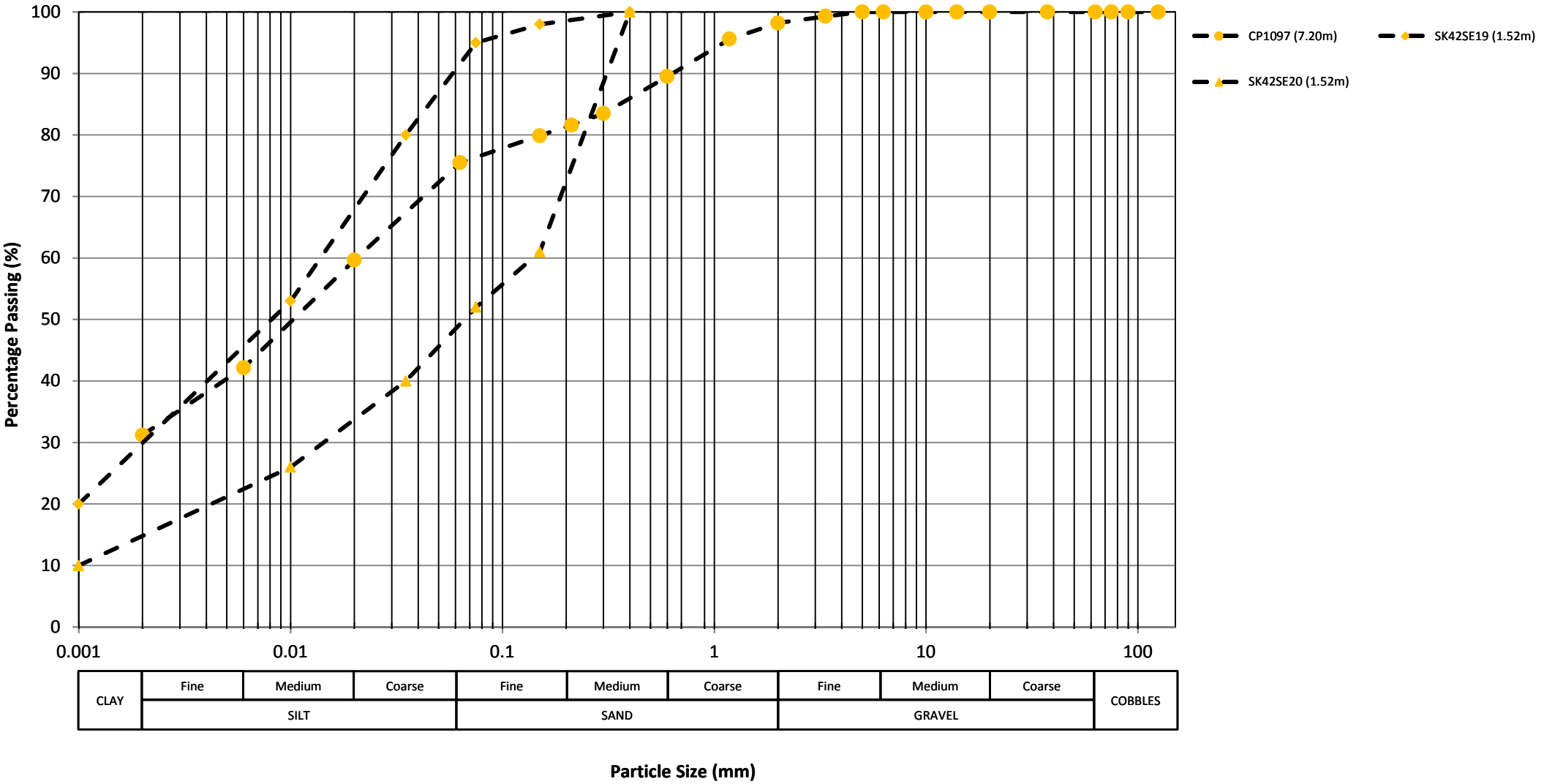


Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
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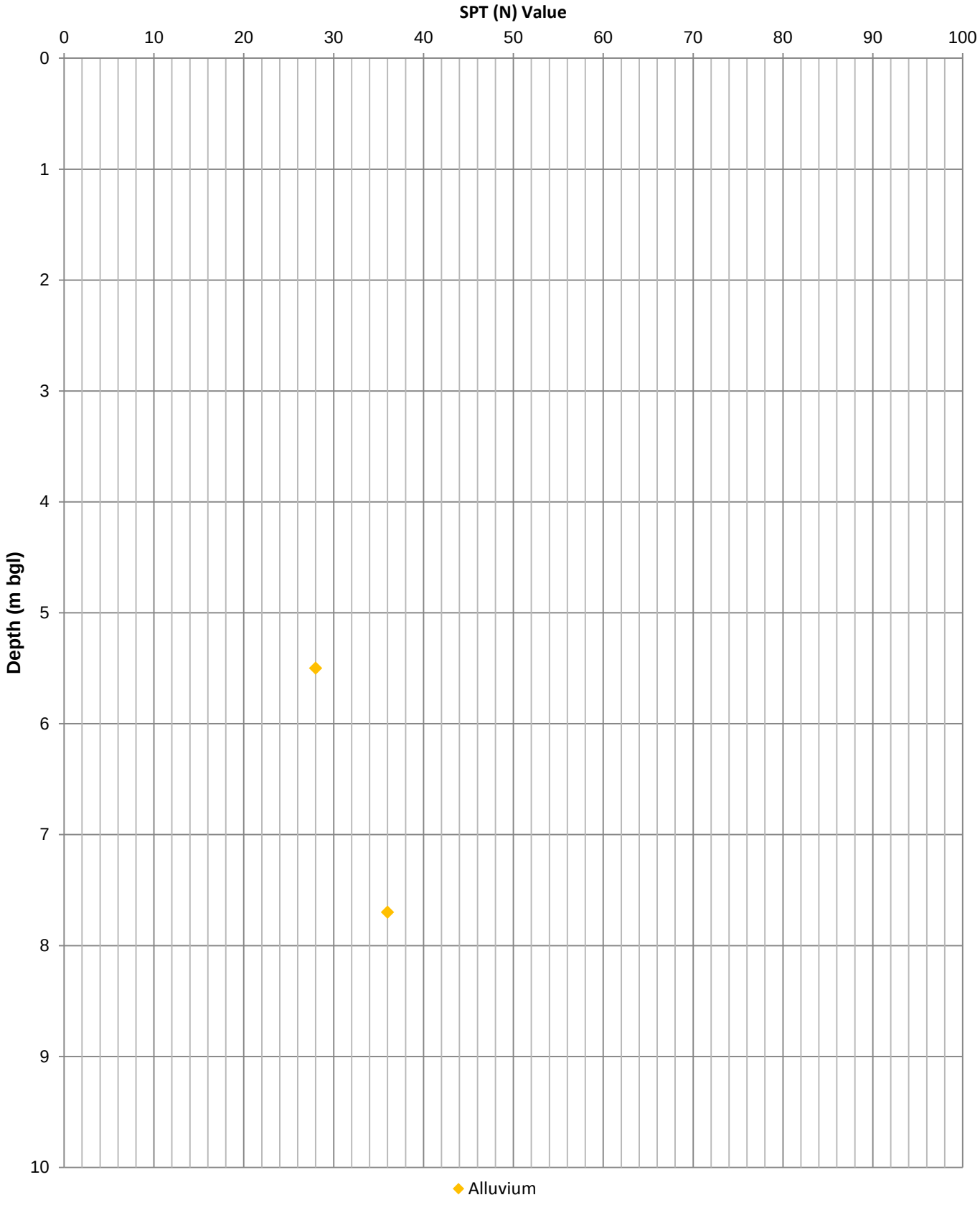
Alluvium - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-4**	



Alluvium - SPT N Value vs Depth

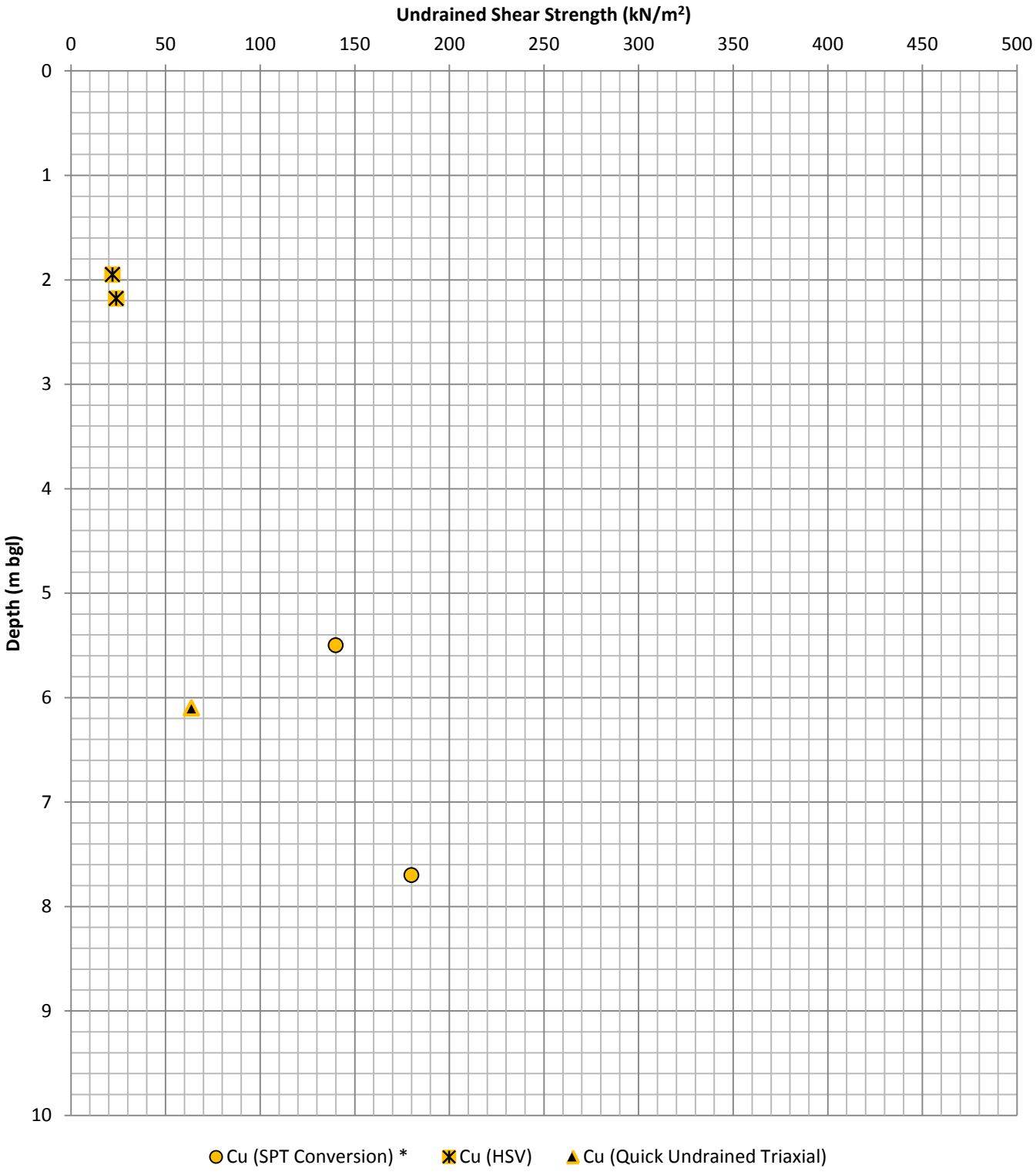
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-6**	



Extrapolated SPT (N) Values >150 have not been shown

Alluvium - Undrained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-7**	

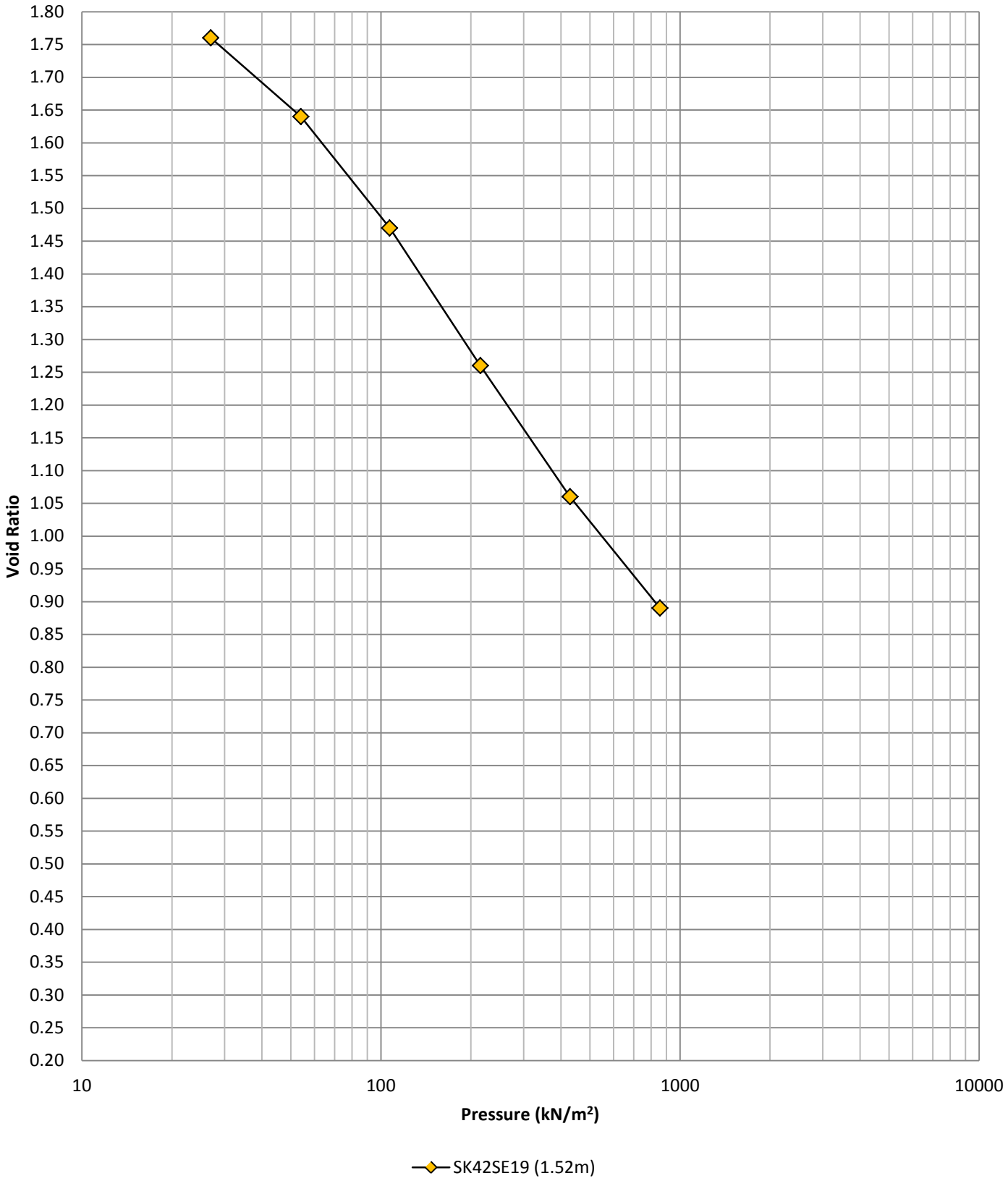


Average PI = 24 Assumed *f*1 = 5

*Stroud, M. A., The Standard Penetration Test in Insensitive Clays and Soft Rocks, Proceedings of the European Symposium on Penetration Testing, **2**, 367-375, 1975.

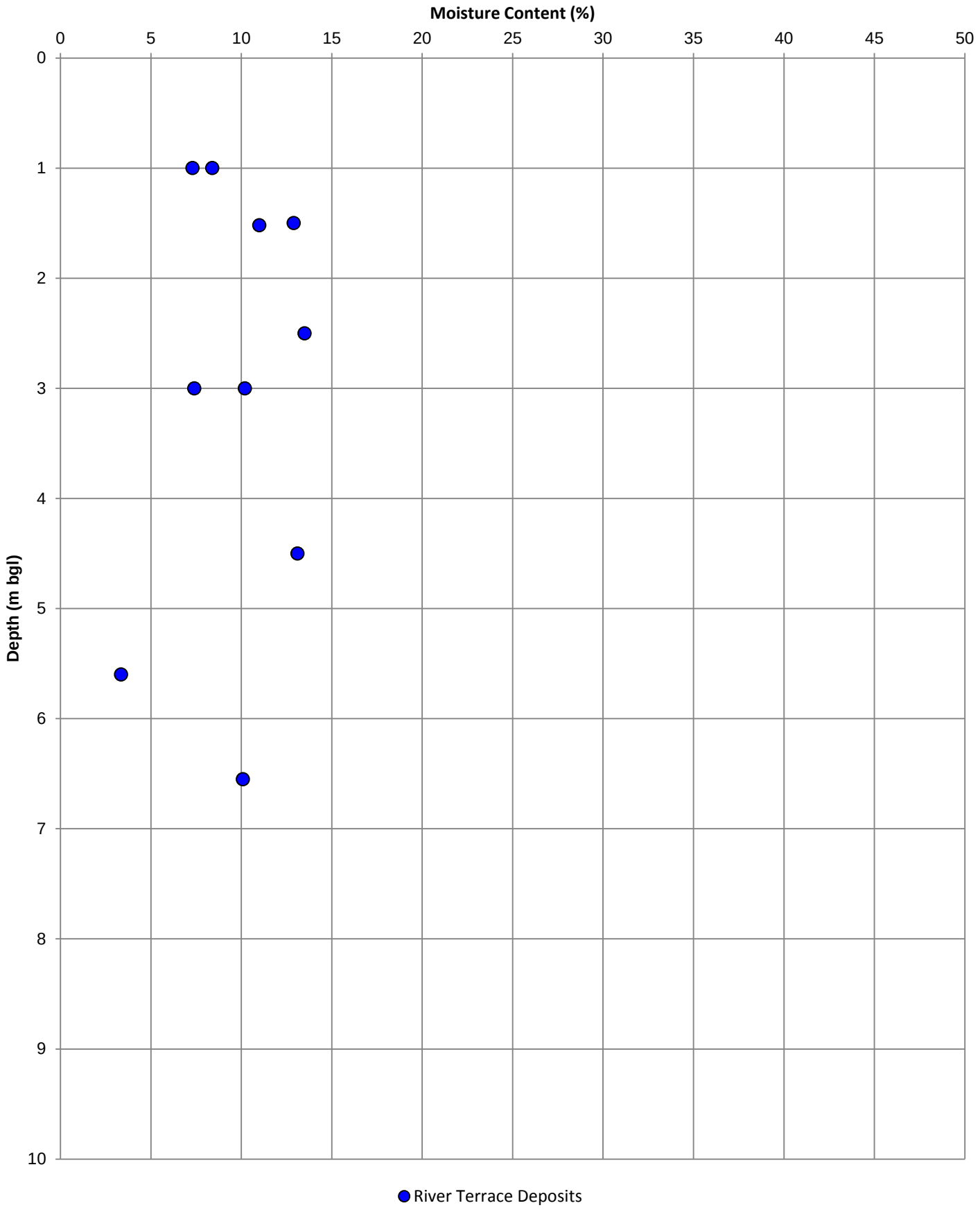
Alluvium - One Dimensional Consolidation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-2-8**	



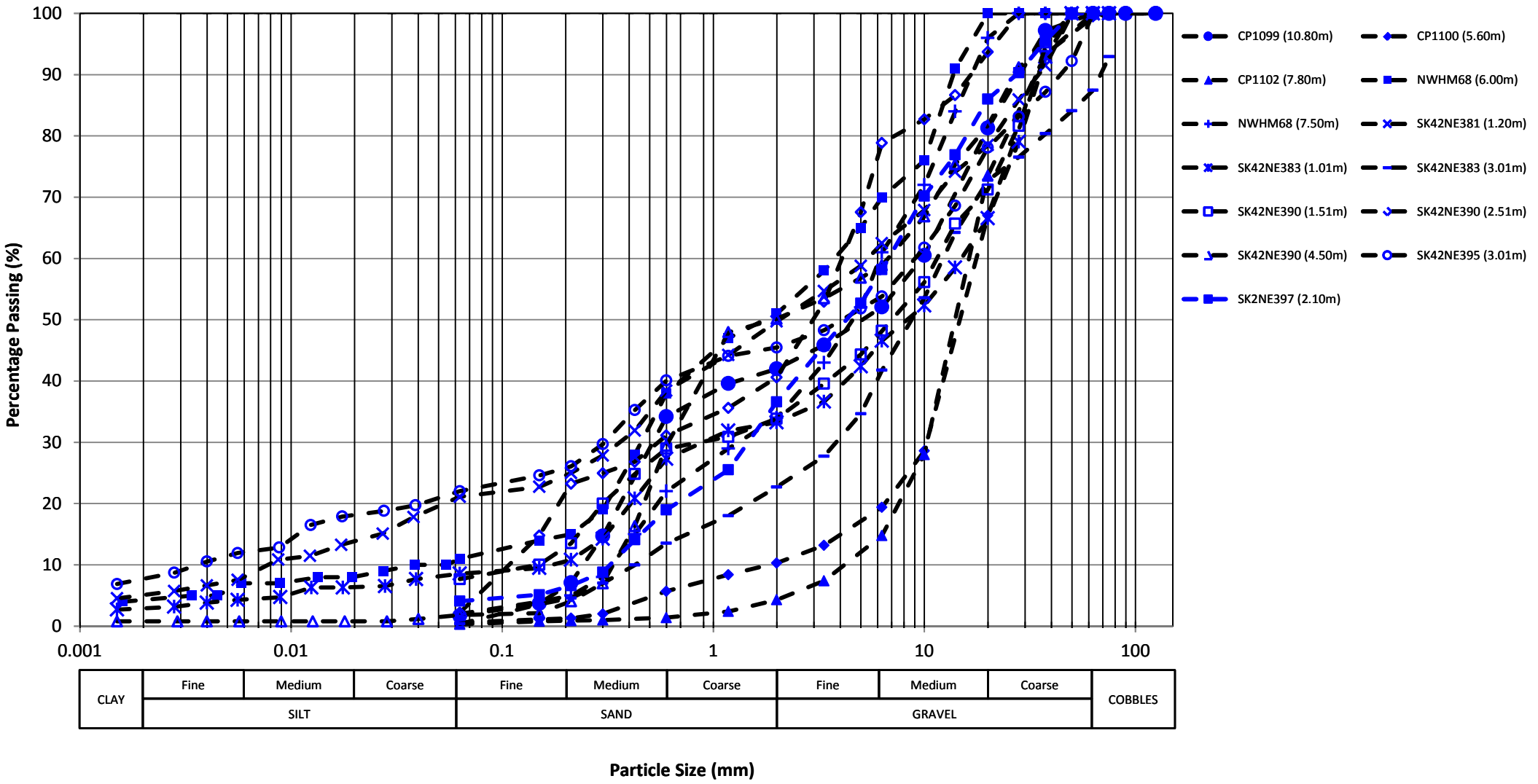
River Terrace Deposits - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-3-1**	



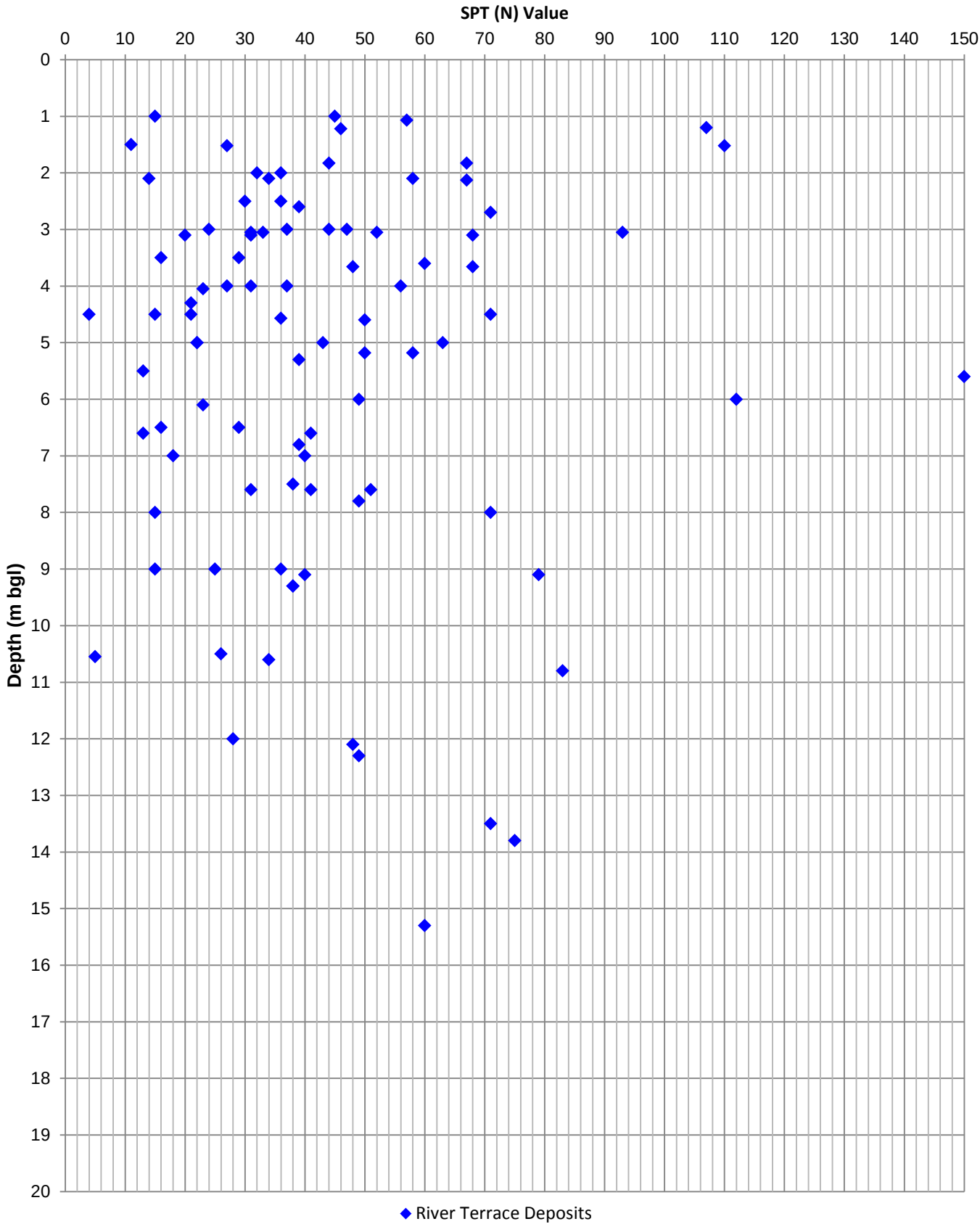
River Terrace Deposits - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-3-4**	



River Terrace Deposits - SPT N Value vs Depth

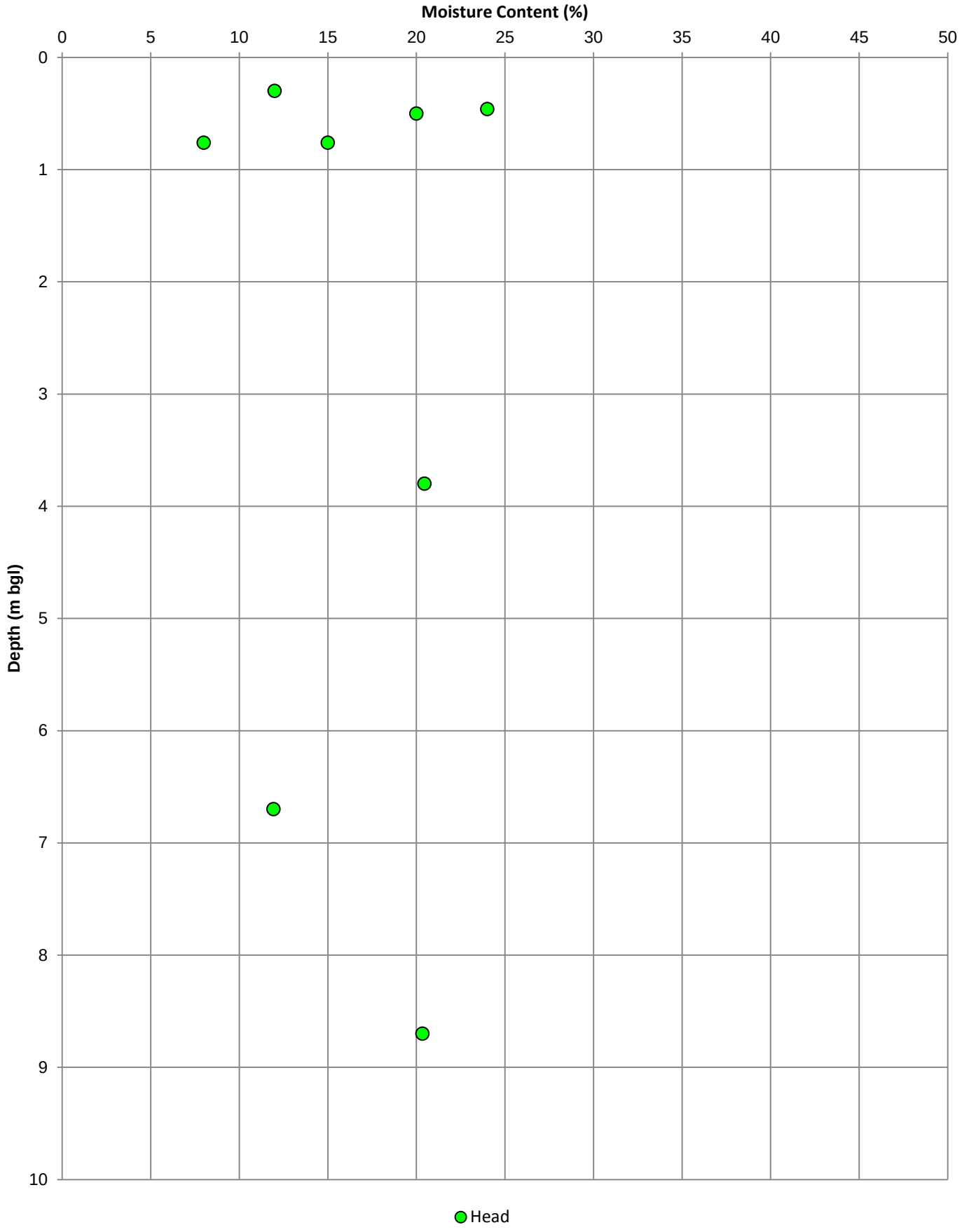
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-3-6**	



Extrapolated SPT (N) Values >150 have not been shown

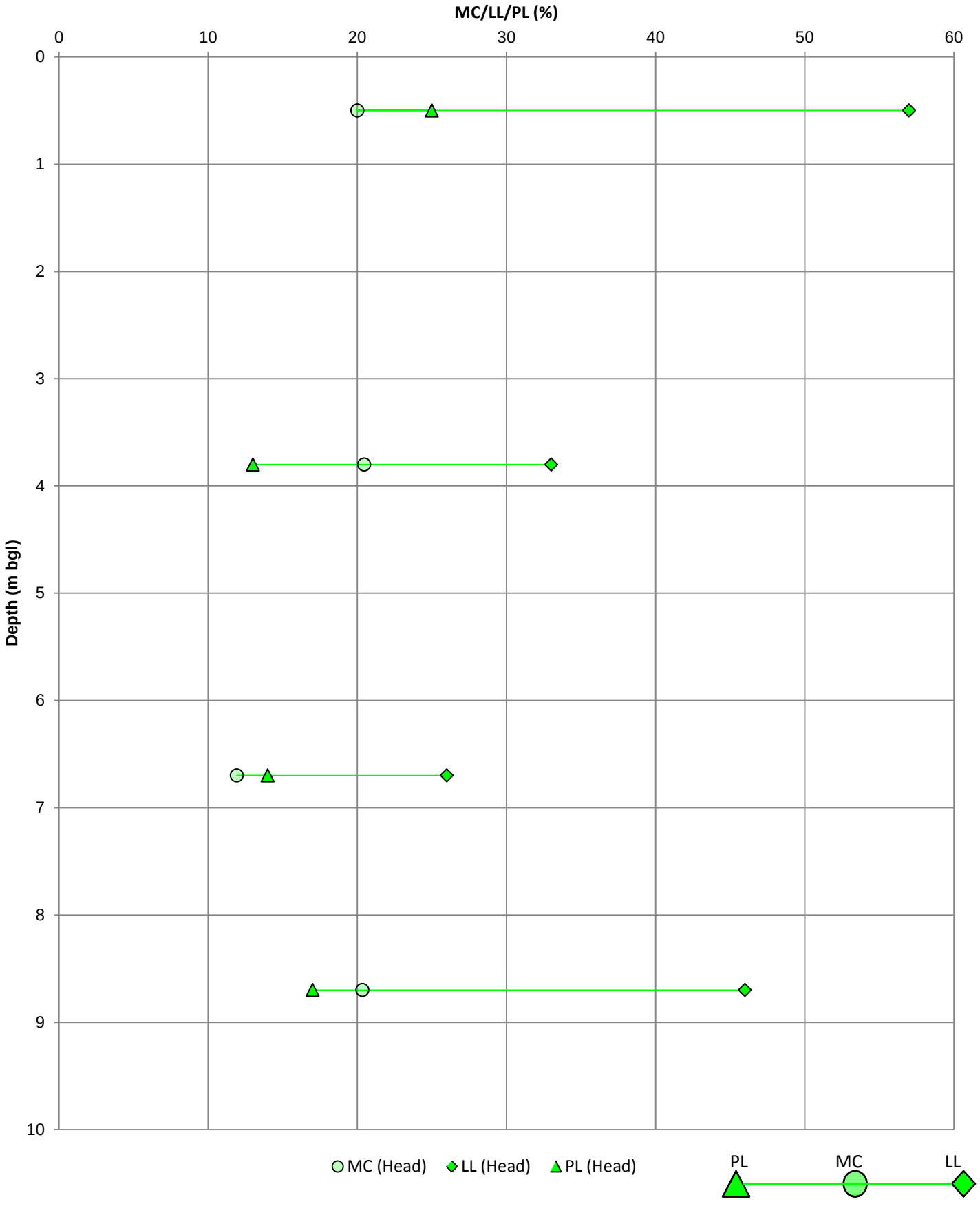
Head - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-4-1**	



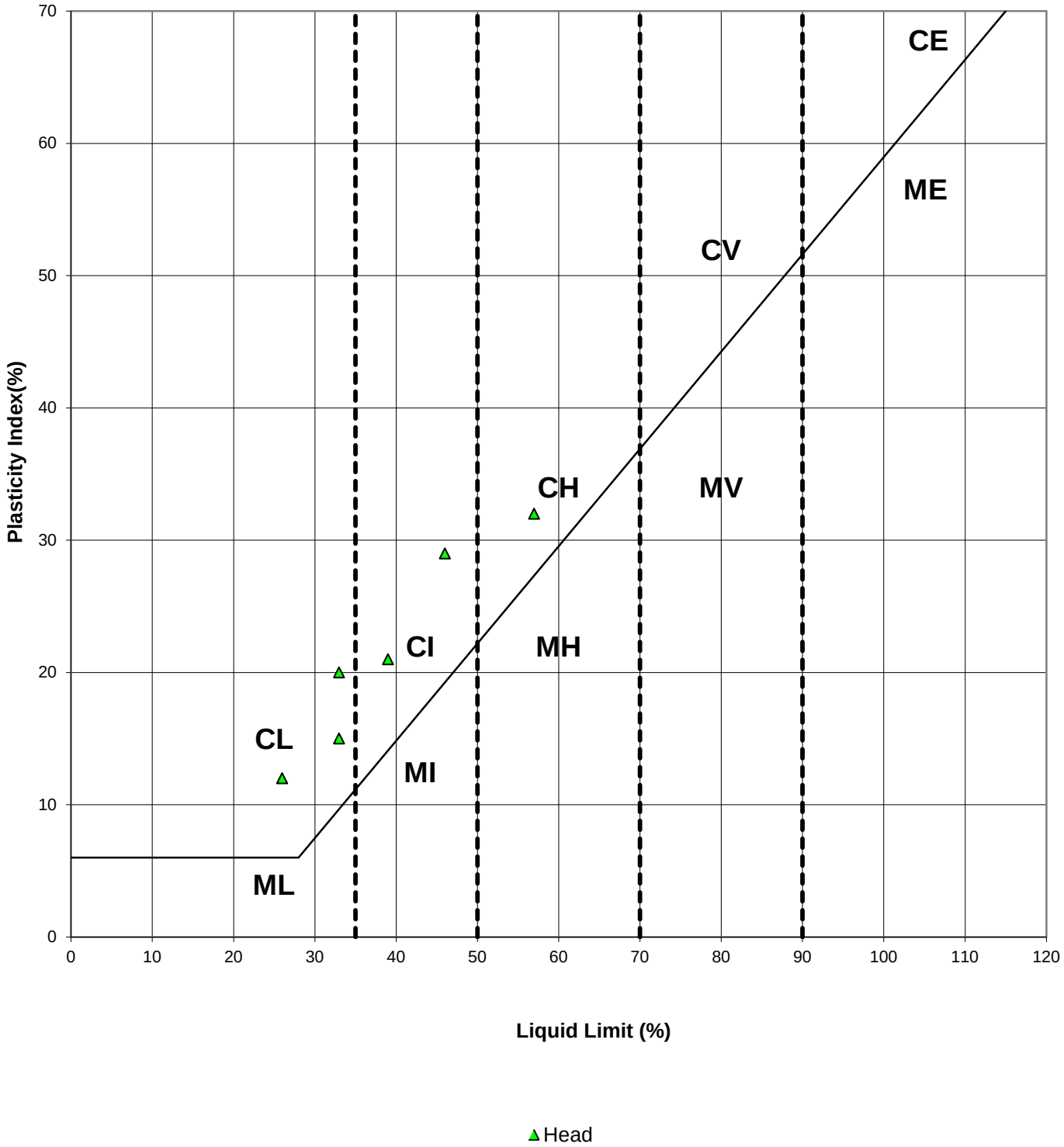
Head - Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-4-2**	



Head - A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-4-3**	

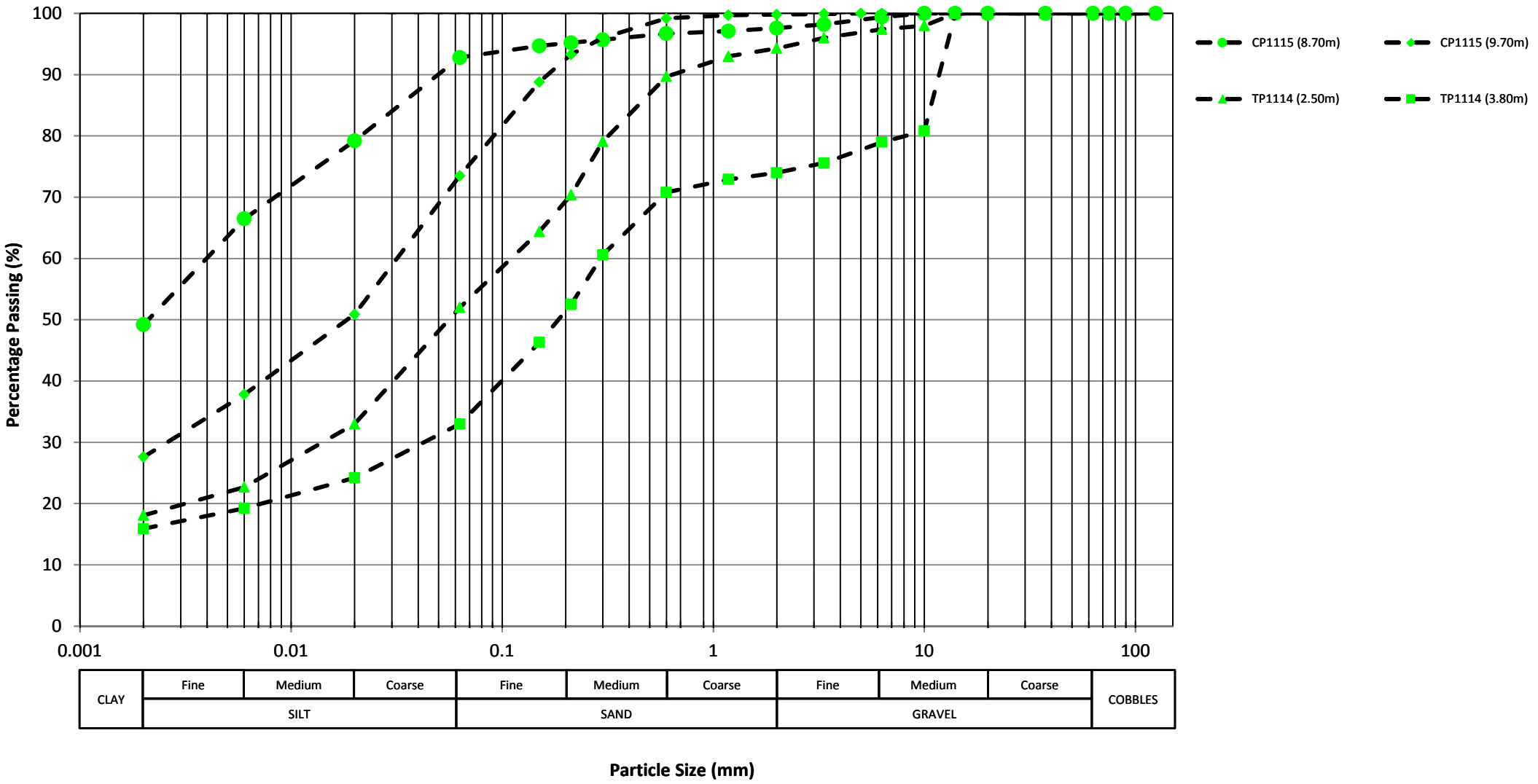


Key

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CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
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CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

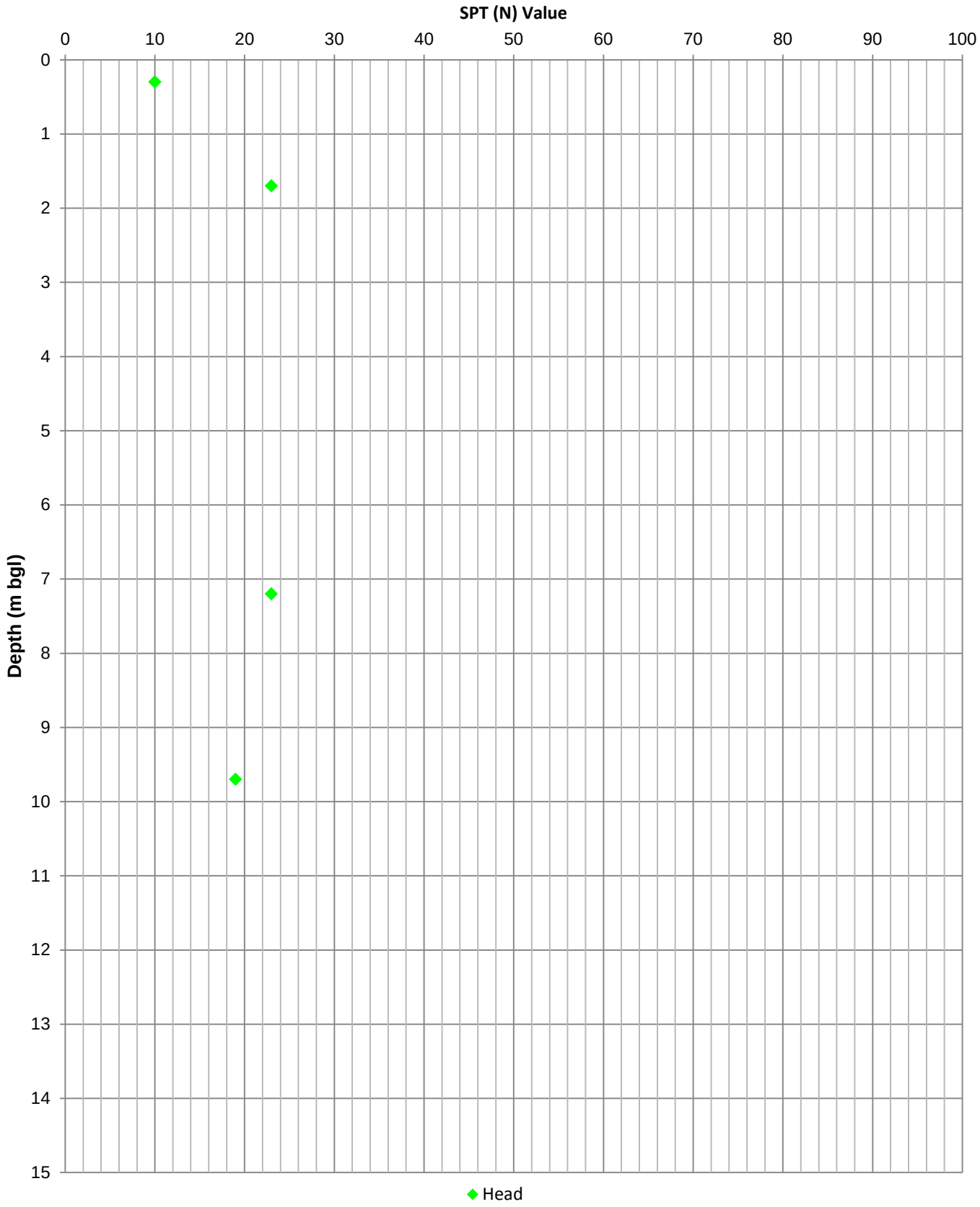
Head - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-4-4**	



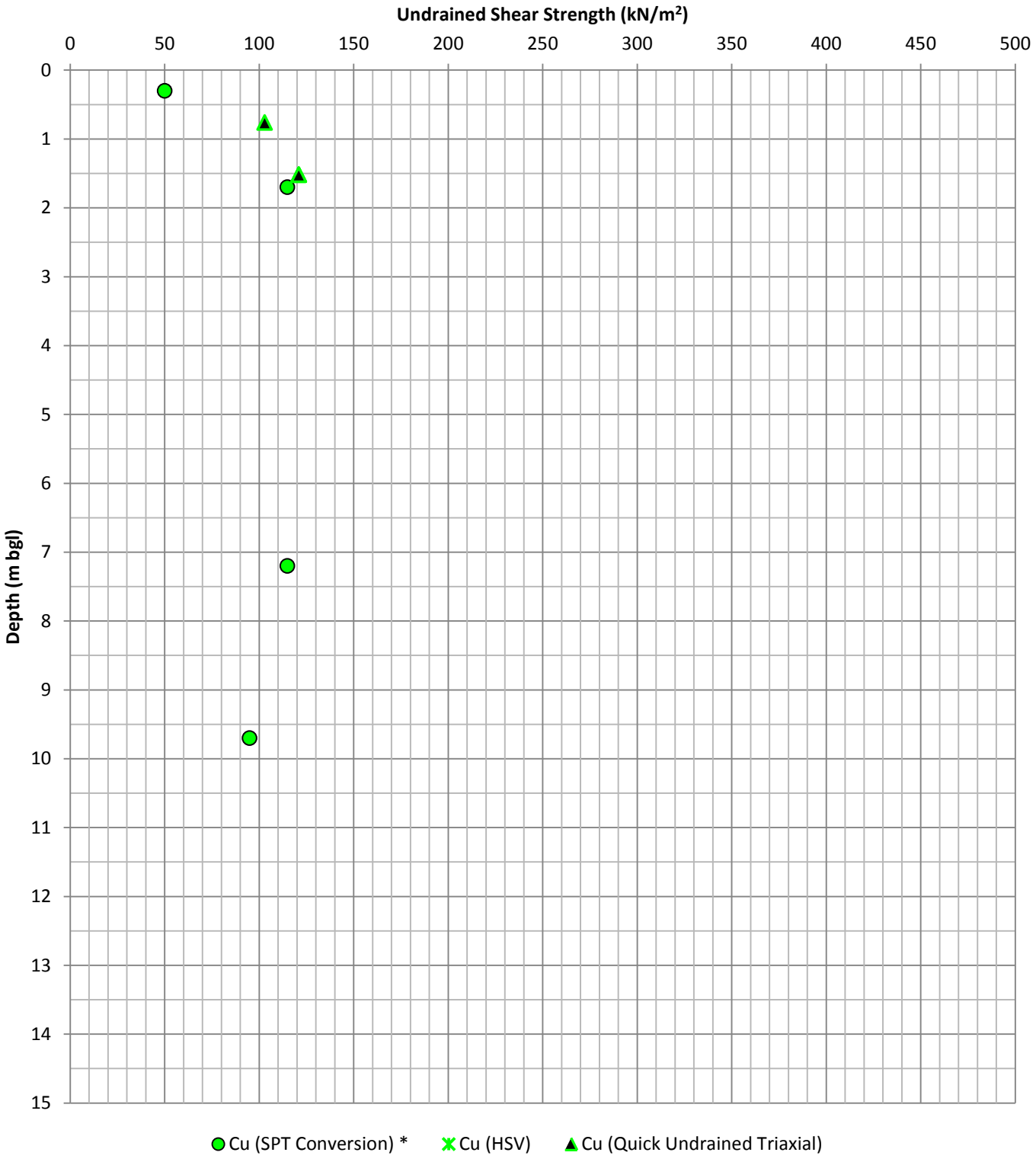
Head - SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-4-6**	



Head - Undrained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-4-7**	

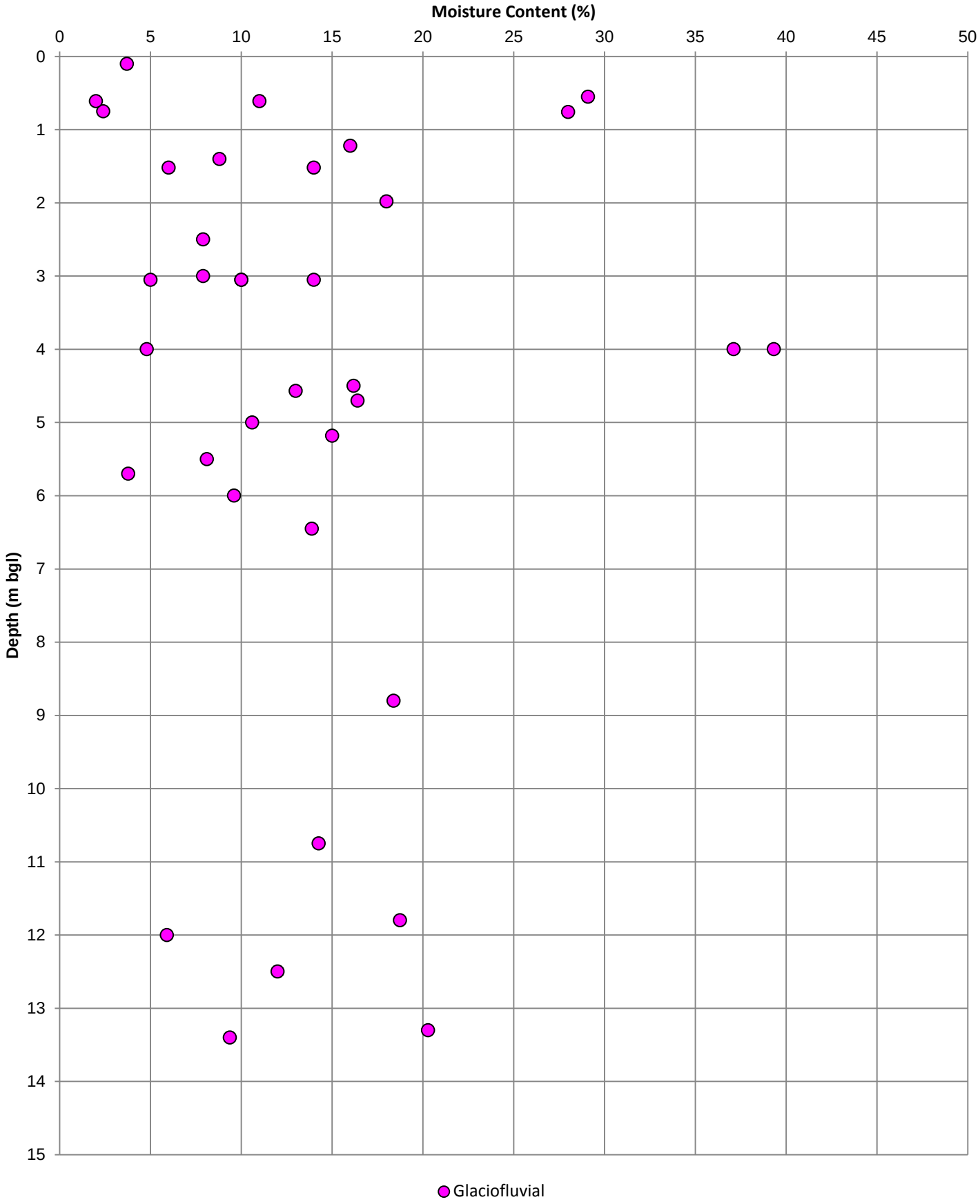


Average PI = 22 Assumed *f*1 = 5

*Stroud, M. A., The Standard Penetration Test in Insensitive Clays and Soft Rocks, Proceedings of the European Symposium on Penetration Testing, **2**, 367-375, 1975.

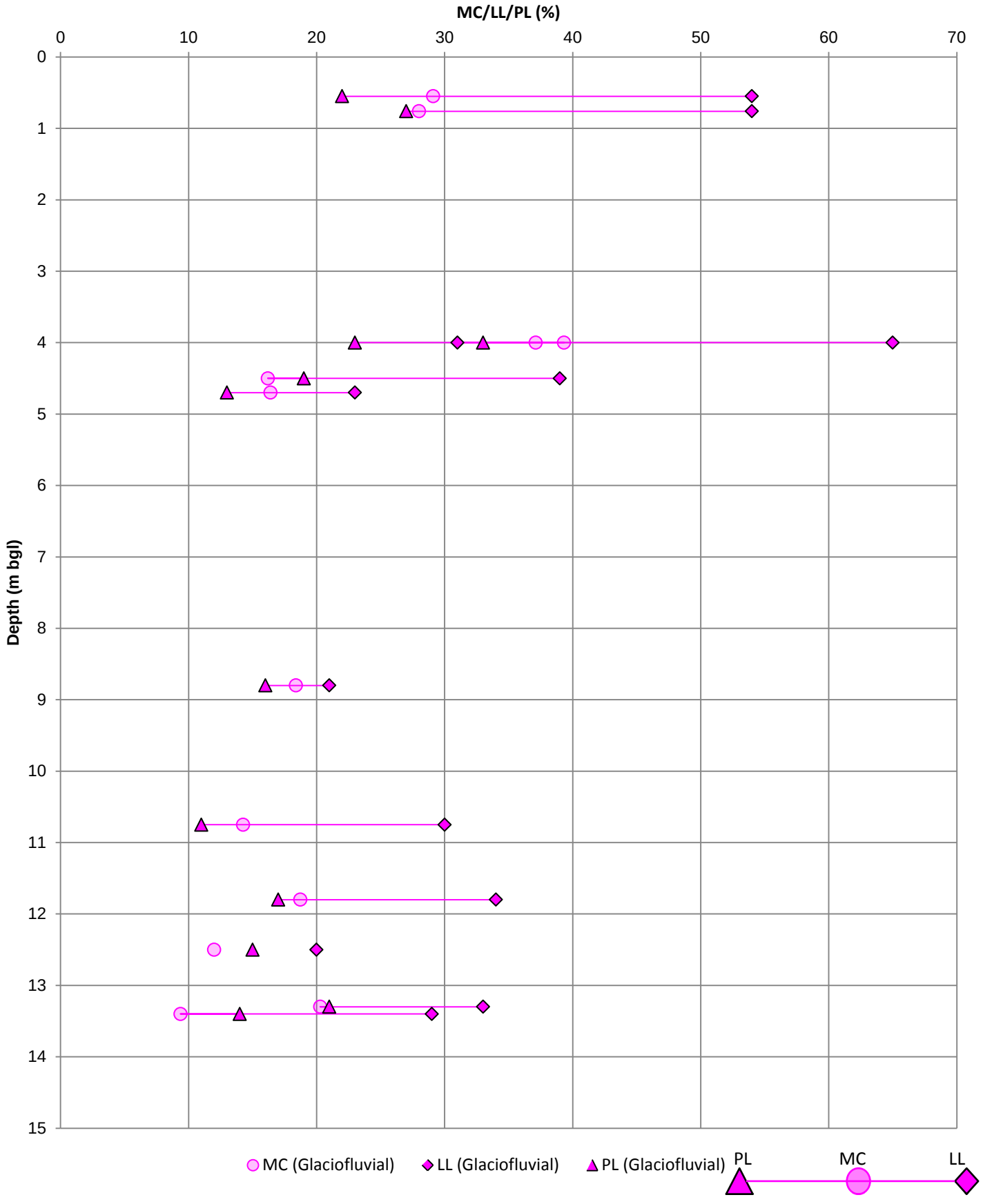
Glaciofluvial - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-1**	



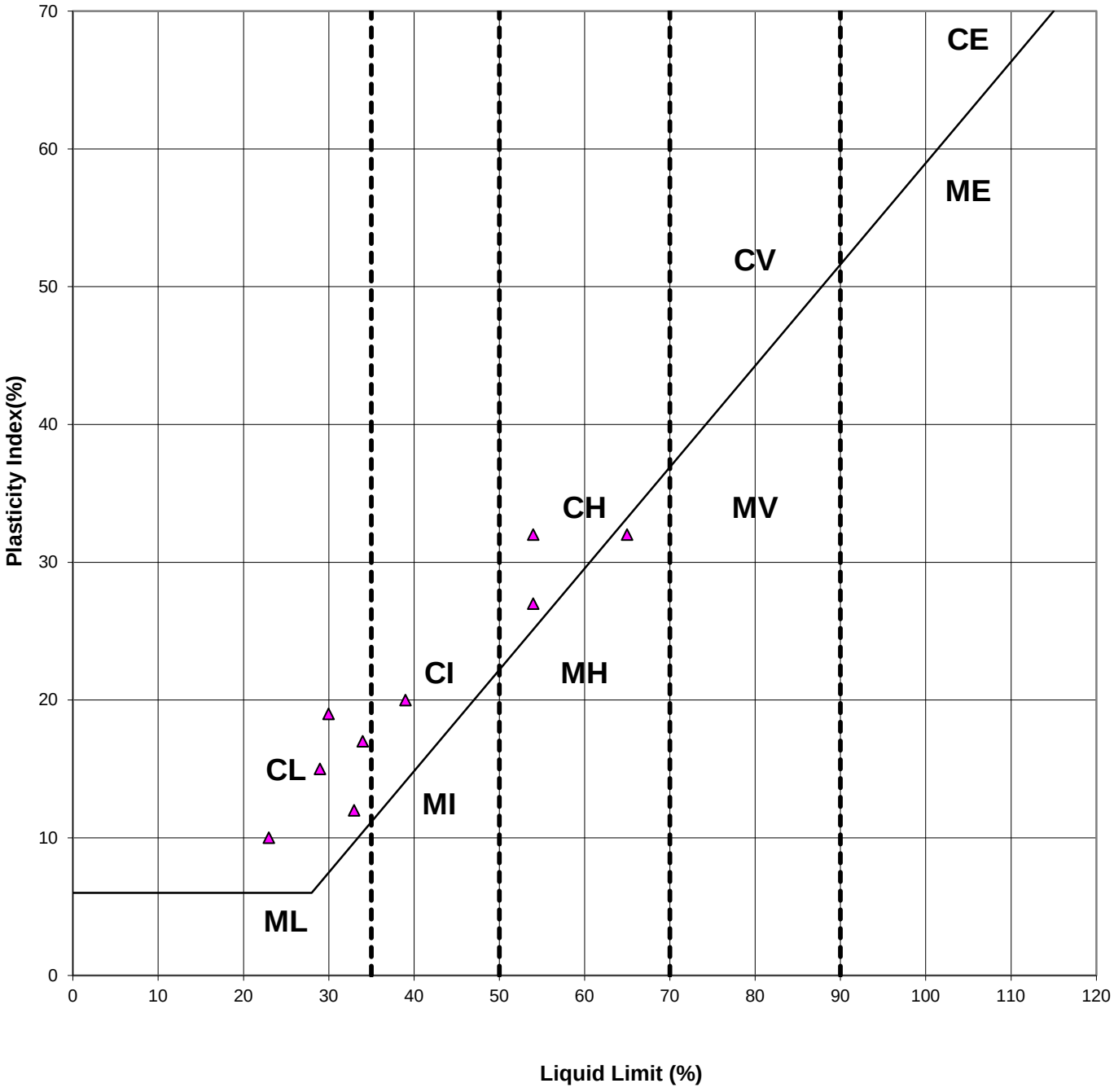
Glaciofluvial - Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-2**	



Glaciofluvial - A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-3**	

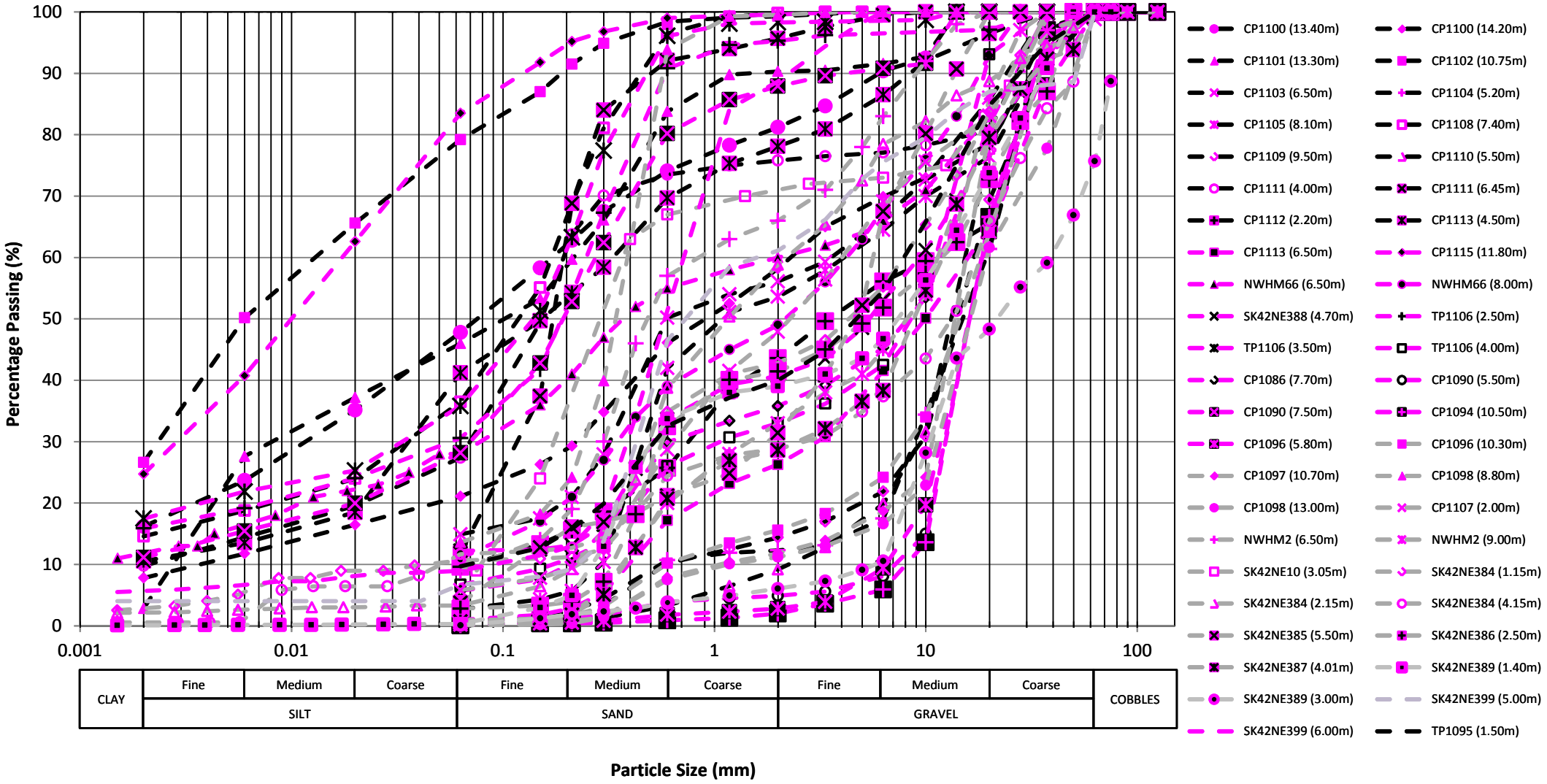


Key

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CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
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CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

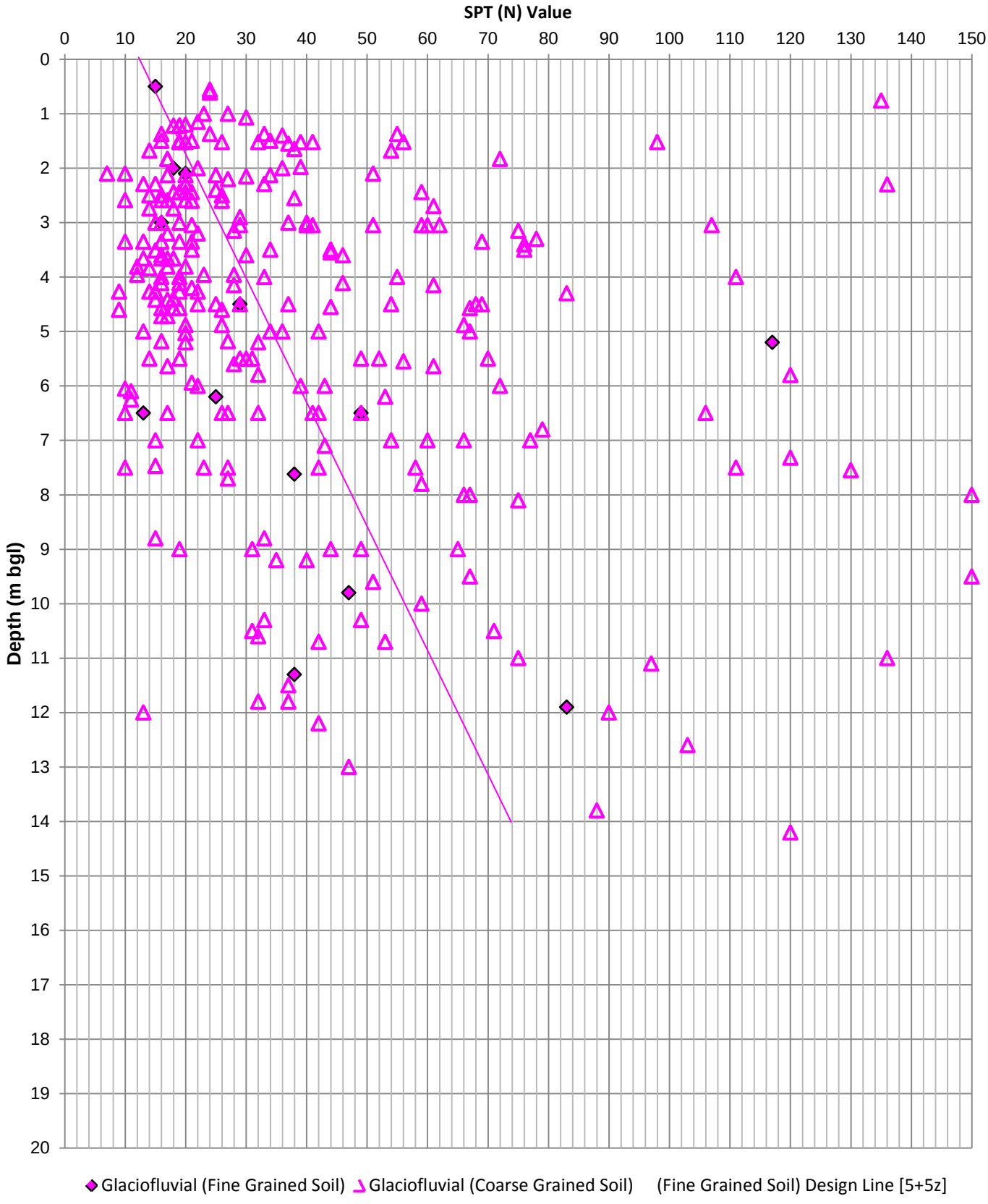
Glaciofluvial - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-4**	



Glaciofluvial - SPT N Value vs Depth

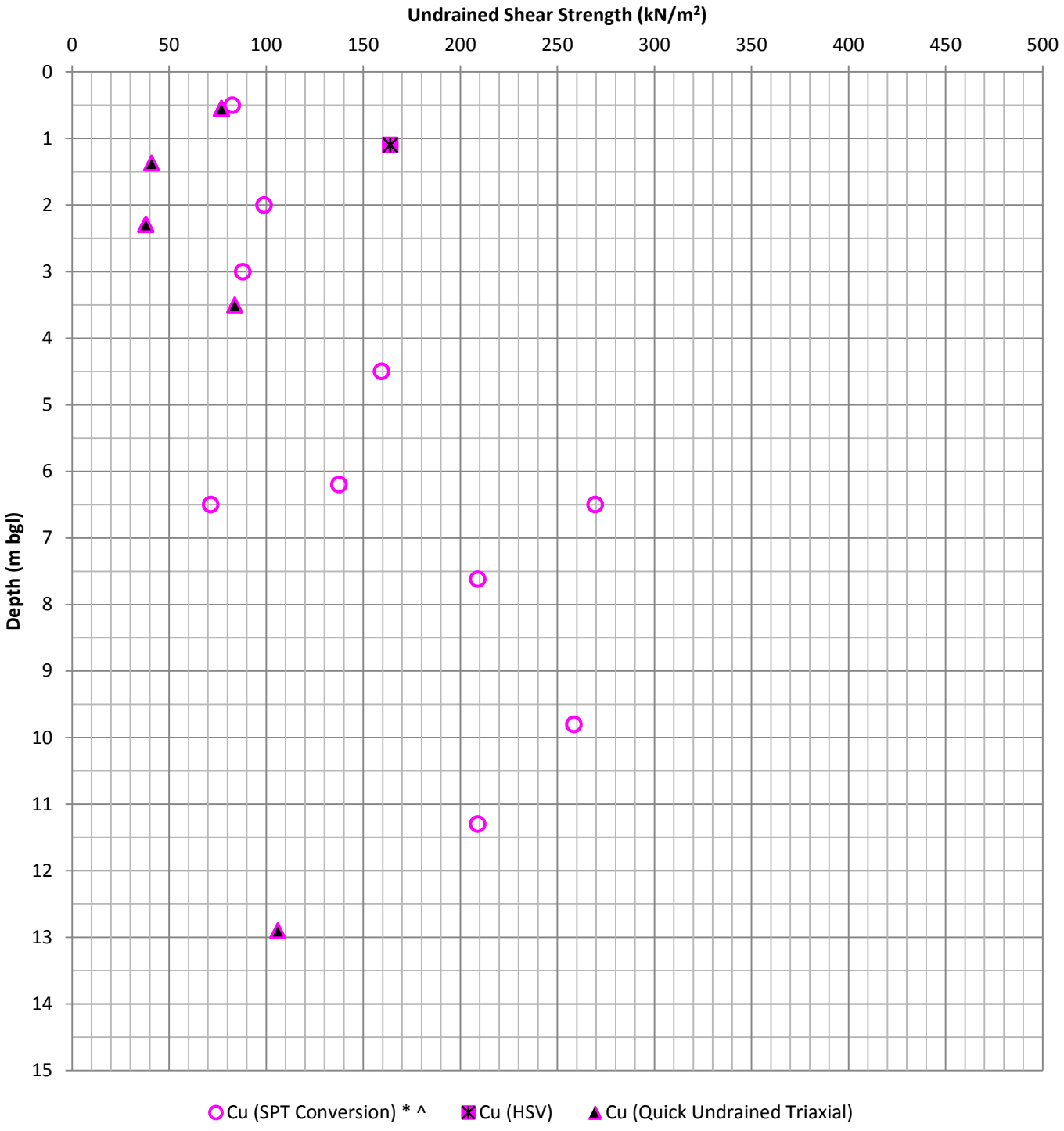
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-6**	



Extrapolated SPT (N) Values >150 have not been shown

Glaciofluvial - Undrained Shear Strength (Fine Grained Component)

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-7**	



Average PI = 17 Assumed *f*1 = 5.5

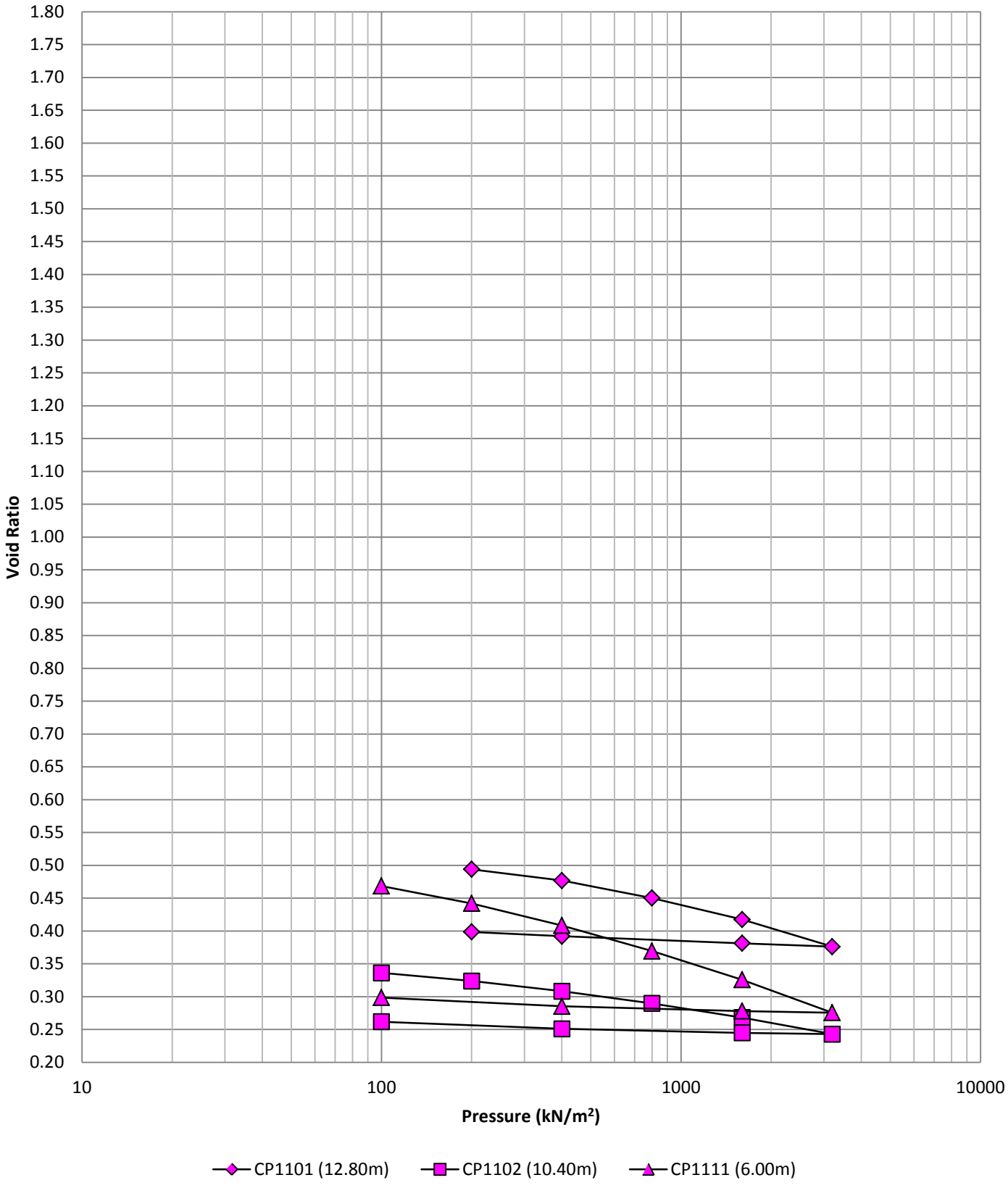
*Stroud, M. A., The Standard Penetration Test in Insensitive Clays and Soft Rocks, Proceedings of the European Symposium on Penetration Testing, **2**, 367-375, 1975.

1 No. Cu value derived from SPT N Values falls beyond the limits of this chart with a results of 869 kPa

^ Cu SPT Conversion based on Fine Grained Soils Only

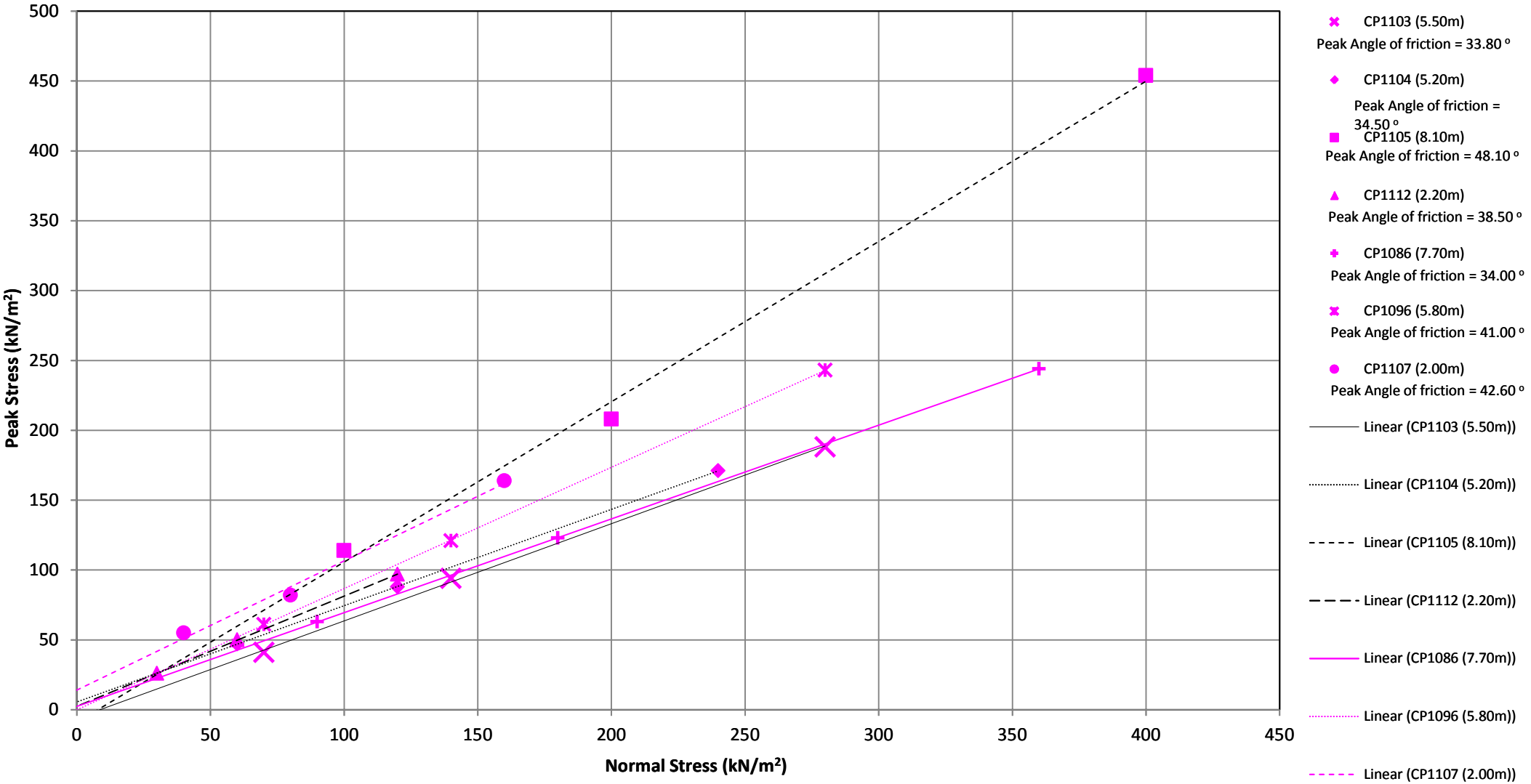
Glaciofluvial - One Dimensional Consolidation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-8**	



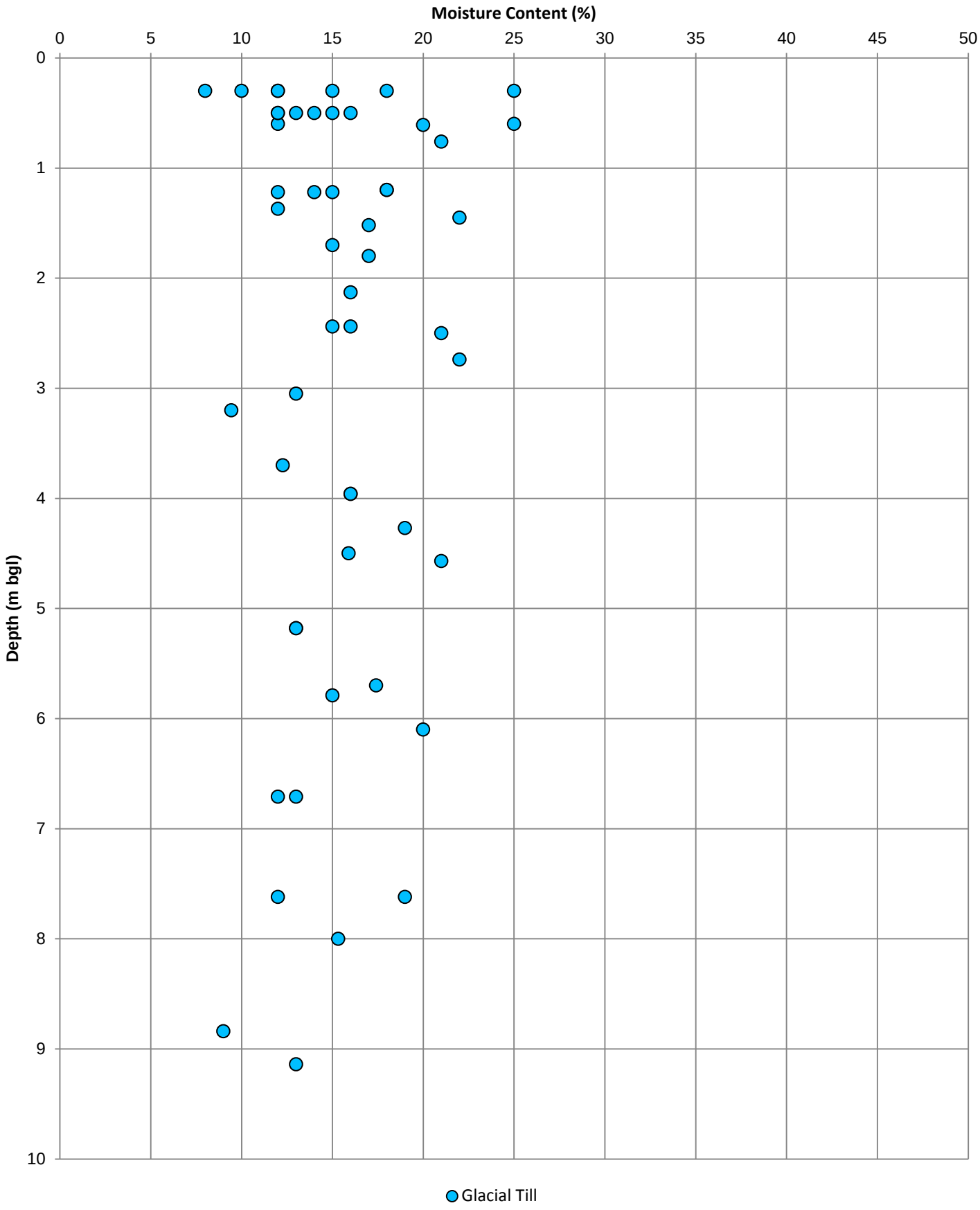
Glaciofluvial - Drained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-5-9**	



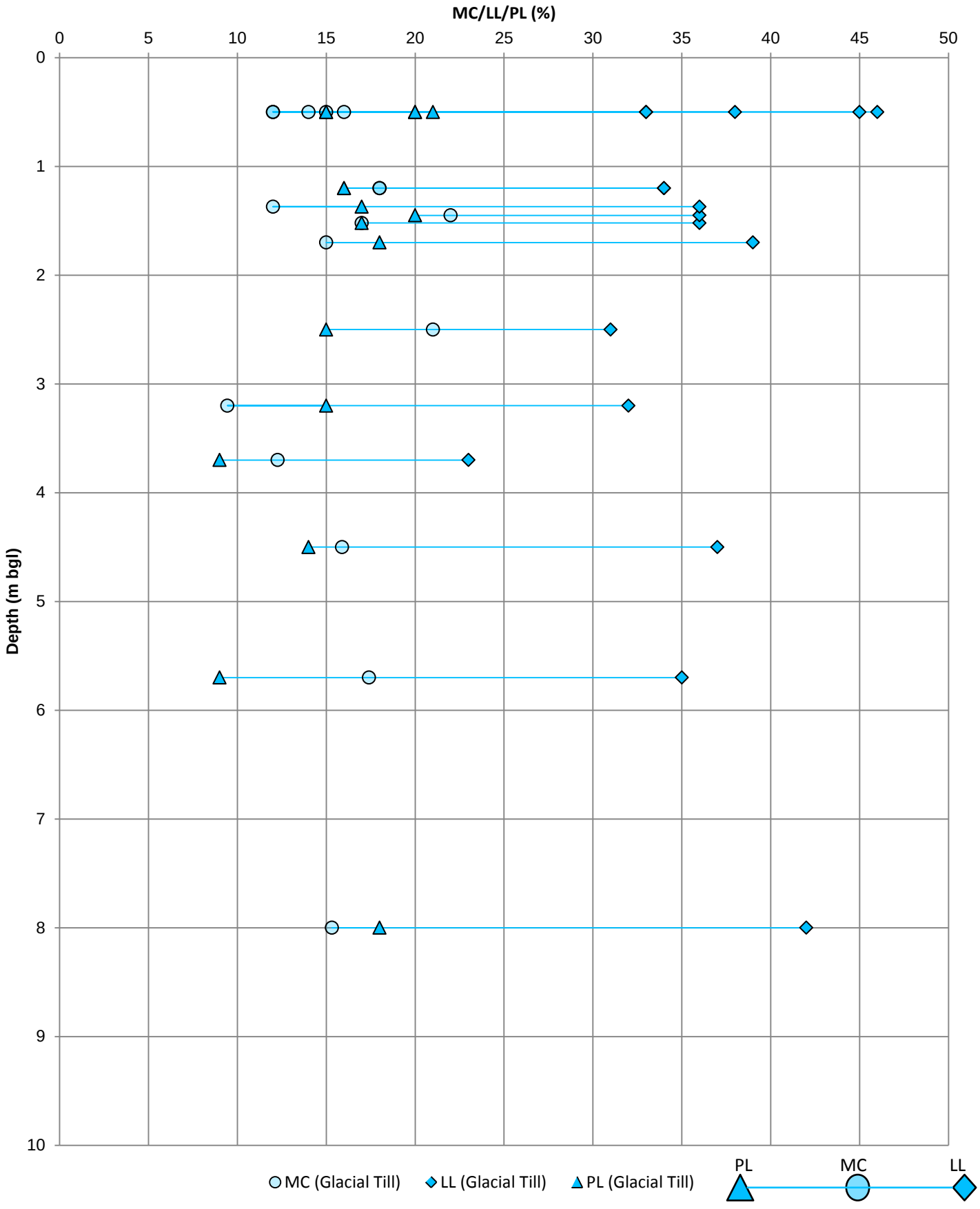
Glacial Till - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-1**	



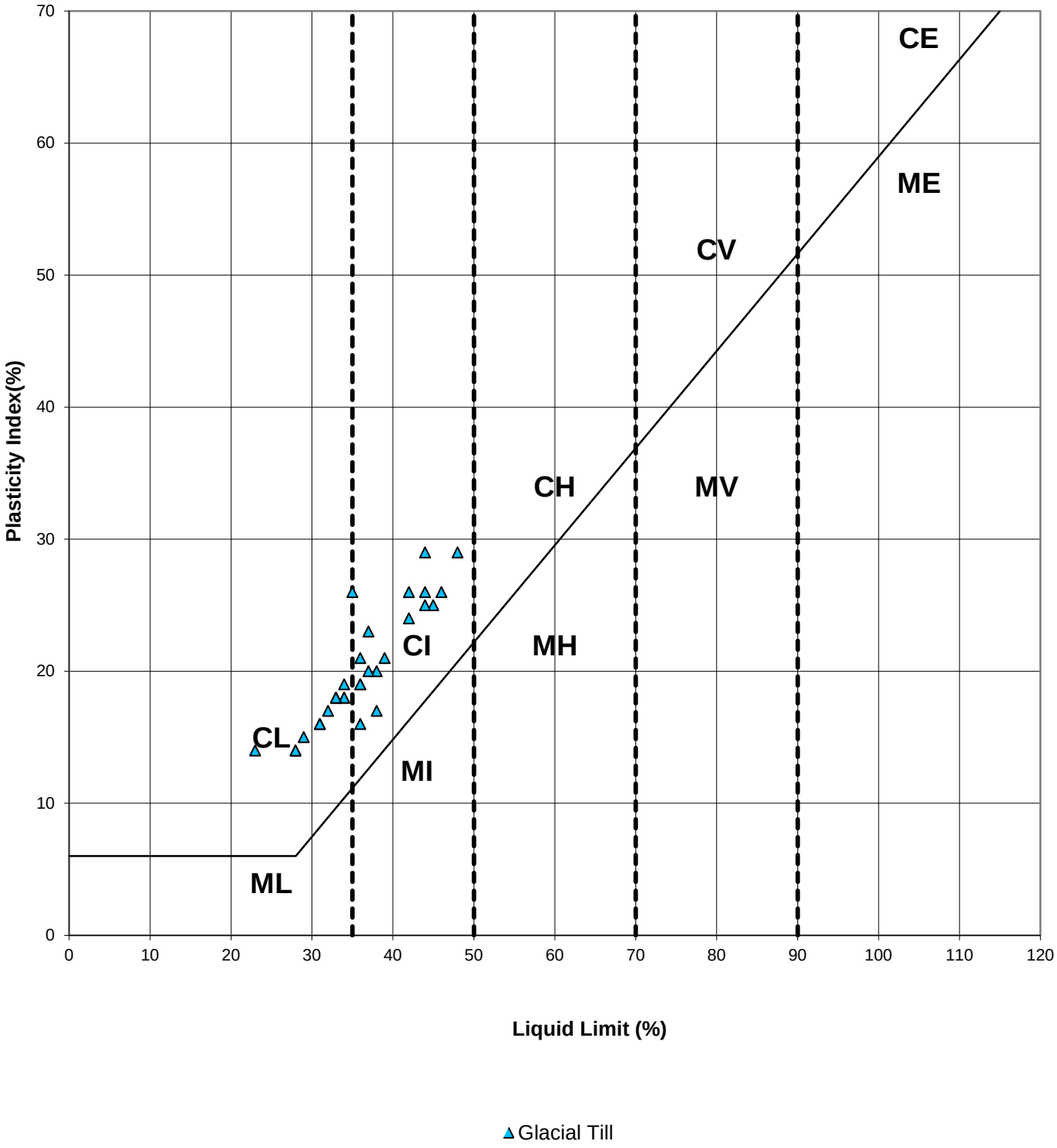
Glacial Till - Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-2**



Glacial Till - A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-3**	

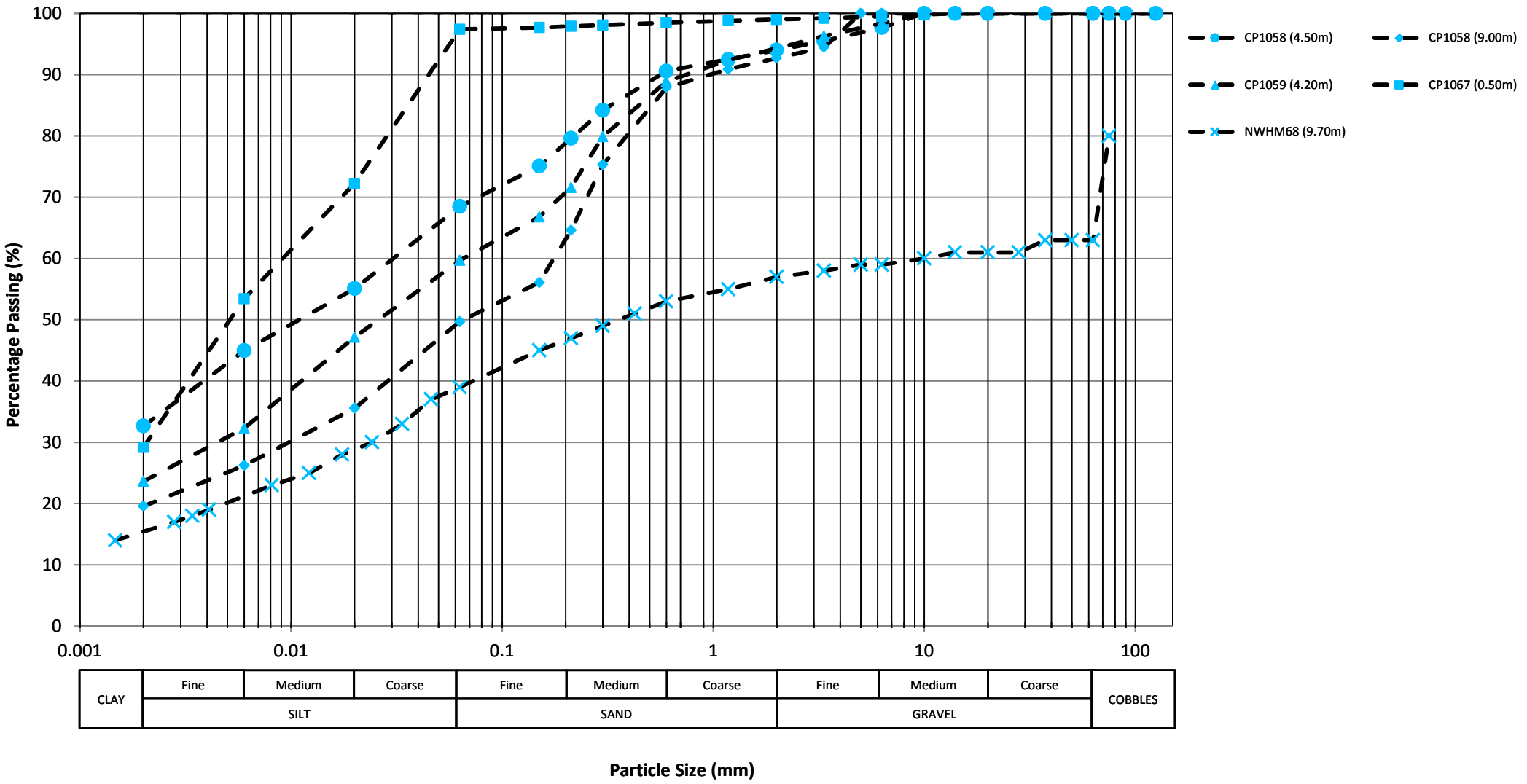


Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

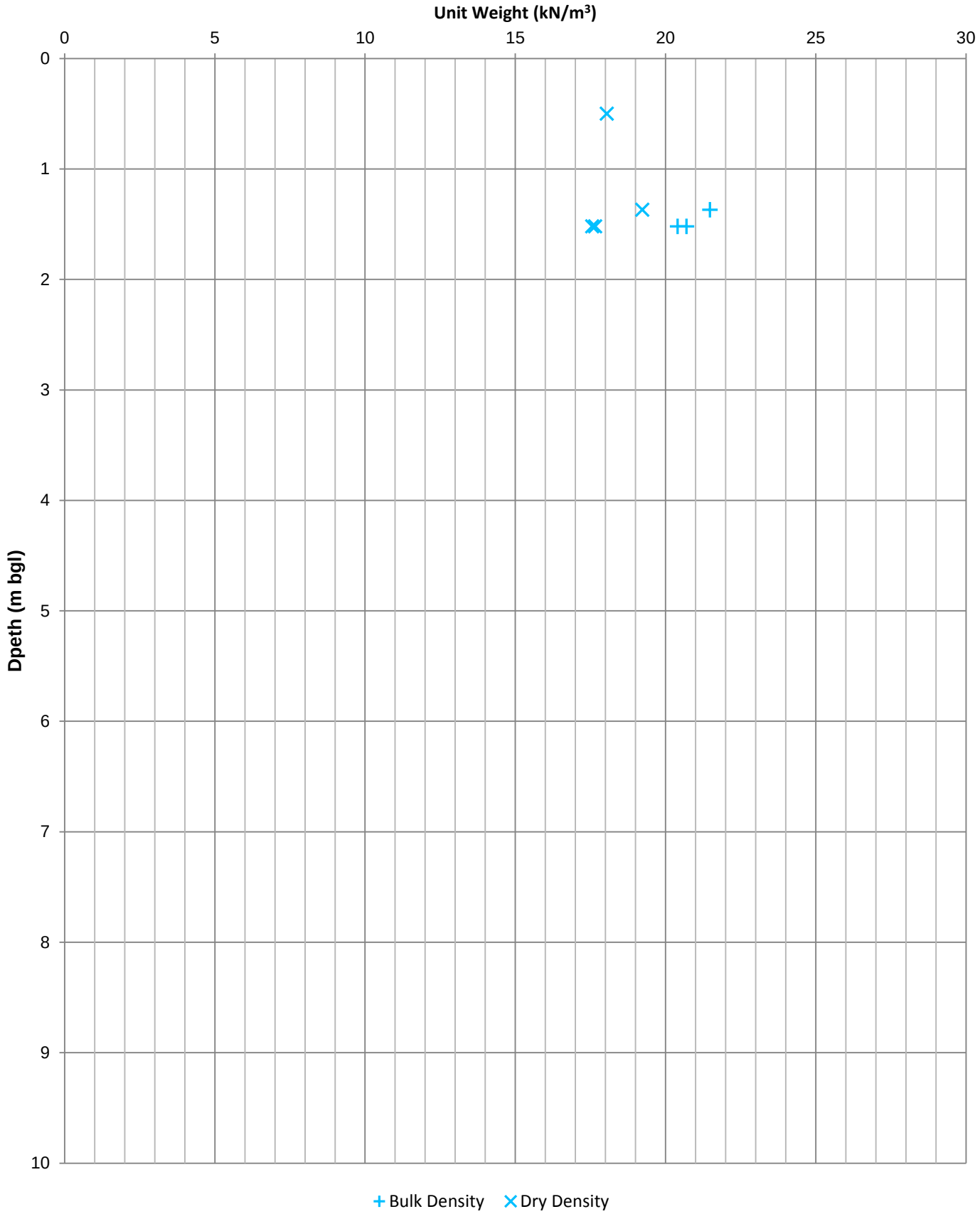
Glacial Till - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-4**	



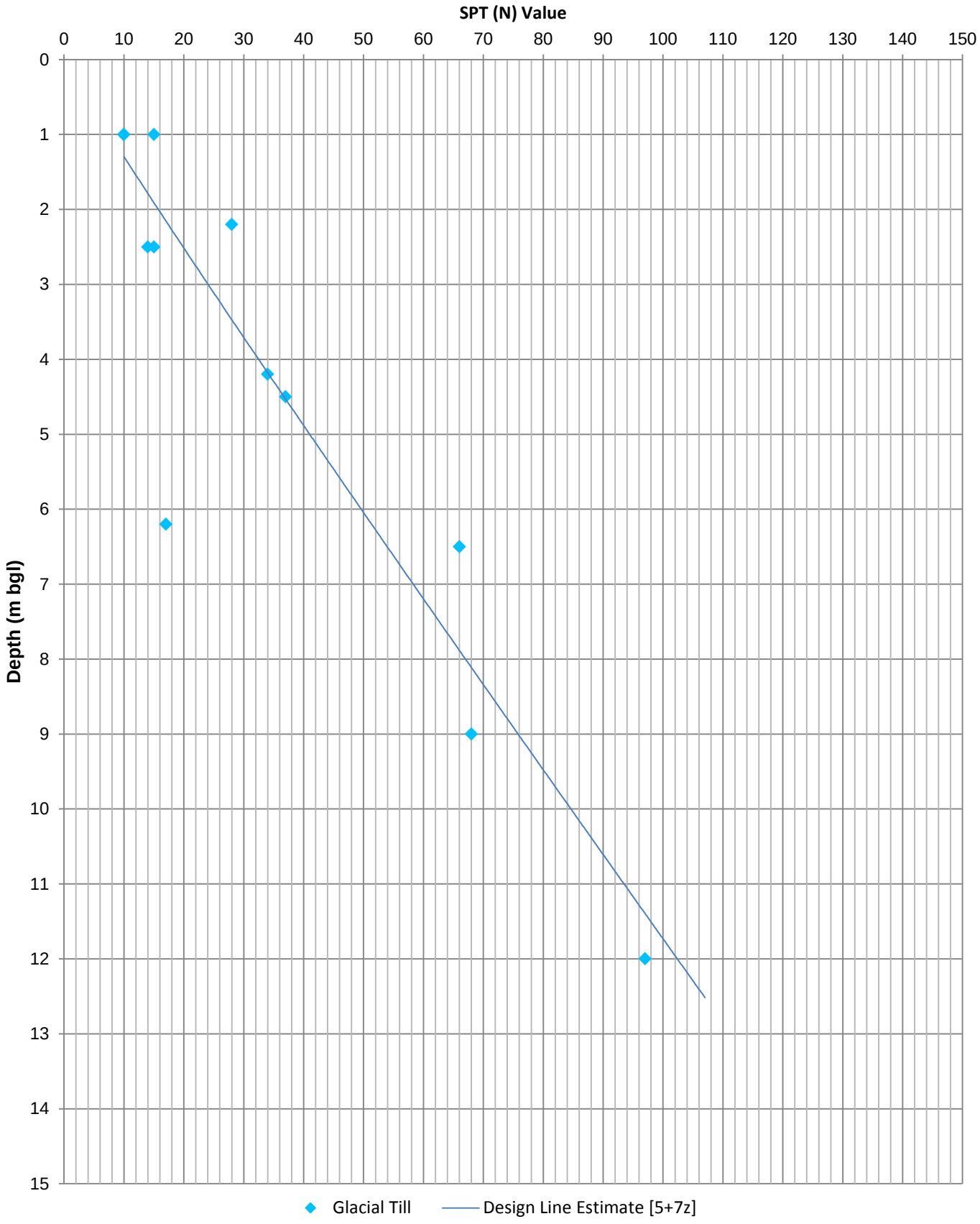
Glacial Till - Unit Weight

Project ID: **COCDFL1SMP01**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-5**	



Glacial Till - SPT N Value vs Depth

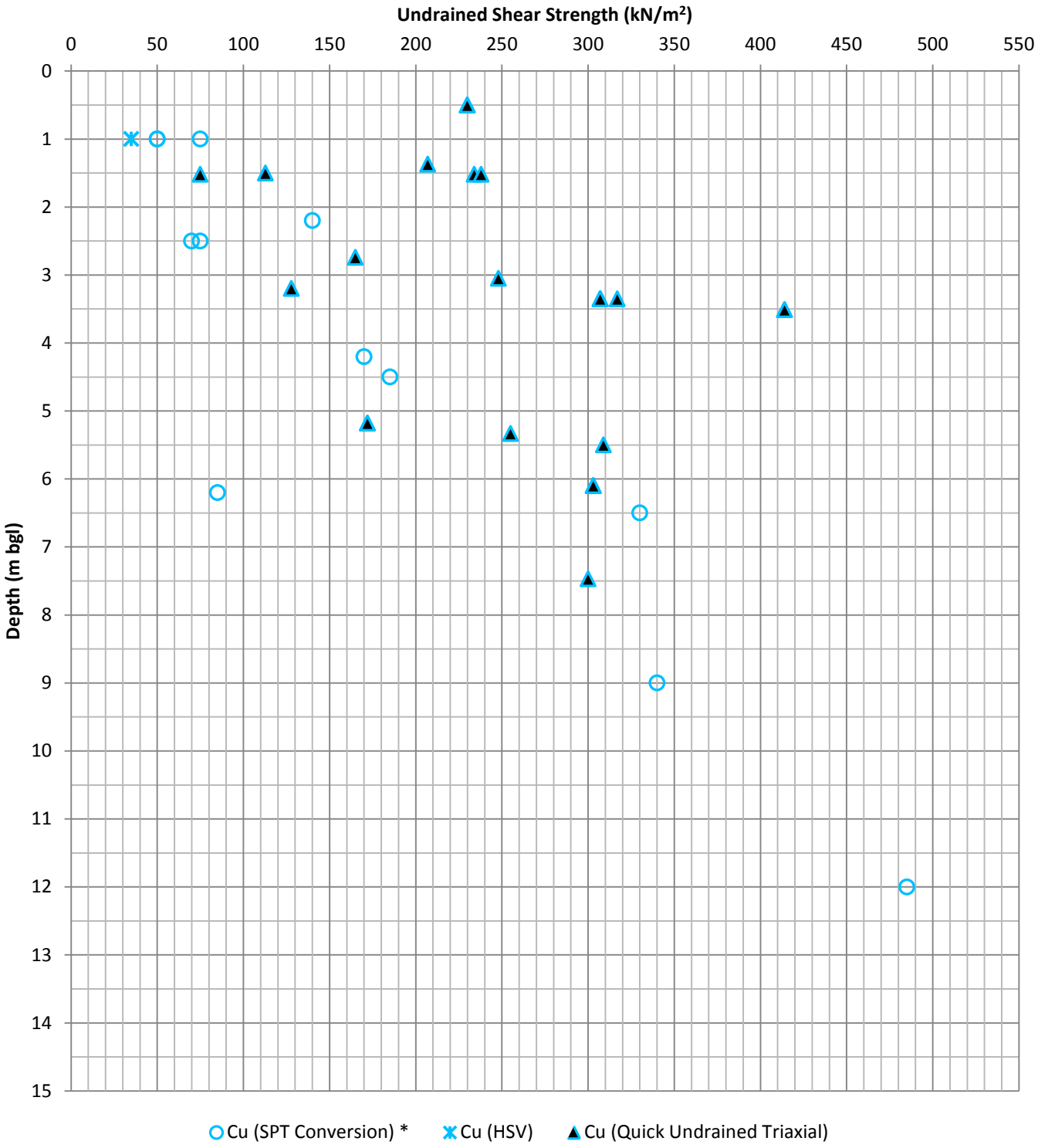
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-6**	



Extrapolated SPT (N) Values >150 are not shown

Glacial Till - Undrained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-7**	



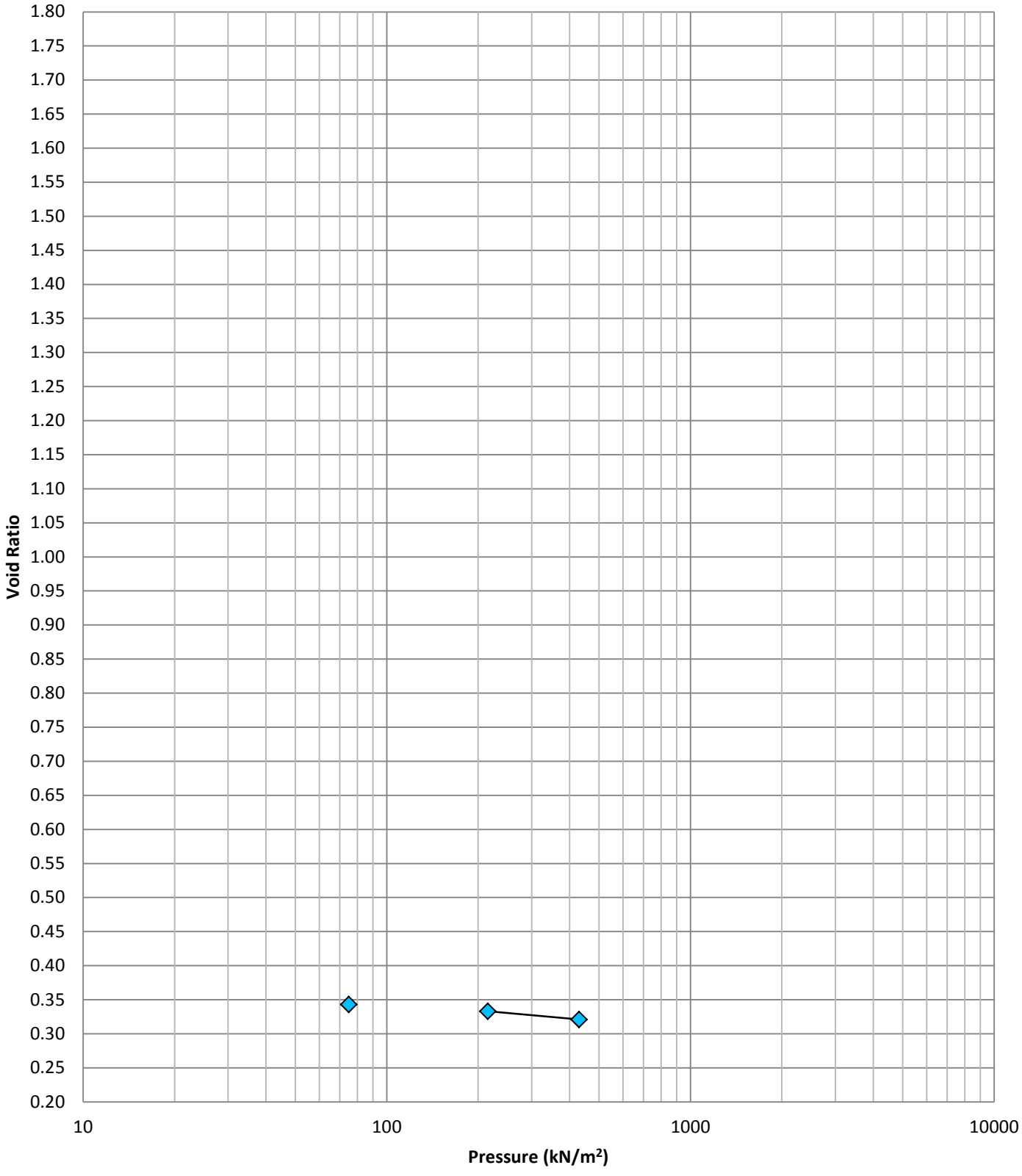
Average PI = 20 Assumed $f1$ = 5

*Stroud, M. A., The Standard Penetration Test in Insensitive Clays and Soft Rocks, Proceedings of the European Symposium on Penetration Testing, **2**, 367-375, 1975.

1 No. Cu value derived from SPT N Values falls beyond the limits of this chart with a result of 7500 kPa

Glacial Till - One Dimensional Consolidation

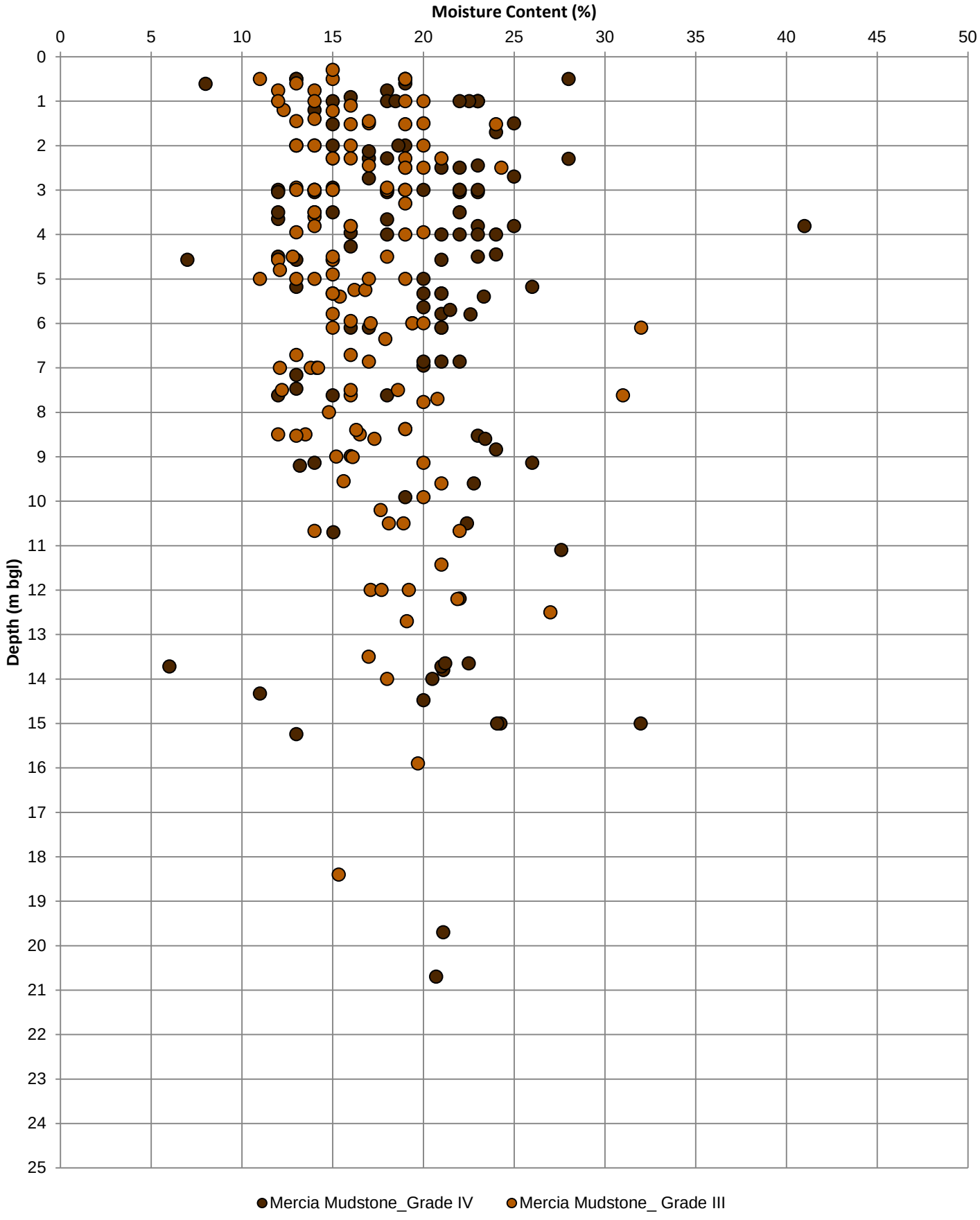
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-6-8**	



Voids ratio result for 2nd increment at 107 kN/m² missing from AGS data

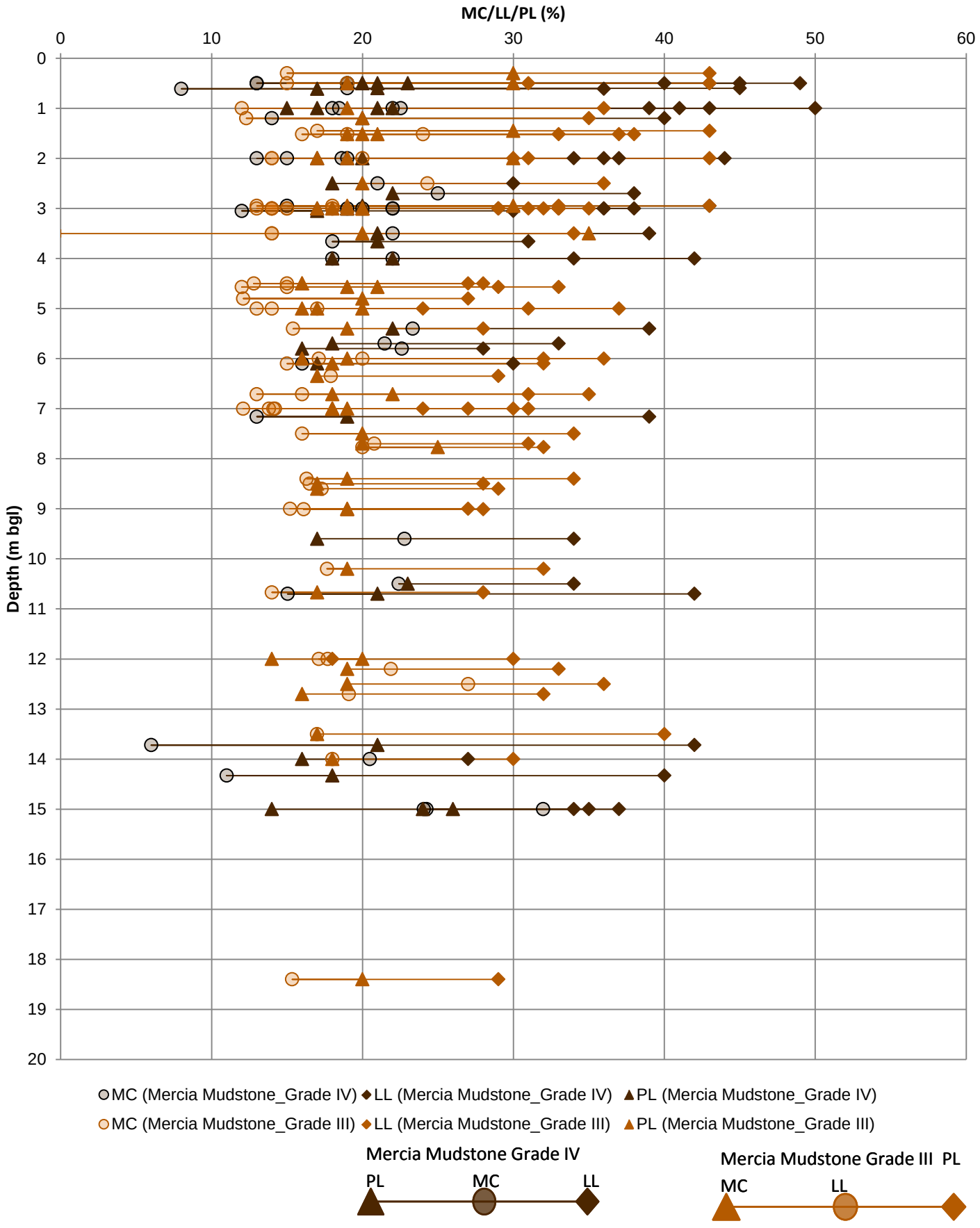
Weathered Merica Mudstone - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-1**	



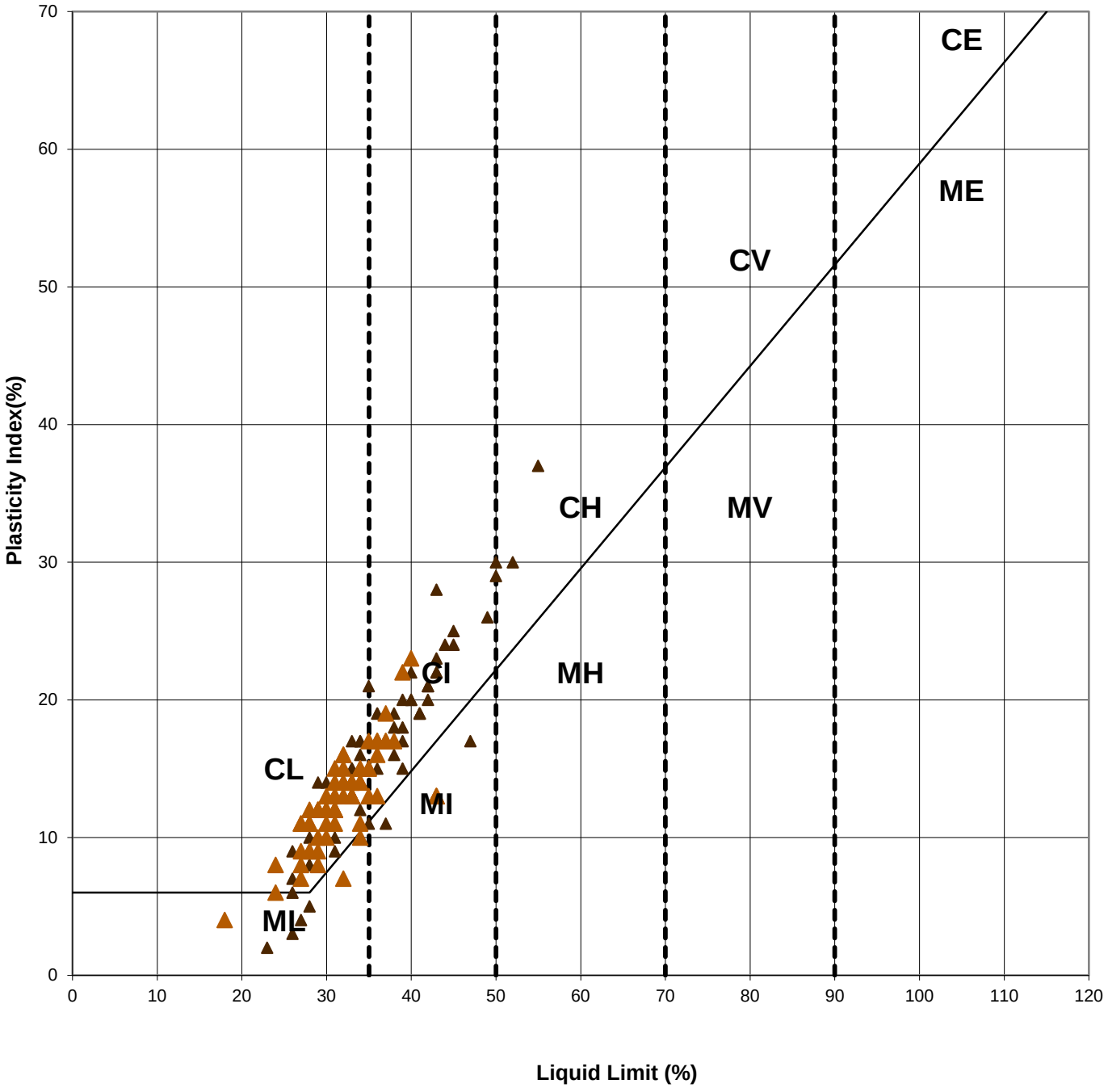
Weathered Mercia Mudstone - Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-2**	



Weathered Mercia Mudstone - A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-3**	

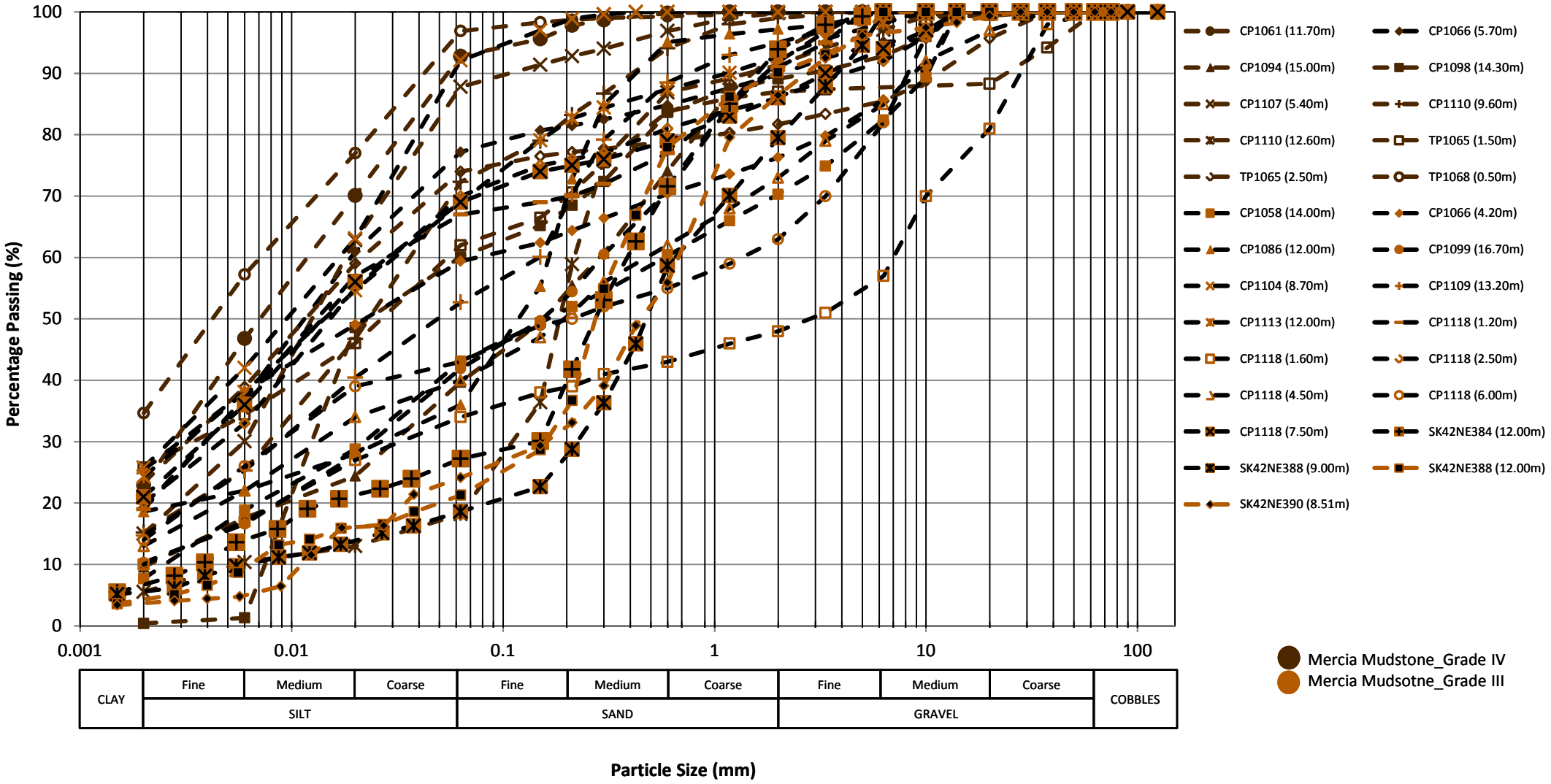


Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

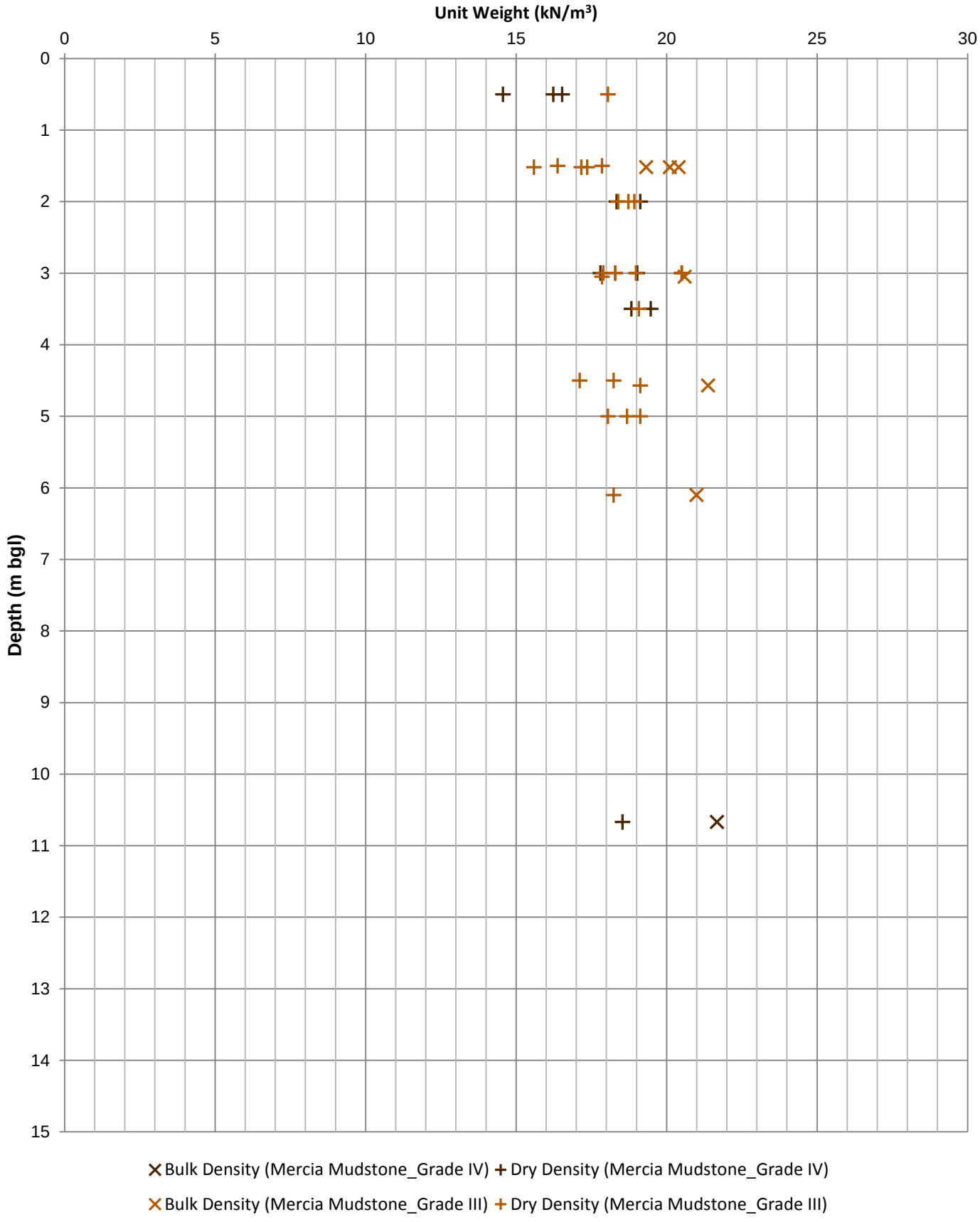
Weathered Mercia Mudstone - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-4**	



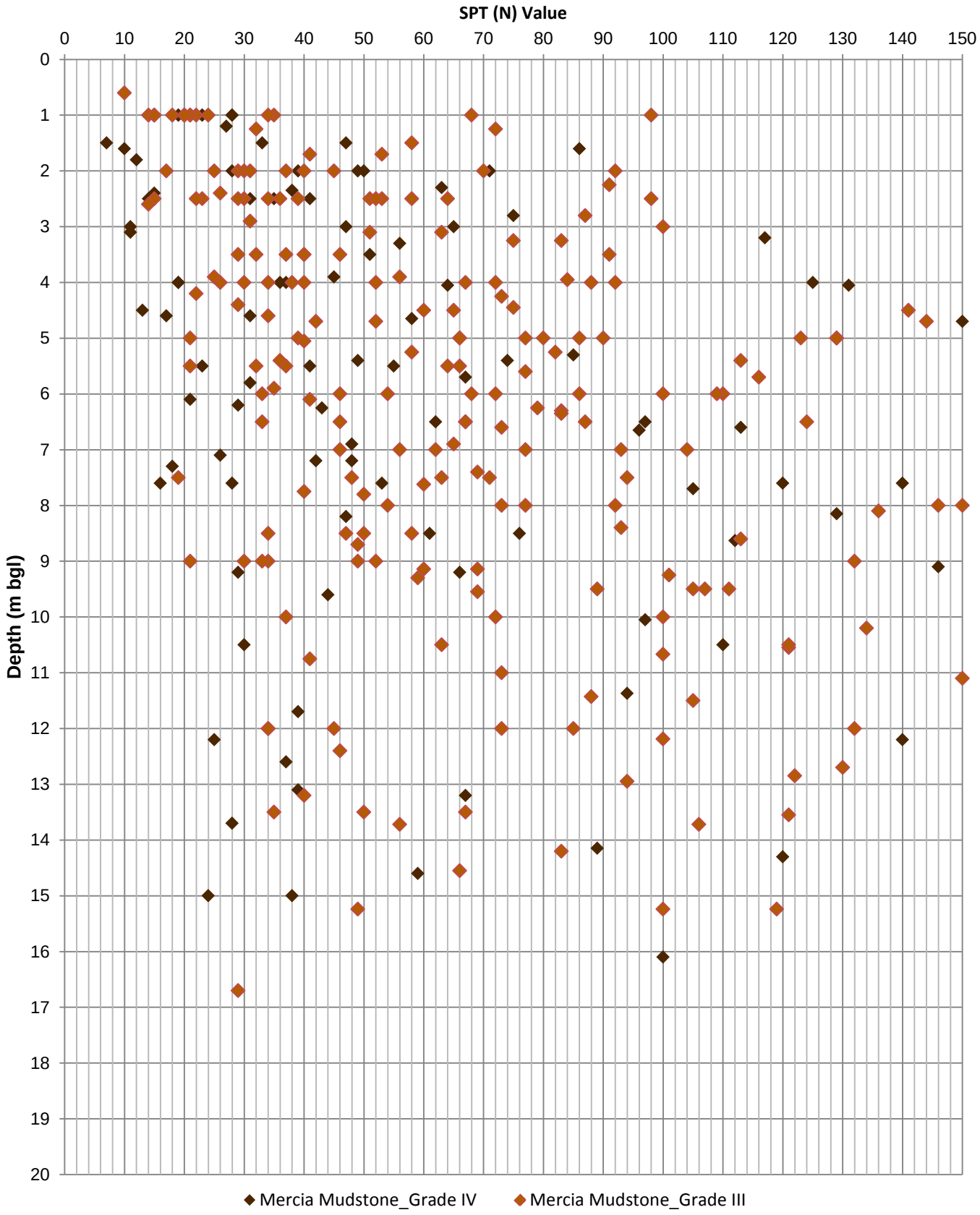
Weathered Mercia Mudstone - Unit Weight

Project ID: **COCDFL1SMP01**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-5**	



Mercia Mudstone - SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-6**	

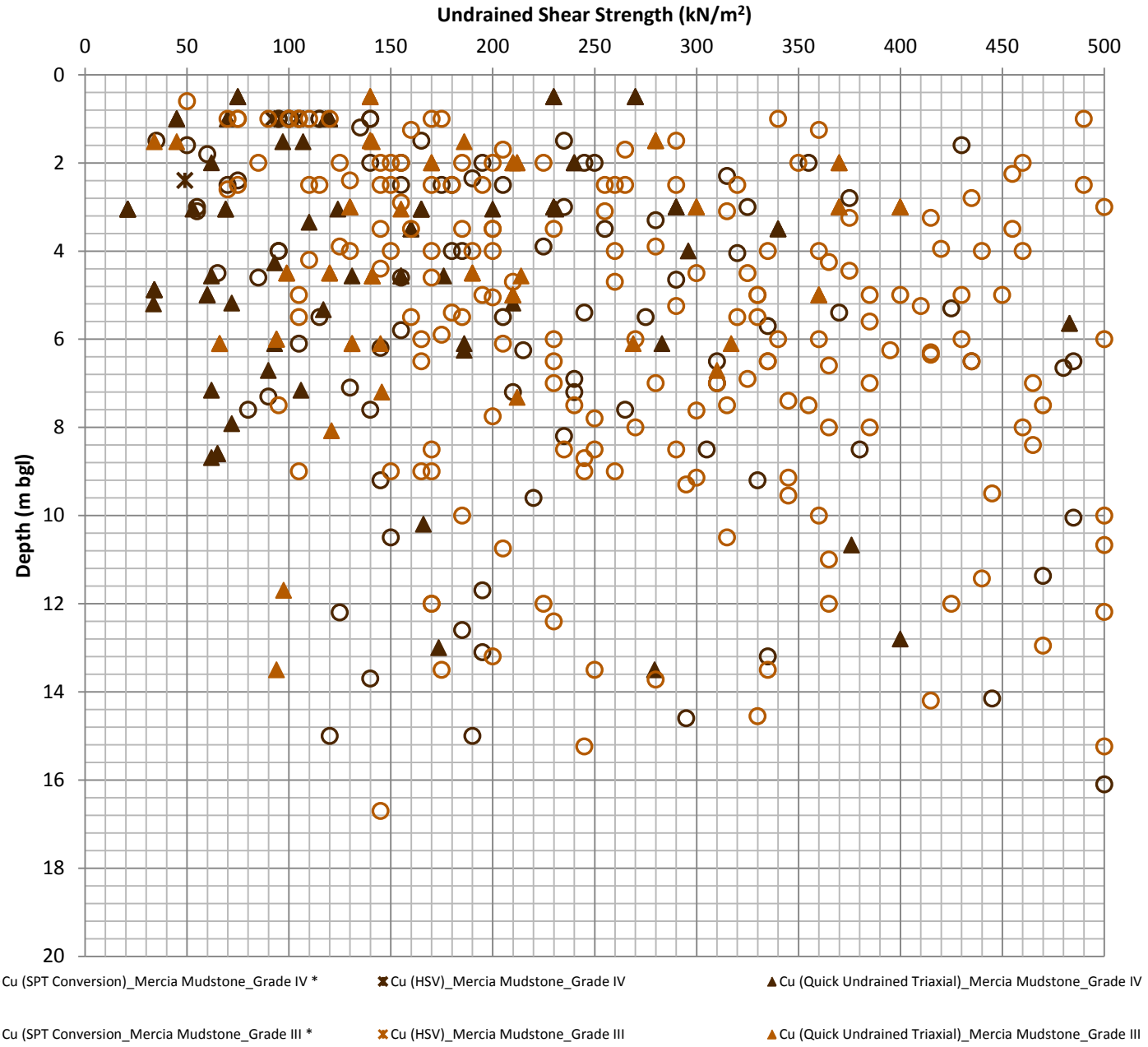


Extrapolated SPT (N) Values >150 are not shown

Extrapolated SPT (N) Values range from 112 - 210 in Grade IV Mudstone (21 No.) & 101 - 1050 in Grade III Mudstone (129 No.)

Weathered Mercia Mudstone - Undrained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-7**	



Mercia Mudstone_Grade IV

Average PI = 14 Assumed *f*1 = 5 ** ** Ciria C570

Mercia Mudstone_Grade III

Average PI = 15 Assumed *f*1 = 5 **

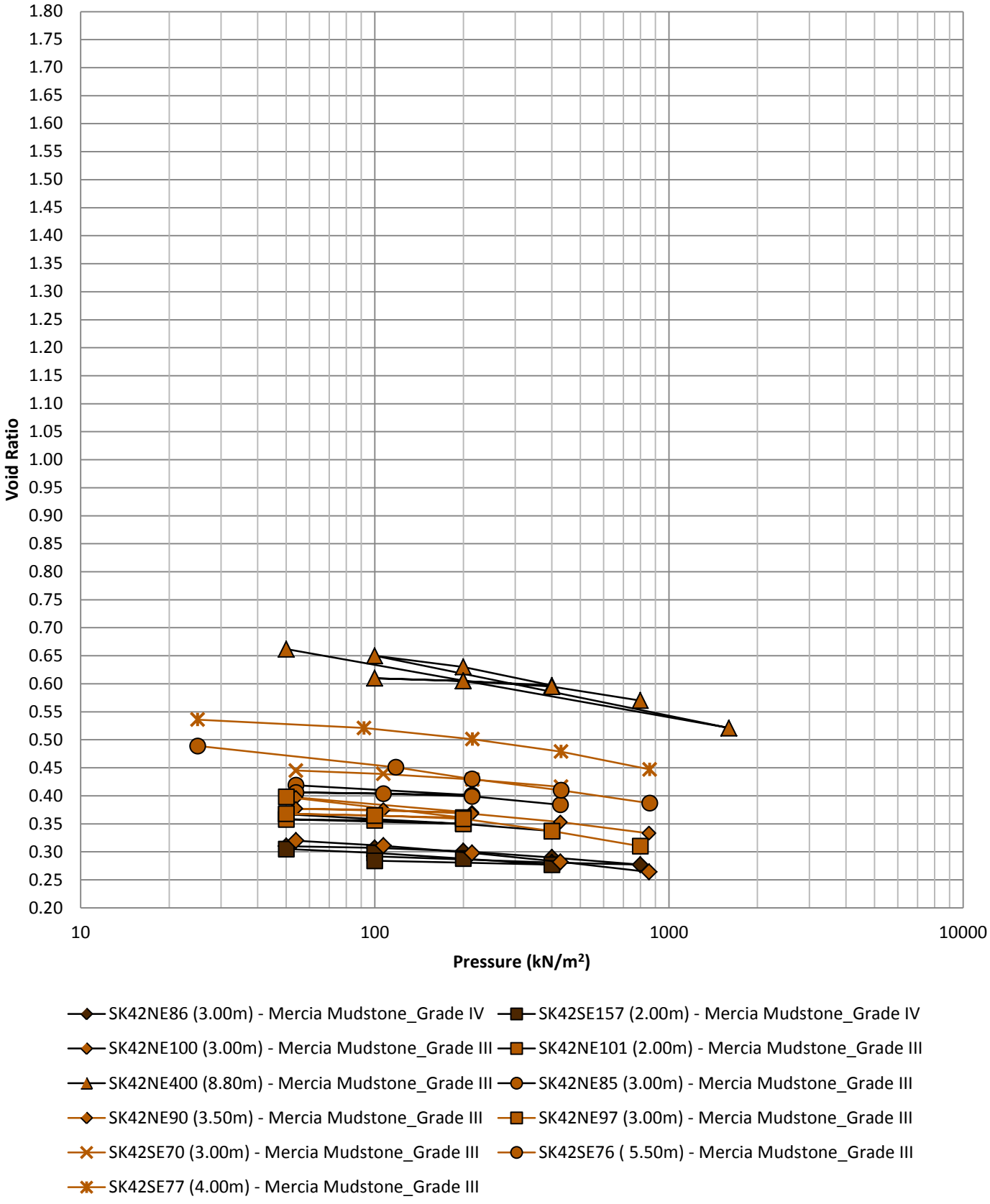
*Stroud, M. A., The Standard Penetration Test in Insensitive Clays and Soft Rocks, Proceedings of the European Symposium on Penetration Testing, **2**, 367-375, 1975.

21 No. Cu values derived from SPT N Values from the Grade IV Mercia Mudstone fall beyond the limits of this chart with results ranging from 560 - 1250 kPa

148 No. Cu values derived from SPT N Values from the Grade III Mercia Mudstone fall beyond the limits of this chart with results ranging from 550 - 5250 kPa

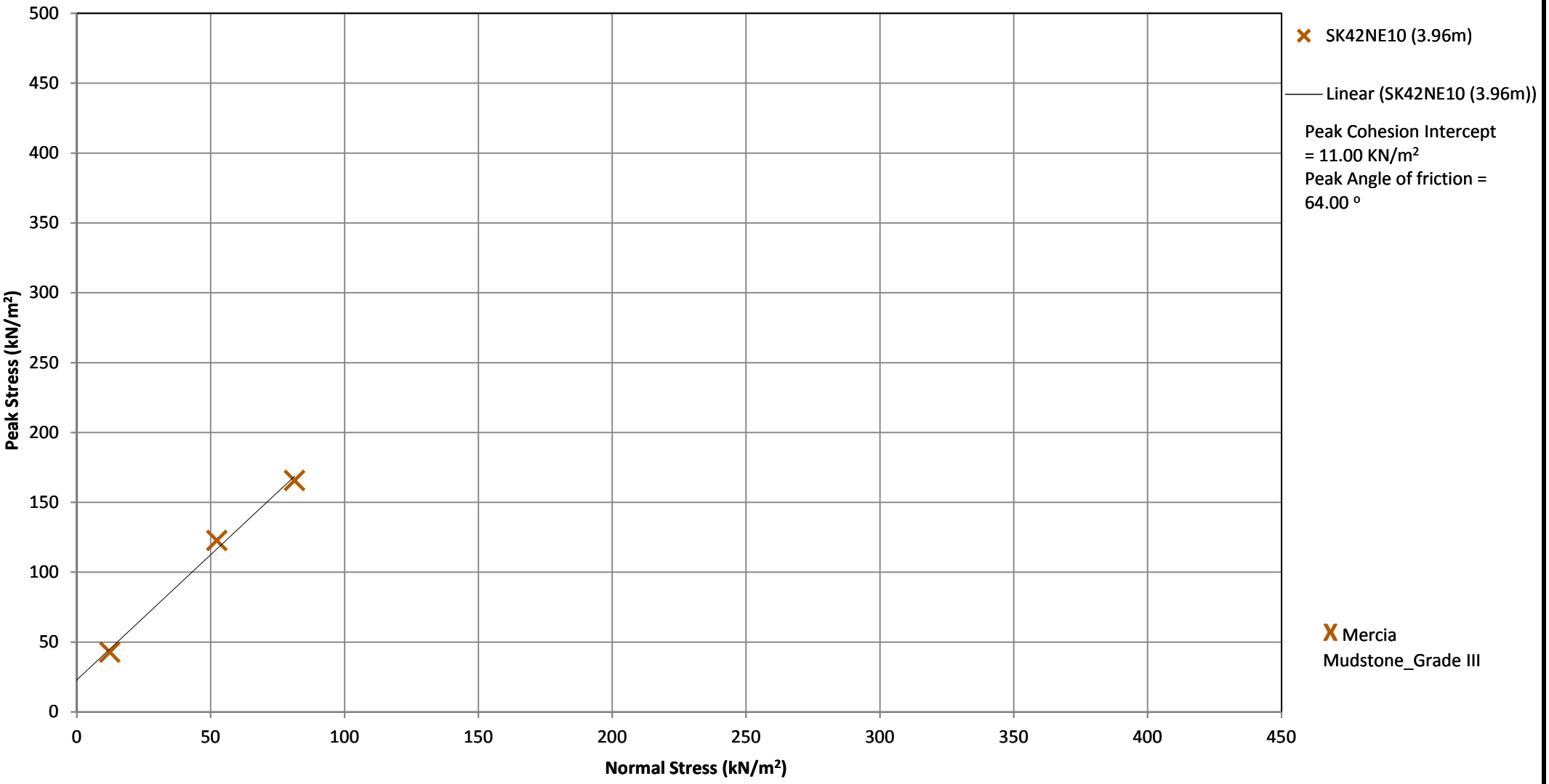
Weathered Mercia Mudstone - One Dimensional Consolidation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-8**	



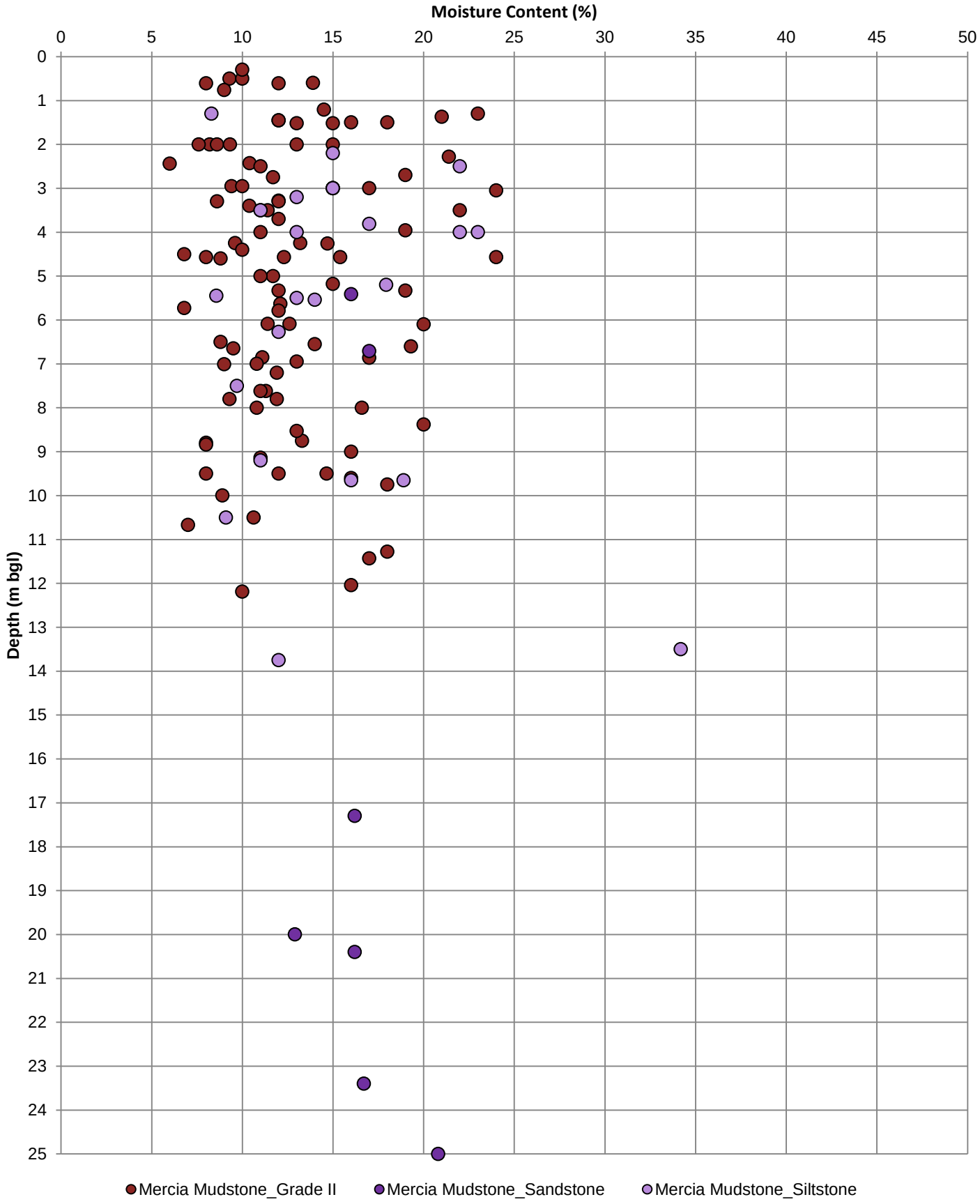
Weathered Mercia Mudstone - Drained Shear Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-7-9**	



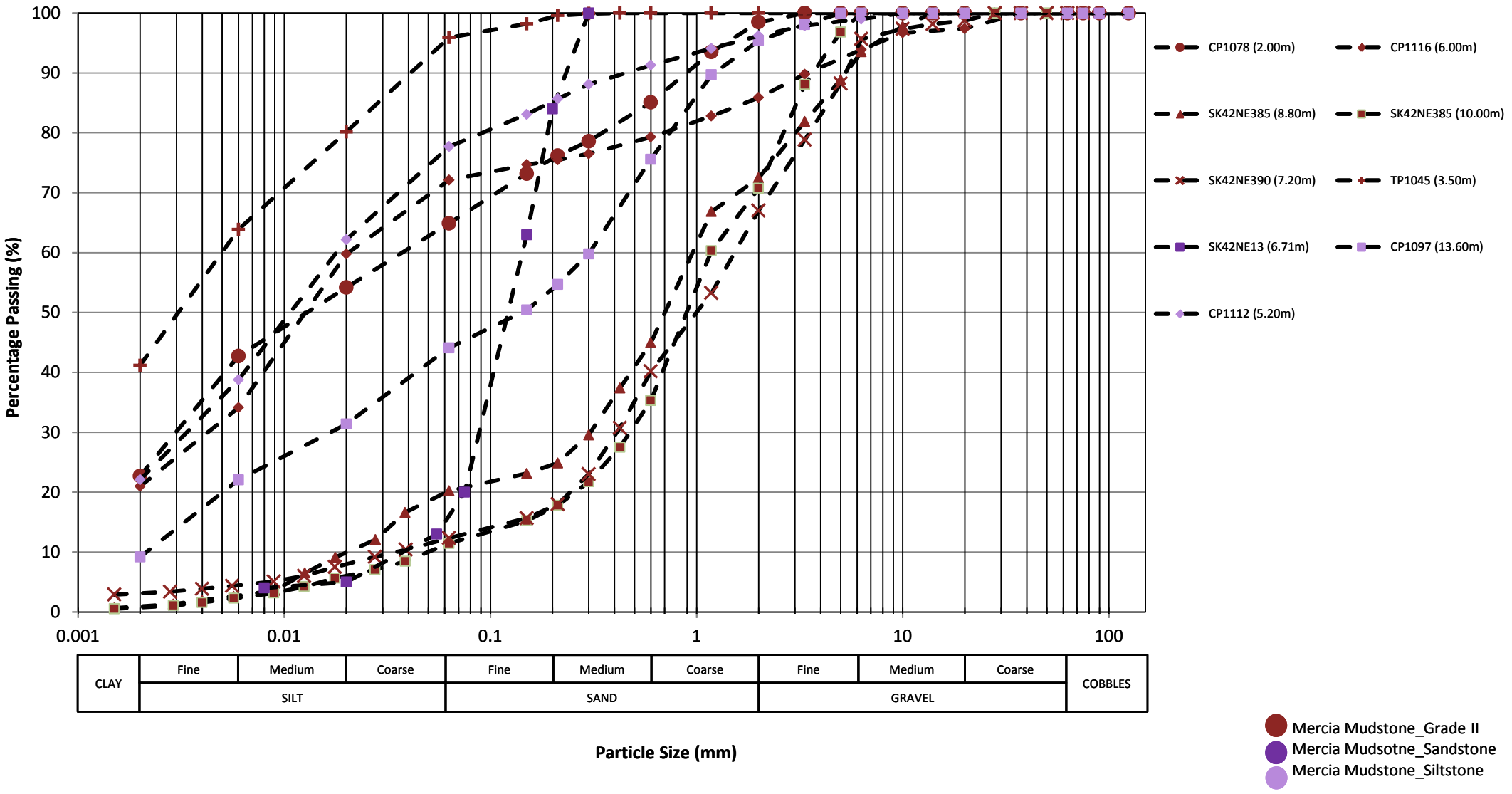
Mercia Mudstone - Moisture Content

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-8-1**	



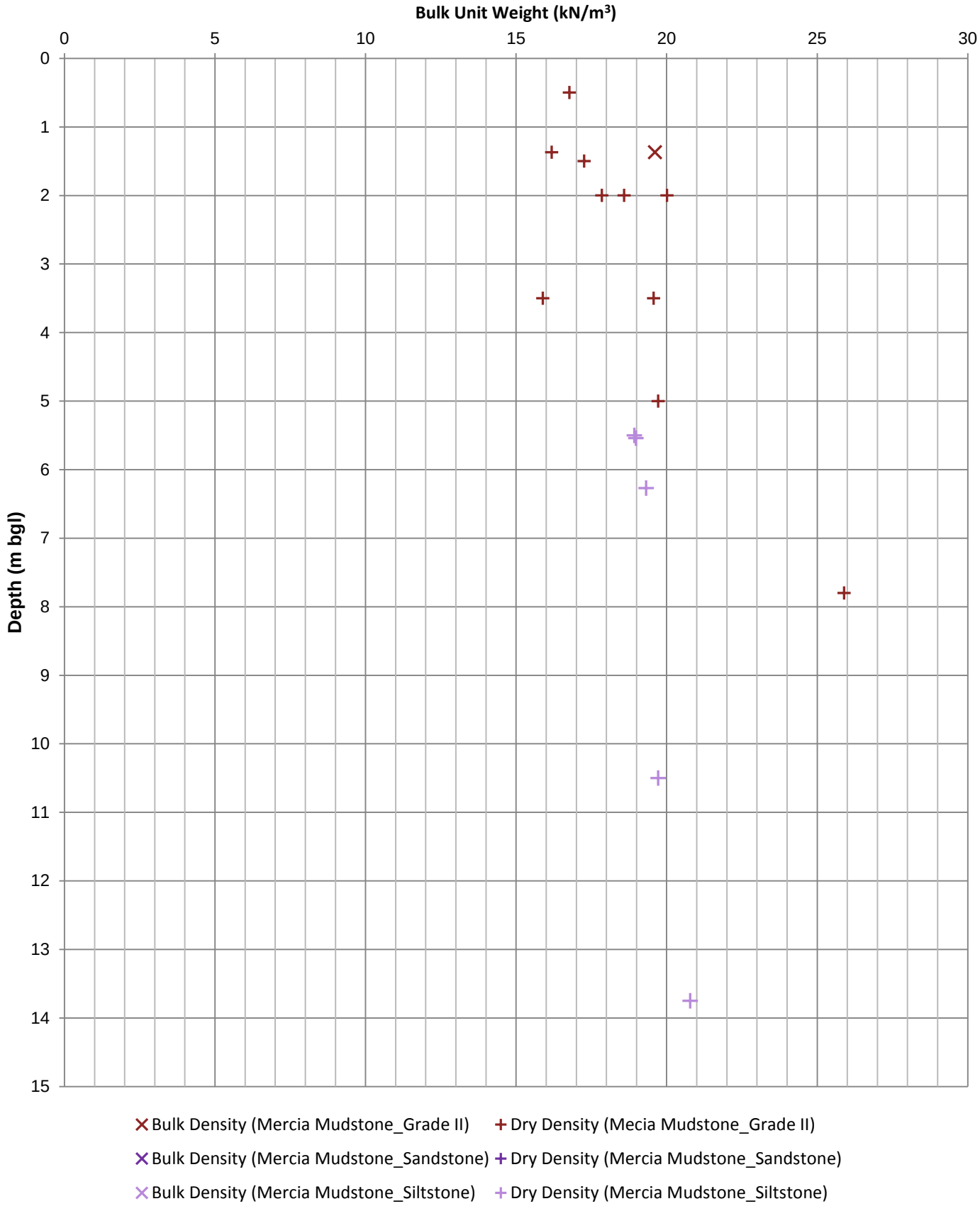
Mercia Mudstone - Grading Results

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-8-4**	



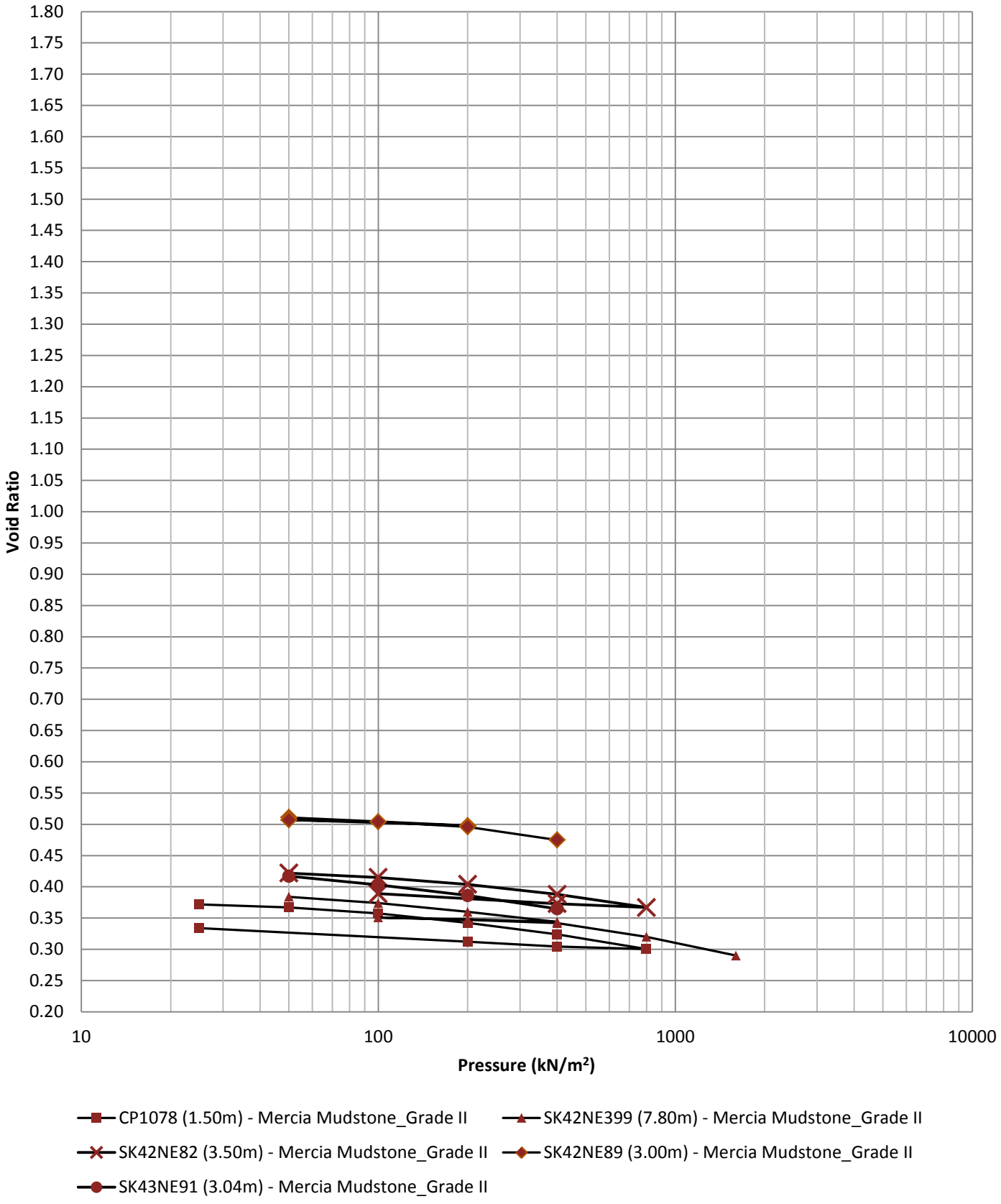
Mercia Mudstone - Unit Weight

Project ID: **COCDFL1SMP01**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-8-5**	



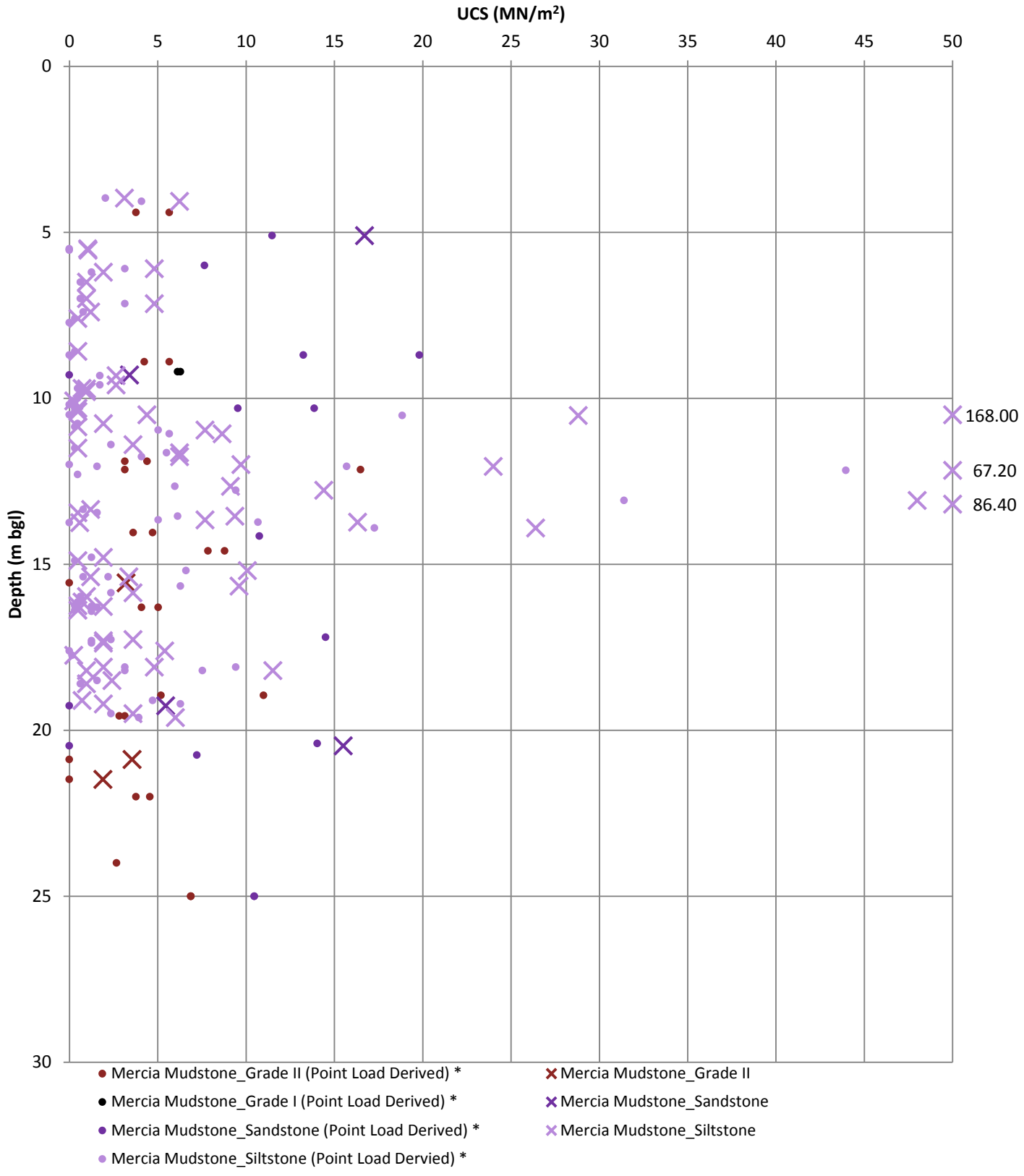
Mercia Mudstone - One Dimensional Consolidation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-8-8**	



Mercia Mudstone - Unconfined Compressive Strength

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-8-10**	

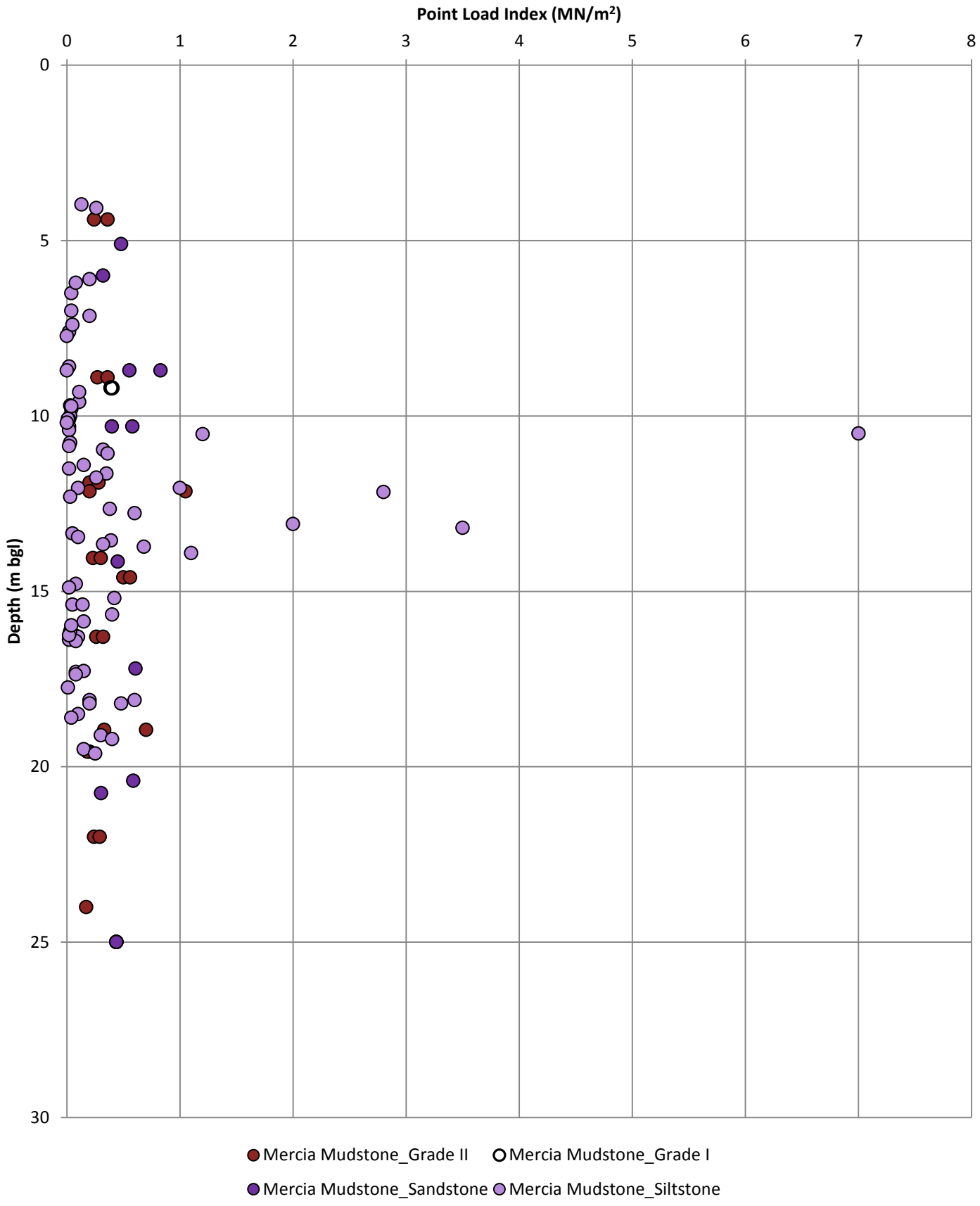


Mercia Mudstone Grade II Poind Load to UCS Conversion Factor = 15.7
Mercia Mudstone Grade I Poind Load to UCS Conversion Factor = 15.7
Mercia Mudstone (Sandstone) Poind Load to UCS Conversion Factor = 23.9
Mercia Mudstone (Siltstone) Poind Load to UCS Conversion Factor = 15.7

* Hobbs et al, Engineering Geology of British Rocks and Soils - Mudstones of the Mercia Mudstone Group, BGS Research Report RR/01/02, 2002

Mercia Mudstone - Point Load

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Report Title: **Ground Investigation Report**
Client: **Highways England**	Figure: **5-8-11**	



Appendix A. Preliminary Geotechnical Schedule

Table A-1 – Preliminary Geotechnical Schedule

Asset	Reference	Chainage	Carriageway	Earthwork Type	Maximum Earthwork Height (m)*	Maximum Earthwork Angle (°)*	Borehole Proximity (m)
Gantry	101	181950	NB	At Grade	0.7	6	7
ERA	E1-A1	185195-185305	NB	Cutting	5.9	23	76
Gantry	202	185880	SB	Embankment	2.9	15	37
Gantry	203	186400	SB	At Grade	1.9	12	26
Gantry	204	186476	NB	Embankment	2.0	23	67
Gantry	301	186630	SB	At Grade	0.0	0	45
ERA	E2-A1	186645-186755	NB	Embankment	3.4	20	28
Gantry	302	187073	SB	Embankment	7.3	22	57
Gantry	326	187300	SB	Embankment	5.5	21	40
Gantry	303	187608	SB	Embankment	2.2	15	90
Gantry	304	187650	NB	Embankment	2.4	15	120
Gantry	305	187833	SB	Embankment	4.1	17	82
ERA	E3-A1	188395-188500	NB	Embankment	8.0	20	42
ERA	E3-B1	188395-188500	SB	Embankment	7.5	20	57
Gantry	307	188529	NB	Embankment	8.1	18	20
Gantry	308	188747	SB	Embankment	4.7	17	44
Gantry	309	188947	SB	Embankment	4.7	19	38
Gantry	311	189780	NB	Embankment	4.5	15	35
Gantry	311	189780	SB	Embankment	4.9	18	5
ERA	E3-B2	190455-190560	SB	Embankment	6.5	14	90
Gantry	312	190585	SB	Embankment	6.1	21	55
ERA	E3-A2	190815-190925	NB	Embankment	3.0	14	130

Asset	Reference	Chainage	Carriageway	Earthwork Type	Maximum Earthwork Height (m)*	Maximum Earthwork Angle (°)*	Borehole Proximity (m)
Gantry	314	190985	NB	Embankment	2.4	15	1
Gantry	315	191296	NB	Embankment	4.5	21	84
Gantry	316	191430	SB	Embankment	2.1	11	3
Gantry	318	191801	NB	Bund	1.9	16	110
ERA	E3-B3	191845-191955	SB	At Grade	0.0	0	38
Gantry	319	192101	NB	Embankment	2.7	17	60
Gantry	321	192476	NB	Embankment	6.7	21	35
Gantry	322	192906	NB	At Grade	0.9	5	1
Gantry	323	193300	SB	At Grade	1.2	26	87
Gantry	324	193331	NB	Cutting	4.1	25	65

Notes
1. * = within 20m of location.
2. NB = northbound; SB = southbound.
3. Geotechnical schedule based on proposed gantry and ERA positions as of 7th February 2016.
4. Schedule only includes proposed new gantry or ERA locations. Gantries which are to reuse existing foundations are not included.

Working on behalf of highways england

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Amey Arup Joint Venture

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highways england

amey ARUP

06 Product Development & Production
Preconstruction and Construction services

Smart Motorways Programme

M1 Junction 23a to 25

Ground Investigation Report

HAGDMS Report No. 28929

Volume 3 of 4 – Appendix B (Drawings)

Issue 01 – February 2016

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

Appendix B. Drawings

HA549342-AMAR-HGT-SWI-DR-CE-000006 – Superficial Geology Plan [Sheet 1 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000007 – Superficial Geology Plan [Sheet 2 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000008 – Superficial Geology Plan [Sheet 3 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000009 – Superficial Geology Plan [Sheet 4 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000010 – Superficial Geology Plan [Sheet 5 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000011 – Solid Geology Plan [Sheet 1 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000012 – Solid Geology Plan [Sheet 2 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000013 – Solid Geology Plan [Sheet 3 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000014 – Solid Geology Plan [Sheet 4 of 5]

HA549342-AMAR-HGT-SWI-DR-CE-000015 – Solid Geology Plan [Sheet 5 of 5]

HA549342-AMAR-HGT-NLA-DR-CE-000001 – Geological Long Sections Key & Legend

HA549342-AMAR-HGT-SWI-DR-CE-000016 – Geological Long Sections Chainage 179400 - 180000

HA549342-AMAR-HGT-SWI-DR-CE-000017 – Geological Long Sections Chainage 180000 - 180600

HA549342-AMAR-HGT-SWI-DR-CE-000018 – Geological Long Sections Chainage 180600 - 181200

HA549342-AMAR-HGT-SWI-DR-CE-000019 – Geological Long Sections Chainage 181200 - 181800

HA549342-AMAR-HGT-SWI-DR-CE-000020 – Geological Long Sections Chainage 181800 - 182400

HA549342-AMAR-HGT-SWI-DR-CE-000021 – Geological Long Sections Chainage 182400 - 183000

HA549342-AMAR-HGT-SWI-DR-CE-000022 – Geological Long Sections Chainage 183000 - 183600

HA549342-AMAR-HGT-SWI-DR-CE-000023 – Geological Long Sections Chainage 183600 - 184200

HA549342-AMAR-HGT-SWI-DR-CE-000024 – Geological Long Sections Chainage 184200 - 184800

HA549342-AMAR-HGT-SWI-DR-CE-000025 – Geological Long Sections Chainage 184800 - 185400

HA549342-AMAR-HGT-SWI-DR-CE-000026 – Geological Long Sections Chainage 185400 - 186000

HA549342-AMAR-HGT-SWI-DR-CE-000027 – Geological Long Sections Chainage 186000 - 186600

HA549342-AMAR-HGT-SWI-DR-CE-000028 – Geological Long Sections Chainage 186600 - 187200

HA549342-AMAR-HGT-SWI-DR-CE-000029 – Geological Long Sections Chainage 187200 - 187800

HA549342-AMAR-HGT-SWI-DR-CE-000030 – Geological Long Sections Chainage 187800 - 188400

HA549342-AMAR-HGT-SWI-DR-CE-000031 – Geological Long Section Chainage 188400 - 189000

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HA549342-AMAR-HGT-SWI-DR-CE-000034 – Geological Long Section Chainage 190200 - 190800

HA549342-AMAR-HGT-SWI-DR-CE-000035 – Geological Long Section Chainage 190800 - 191400

HA549342-AMAR-HGT-SWI-DR-CE-000036 – Geological Long Section Chainage 191400 - 192000

HA549342-AMAR-HGT-SWI-DR-CE-000037 – Geological Long Section Chainage 192000 - 192600

HA549342-AMAR-HGT-SWI-DR-CE-000038 – Geological Long Section Chainage 192600 - 193200

HA549342-AMAR-HGT-SWI-DR-CE-000039 – Geological Long Section Chainage 193200 - 193800

HA549342-AMAR-HGT-SWI-DR-CE-000040 – Geological Long Section Chainage 193800 - 194400

HA549342-AMAR-HGT-SWI-DR-CE-000041 – Geological Long Section Chainage 194400 - 195000

HA549342-AMAR-HGT-SWI-DR-CE-000042 – Geological Long Section Chainage 195000 – 195600

HA549342-AMAR-HGT-NLA-DR-CE-000002 – Geotechnical Hazard Plans Key & Legend

HA549342-AMAR-HGT-SWI-DR-CE-000043 – Geotechnical Hazard Plans [Sheet 1 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000044 – Geotechnical Hazard Plans [Sheet 2 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000045 – Geotechnical Hazard Plans [Sheet 3 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000046 – Geotechnical Hazard Plans [Sheet 4 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000047 – Geotechnical Hazard Plans [Sheet 5 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000048 – Geotechnical Hazard Plans [Sheet 6 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000049 – Geotechnical Hazard Plans [Sheet 7 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000050 – Geotechnical Hazard Plans [Sheet 8 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000051 – Geotechnical Hazard Plans [Sheet 9 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000052 – Geotechnical Hazard Plans [Sheet 10 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000053 – Geotechnical Hazard Plans [Sheet 11 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000054 – Geotechnical Hazard Plans [Sheet 12 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000055 – Geotechnical Hazard Plans [Sheet 13 of 17]

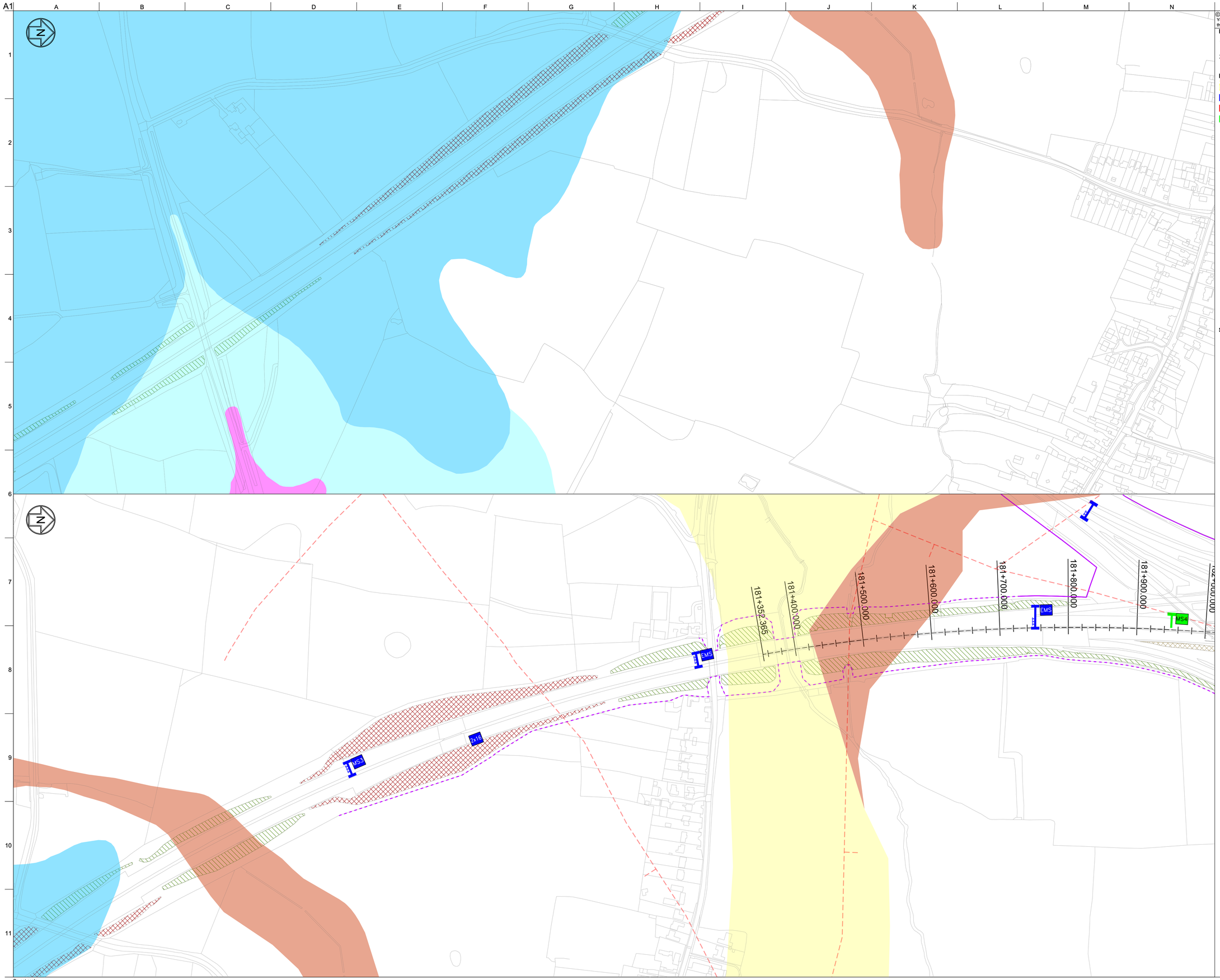
HA549342-AMAR-HGT-SWI-DR-CE-000056 – Geotechnical Hazard Plans [Sheet 14 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000057 – Geotechnical Hazard Plans [Sheet 15 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000058 – Geotechnical Hazard Plans [Sheet 16 of 17]

HA549342-AMAR-HGT-SWI-DR-CE-000059 – Geotechnical Hazard Plans [Sheet 17 of 17]

A1



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Notes:

1. All measurements to be in metres unless specified otherwise.
2. This drawing is to be read in conjunction with the HA549342-AAJV-HGT-SWI-RP-CG-000002.

Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- MS3 Strategic MS3 Retained/Relocated
- MS3 Existing MS3 Removed
- MS4 Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Alluvium
- Beestone
- Eagle Member
- Eggington Common Sand
- Glaciofluvial Deposit
- Head
- Hemmington
- Holme Pierrepont
- Oadby Member
- Syston Member
- Terrace
- Thrussington
- Wanlip Member

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

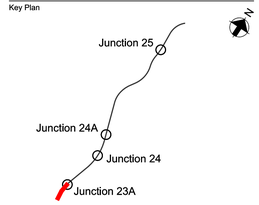
First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Superficial Geology Plan [Sheet 1 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000006**

Do not scale

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Notes:

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Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- MS3 Strategic MS3 Retained/Relocated
- MS3 Existing MS3 Removed
- MS4 Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Alluvium
- Beestone
- Eagle Member
- Eggington Common Sand
- Glaciofluvial Deposit
- Head
- Hemmington
- Holme Pierrepont
- Oadby Member
- Syston Member
- Terrace
- Thrussington
- Wanlip Member

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P01	19/02/16	OY	SA	TB

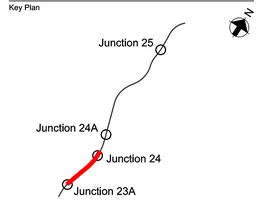
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Client

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
Superficial Geology Plan
[Sheet 2 of 5]

Scale at A1 1:2500

Role Civil Engineer - Geotechnics

Suitability S2 - Fit for information

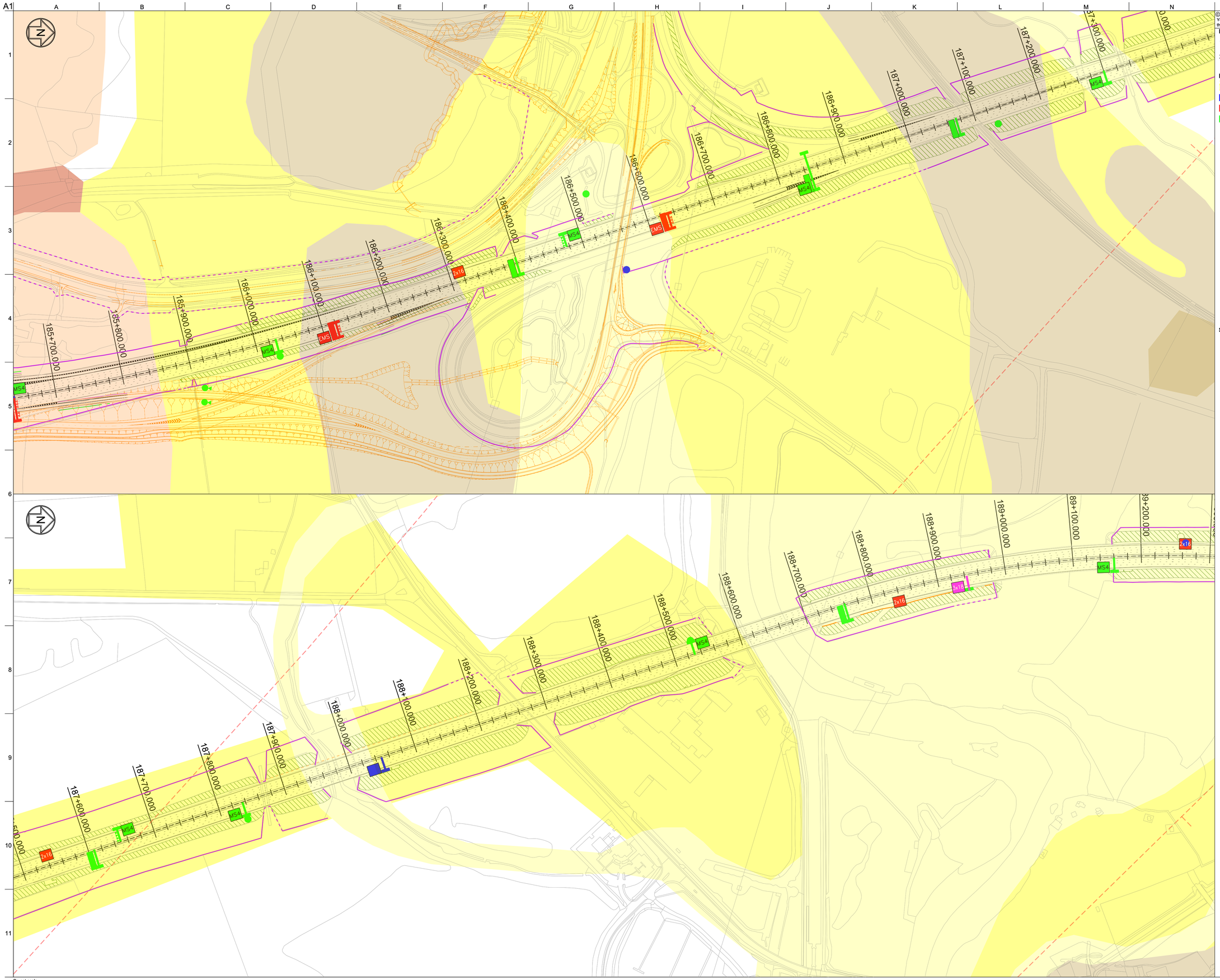
Job No **244508-00**

Rev **P01**

Name **HA549342-AMAR-HGT-SWI-DR-CE-000007**

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Notes:

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Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- MS3 — Strategic MS3 Retained/Relocated
- MS3 — Existing MS3 Removed
- MS4 — Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX — Existing Overbridge
- UBXXX — Existing Underbridge
- CXXXX — Existing Culvert
- RXXXX — Existing Retaining Wall
- EXXXX — Proposed ERA

Superficial Geology Key:

- Alluvium
- Beestone
- Eagle Member
- Eggington Common Sand
- Glaciofluvial Deposit
- Head
- Hemmington
- Holme Pierrepont
- Oadby Member
- Syston Member
- Terrace
- Thrussington
- Wanlip Member

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

First Issue

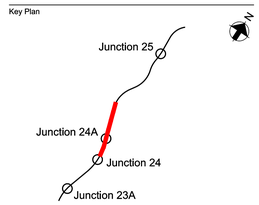
amey ARUP

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england — driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Superficial Geology Plan [Sheet 3 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

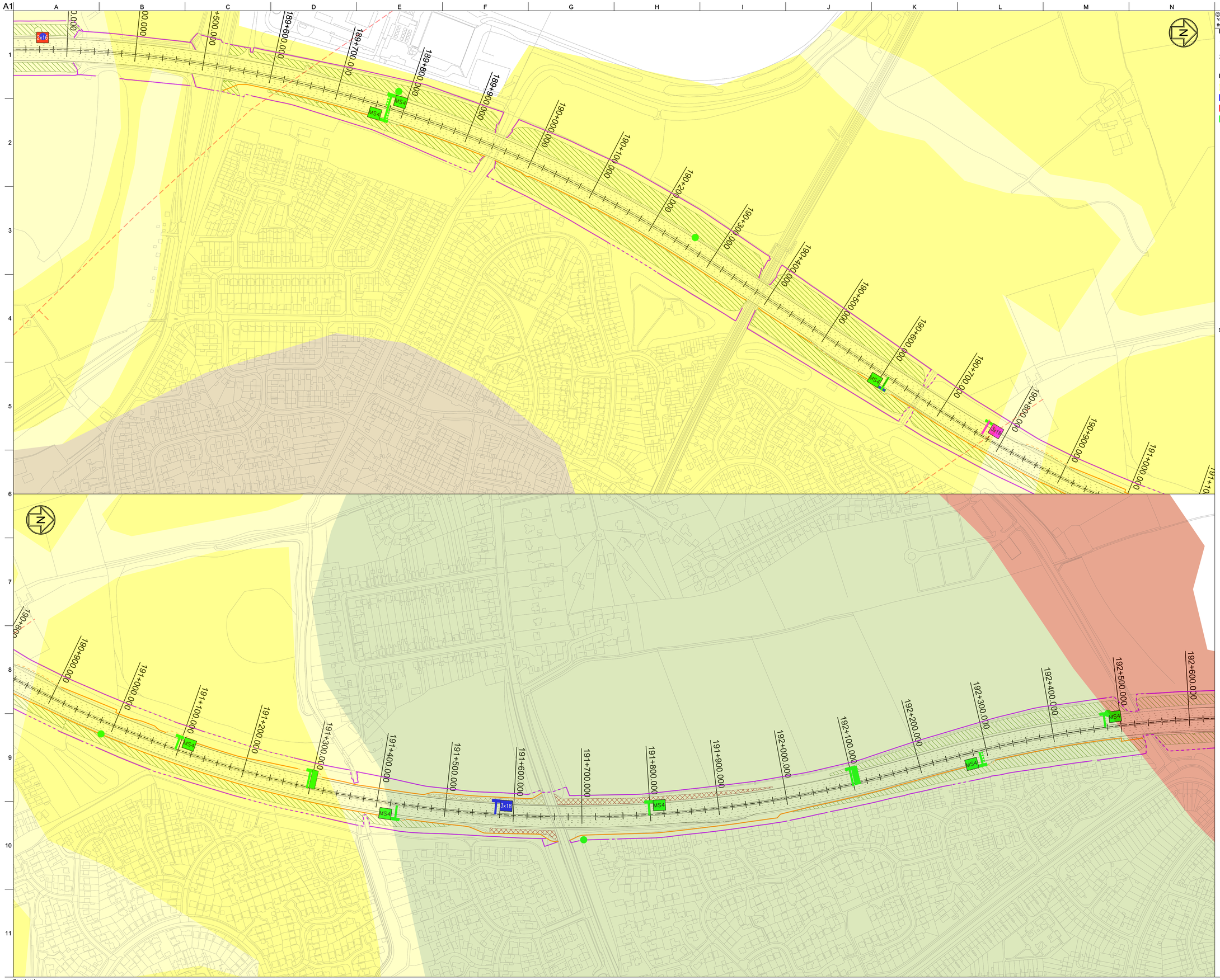
Suitability: S2 - Fit for information

Job No: **244508-00** | Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000008**

Do not scale

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Notes:

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Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- Strategic MS3 Retained/Relocated
- Existing MS3 Removed
- Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Alluvium
- Beestone
- Eagle Member
- Eggington Common Sand
- Glaciofluvial Deposit
- Head
- Hemmington
- Holme Pierrepont
- Oadby Member
- Syston Member
- Terrace
- Thrussington
- Wanlip Member

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

First Issue

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Birmingham B4 6AT
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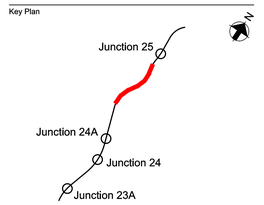
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Superficial Geology Plan
[Sheet 4 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000009**

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Notes:

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Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- Strategic MS3 Retained/Relocated
- Existing MS3 Removed
- Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Alluvium
- Beestone
- Eagle Member
- Eggington Common Sand
- Glaciofluvial Deposit
- Head
- Hemmington
- Holme Pierrepont
- Oadby Member
- Syston Member
- Terrace
- Thrussington
- Wanlip Member

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P01	19/02/16	OY	SA	TB

First Issue

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Birmingham B4 6AT
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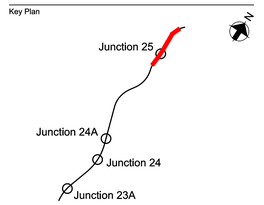
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Superficial Geology Plan
[Sheet 5 of 5]

Scale at A1 1:2500

Role Civil Engineer - Geotechnics

Suitability S2 - Fit for information

Job No **244508-00**

Rev **P01**

Name **HA549342-AMAR-HGT-SWI-DR-CE-000010**

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Key:

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- Existing Gantry Removed
- Proposed Gantry
- MS3 — Strategic MS3 Retained/Relocated
- MS3 — Existing MS3 Removed
- MS4 — Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX — Existing Overbridge
- UBXXX — Existing Underbridge
- CXXXX — Existing Culvert
- RXXXX — Existing Retaining Wall
- EXXXX — Proposed ERA

Superficial Geology Key:

- Arden Sandstone
- Branscombe
- Bromsgrove
- Crawshaw Sandstone
- Diesworth Sandstone
- Edwarlton Member
- Gunthorpe Member (Mudstone)
- Gunthorpe Mudstone (Siltstone)
- Mercia Mudstone (Mudstone)
- Mercia Mudstone (Siltstone Dolomitic)
- Radcliffe Member
- Tarporley Siltstone
- Tarporley Sandstone
- Dip Arrows
- Faults

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

First Issue

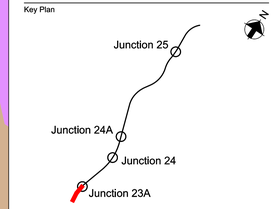
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england — driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Solid Geology Plan [Sheet 1 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

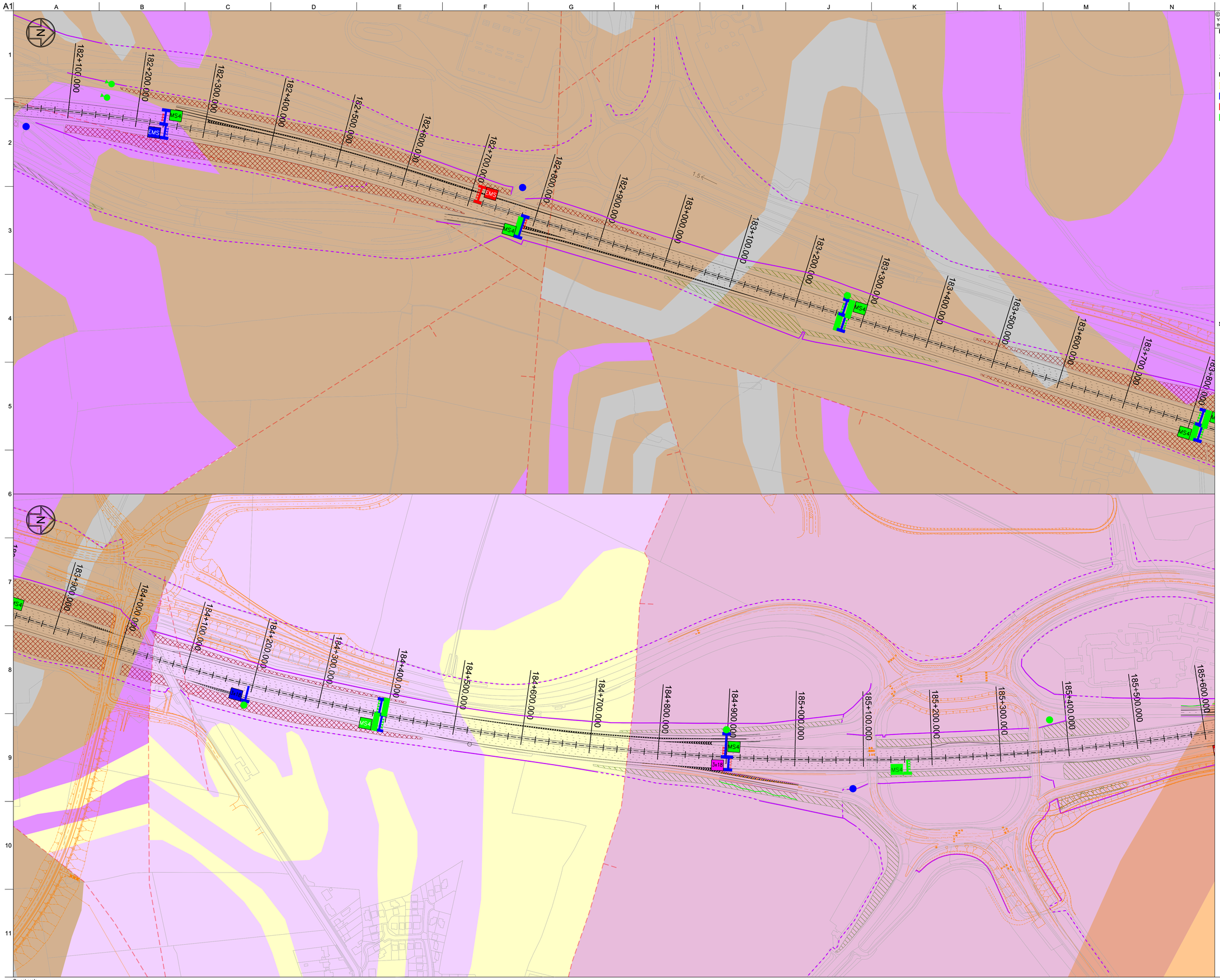
Suitability: S2 - Fit for information

Job No: **244508-00** | Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000011**

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Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- MS3 Strategic MS3 Retained/Relocated
- MS3 Existing MS3 Removed
- MS4 Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Arden Sandstone
- Branscombe
- Bromsgrove
- Crawshaw Sandstone
- Diesworth Sandstone
- Edwarlton Member
- Gunthorpe Member (Mudstone)
- Gunthorpe Mudstone (Siltstone)
- Mercia Mudstone (Mudstone)
- Mercia Mudstone (Siltstone Dolomitic)
- Radcliffe Member
- Tarporley Siltstone
- Tarporley Sandstone
- Dip Arrows
- Faults

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

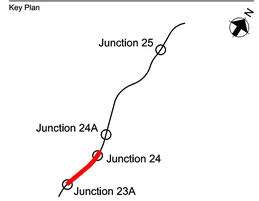
First Issue

amey ARUP
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Solid Geology Plan [Sheet 2 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000012**

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Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
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- Proposed Gantry
- MS3 Strategic MS3 Retained/Relocated
- MS3 Existing MS3 Removed
- MS4 Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Arden Sandstone
- Branscombe
- Bromsgrove
- Crawshaw Sandstone
- Diesworth Sandstone
- Edwarlton Member
- Gunthorpe Member (Mudstone)
- Gunthorpe Mudstone (Siltstone)
- Mercia Mudstone (Mudstone)
- Mercia Mudstone (Siltstone Dolomitic)
- Radcliffe Member
- Tarporley Siltstone
- Tarporley Sandstone
- Dip Arrows
- Faults

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

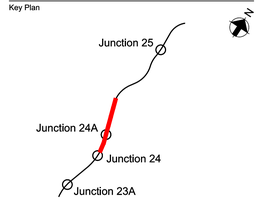
First Issue

amey ARUP
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Soild Geology Plan [Sheet3 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

Suitability: S2 - Fit for information

Job No: 244508-00

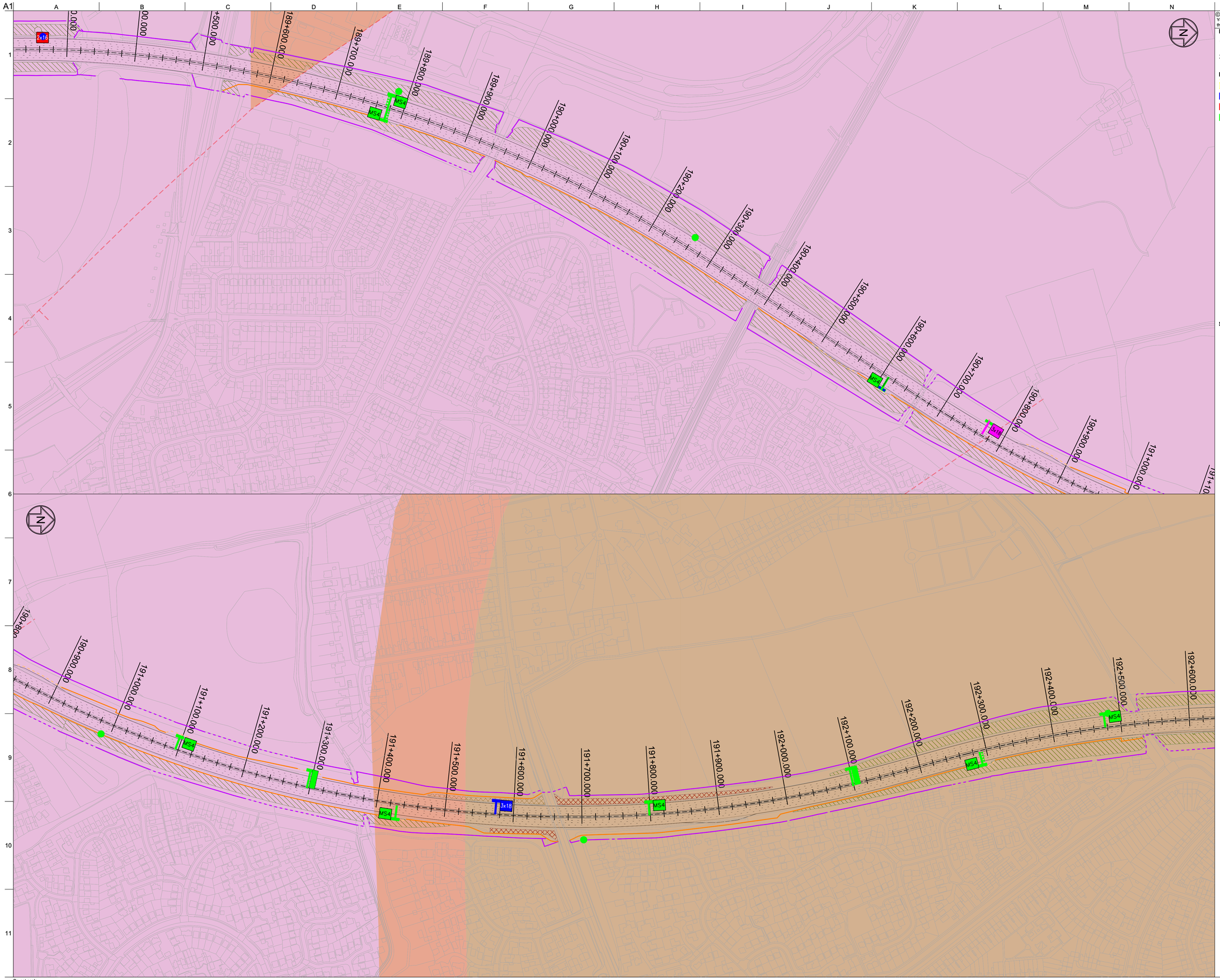
Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000013

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A1



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Notes:

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2. This drawing is to be read in conjunction with the HA549342-AAJV-HGT-SWI-RP-CG-000002.

Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- MS3 Strategic MS3 Retained/Relocated
- MS3 Existing MS3 Removed
- MS4 Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Arden Sandstone
- Branscombe
- Bromsgrove
- Crawshaw Sandstone
- Diesworth Sandstone
- Edwarlton Member
- Gunthorpe Member (Mudstone)
- Gunthorpe Mudstone (Siltstone)
- Mercia Mudstone (Mudstone)
- Mercia Mudstone (Siltstone Dolomitic)
- Radcliffe Member
- Tarporley Siltstone
- Tarporley Sandstone
- Dip Arrows
- Faults

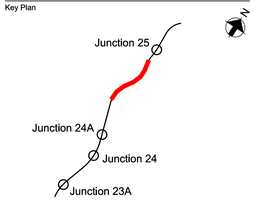
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB
First Issue				

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Solid Geology Plan [Sheet 4 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

Suitability: S2 - Fit for information

Job No: 244508-00

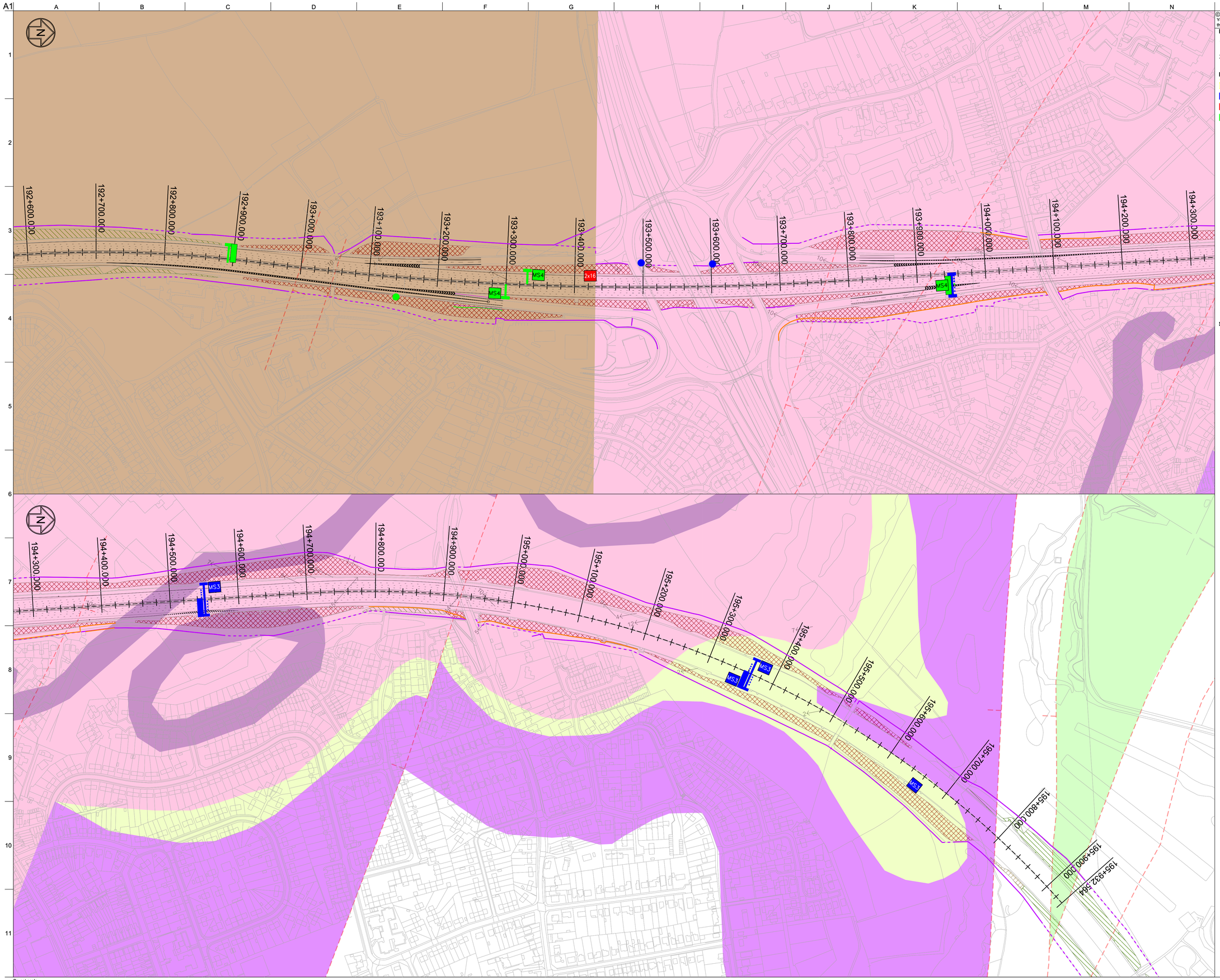
Rev: P01

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Do not scale

A1



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Notes:

1. All measurements to be in metres unless specified otherwise.
2. This drawing is to be read in conjunction with the HA549342-AAJV-HGT-SWI-RP-CG-000002.

Key:

- Rail Freight Terminal Works
- Existing Gantry Retained
- Existing Gantry Removed
- Proposed Gantry
- Strategic MS3 Retained/Relocated
- Existing MS3 Removed
- Proposed MS4
- Existing AMI Retained
- Existing AMI Removed
- Proposed AMI
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX Existing Overbridge
- UBXXX Existing Underbridge
- CXXXX Existing Culvert
- RXXXX Existing Retaining Wall
- EXXXX Proposed ERA

Superficial Geology Key:

- Arden Sandstone
- Branscombe
- Bromsgrove
- Crawshaw Sandstone
- Diesworth Sandstone
- Edwarlton Member
- Gunthorpe Member (Mudstone)
- Gunthorpe Mudstone (Siltstone)
- Mercia Mudstone (Mudstone)
- Mercia Mudstone (Siltstone Dolomitic)
- Radcliffe Member
- Tarporley Siltstone
- Tarporley Sandstone
- Dip Arrows
- Faults

P01	19/02/16	OY	SA	TB

First Issue

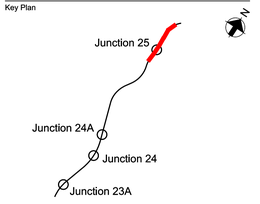
Rev	Date	By	Chkd	Appd

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Solid Geology Plan [Sheet 5 of 5]

Scale at A1: 1:2500

Role: Civil Engineer - Geotechnics

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000015**

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Plan Legend

Historical Exploratory Holes

- Cable Percussive Borehole
- Trial Pit
- Cable Percussive with Rotary Coring follow on Borehole
- Window Sample
- Rotary Cored Borehole
- Exploratory Hole Not Used In Geological Long Sections
- Exploratory Hole Used in Geological Long Section
- Proposed Gantries and Lane Positioning
- Proposed Rail Freight Terminal Positioning

Superficial Geology

- Alluvium (ALV)
- River Terrace Deposits (RTD)
- Head (HDD)
- Glacial Till (GTA)
- Fluvioglacial (FGA)

Plan Key

- Existing Highway Fenceline
- Assumed Highway Fenceline
- Proposed Environmental Noise Barrier
- Existing Environmental Noise Barrier
- Rail Freight Terminal Works
- Existing Gantry Retained in situ
- Existing Gantry Removed
- Proposed Gantry
- Existing Advanced Motorway Indicator Retained In Situ
- Proposed Advanced Motorway Indicator
- Existing Matrix Indicator Retained In Situ
- Existing Matrix Indicator Removed
- EMS — Existing Message Sign 2x12 Retained In Situ
- 3x18 — Existing Strategic MS3 3x18 Retained In Situ
- 3x18 — Existing Strategic MS3 3x18 Retained and Relocated
- 2x16 — Strategic MS3 2x16 Removed
- EMS — Existing Message Sign 2x12 Removed
- MS4 — Proposed MS4
- Existing ADS Retained
- Existing ADS Removed
- Proposed ADS
- Proposed ROTTMS
- Existing ESS Retained
- Proposed Post Mounted AMI
- Existing CCTV
- Proposed CCTV
- OBXXX — Existing Overbridge
- UBXXX — Existing Underbridge
- CXXXX — Existing Culvert
- RXXXX — Existing Retaining Wall
- EXXXX — Proposed ERA
- Proposed Site Clearance Boundary
- Scheme Chainage (XXXXXX)

As defined by HAGDMS:

- Bund
- Cutting
- Embankment

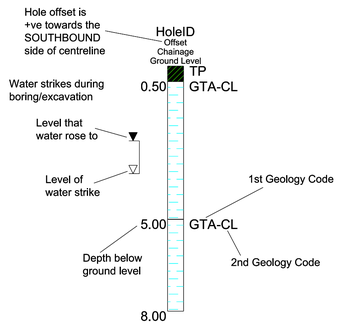
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NOTES

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2. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
3. IF THE LOG IS 'GREYED' OUT IT HAS BEEN DEEMED NOT SUITABLE FOR USE IN THE GEOLOGICAL LONG SECTIONS, USING AN INITIAL RAG ASSESMENT [I.E RED], AS OUTLINED IN THE STATEMENT OF INTENT.
4. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALISED GROUND MODEL.

Long Section Legend

Hole Legend



Superficial Geology

- Alluvium (ALV)
- River Terrace Deposits (RTD)
- Head (HDD)
- Glacial Till (GTA)
- Fluvioglacial (FGA)

Solid Geology

- Mercia Mudstone (Undifferentiated) (MM)
- Bromsgrove Sandstone (ST)

Made Ground

- Made Ground

1st Geology Codes

- Topsoil (TP)
- Made Ground (MG)
- Peat (PEAT)
- Alluvium (ALV)
- River Terrace Deposits (RTD)
- Head (HDD)
- Fluvioglacial (FGA)
- Glacial Till (GTA)
- Mercia Mudstone (MM)
- No Recovery (NR)
- Open Hole (OH)

2nd Geology Codes

- Engineering Fill (EF)
- Sand/Gravel (SG)
- Sandstone (ST)
- Clay/Cohesive (CL)
- Zone IV Mudstone (Z4)
- Zone III Mudstone (Z3)
- Zone II Mudstone (Z2)
- Zone I Mudstone (Z1)
- Open Hole (OH)

Soil Hatching Patterns

- TOPSOIL
- MADE GROUND
- CONCRETE
- CLAY
- Silty CLAY
- Sandy CLAY
- Gravelly CLAY
- Bouldery CLAY
- Silty Sandy CLAY
- Silty Gravelly CLAY
- Silty Sandy Gravelly CLAY
- Sandy Gravelly CLAY
- Sandy Gravelly Organic CLAY
- Organic CLAY
- SILT/CLAY
- SILT
- Sandy SILT
- Gravelly SILT
- Sandy Gravelly SILT
- SAND
- Clayey SAND
- Silty SAND
- Gravelly SAND
- Cobbly SAND
- Silty Gravelly SAND
- Clayey Gravelly SAND
- Gravelly Cobbly SAND
- Silty Gravelly Cobbley SAND
- Gravelly Organic SAND
- SAND and GRAVEL
- GRAVEL
- Silty GRAVEL
- Sandy GRAVEL
- Cobbly GRAVEL
- Clayey Sandy GRAVEL
- Silty Sandy GRAVEL
- Sandy Cobbly GRAVEL
- PEAT
- COBBLES
- Sandy COBBLES
- Clayey Sandy COBBLES
- MUDSTONE
- SILTSTONE
- SANDSTONE
- Open Hole or No Recovery

Long Section Key

- Motorway Level
- Maximum Height of Cutting
- Cutting - Colour represents geology within the cutting
- Geological Fault
- ? — Inferred Geology

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england — driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: Geological Long Section Plan & Profile Notes and Legend

Scale at A1: NTS

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

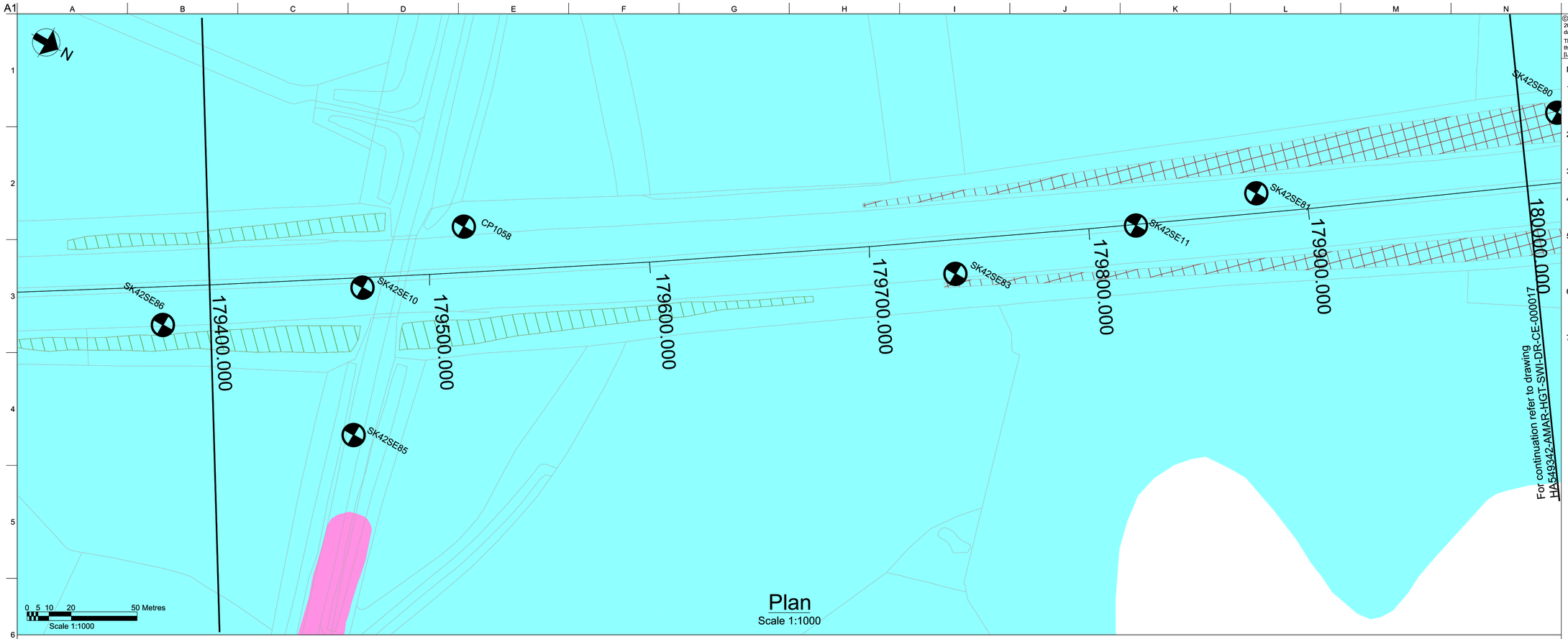
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Rev: **P01**

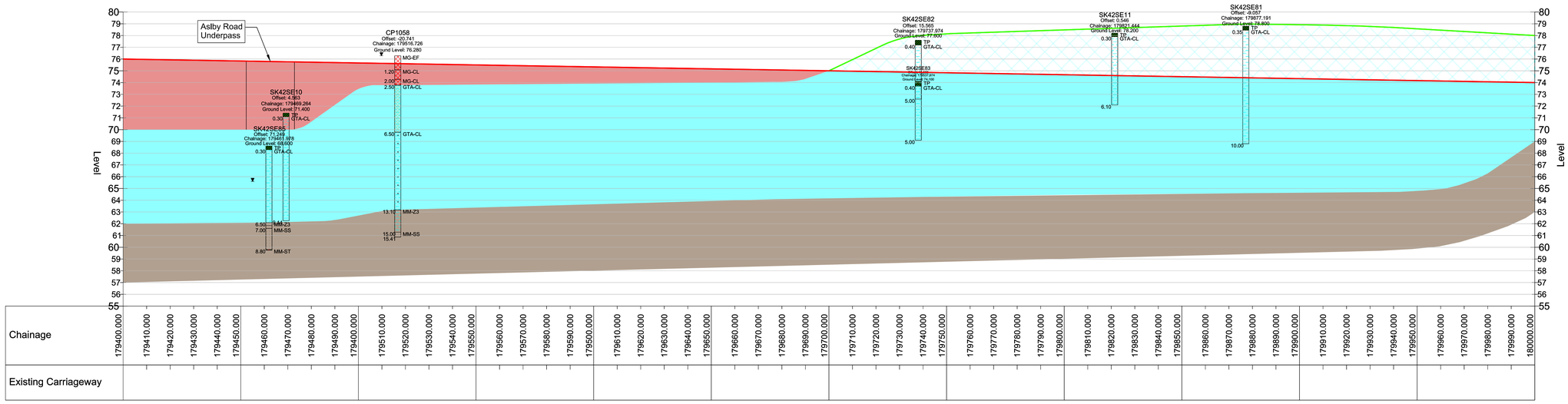
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
5. IF THE LOG IS 'GREYED' OUT IT HAS BEEN DEEMED NOT SUITABLE FOR USE IN THE GEOLOGICAL LONG SECTIONS, USING AN INITIAL RAG ASSESMENT [I.E RED], AS OUTLINED IN THE STATEMENT OF INTENT.
6. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALISED GROUND MODEL.
7. FOR GEOTECHNICAL HAZARDS REFER TO GEOTECHNICAL HAZARD PLANS HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.

P01	19/02/16	OY	SB	TB

First Issue

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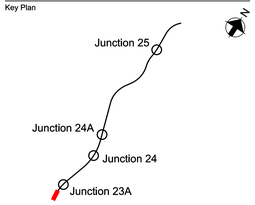
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geological Long Section
Plan & Profile
Chainage 179400 - 180000
Sheet 1 to 27

Scale at A1: NTS

Role: Civil - Geotechnics

Suitability: S2 - Fit for information

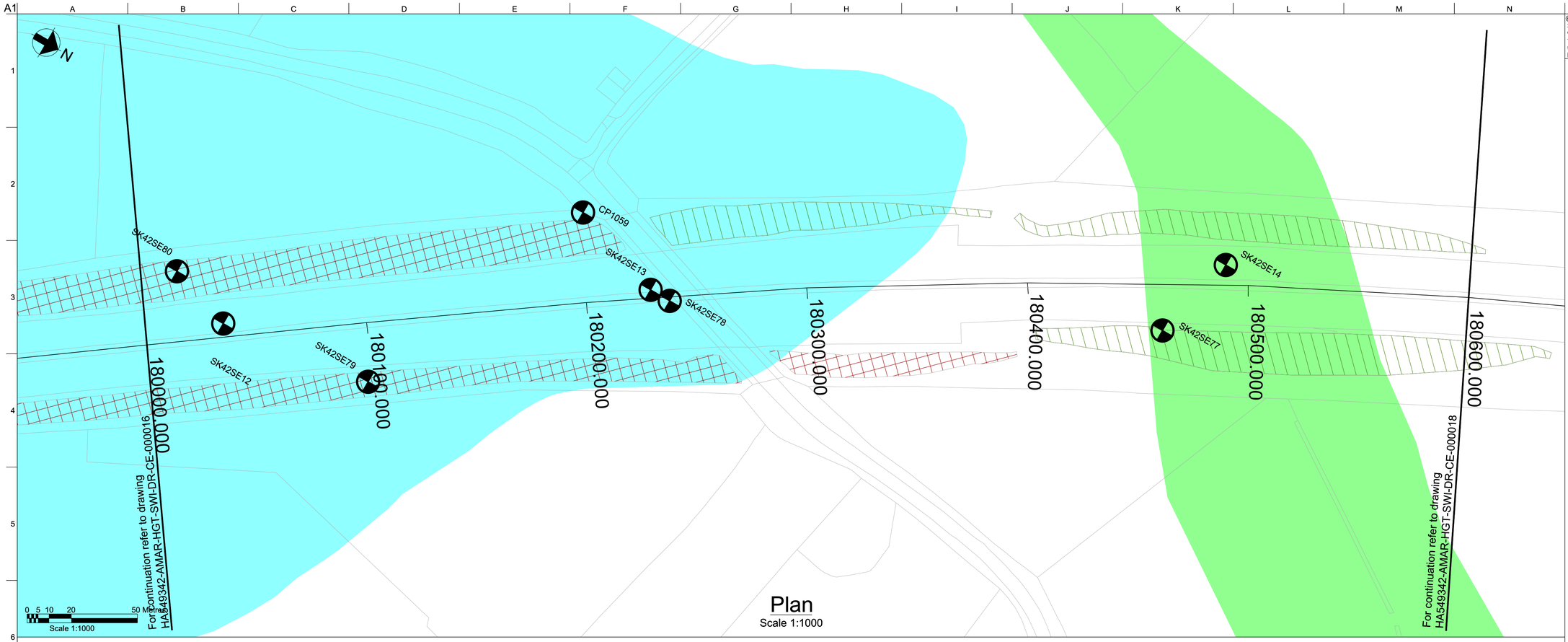
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Rev: **P01**

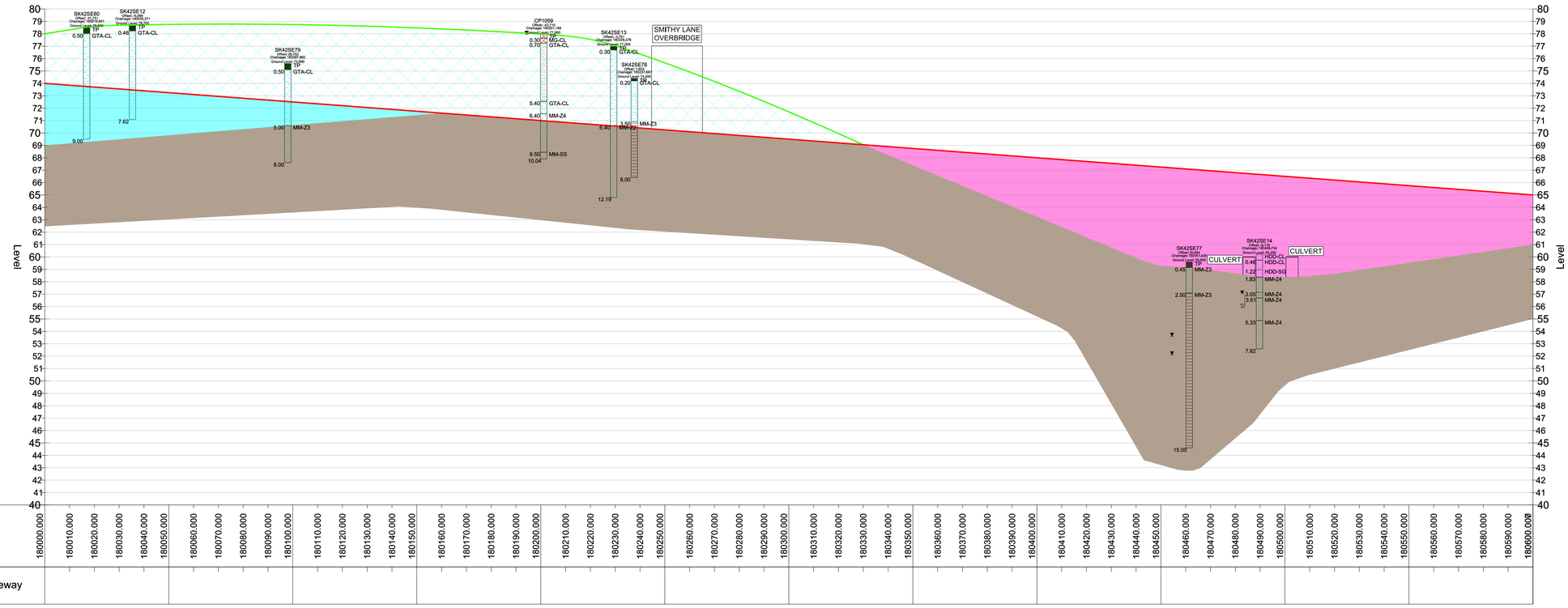
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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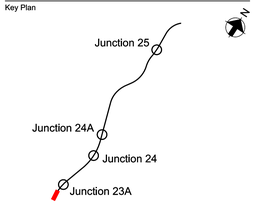
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P01	19/02/16	OY	SB	TB
First Issue				

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client
highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
Geological Long Section
Plan & Profile
Chainage 180000 - 180600
Sheet 2 to 27

Scale at A1: NTS

Role: Civil - Geotechnics

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

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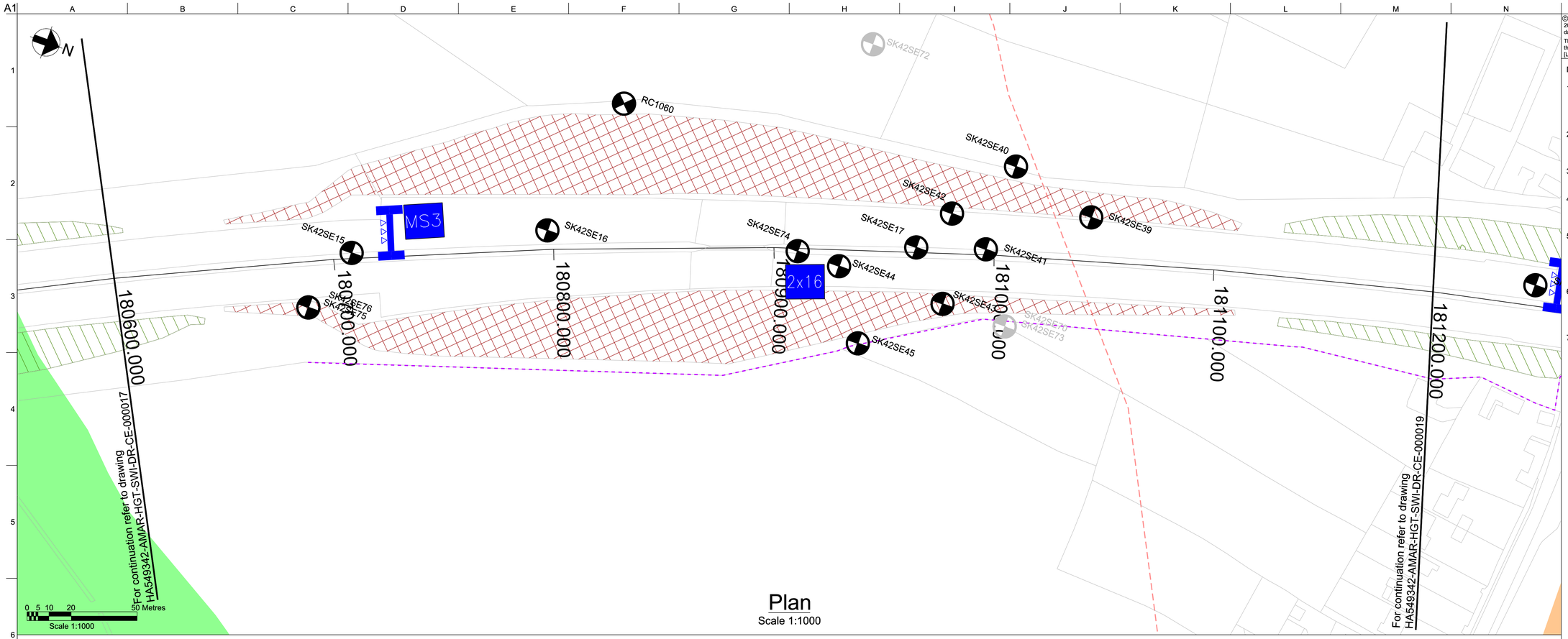
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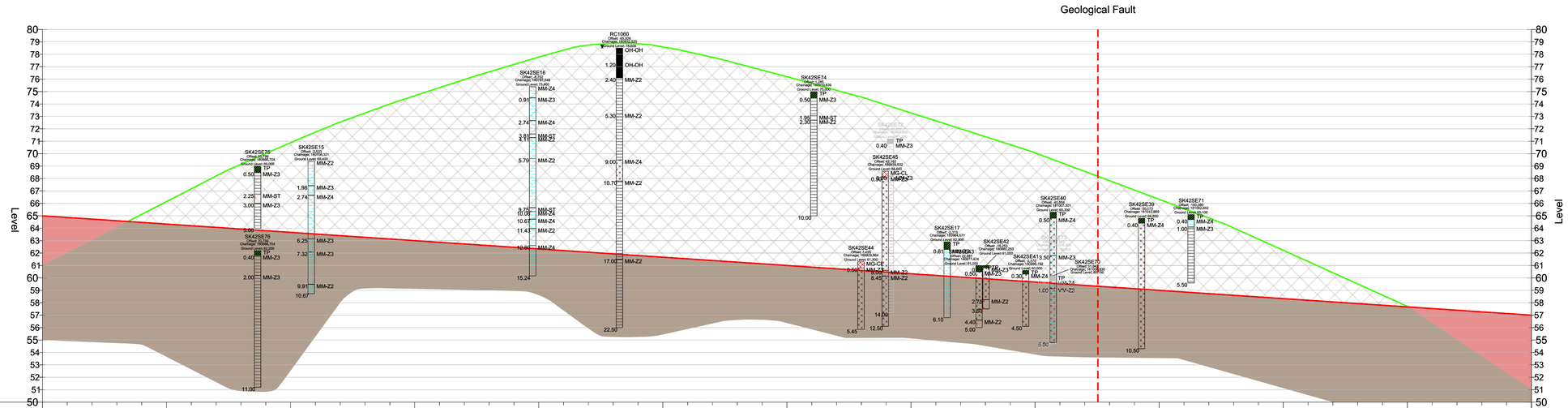
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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
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7. FOR GEOTECHNICAL HAZARDS REFER TO GEOTECHNICAL HAZARD PLANS HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.



Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

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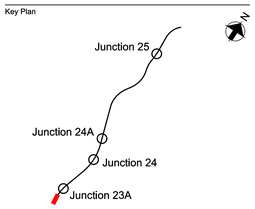
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P01	19/02/16	OY	SB	TB
First Issue				

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 180600 - 181200
Sheet 3 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

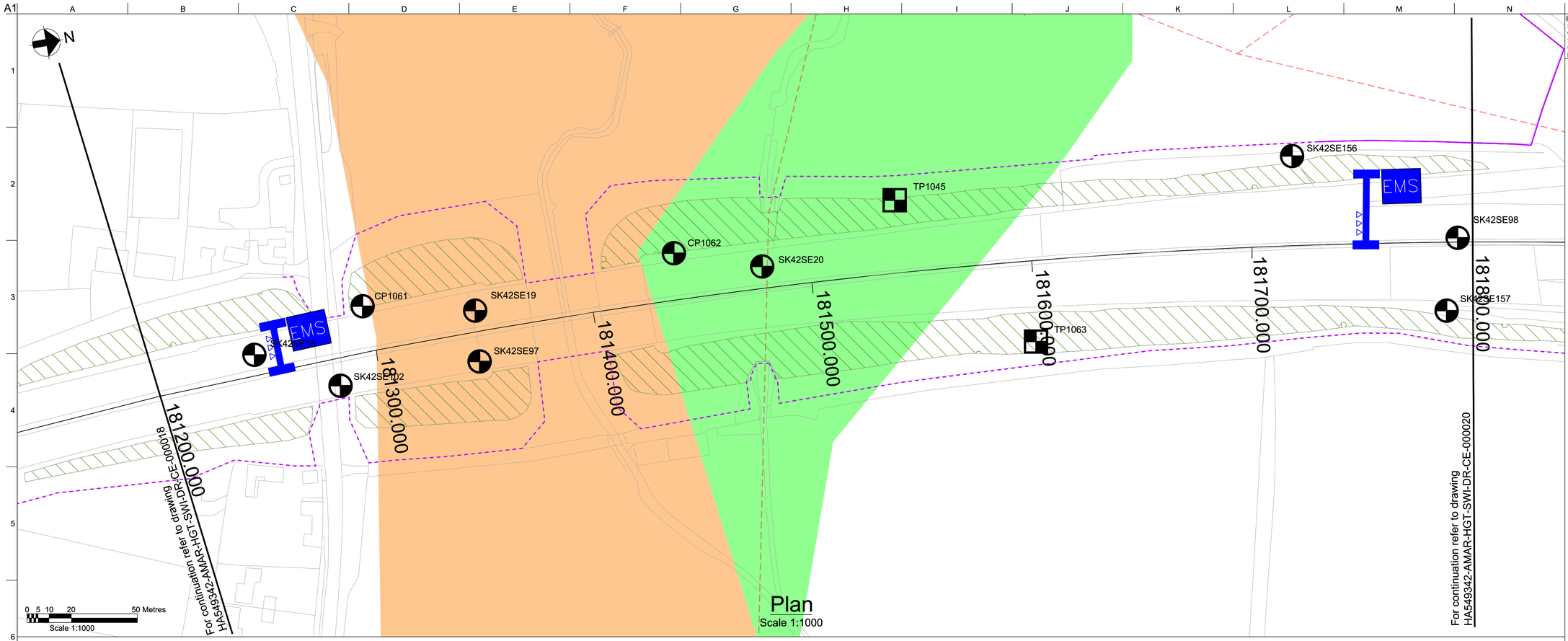
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Job No: 244508-00

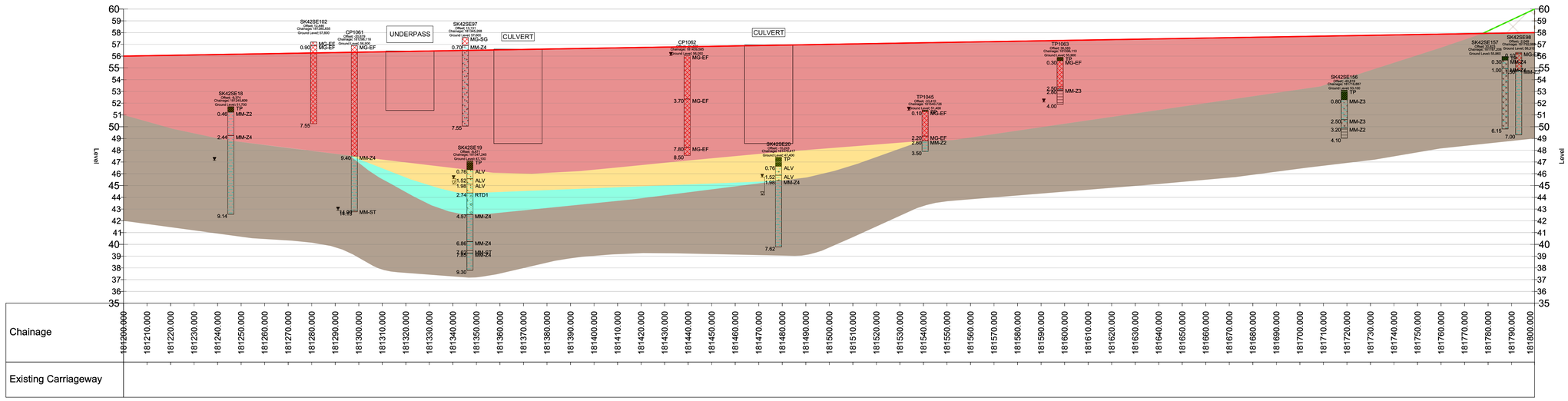
Rev: P01

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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

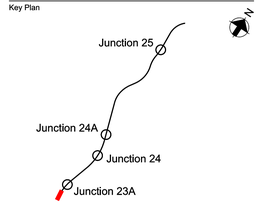
First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 181200 - 181800
Sheet 4 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

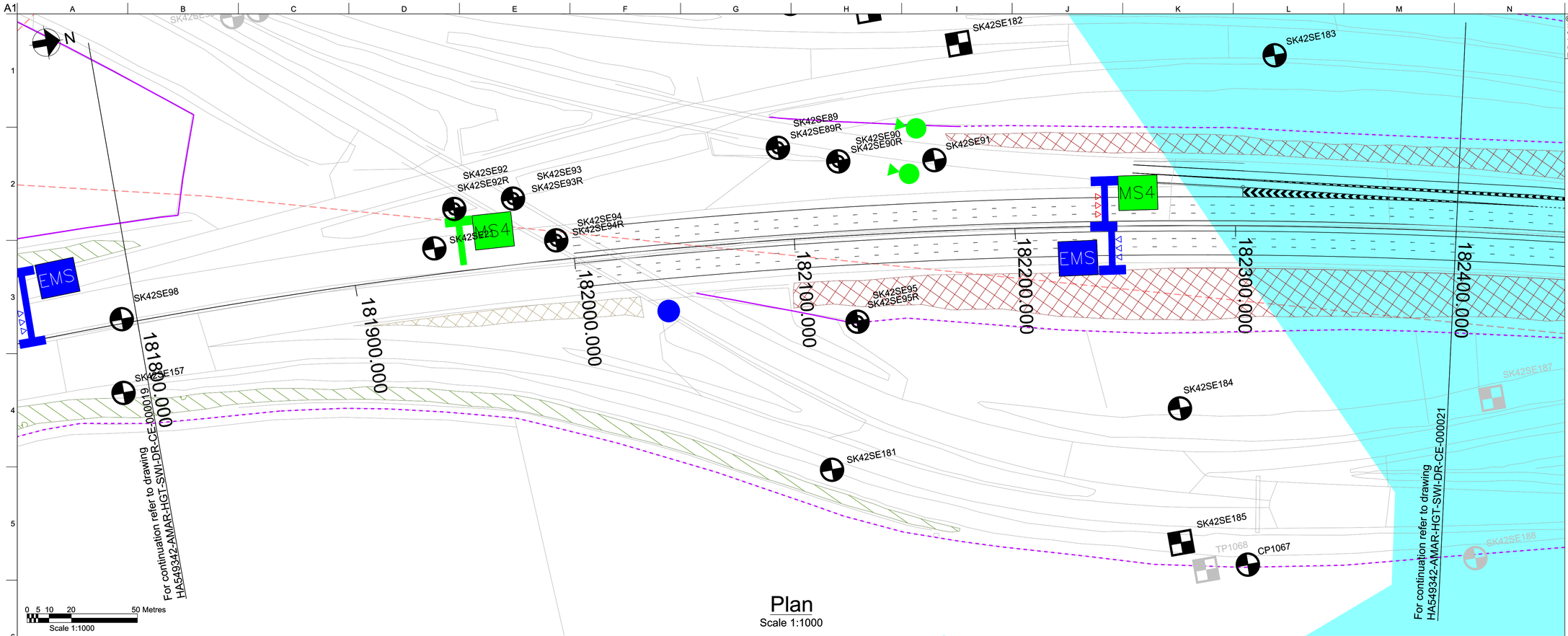
Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

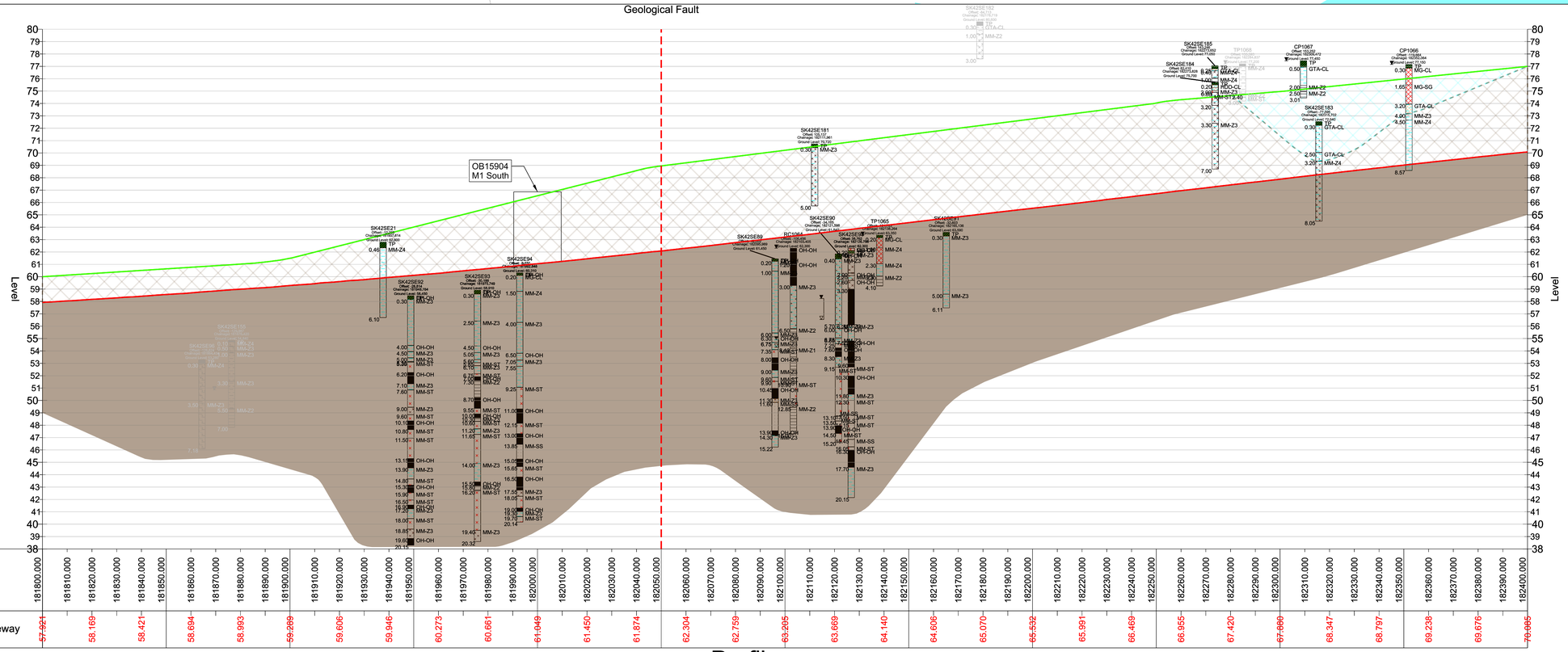
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Plan

Scale 1:1000



Profile

Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

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Birmingham B4 6AT
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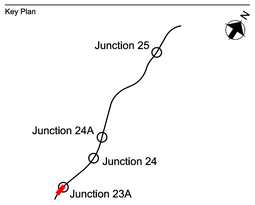
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geological Long Section
Plan & Profile
Chainage 181800 - 182400
Sheet 5 of 27

Scale at A1 NTS

Role Civil - Geotechnics

Suitability S2 - Fit for information

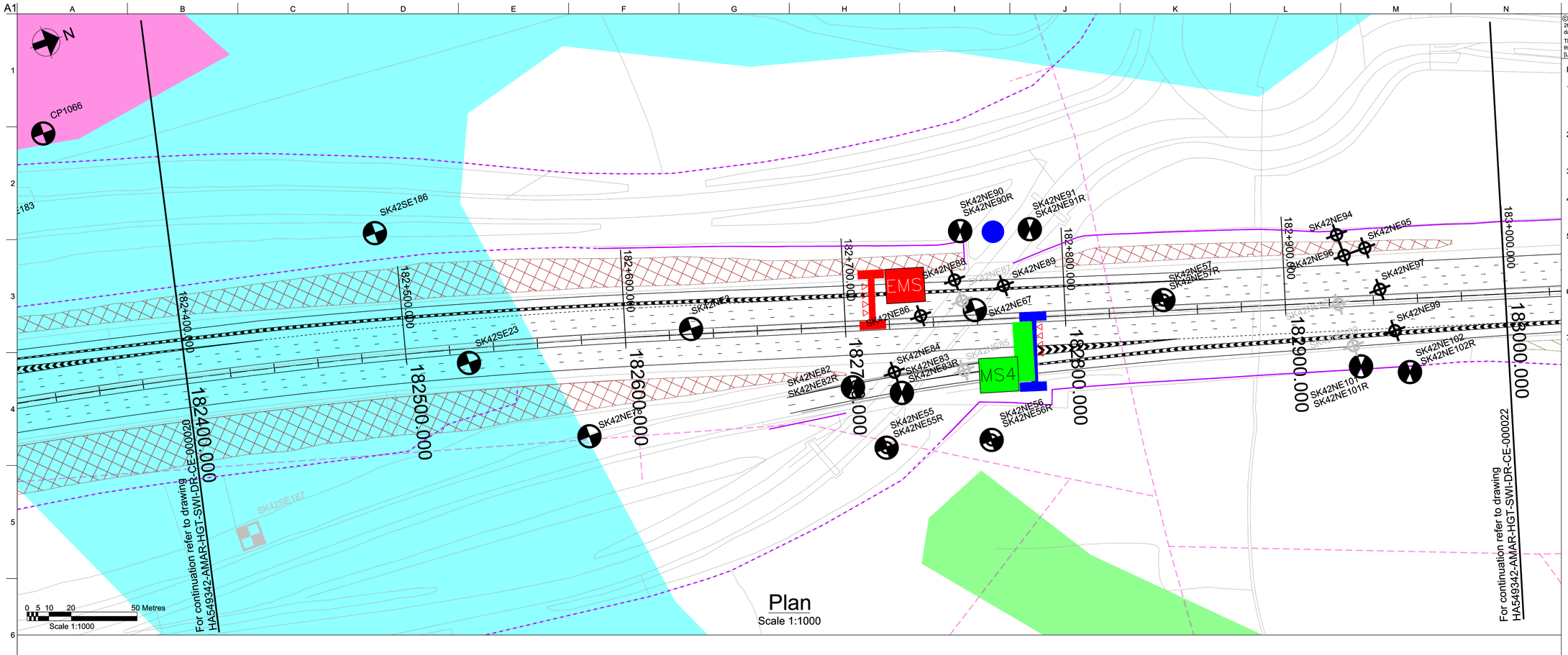
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Rev **P01**

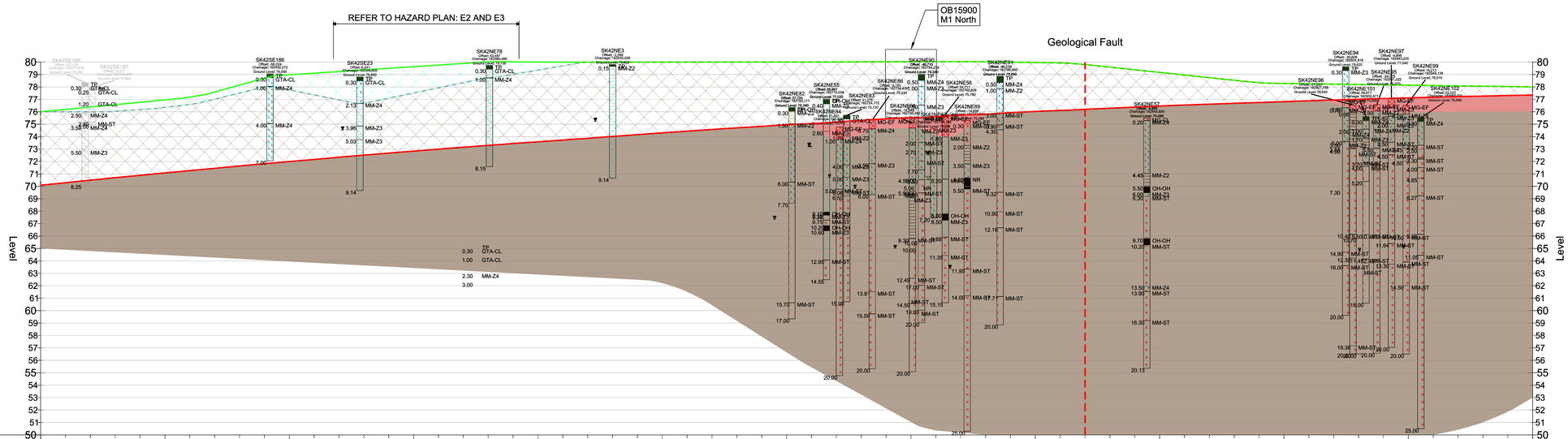
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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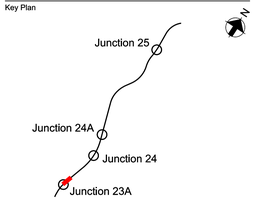
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client
highways england
driving forward

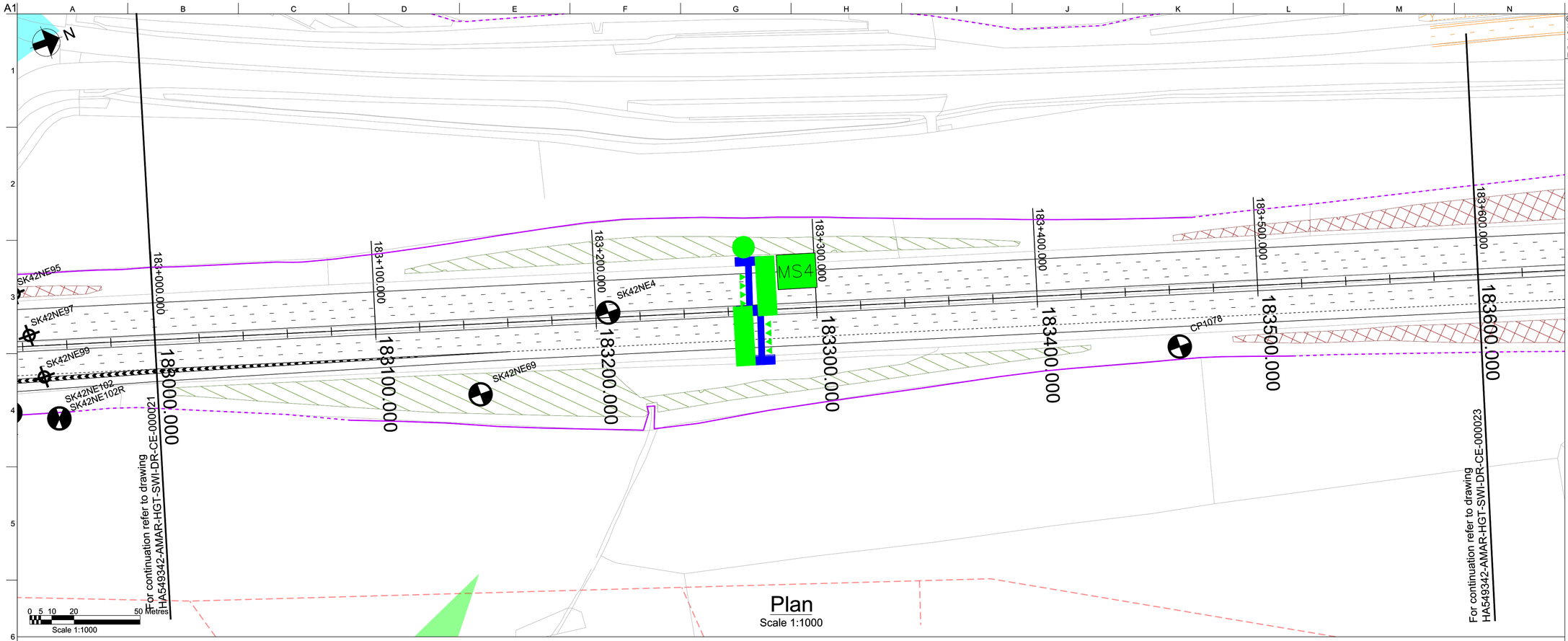
Project Title
SMP M1 J23a - J25

Key Plan


Drawing Title
Geological Long Section
Plan & Profile
Chainage 182400 - 183000
Sheet 6 of 27

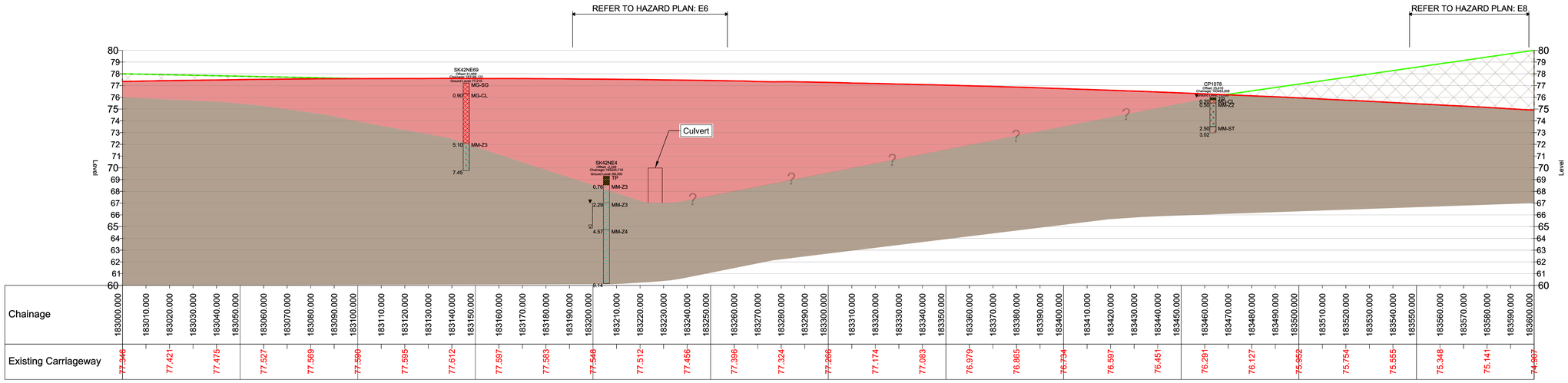
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Suitability: S2 - Fit for information
Job No: 244508-00
Rev: P01
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Plan

Scale 1:1000



Profile

Scale 1:500h 1:100v

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NOTES

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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

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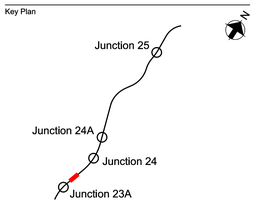
Client

highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geological Long Section
Plan & Profile
Chainage 183000 - 183600
Sheet 7 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000022**

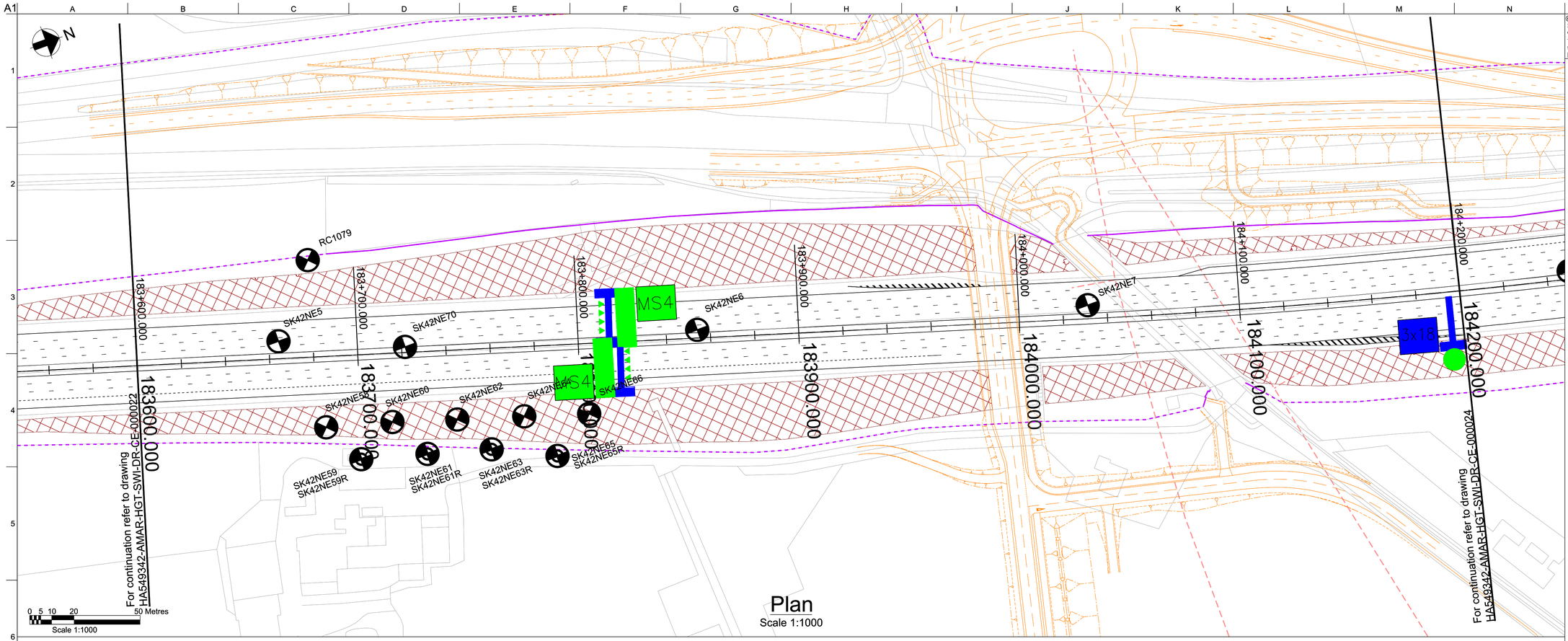
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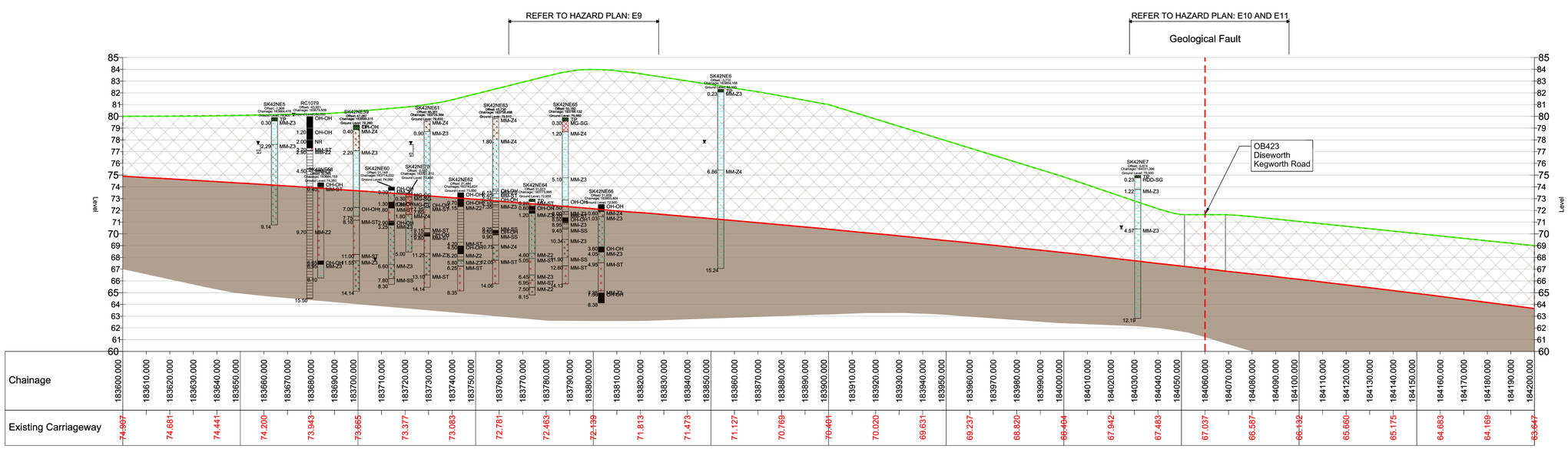
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1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

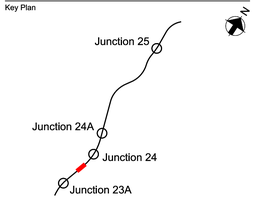
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan

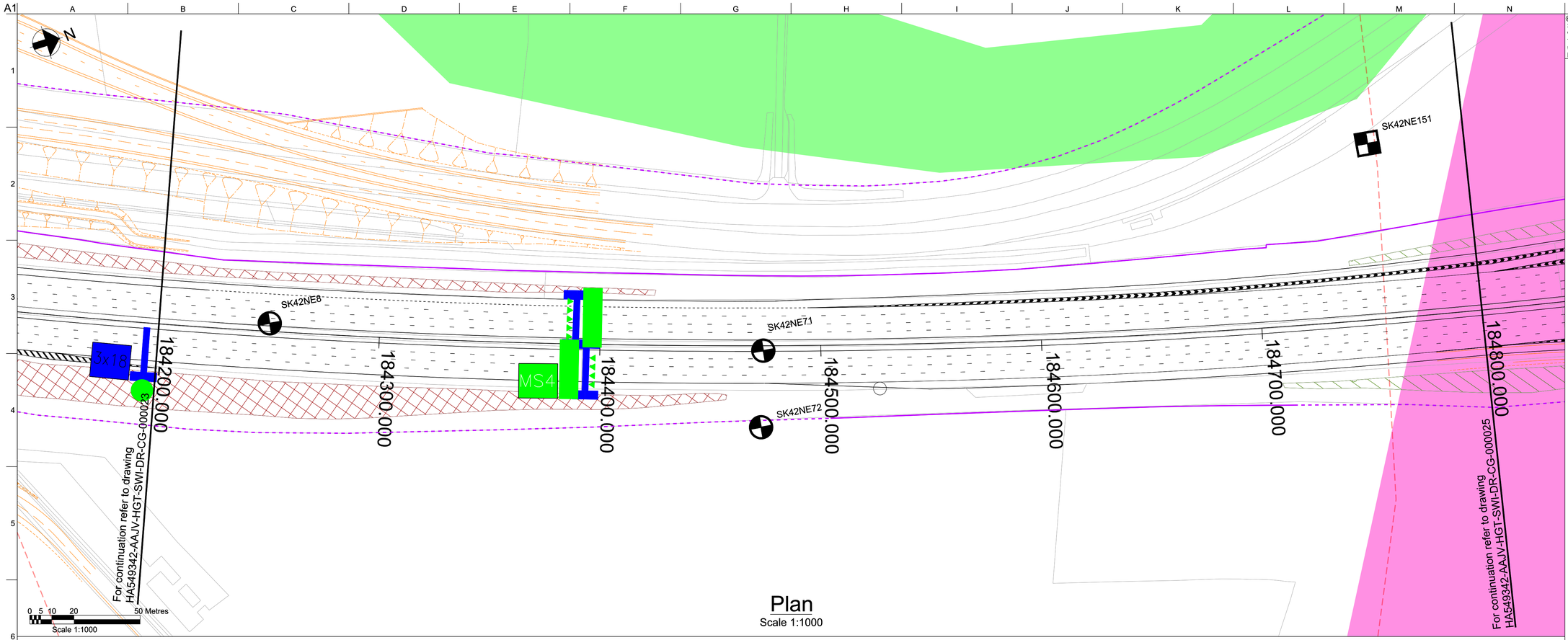


Drawing Title
Geological Long Section
Plan & Profile
Chainage 183600 - 184200
Sheet 8 of 27

Scale at A1	NTS
Role	Civil - Geotechnics
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
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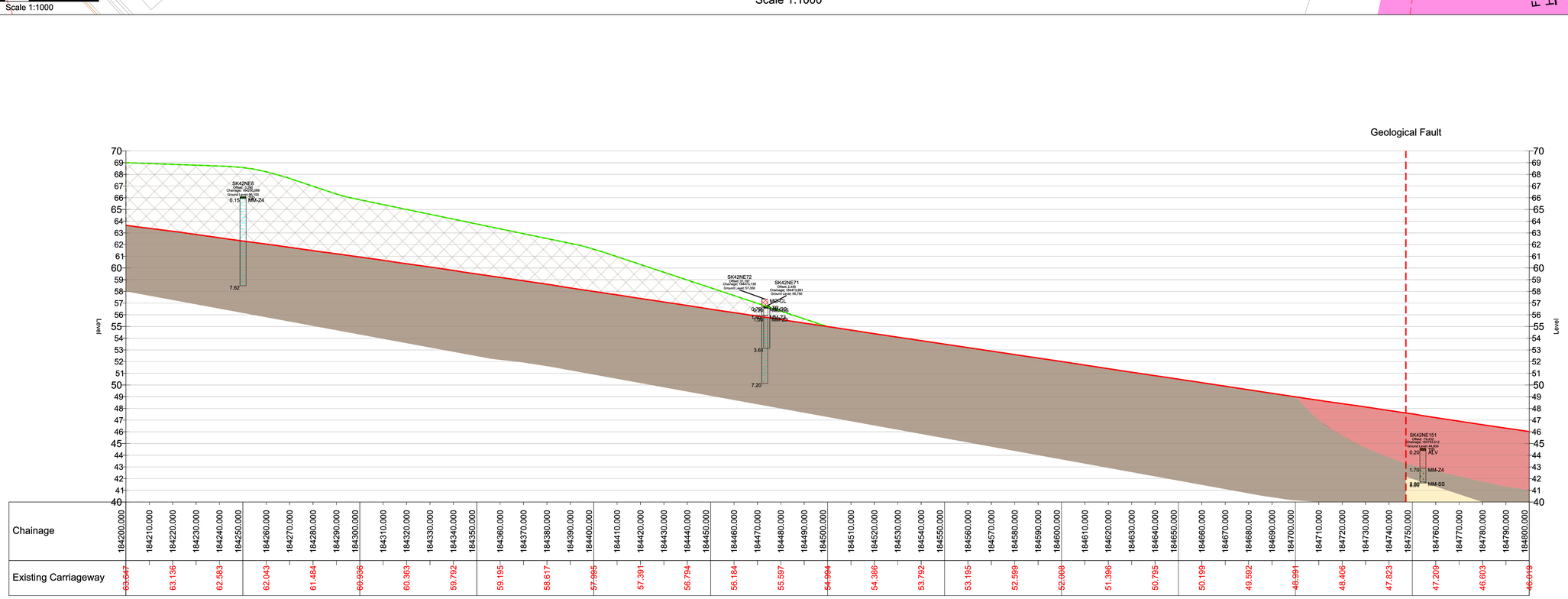
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Plan

Scale 1:1000



Profile

Scale 1:500h 1:100v

Do not scale

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NOTES

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

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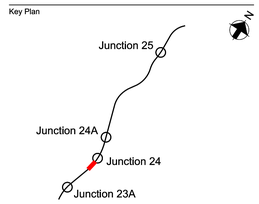
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highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geological Long Section
Plan & Profile
Chainage 184200 - 184800
Sheet 9 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

Suitability: S2 - Fit for information

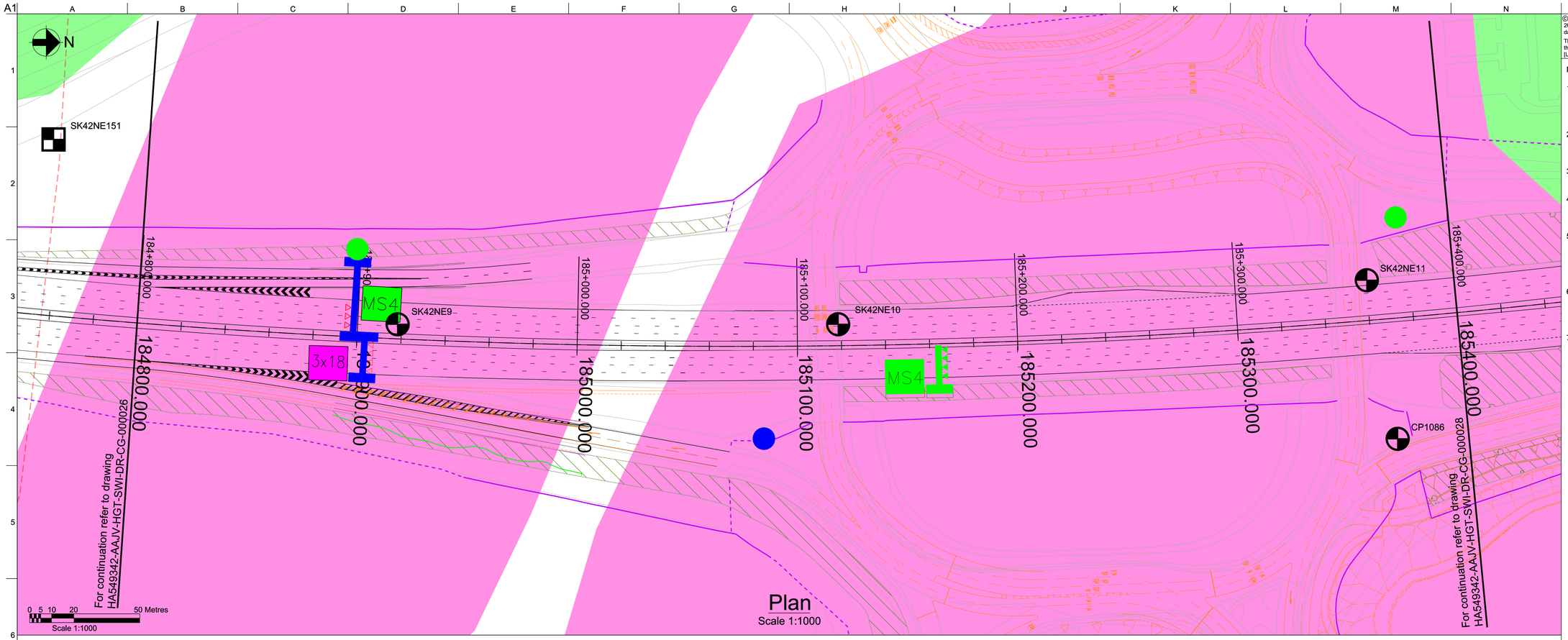
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Rev: **P01**

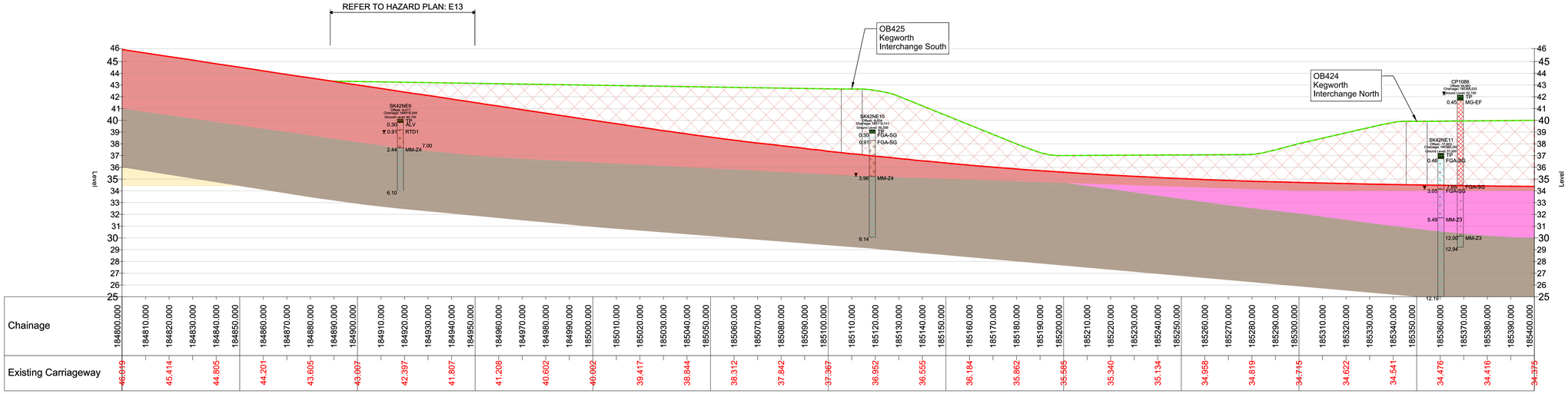
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

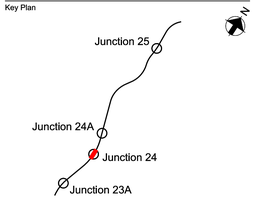
First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section Plan & Profile Chainage 184800 - 185400 Sheet 10 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

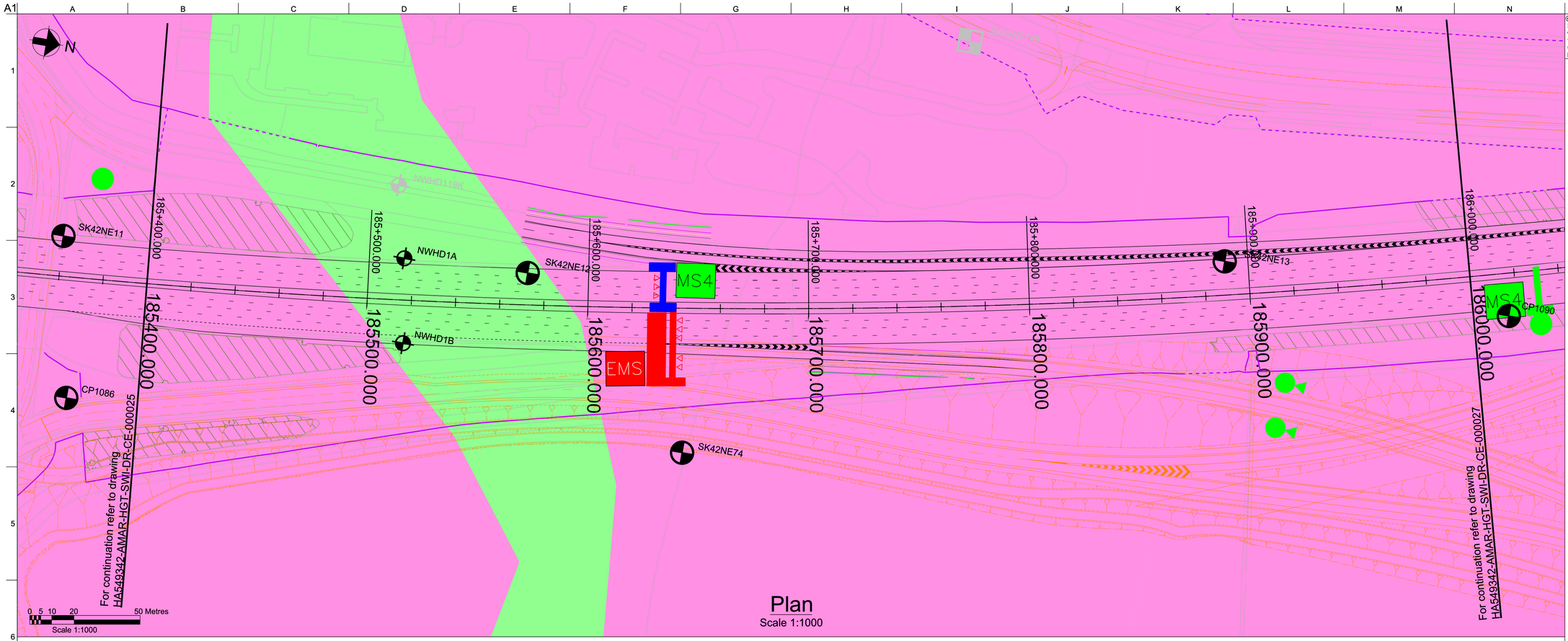
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Job No: 244508-00

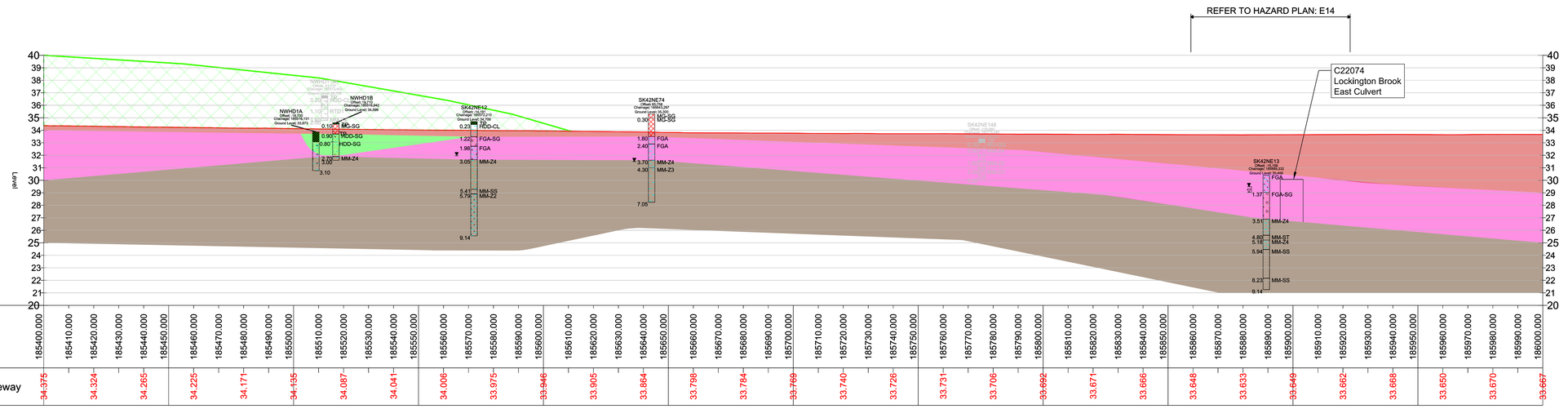
Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000025

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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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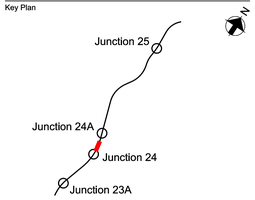
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB
First Issue				

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 185400 - 186000
Sheet 11 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

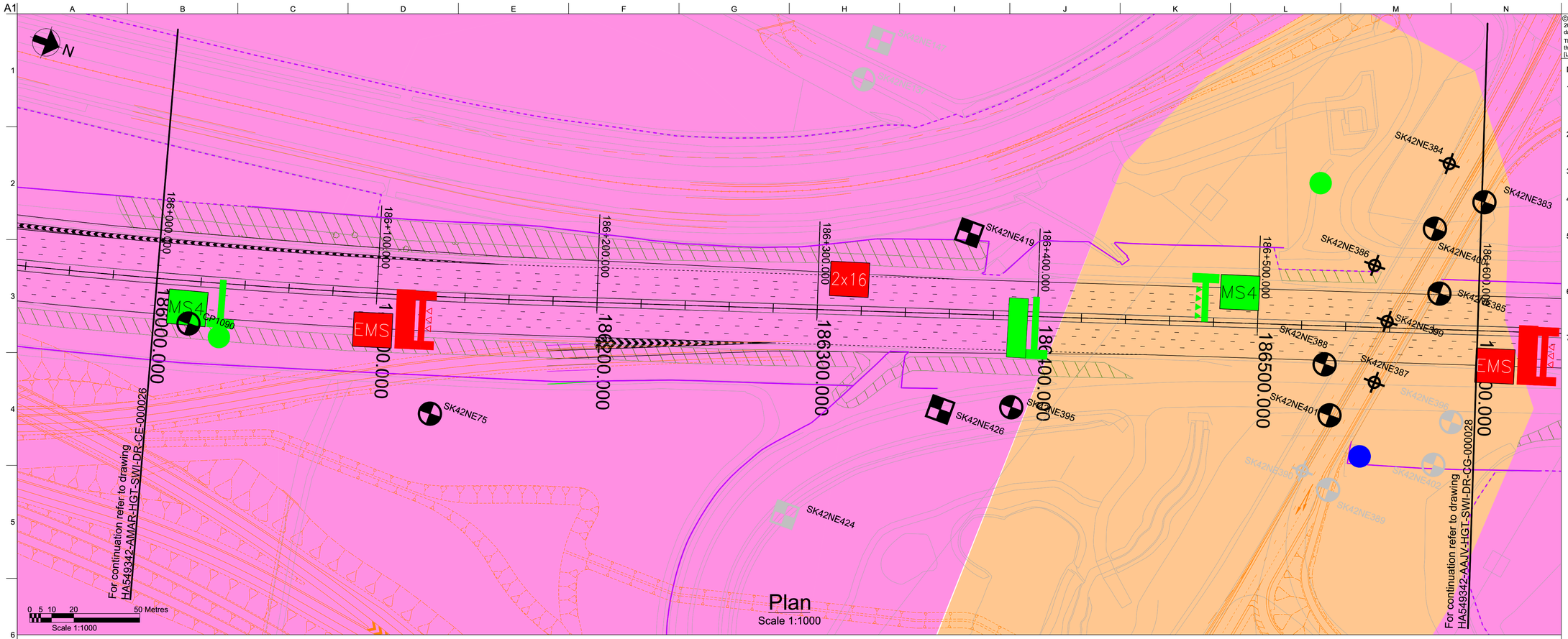
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Job No: **244508-00**

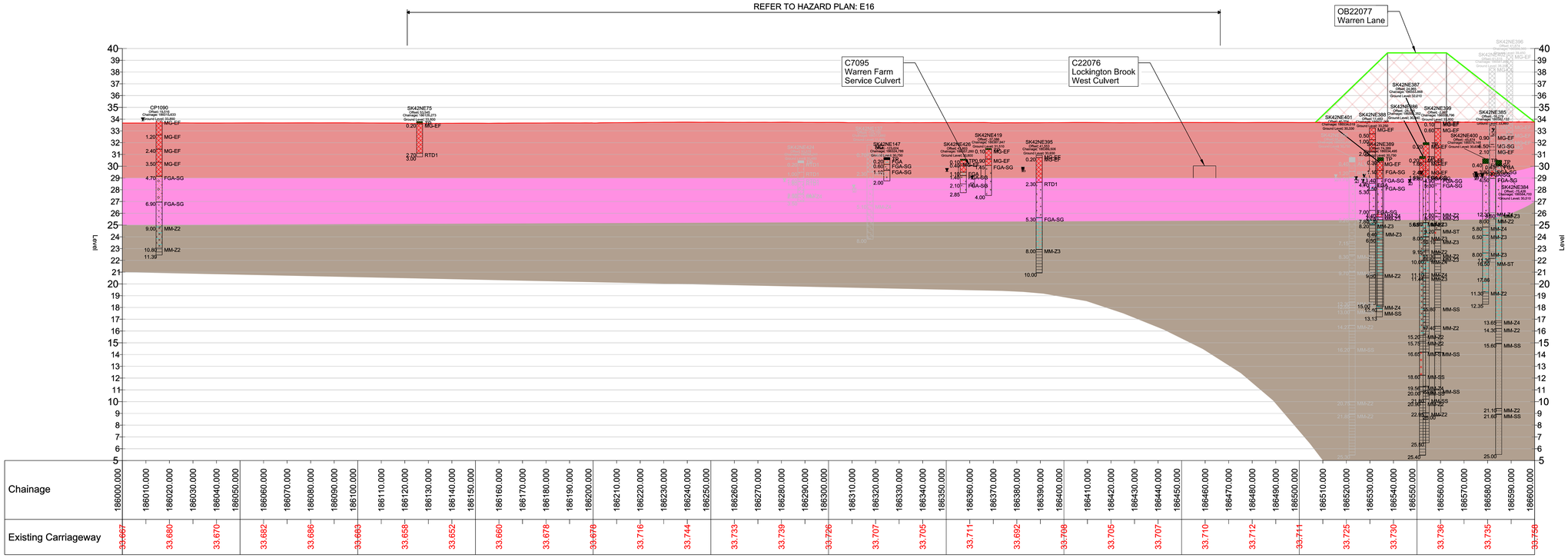
Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000026**

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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
5. IF THE LOG IS 'GREYED' OUT IT HAS BEEN DEEMED NOT SUITABLE FOR USE IN THE GEOLOGICAL LONG SECTIONS, USING AN INITIAL RAG ASSESMENT [I.E RED], AS OUTLINED IN THE STATEMENT OF INTENT.
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7. FOR GEOTECHNICAL HAZARDS REFER TO GEOTECHNICAL HAZARD PLANS HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.

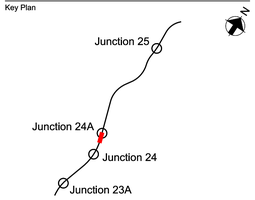
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client
highways england
driving forward

Project Title
SMP M1 J23a - J25

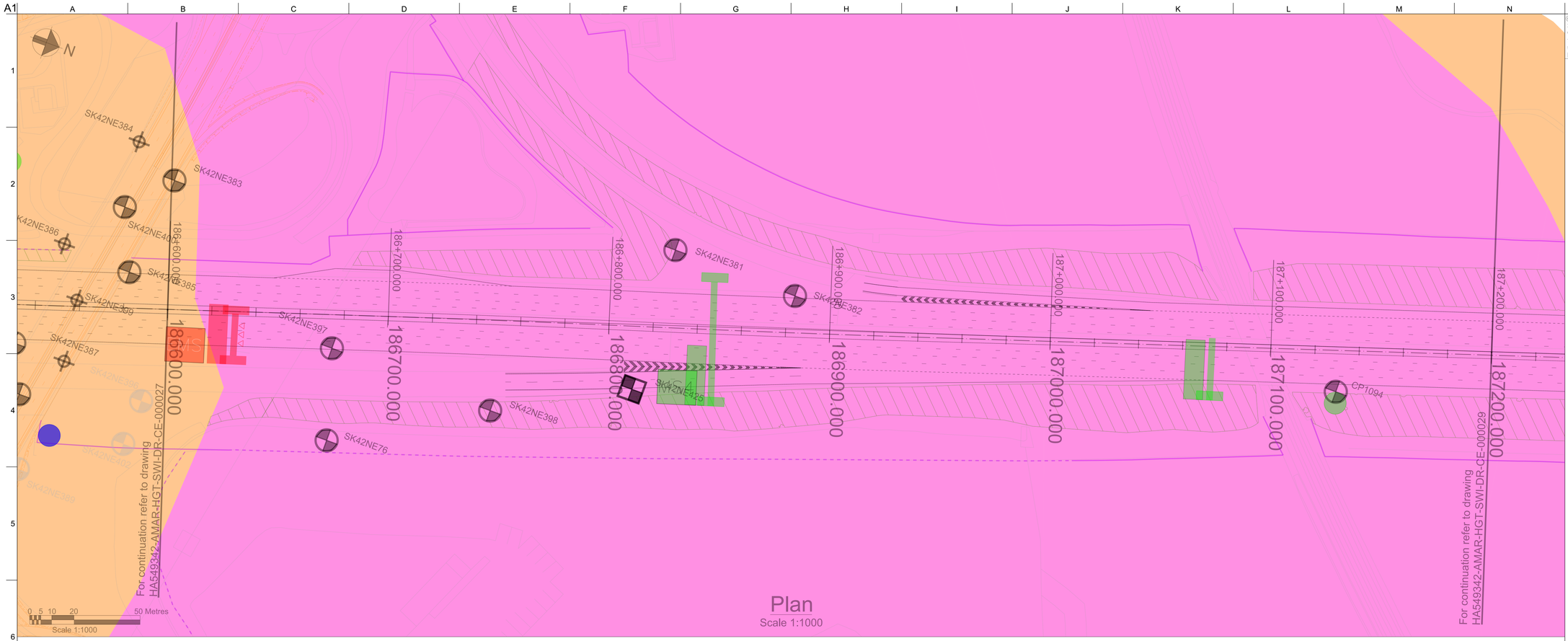
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Drawing Title
Geological Long Section
Plan & Profile
Chainage 186000 - 186600
Sheet 12 of 27

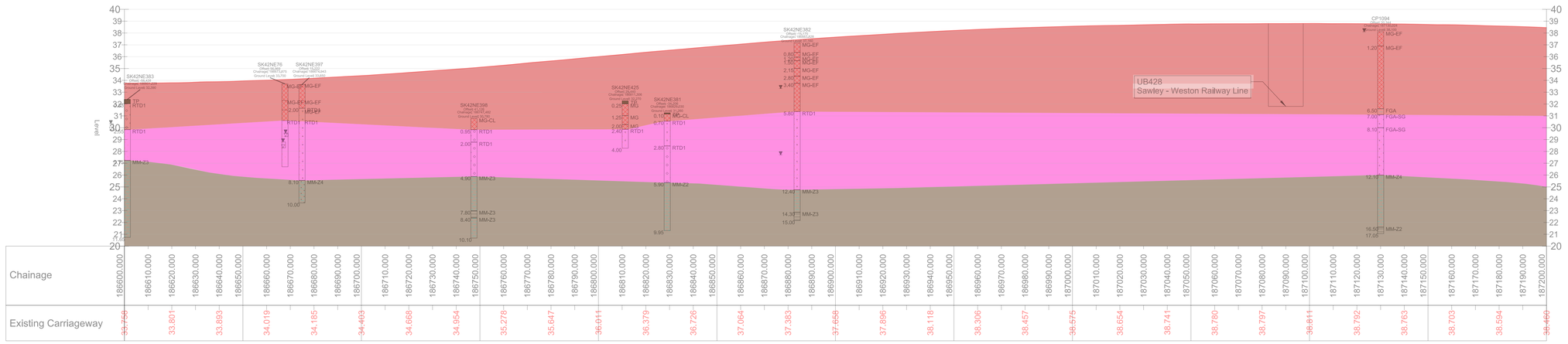
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Job No 244508-00
Rev P01
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A1



Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
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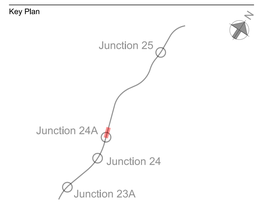
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P01	19/02/16	OY	SB	TB
First Issue				

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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

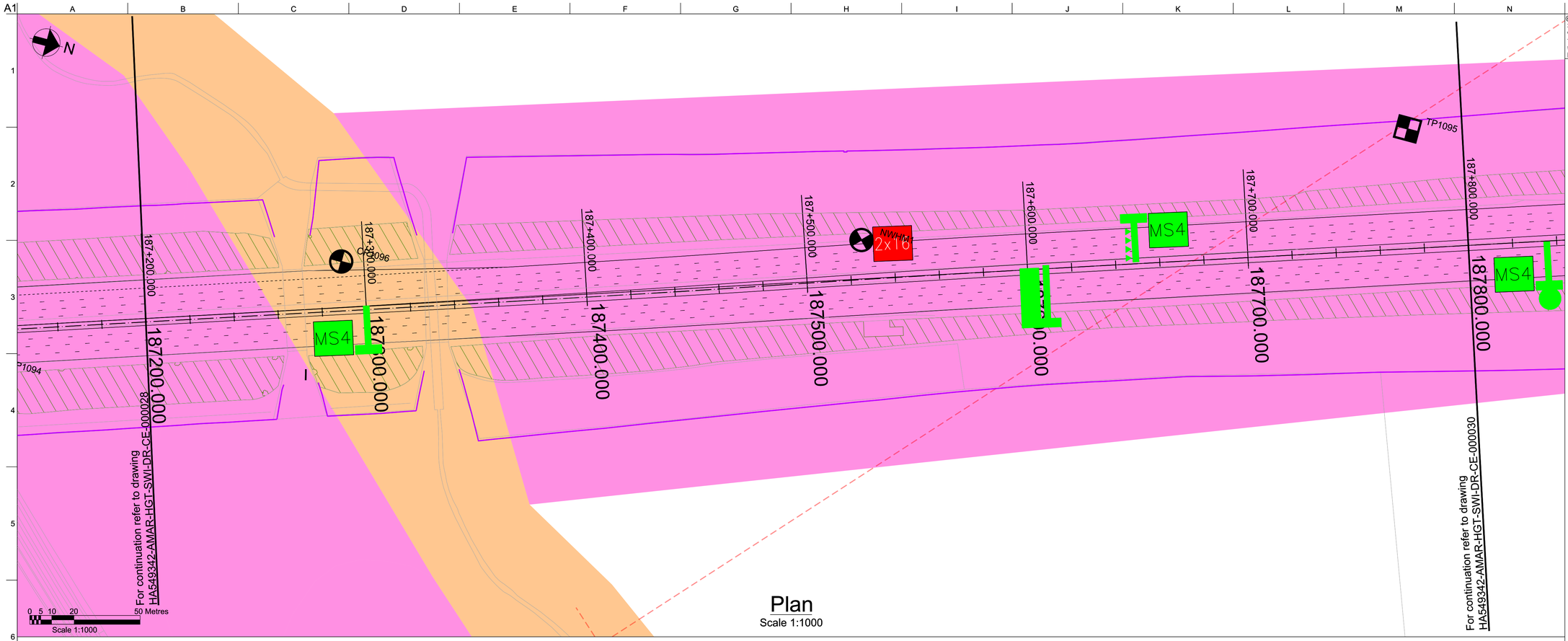
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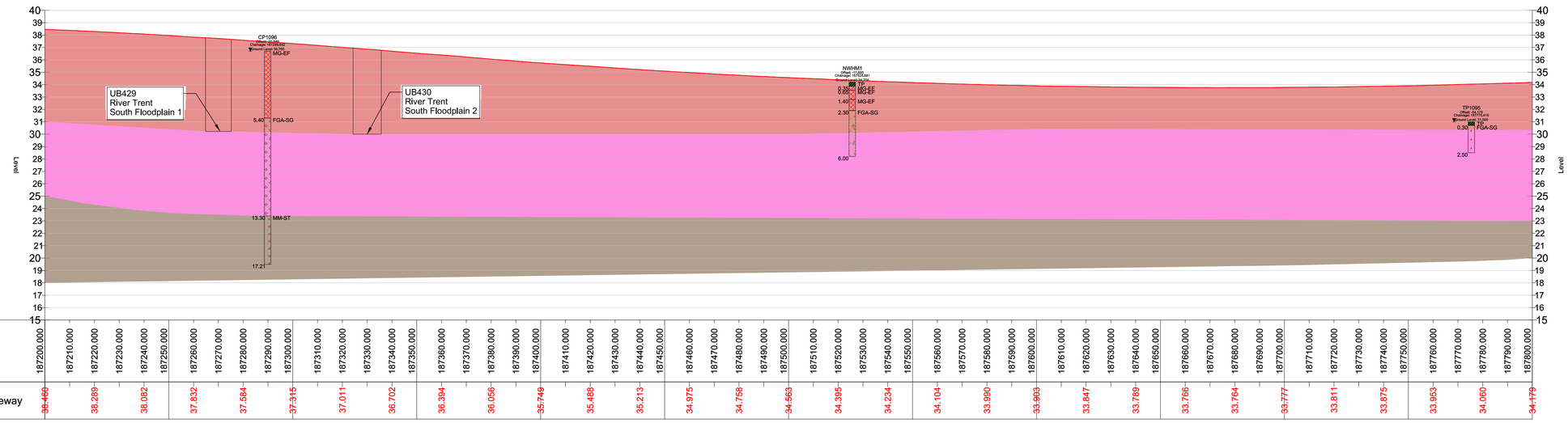
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Scale at A1	NTS
Role	Civil - Geotechnics
Suitability	S2 - Fit for Information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000028

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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

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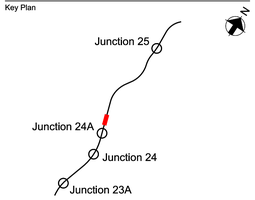
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan

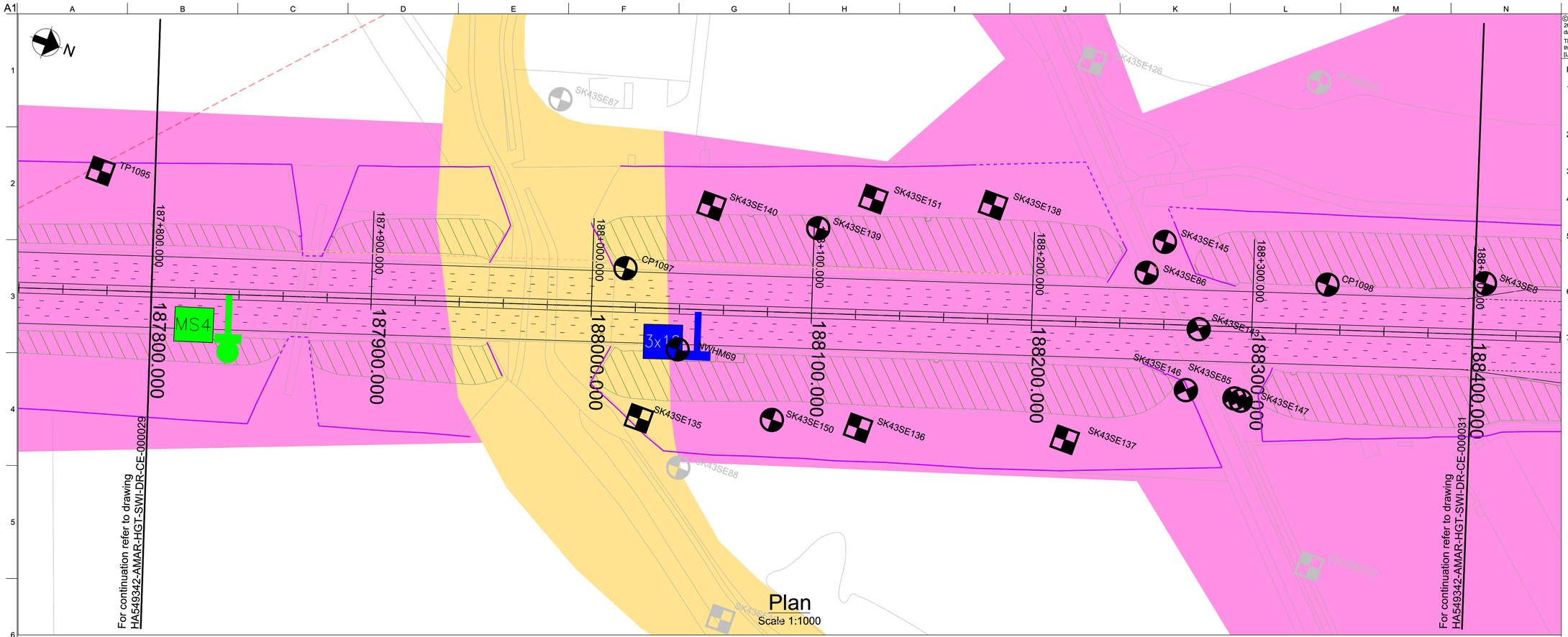


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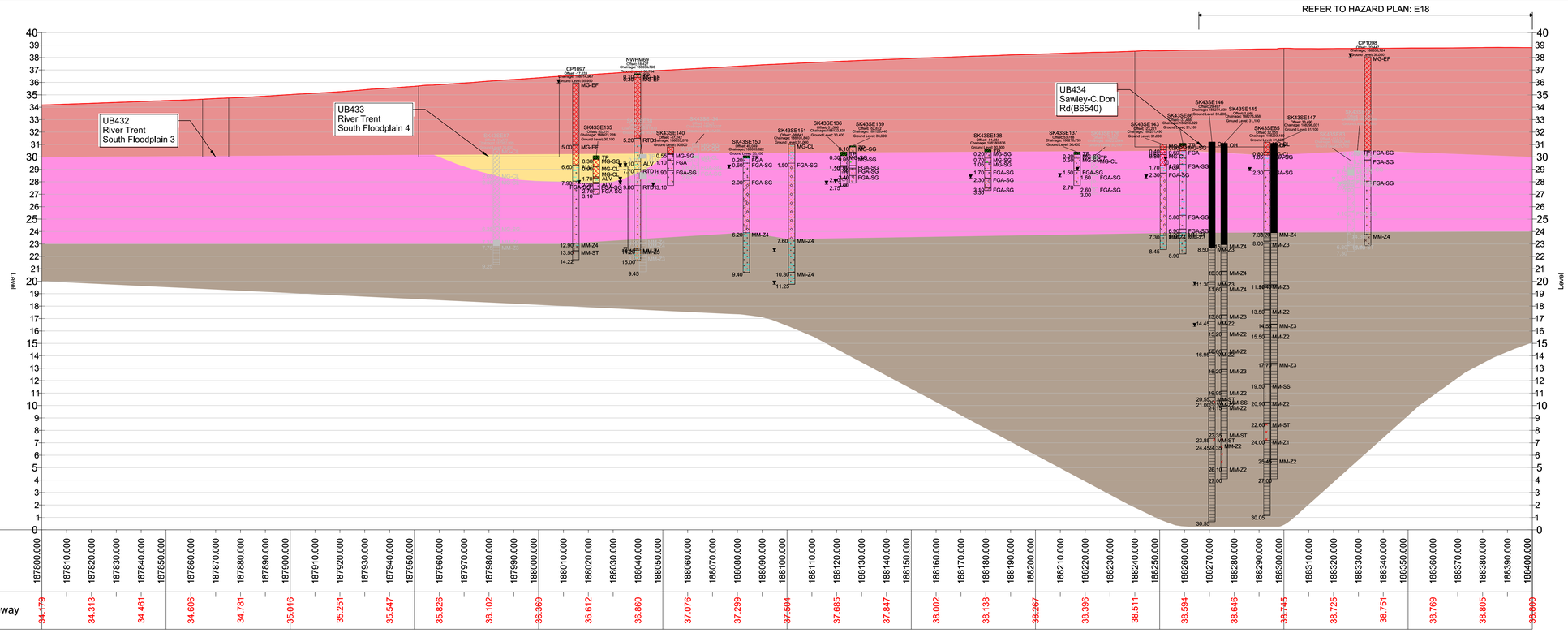
Geological Long Section
Plan & Profile
Chainage 187200 - 187800
Sheet 14 of 27

Scale at A1	NTS
Role	Civil - Geotechnics
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
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Rev	Date	By	Chkd	Appd
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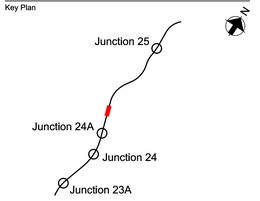
First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 187800 - 188400
Sheet 15 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

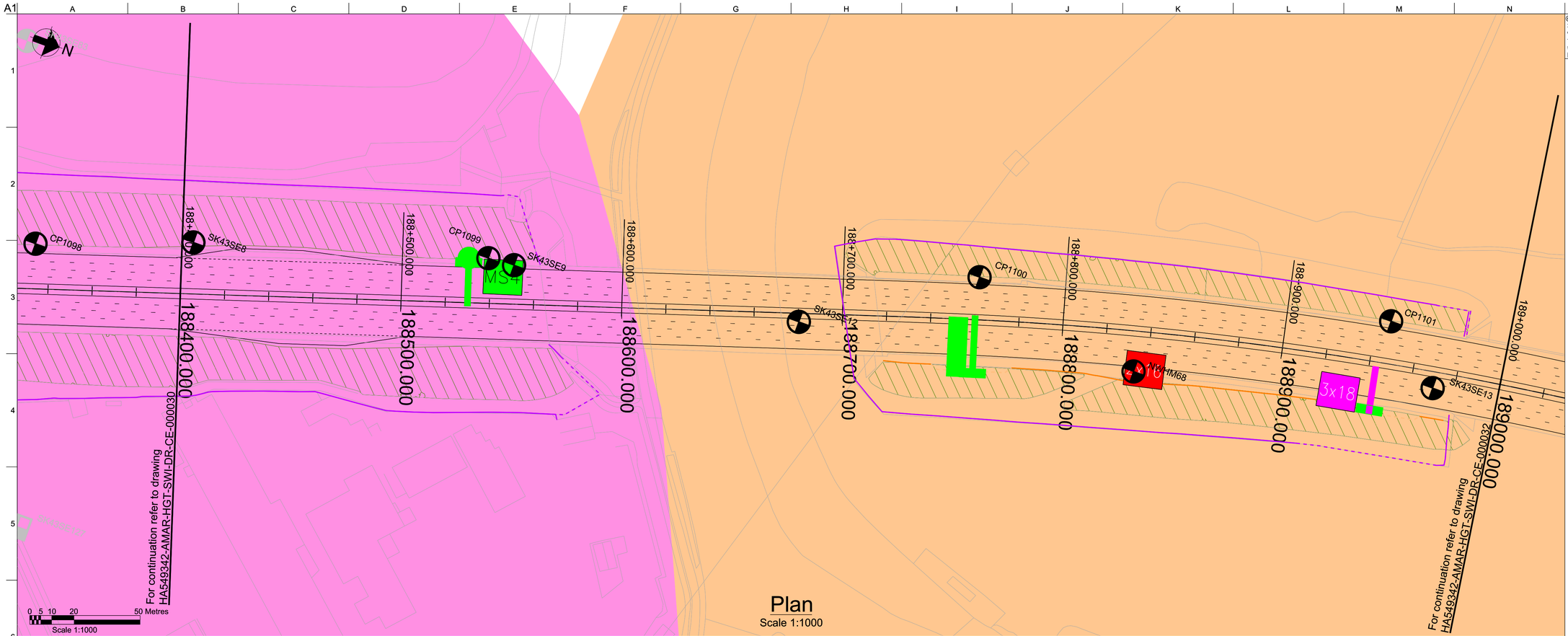
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Job No: 244508-00

Rev: P01

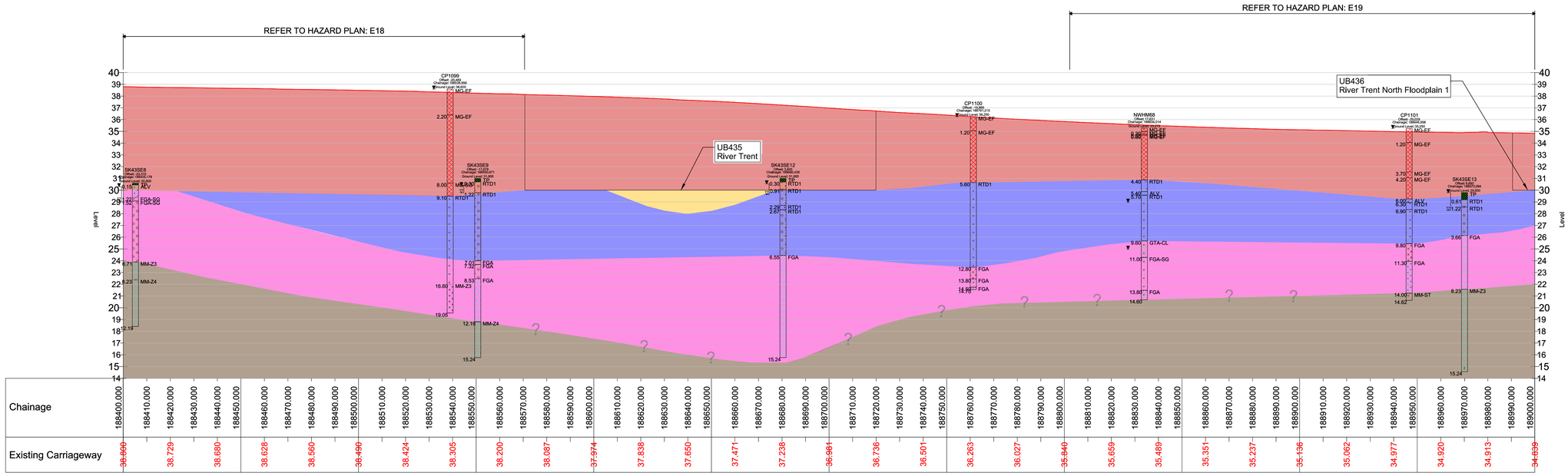
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Plan

Scale 1:1000



Profile

Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

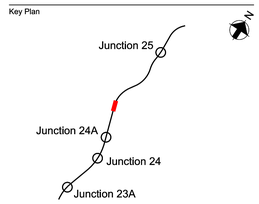
First Issue

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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section Plan & Profile Chainage 188400 to 189000 Sheet 16 of 27

Scale at A1: NTS

Role: Civil - Geotechnics

Suitability: S2 - Fit for information

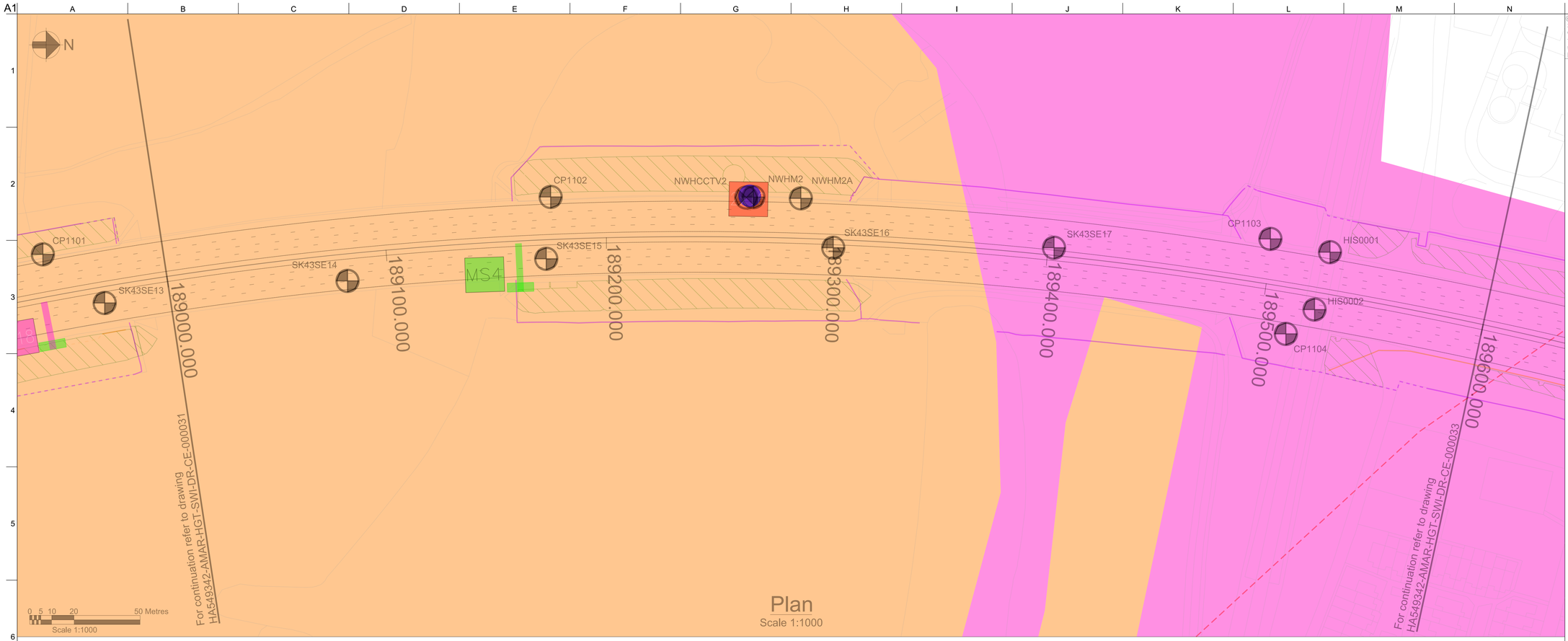
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Rev: P01

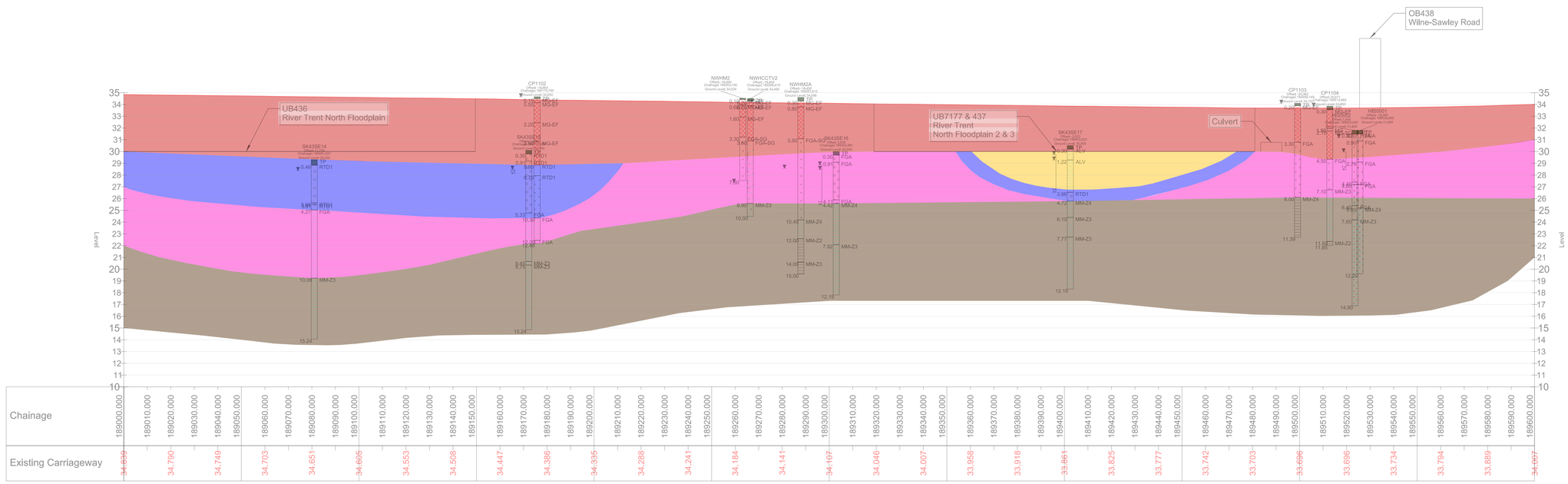
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A1



Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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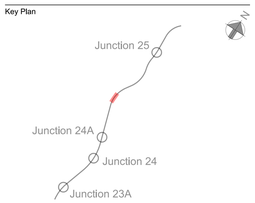
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB
First Issue				

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Birmingham B4 6AT
Tel 0121 214 2000

Client
highways england
driving forward

Project Title
SMP M1 J23a - J25

Key Plan


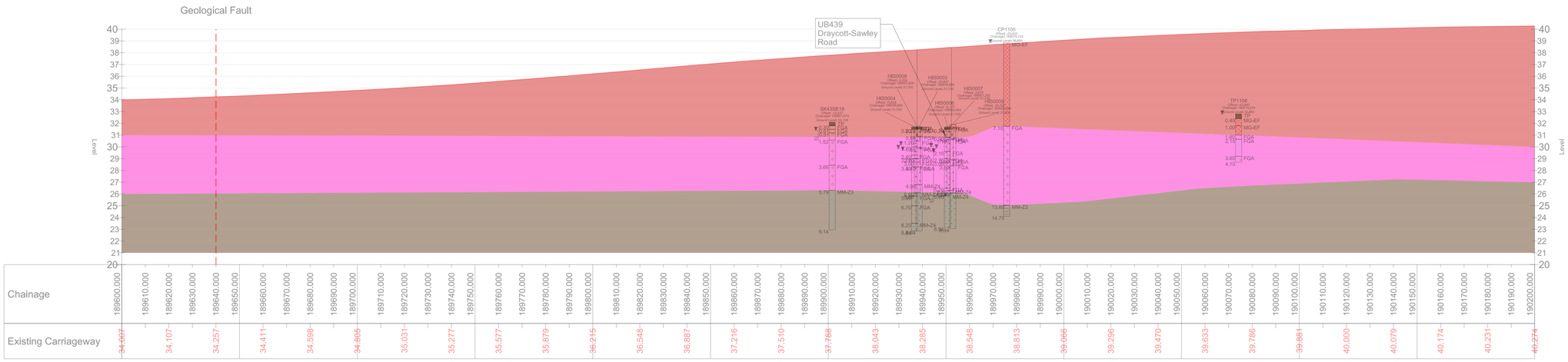
Drawing Title
Geological Long Section
Plan & Profile
Chainage 189000 - 189600
Sheet 17 of 27

Scale at A1: NTS
Role: Civil - Geotechnics
Suitability: S2 - Fit for Information
Job No: 244508-00
Rev: P01
Name: HA549342-AMAR-HGT-SWI-DR-CE-000032

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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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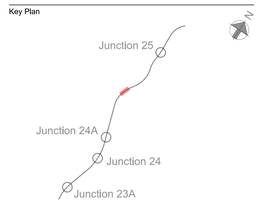
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB
First Issue				

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Birmingham B4 6AT
Tel 0121 214 2000

Client
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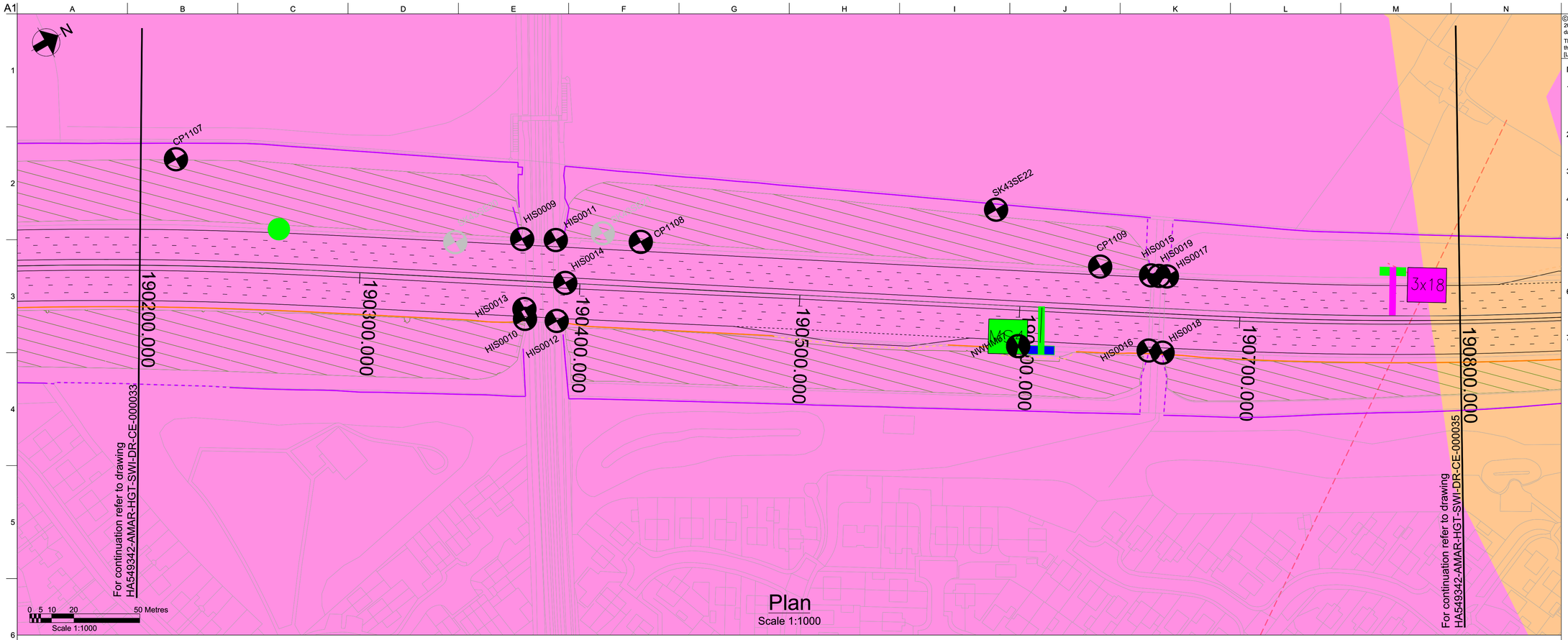
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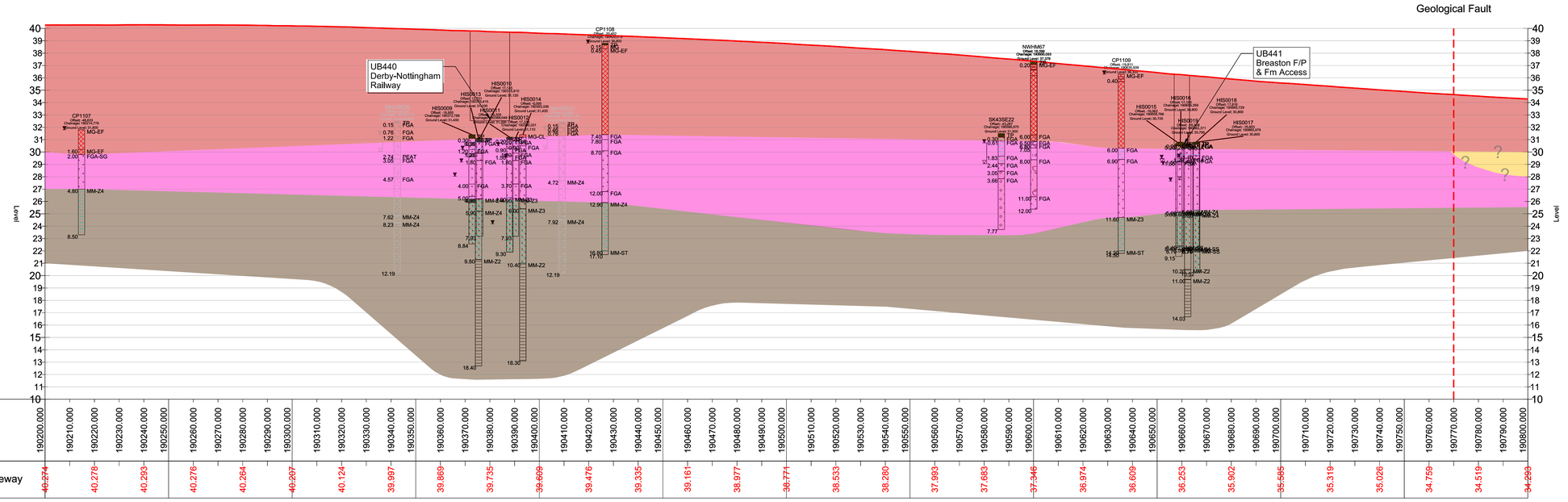
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Geological Long Section
Plan & Profile
Chainage 189600 - 190200
Sheet 18 of 27

Scale at A1: NTS
Role: Civil - Geotechnics
Suitability: S2 - Fit for Information
Job No: 244508-00
Rev: P01
Name: HA549342-AMAR-HGT-SWI-DR-CE-000033

pw:\\MCONTSIX4.global.arup.com:PW_ARUP_UK\Documents\SMP M1 J23a - J25\01 Amey Arup JVCE - Civil Engineer - Geotechnics\DR - Drawings\HA549342-AMAR-HGT-SWI-DR-CE-000033



Plan
Scale 1:1000



Chainage	190200.000	190210.000	190220.000	190230.000	190240.000	190250.000	190260.000	190270.000	190280.000	190290.000	190300.000	190310.000	190320.000	190330.000	190340.000	190350.000	190360.000	190370.000	190380.000	190390.000	190400.000	190410.000	190420.000	190430.000	190440.000	190450.000	190460.000	190470.000	190480.000	190490.000	190500.000	190510.000	190520.000	190530.000	190540.000	190550.000	190560.000	190570.000	190580.000	190590.000	190600.000	190610.000	190620.000	190630.000	190640.000	190650.000	190660.000	190670.000	190680.000	190690.000	190700.000	190710.000	190720.000	190730.000	190740.000	190750.000	190760.000	190770.000	190780.000	190790.000	190800.000
Existing Carriageway	40.274	40.278	40.293	40.276	40.264	40.207	40.124	39.997	39.869	39.735	39.609	39.476	39.335	39.161	38.977	38.771	38.533	38.280	37.993	37.683	37.346	35.974	36.609	36.253	35.902	35.585	35.319	35.026	34.759	34.519	34.293

Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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4. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

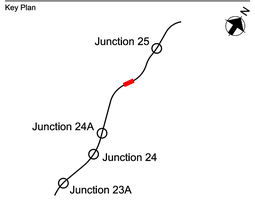
First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 190200 - 190800
Sheet 19 of 27

Scale at A1: NTS

Role: Civil - Earthworks

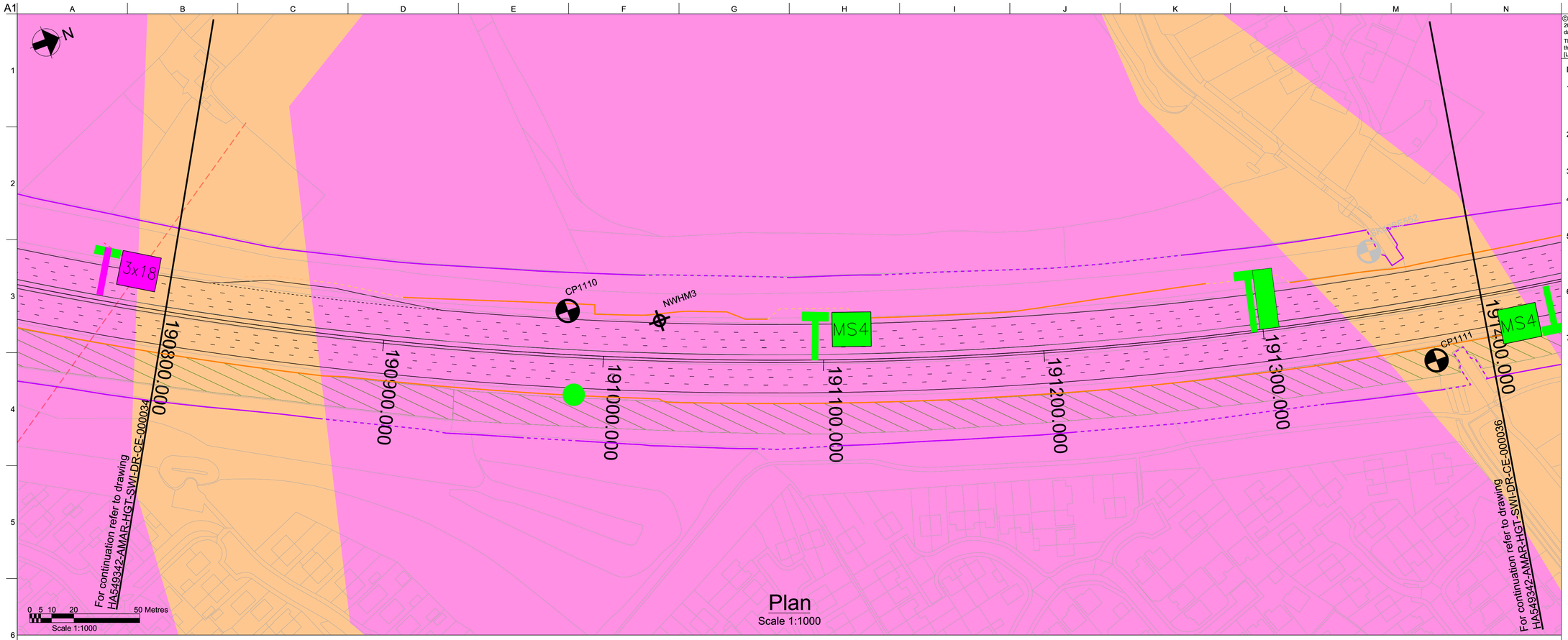
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Job No: 244508-00

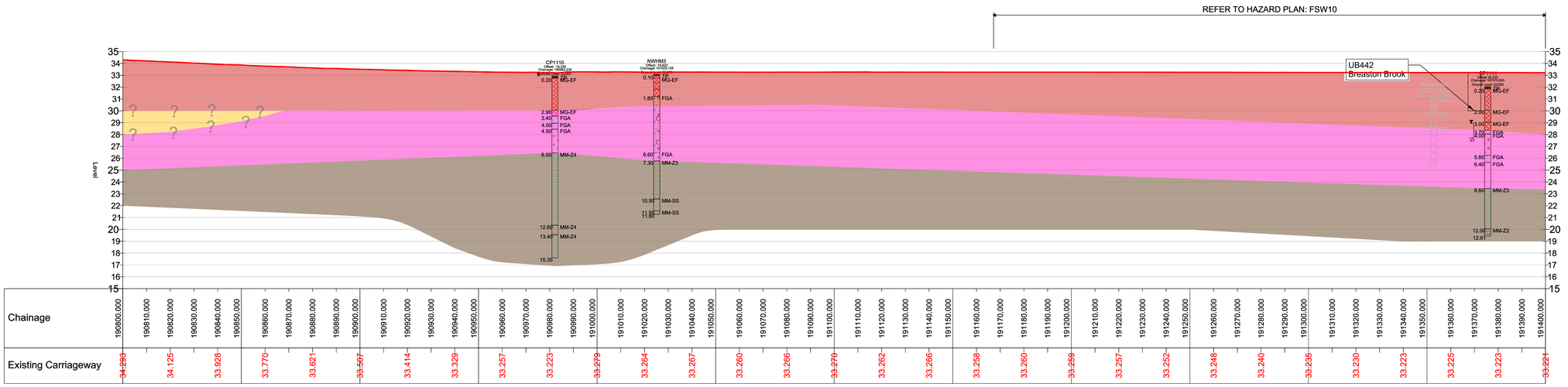
Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000034

pw:\\MCCNTS04.global.arup.com:PW_ARUP_UKDocuments\SMP M1 J23a - J25\01 Arvey Arup JV\CE - Civil - Earthworks and Geotechnics\DR - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-000034



Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

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Birmingham B4 6AT
Tel 0121 214 2000

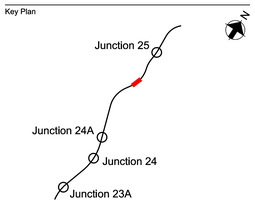
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geological Long Section
Plan & Profile
Chainage 190800 - 191400
Sheet 20 of 27

Scale at A1: NTS

Role: Civil - Earthworks

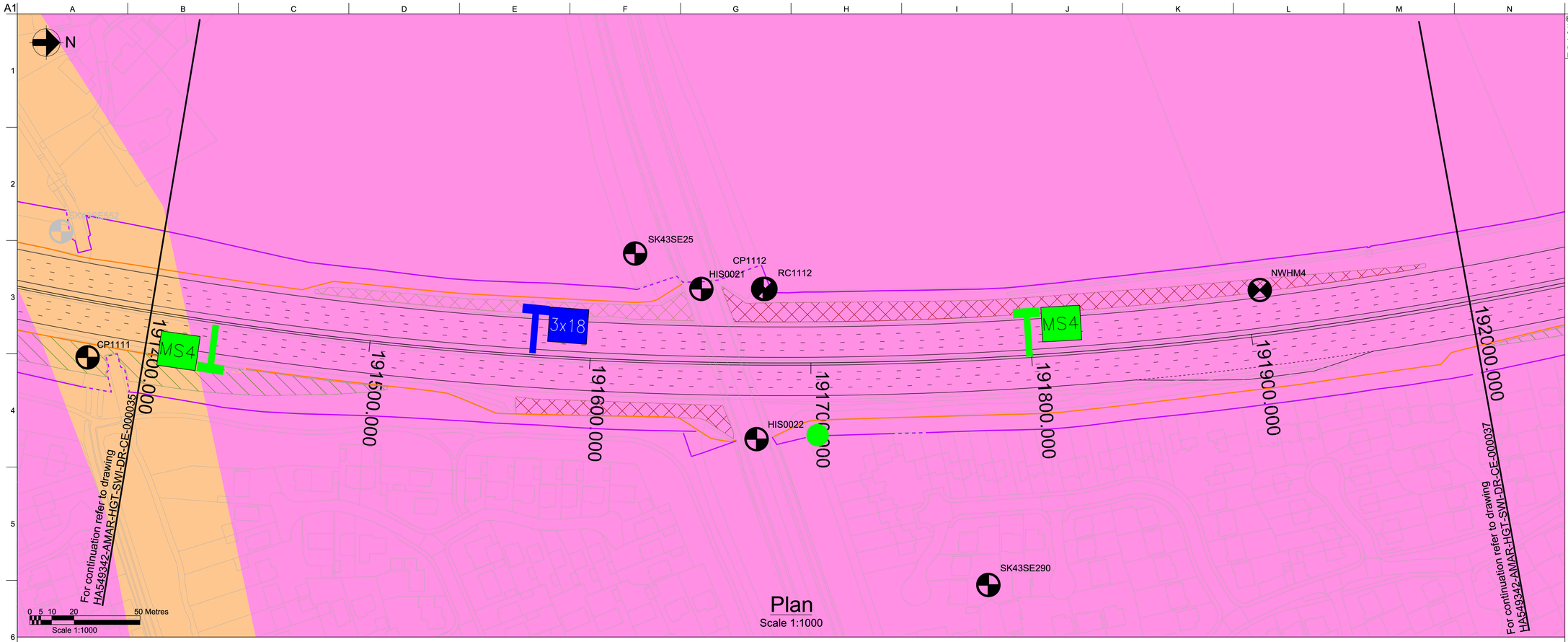
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Job No: **244508-00**

Rev: **P01**

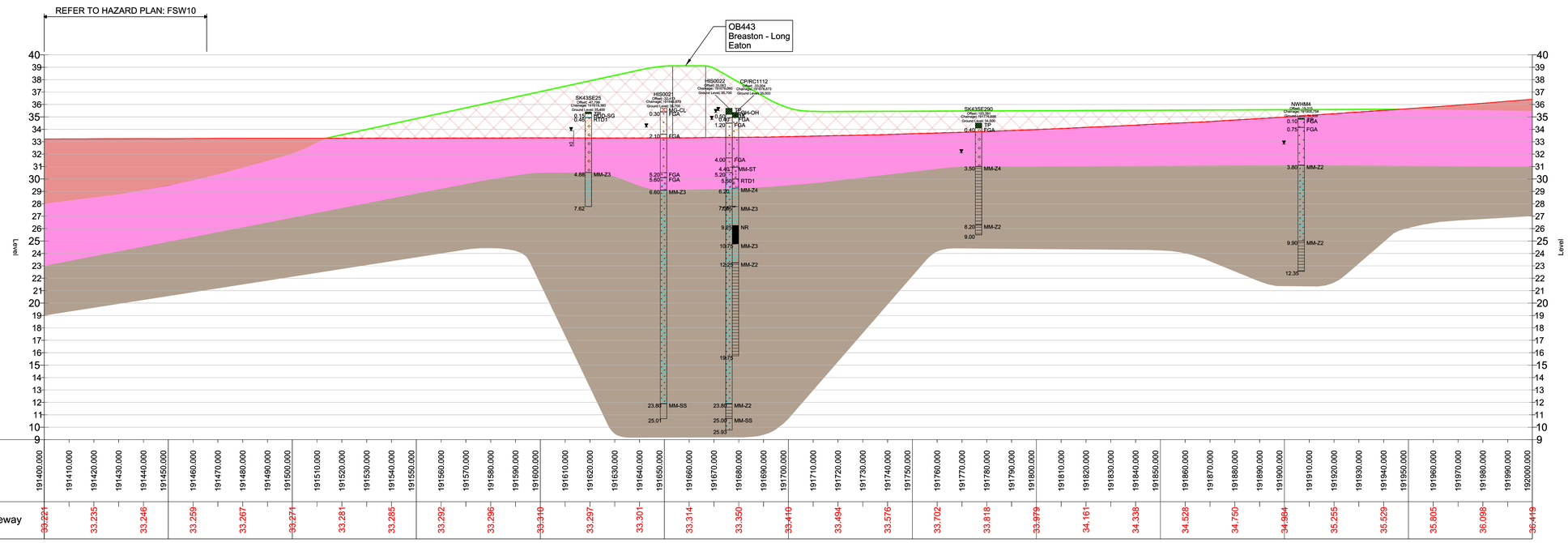
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Plan

Scale 1:1000



Profile

Scale 1:500h 1:100v

Do not scale

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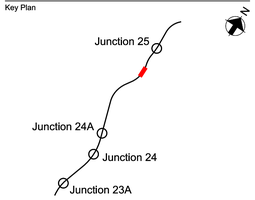
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB
First Issue				

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 191400 - 192000
Sheet 21 of 27

Scale at A1: NTS

Role: Civil - Earthworks

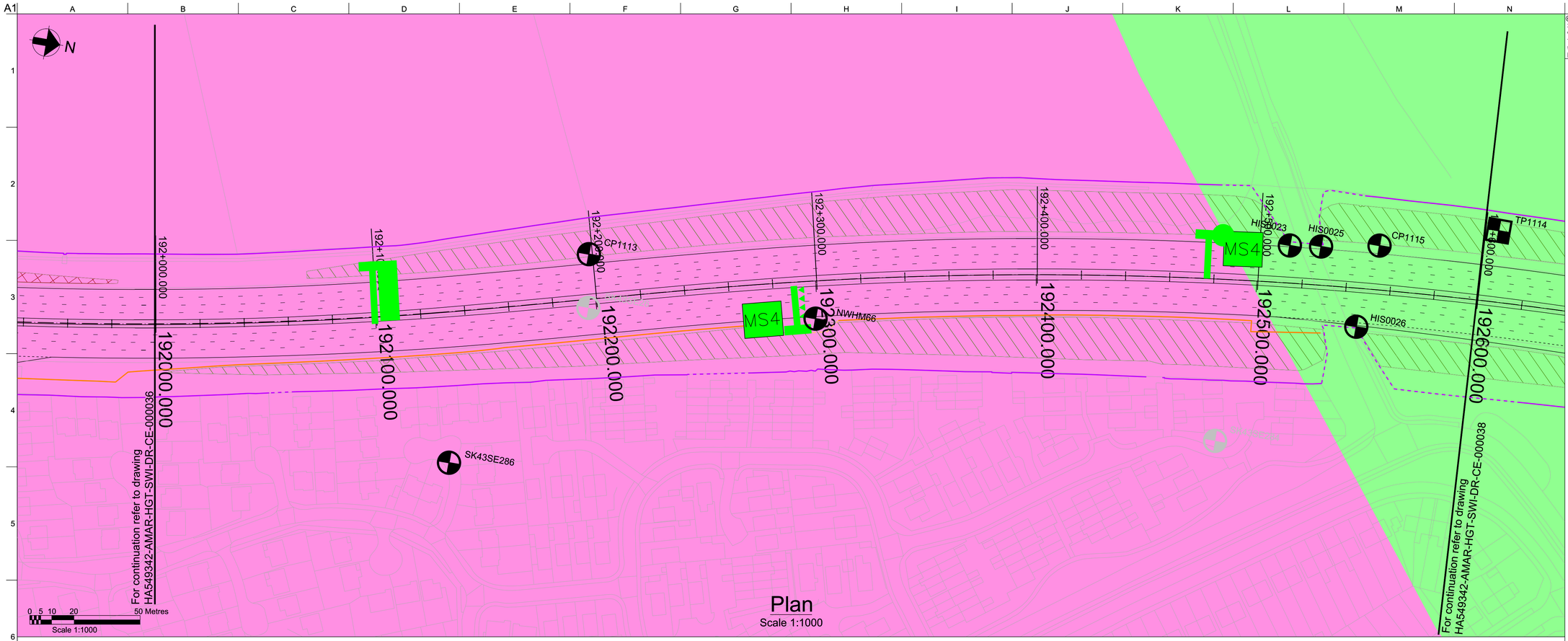
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Job No: 244508-00

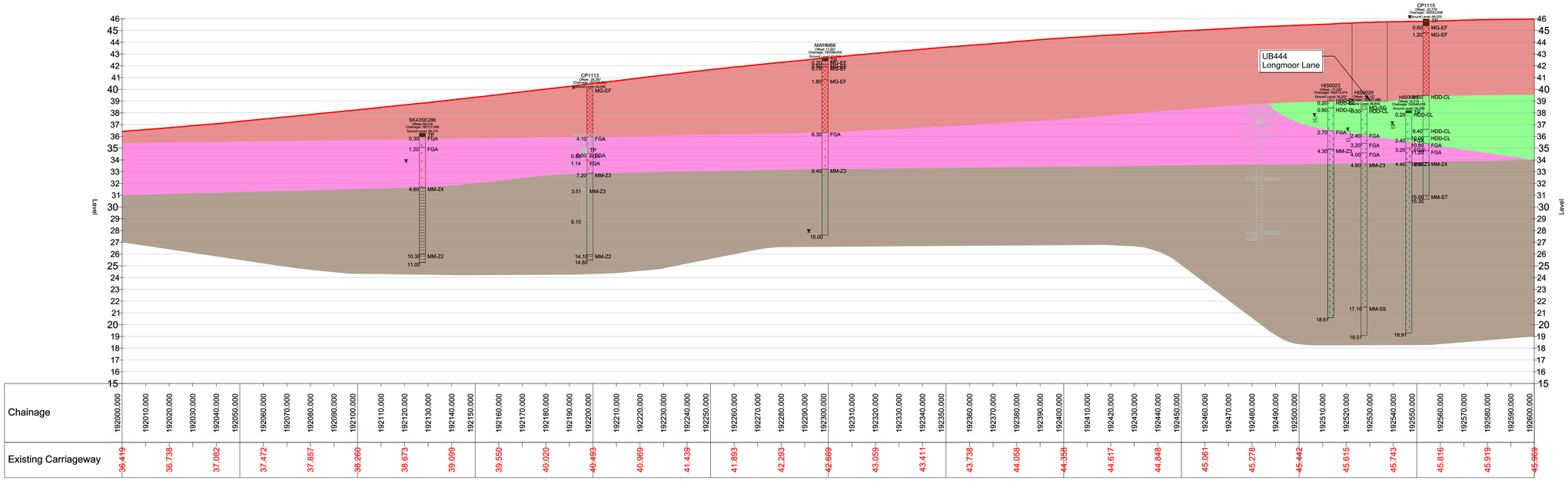
Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000036

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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

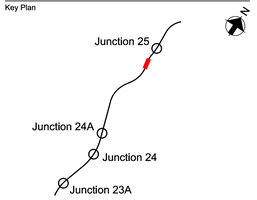
First Issue

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section
Plan & Profile
Chainage 192000 - 192600
Sheet 22 of 27

Scale at A1: NTS

Role: Civil - Earthworks

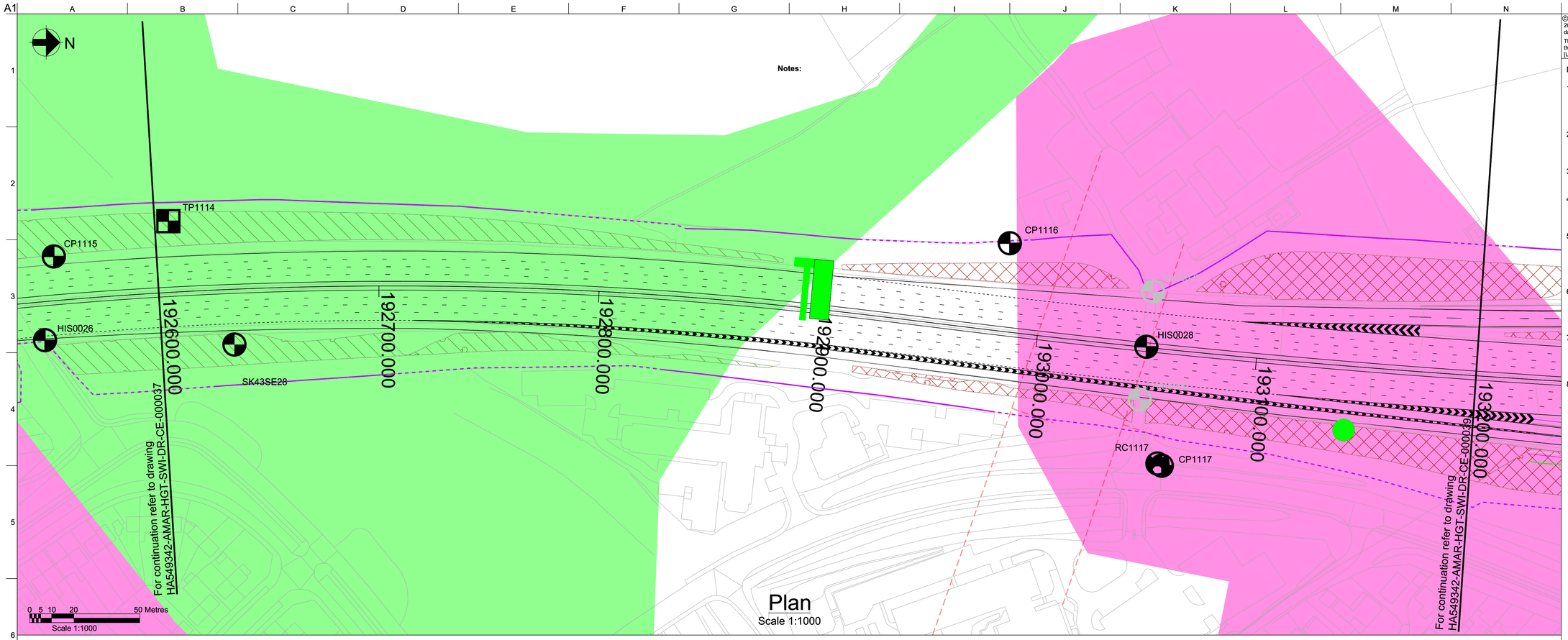
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Job No: 244508-00

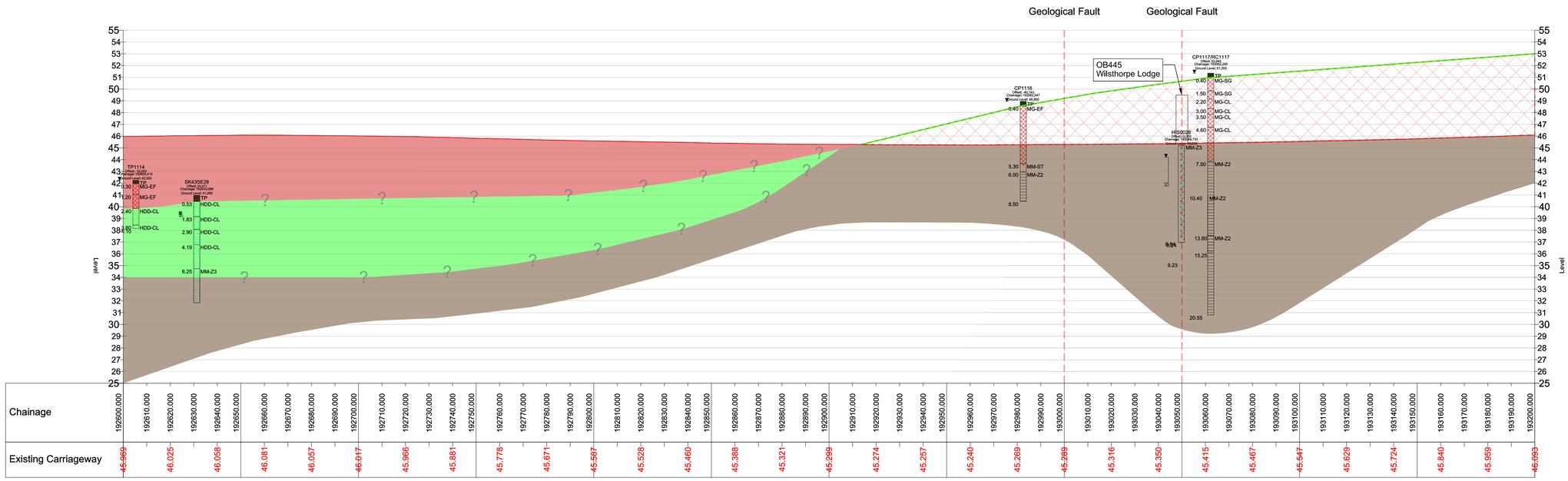
Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000037

pw:\\MCONTS04.global.arup.com\PW_ARUP_UKDocuments\SMP M1 J23a - 225101 Aney Arup JV\CE - Civil - Earthworks and Geotechnics\DR - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-000037



Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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NOTES

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
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8. CH 192990 TO CH 193300 FGA DEPOSITS IN THE AREA LIKELY TO HAVE BEEN REMOVED AS PART OF ROAD CONSTRUCTION.

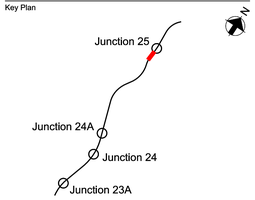
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB
First Issue				

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section Plan & Profile Chainage 192600 - 193200 Sheet 23 of 27

Scale at A1: NTS

Role: Civil - Earthworks

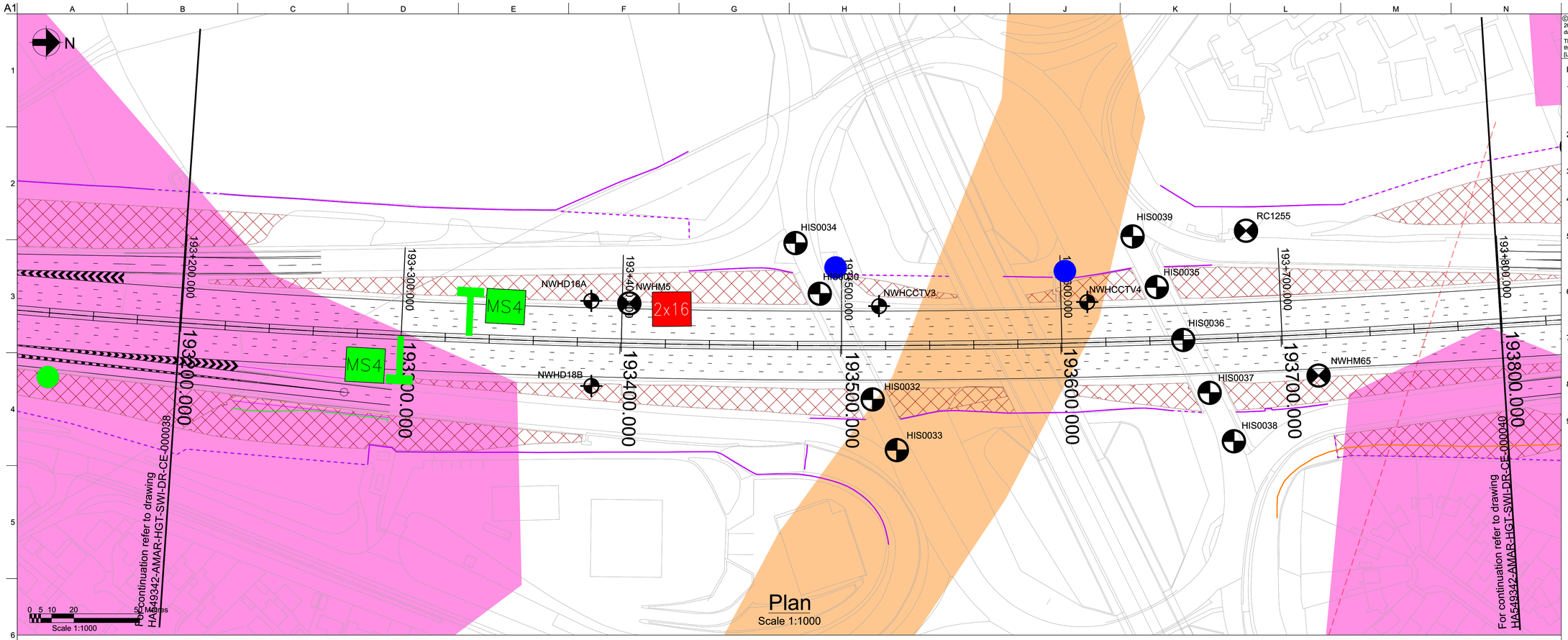
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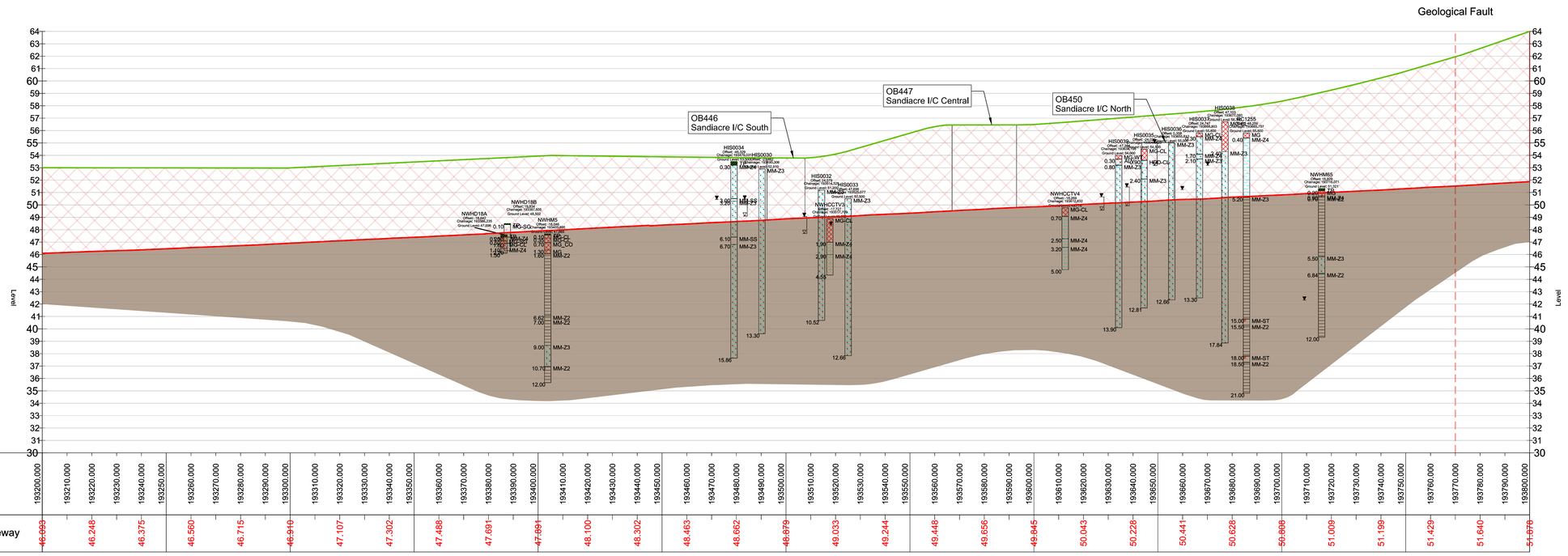
Job No: 244508-00

Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000038

pw:\\MCCNTS04.global.arup.com:PW_ARUP_UKCDocuments\SMP M1 J23a - 225201 Amey Arup JV\CE - Civil - Earthworks and Geotechnics\DR - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-000038





Profile
Scale 1:500h 1:100v

Do not scale

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8. CH 192990 TO CH 193300 FGA DEPOSITS IN THE AREA LIKELY TO HAVE BEEN REMOVED AS PART OF ROAD CONSTRUCTION.
9. CH 193520 TO CH 193610 ALV DEPOSITS IN THE AREA LIKELY TO HAVE BEEN REMOVED AS PART OF ROAD CONSTRUCTION.

P01	19/02/16	OY	SB	TB

First Issue

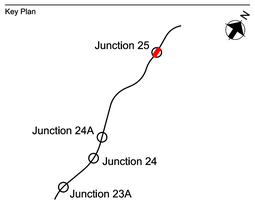
Rev	Date	By	Chkd	Appd

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client
highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
Geological Long Section
Plan & Profile
Chainage 193200 - 193800
Sheet 24 of 27

Scale at A1 NTS

Role Civil - Earthworks

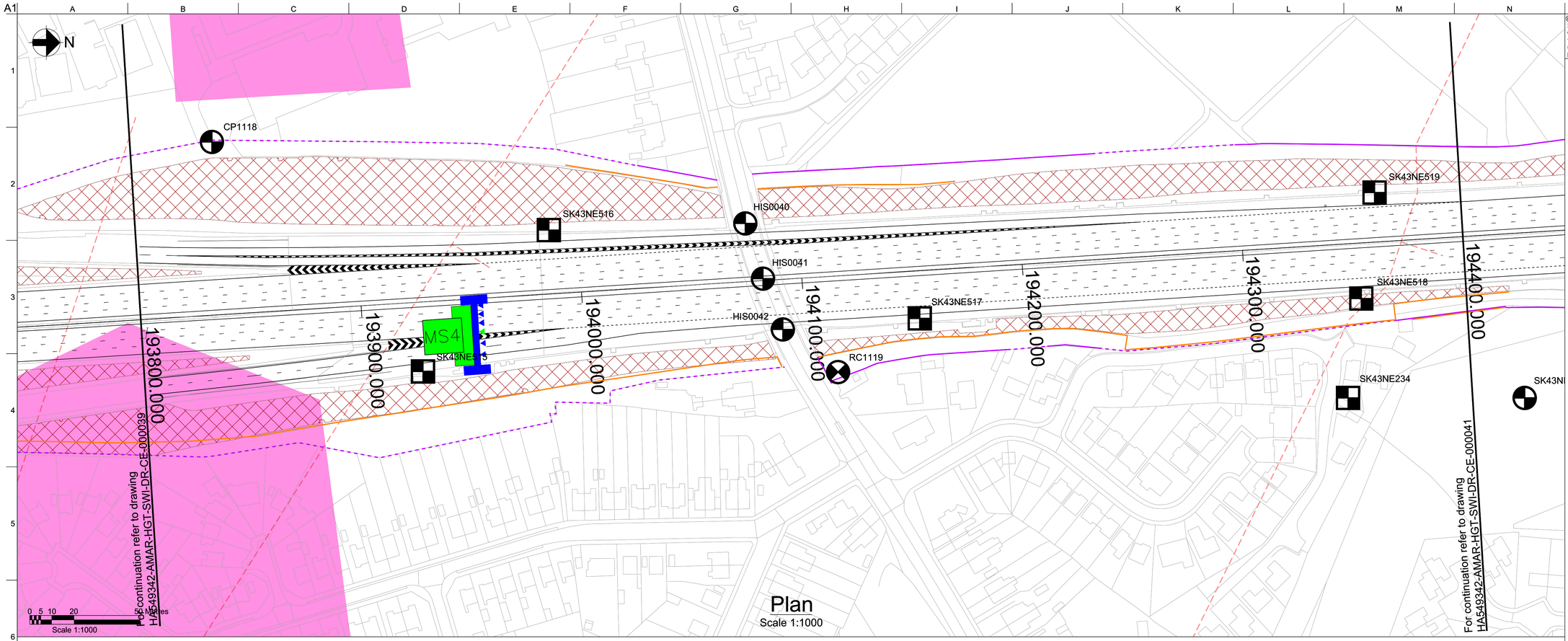
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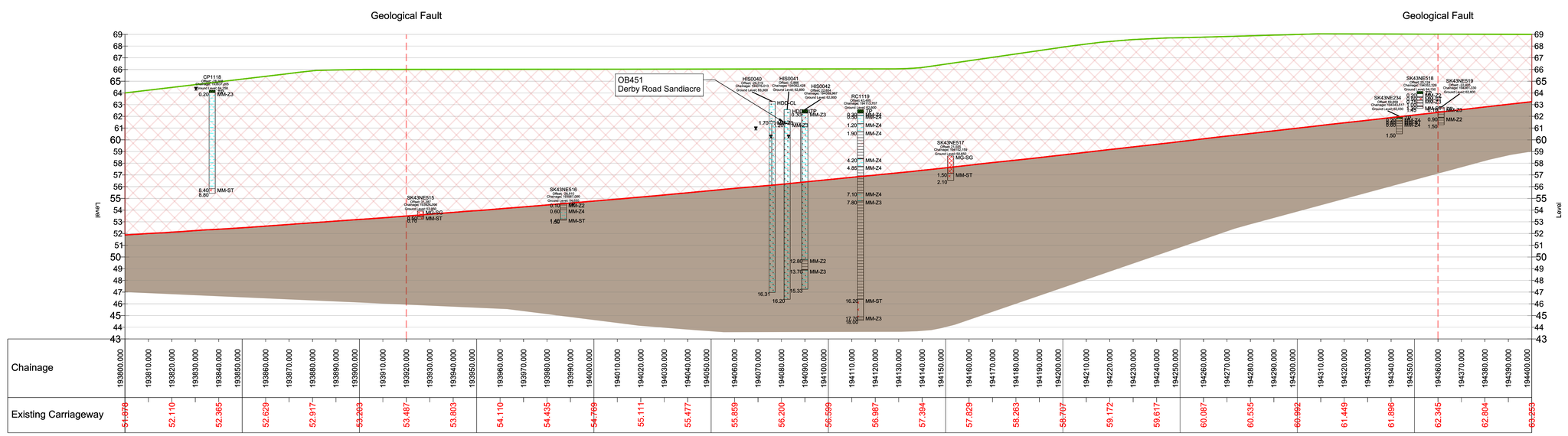
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Plan
Scale 1:1000



Profile
Scale 1:500h 1:100v

Do not scale

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Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB

First Issue

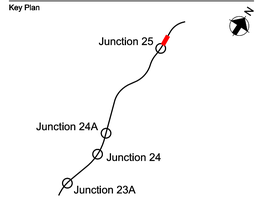
amey ARUP

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geological Long Section Plan & Profile Chainage 193800 - 194400 Sheet 25 of 27

Scale at A1: NTS

Role: Civil - Earthworks

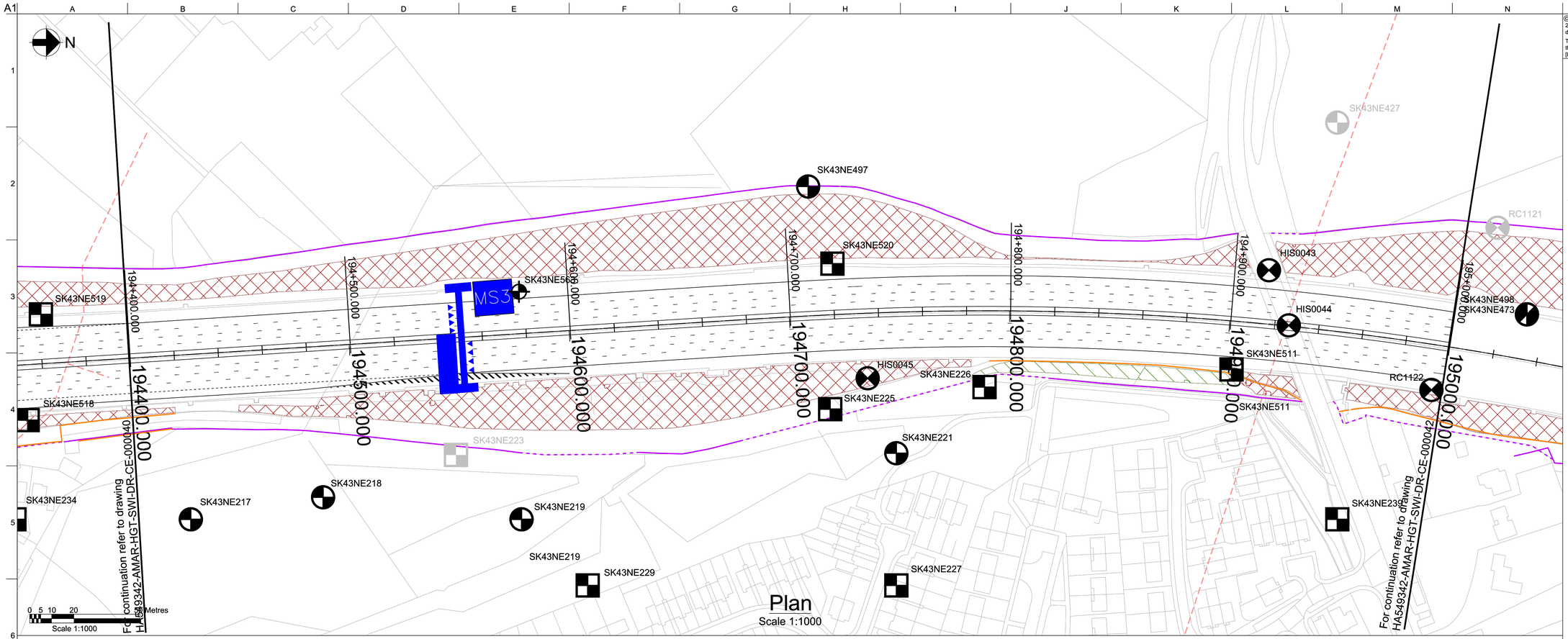
Suitability: S2 - Fit for information

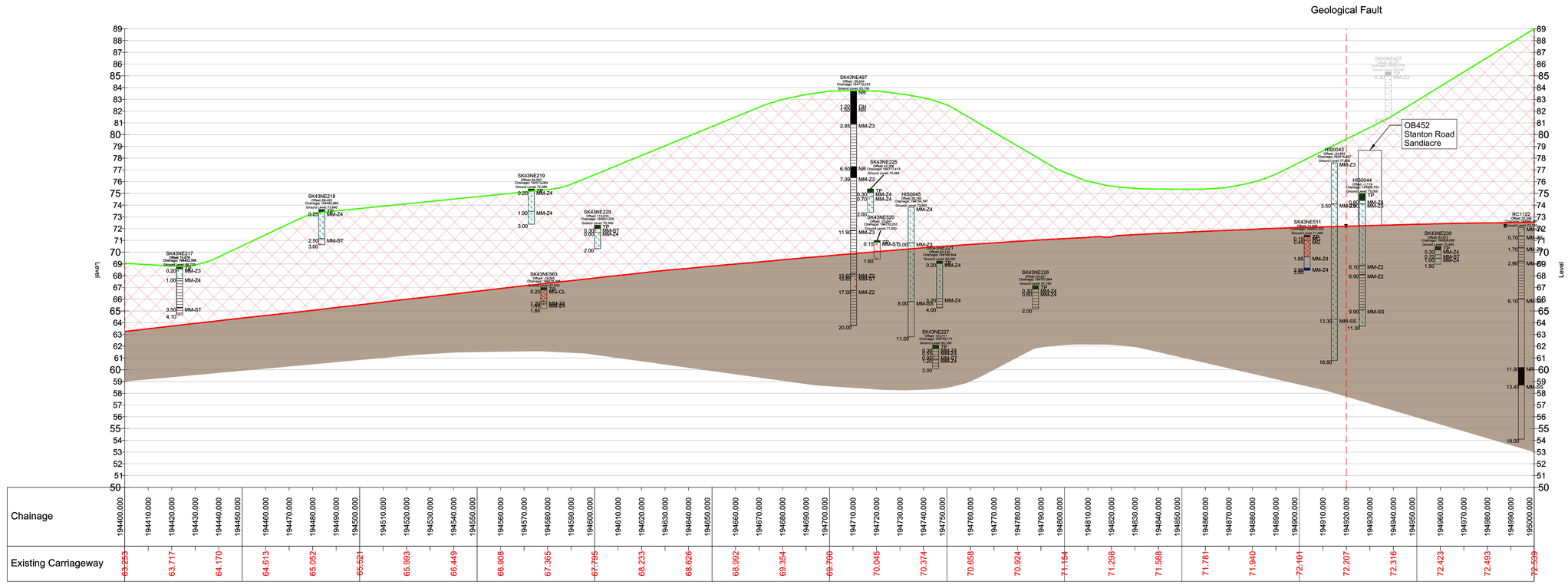
Job No: 244508-00

Rev: P01

Name: HA549342-AMAR-HGT-SWI-DR-CE-000040

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000001.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
5. IF THE LOG IS 'GREYED' OUT IT HAS BEEN DEEMED NOT SUITABLE FOR USE IN THE GEOLOGICAL LONG SECTIONS, USING AN INITIAL RAG ASSESMENT [I.E RED], AS OUTLINED IN THE STATEMENT OF INTENT.
6. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALISED GROUND MODEL.
7. FOR GEOTECHNICAL HAZARDS REFER TO GEOTECHNICAL HAZARD PLANS HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.
8. CUTTING CH 194700 - 195000 IS GREATER IN HEIGHT BUT ONLY THE CUTTING SLOPE WITHIN THE HIGHWAYS BOUNDARY IS INCLUDED IN THE LONG SECTION.

P01	19/02/16	OY	SB	TB
First Issue				

Rev	Date	By	Chkd	Appd

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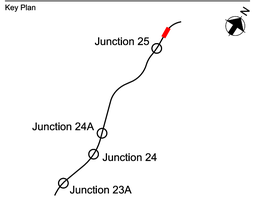
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



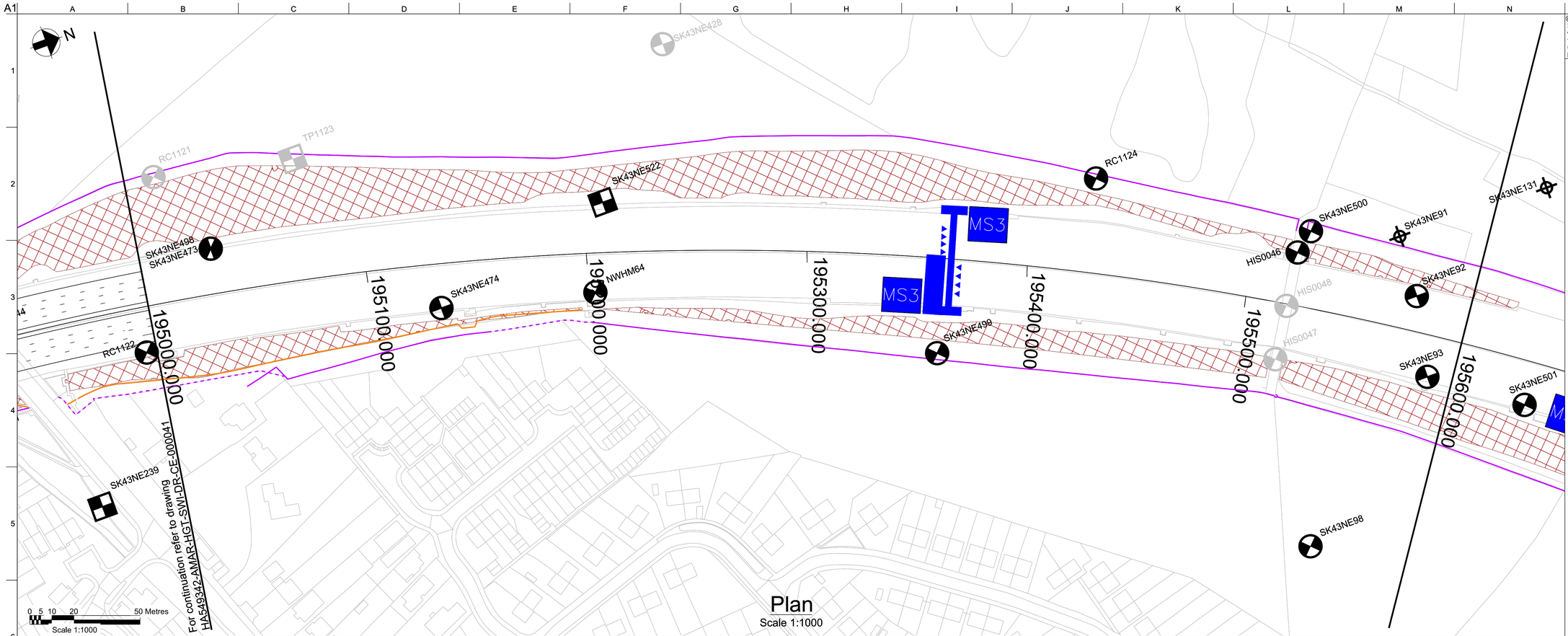
Drawing Title

Geological Long Section
Plan & Profile
Chainage 194400 - 195000
Sheet 26 of 27

Scale at A1	NTS
Role	Civil - Earthworks
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000041

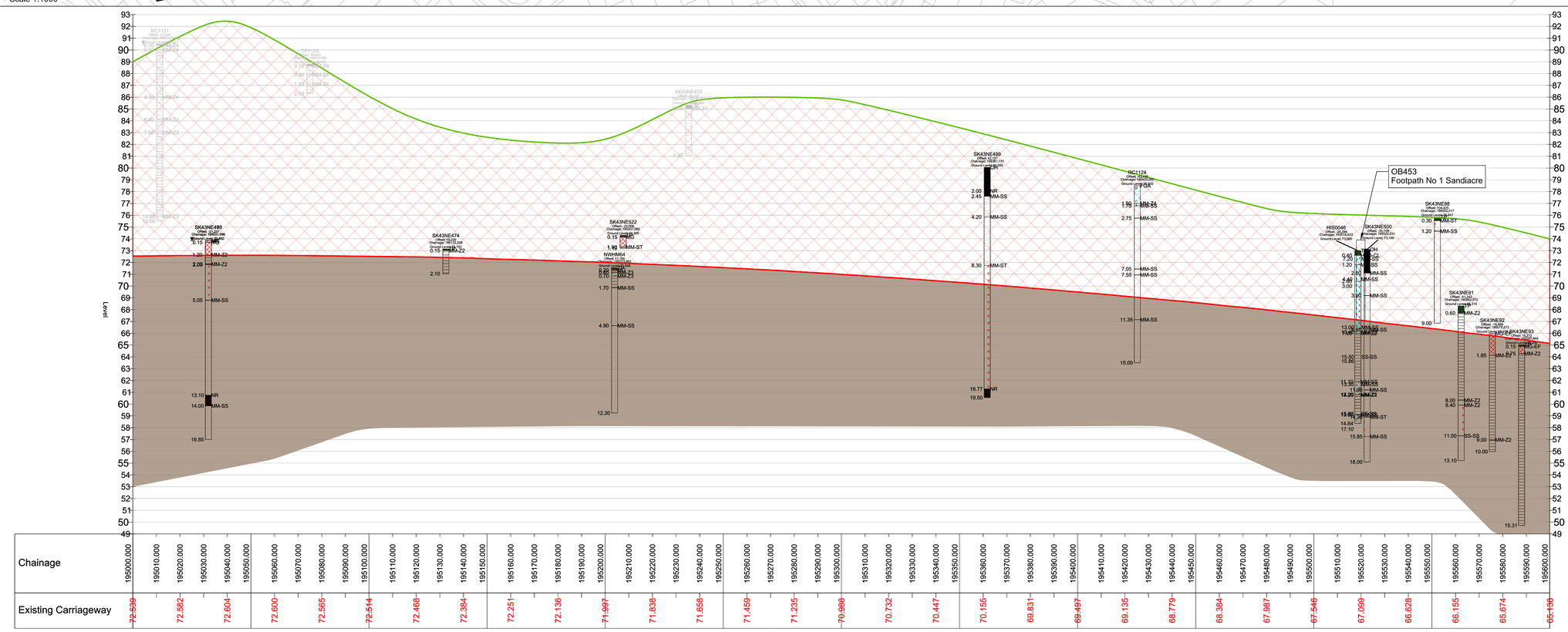
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Do not scale



Plan

Scale 1:1000



Profile

Scale 1:500h 1:100v

Do not scale

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8. CUTTING AROUND FOOTBRIDGE IS GREATER IN HEIGHT BUT ONLY THE CUTTING SLOPE WITHIN THE HIGHWAYS BOUNDARY IS INCLUDED IN THE LONG SECTION.

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SB	TB
First Issue				

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20 Colmore Circus Queensway
Birmingham B4 6AT
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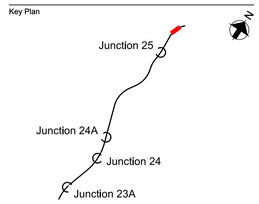
Client

highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geological Long Section
Plan & Profile
Chainage 195000 - 196000
Sheet 27 of 27

Scale at A1 NTS

Role Civil - Earthworks

Suitability S2 - Fit for information

Job No **244508-00**

Rev **P01**

Name **HA549342-AMAR-HGT-SWI-DR-CE-000042**

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FEATURES

CENTRELINE OF EXISTING MOTORWAY

WATERCOURSE (WITH FLOW DIRECTION)

FORMER WATERCOURSE

EXISTING MOTORWAY FEATURES

WATER FEATURES

VEGETATION FEATURES

MAN-MADE FEATURES (STRUCTURES)

OPENCAST AND SHALLOW MINEWORKINGS; SOME WHOLLY OR PARTIALLY BACKFILLED

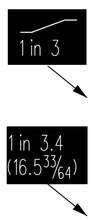
LANDFILL AND MADE GROUND

BOUNDARY OF EXISTING FEATURE

BOUNDARY OF FORMER FEATURE

BOUNDARY OF FORMER WATER FEATURE

SIDESLOPE INDICATORS (VERTICAL IN HORIZONTAL)



SIDESLOPE INDICATORS (MEASURED)

HAZARD LABELS

X1	FEATURE NUMBER
D	DRAIN
E	EXCAVATION
U	UTILITIES
F	FARMLAND
I	INDUSTRIAL
SW	SURFACE WATER FEATURE
C	COMMERCIAL
FSW	FORMER SURFACE WATER FEATURE
L	LANDFILL
R	RESIDENTIAL
RW	RETAINING WALL
RS	REMEDIAL SOLUTION
PO	POLLUTION INCIDENT
FR	FLOOD RISK
T	TRANSPORT
MF	MOTORWAY FEATURE
FMF	FORMER MOTORWAY FEATURE
M	MOUND
N	NATURE RESERVE/FOREST
HA	HAGDMS DEFECT

MINING FEATURES

DISUSED COAL SHAFT

DISUSED SHAFT (NATURE UNKNOWN)

P1 TREATED SHAFTS

DISUSED SHAFT (NOT COAL)

KNOWN SHAFTS WITH NO RECORD OF TREATMENT

SUSPECTED SHAFTS

B BELLPIT IDENTIFIED FROM AERIAL PHOTO

PLAN KEY

- EXISTING HIGHWAY FENCELINE
- ASSUMED HIGHWAY FENCELINE
- PROPOSED ENVIRONMENTAL NOISE BARRIER
- EXISTING ENVIRONMENTAL NOISE BARRIER
- RAIL FREIGHT TERMINAL WORKS
- EXISTING GANTRY RETAINED IN SITU
- EXISTING GANTRY REMOVED
- PROPOSED GANTRY
- EXISTING ADVANCED MOTORWAY INDICATOR RETAINED IN SITU
- PROPOSED ADVANCED MOTORWAY INDICATOR
- EXISTING MATRIX INDICATOR RETAINED IN SITU
- EXISTING MATRIX INDICATOR REMOVED
- EXISTING MESSAGE SIGN 2X12 RETAINED IN SITU
- EXISTING STRATEGIC MS3 3X18 RETAINED IN SITU
- EXISTING STRATEGIC MS3 3X18 RETAINED AND RELOCATED
- STRATEGIC MS3 2X16 REMOVED
- EXISTING MESSAGE SIGN 2X12 REMOVED
- PROPOSED MS4
- EXISTING ADS RETAINED
- EXISTING ADS REMOVED
- PROPOSED ADS
- PROPOSED ROTTMS
- EXISTING ESS RETAINED
- PROPOSED POST MOUNTED AMI
- EXISTING CCTV
- PROPOSED CCTV
- OBXXX EXISTING OVERBRIDGE
- UBXXX EXISTING UNDERBRIDGE
- CXXXX EXISTING CULVERT
- RXXXX EXISTING RETAINING WALL
- EXXXX PROPOSED ERA
- PROPOSED SITE CLEARANCE BOUNDARY
- SCHEME CHAINAGE 19000.000

AS DEFINED BY HAGDMS:

- BUND
- CUTTING
- EMBANKMENT

NOTES

1. THIS SEQUENCE OF GEOTECHNICAL HAZARD PLANS HAVE BEEN DEVELOPED FROM THE ARUP PSSR No 001, DRAWING No GRP_1790_33 TO GRP_1955_55.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH GEOTECHNICAL HAZARD PLAN DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB
First Issue				

amey ARUP

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: Geotechnical Hazard Plan Legend

Scale at A1: NTS

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-NLA-DR-CE-000002**

Do not scale

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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000043

Feature Number	Feature Description	Source	Comment
PO1	Substantiated Pollution Incident Register	Envirocheck	31st March 2003, general biodegradable pollution
N1	Ancient & Semi - Natural woodland		
PO2	Substantiated Pollution Incident Register	Envirocheck	10th January 2002, general biodegradable pollution.
SW1	Pond	OS	

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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000002.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. FOR GEOTECHNICAL LONG SECTIONS REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.

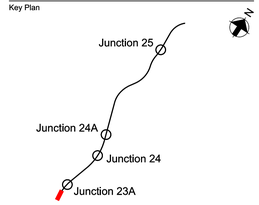
Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB
First Issue				

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 179400 - 180000

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000043

Do not scale

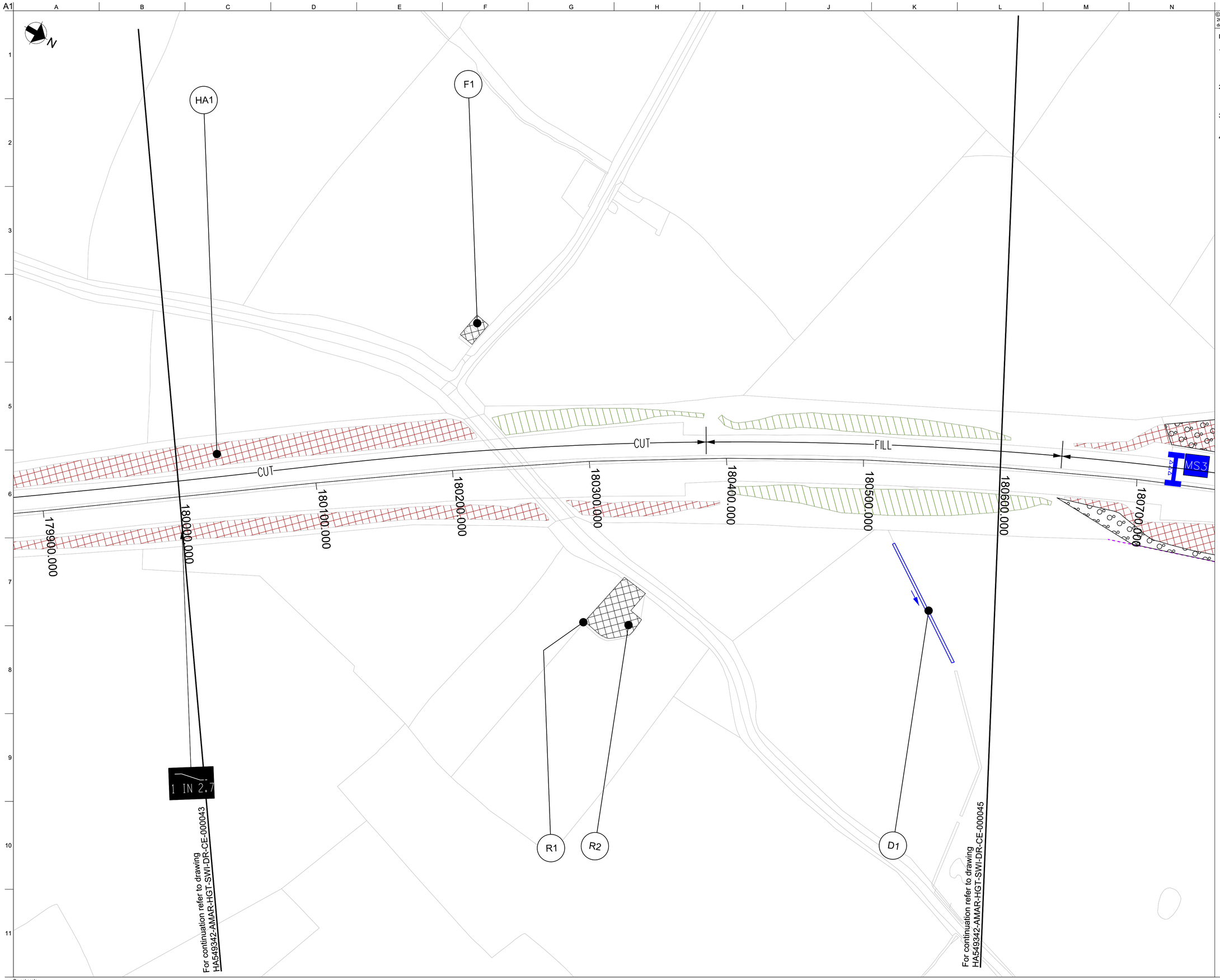
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000044

Feature Number	Feature Description	Source	Comment
F1	Building (Farm)	OS	
R1	Residential Property	OS	
R2	Residential property	OS	Includes Motorway Lighting substation according to Northwest Leicestershire District Council
D1	Drain	OS	
HA1	Slope Defect (7_M1_42102_528723)	HAGDMS – October 2015 inspections	Slope bulge, hydro vegetation. “Slight slope bulge and backscarp with hydrophilic vegetation above brick box and drainage cover”.

A1



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NOTES

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000002.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. FOR GEOTECHNICAL LONG SECTIONS REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

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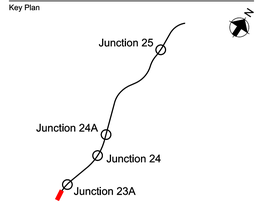
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 180000 - 180600

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000044**

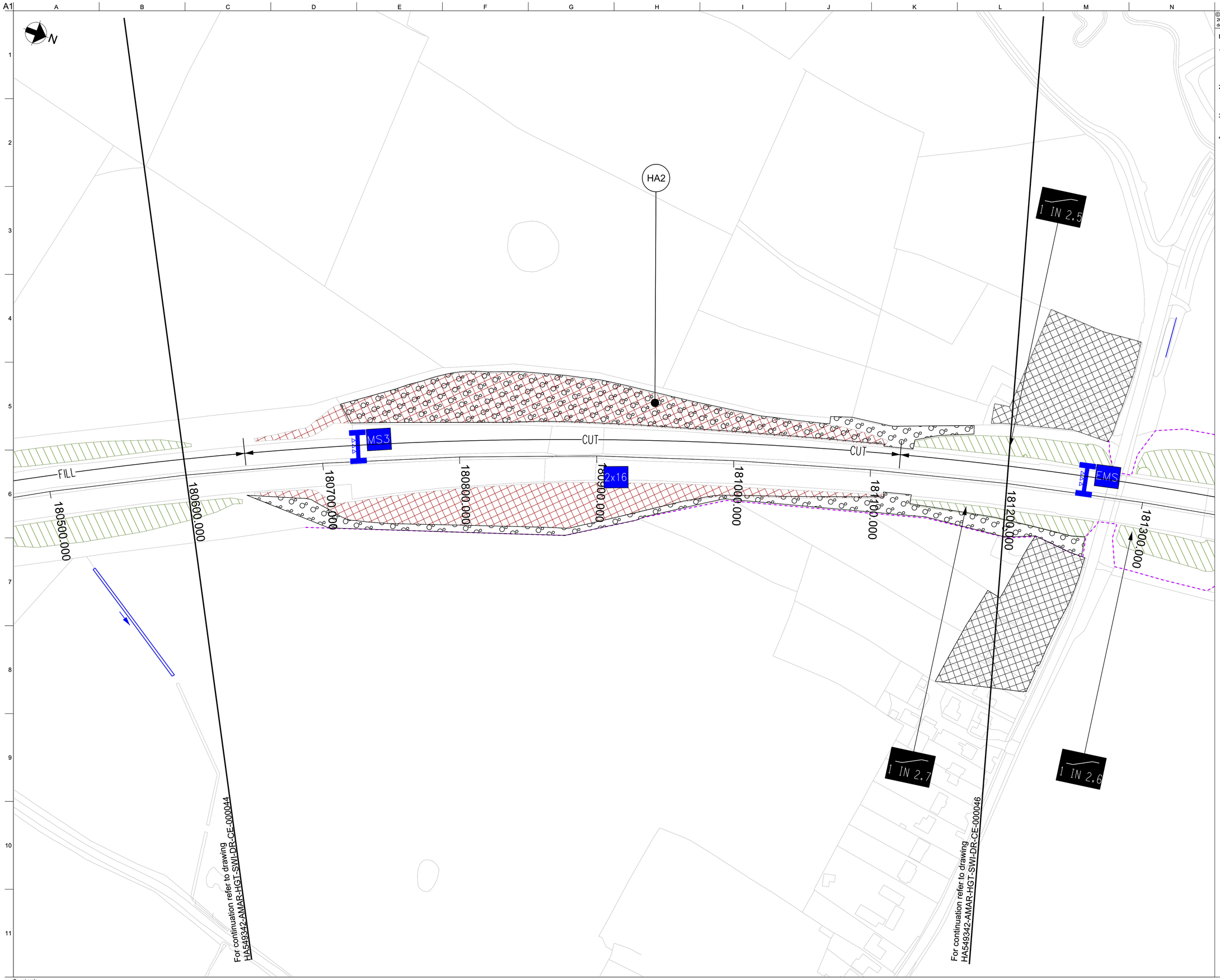
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Do not scale

Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000045

Feature Number	Feature Description	Source	Comment
HA2	Slope Defect (7_M1_42105_528528)	HAGDMS – October 2015 inspections	Dislocated trees. “Slight hummocking of slope. Trees leaning slightly”.



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NOTES

1. THIS DRAWING TO BE READ AS PART OF DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000043 TO HA549342-AMAR-HGT-SWI-DR-CE-000069.
2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000002.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. FOR GEOTECHNICAL LONG SECTIONS REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB
First Issue				

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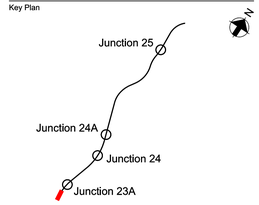
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 180600 - 181200

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000045**

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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000046

Feature Number	Feature Description	Source	Comment
F2	Farm	OS	
D2	Drain	OS	
I1	Substation, motorway lighting supplies	Northwest Leicestershire District Council	
FSW1	Alluvium along the course of Long Whatton Brook and Diseworth Brook.	M1 Widening M1 Widening Site Visit	Well drained valley bottom, stream water level well below valley bottom. According to the aerial photo there may be filled meanders.
SW2	Long Whatton Brook, culverted under the motorway	OS	
SW3	Diseworth Brook, Culverted under the motorway	OS	
E1	Approximate location of made ground (from A42 Construction)	M1 Widening M1 Widening Site Visit	Area of filling on north valley side completely restored to agriculture
D3	Drain	OS	
R3	Residential Area	OS	
F3	Building (Farm)	OS	
FSW2	Infilled meanders	Aerial photo	Channel straightened between 1976 and 1971
L1	Landfill site with 1m of inert material from A42 works and reinstated in 1992	Travers Morgan	
FR1	Low to high flood risk (Flood zone 3)	Environment Agency	Added 2015

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NOTES

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2. THE LEGEND FOR THIS DRAWING SEQUENCE IS FOUND ON DRAWING No. HA549342-AMAR-HGT-NLA-DR-CE-000002.
3. ALL MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
4. FOR GEOTECHNICAL LONG SECTIONS REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-000016 TO HA549342-AMAR-HGT-SWI-DR-CE-000042.

Rev	Date	By	Chkd	Appd
P01	19/02/16	OY	SA	TB

First Issue

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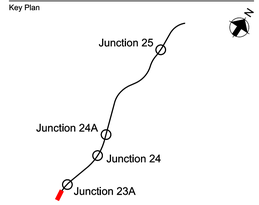
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 181200 - 181800

Scale at A1 1:1250

Role Civil - Earthworks and Geotech

Suitability S2 - Fit for information

Job No **244508-00**

Rev **P01**

Name **HA549342-AMAR-HGT-SWI-DR-CE-000046**

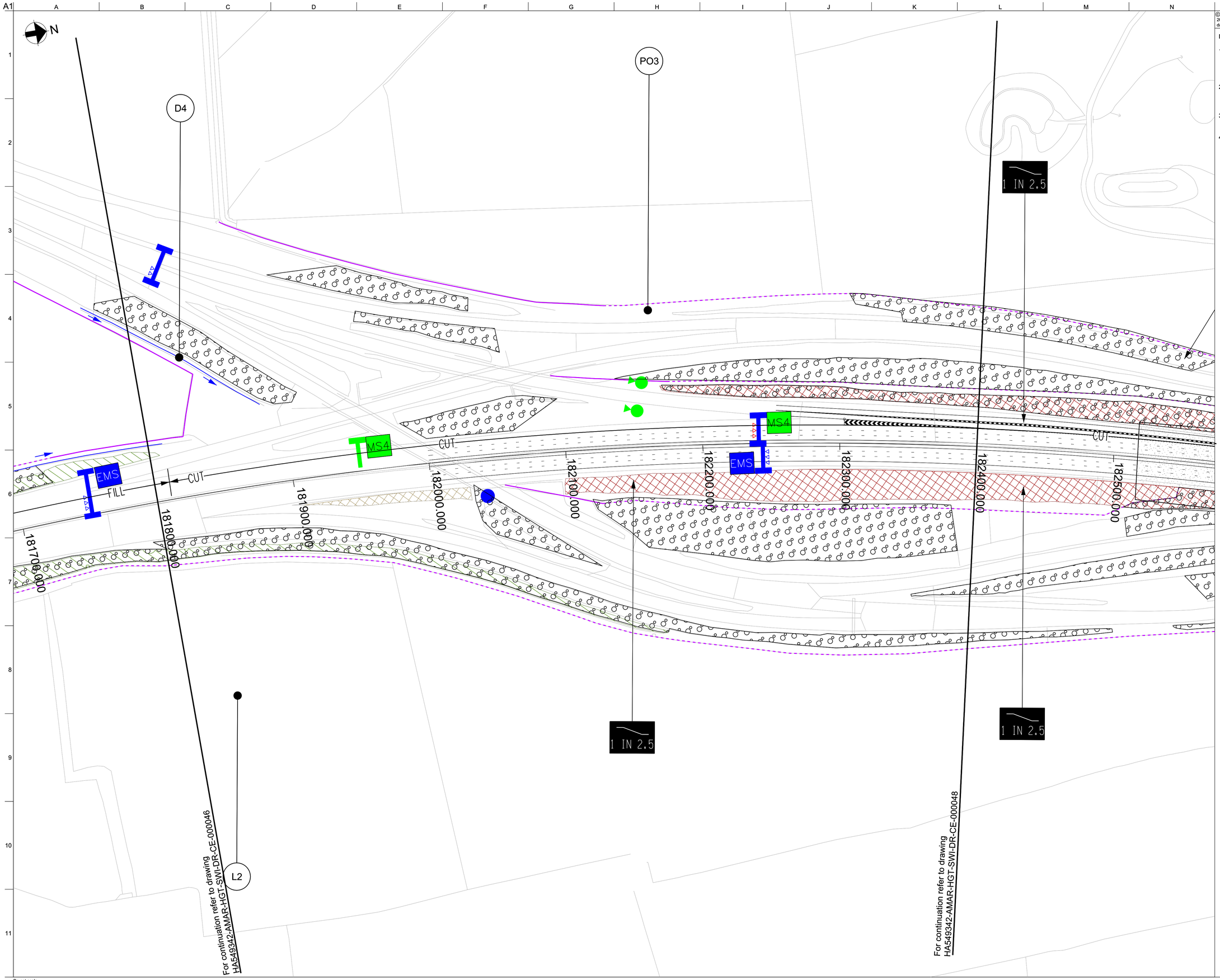
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000047

Feature Number	Feature Description	Source	Comment
D4	Drain	OS	
PO3	Pollution Incident to Controlled Waters	Envirocheck	13th March 1997, road accident, diesel spill.
L2	Old landfill site filled with 1m of inert material from A42 works and reinstated in 1992	Travers Morgan	



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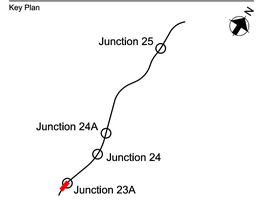
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 181800 - 182400

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000047**

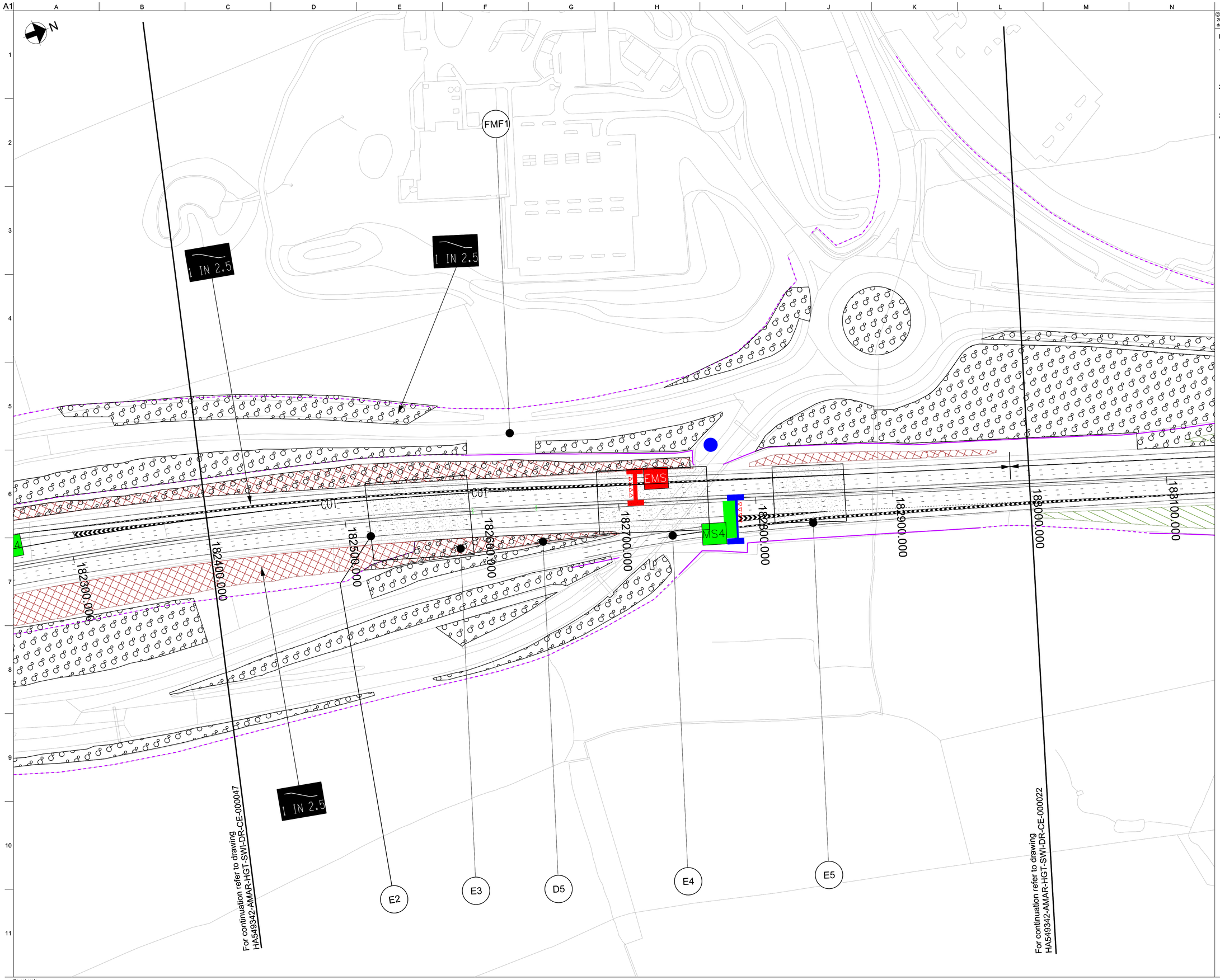
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000048

Feature Number	Feature Description	Source	Comment
E2	600mm of unsuitable material removed below formation level	Travers Morgan	
FMF1	Site of demolished motorway bridge	Travers Morgan, aerial photo	
E3	600mm of unsuitable material removed below formation level	Travers Morgan	
D5	Trench drains	Aerial photo	
E4	600mm of unsuitable material removed below formation level	Travers Morgan	
E5	600mm of unsuitable material removed below formation level	Travers Morgan	



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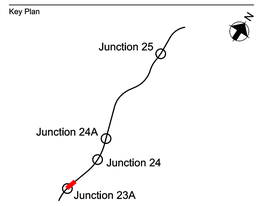
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P01	19/02/16	OY	SA	TB
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 182400 - 183000

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000048**

Do not scale

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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000049

Feature Number	Feature Description	Source	Comment
PO4	Pollution incident to controlled waters	Envirocheck	27th November 1996, chemical spill, minor incident.
D6	Drain, culverted under the motorway	OS	
E6	2m of unsuitable material removed below formation level	Travers Morgan	
E8	600mm of unsuitable material removed below formation level	Travers Morgan	



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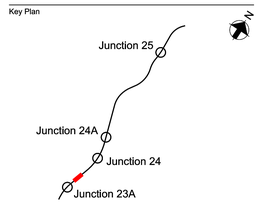
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 183000 - 183600

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000049**

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Do not scale

Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000050

Feature Number	Feature Description	Source	Comment
D7	Gravel filled trench drain at toe of cutting	Aerial photo	Dated 1971, remedial works indicate previous instability.
RS1	Location of repaired topsoil slip, now erased by widening works	Travers Morgan	
E7	600mm of unsuitable material removed below formation level	Travers Morgan	
F4	Molenhill Farm	OS	
E9	600mm of unsuitable material removed below formation level	Travers Morgan	
T1	East Midlands Airport runway lights	OS	In 2015, lights were located in central reserve and hard shoulder.
T2	Rail Freight Terminal Scheme works		Added in 2015, the interaction between proposed slip roads and construction into the motorway scheme.
F5	Farm building	OS	Belonging to Molenhill Farm.
E10	600mm of unsuitable material removed below formation level	Travers Morgan	
E11	2m of unsuitable removed below ground level	Travers Morgan	

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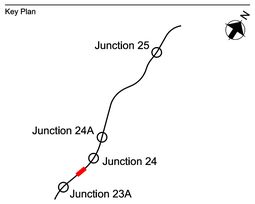
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 183600 - 184200

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000050

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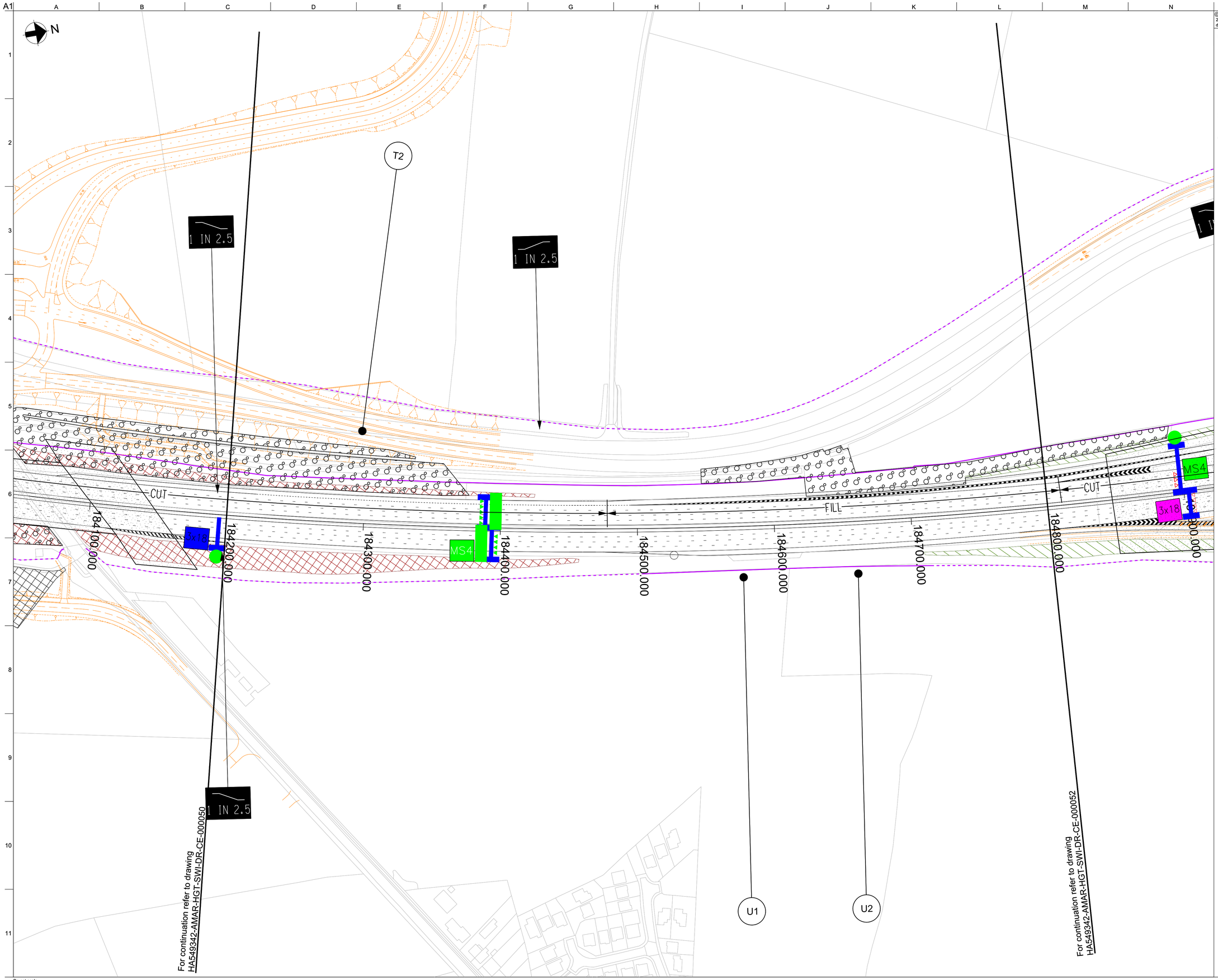
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000051

Feature Number	Feature Description	Source	Comment
U1	27” Gas pipeline	Travers Morgan	
U2	Communication substation	Northwest Leicestershire District Council	
T2	Rail Freight Terminal Scheme works		Added in 2015, the interaction between proposed slip roads and construction into the motorway scheme.

A1



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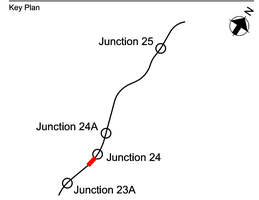
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 184200 - 184800

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000051**

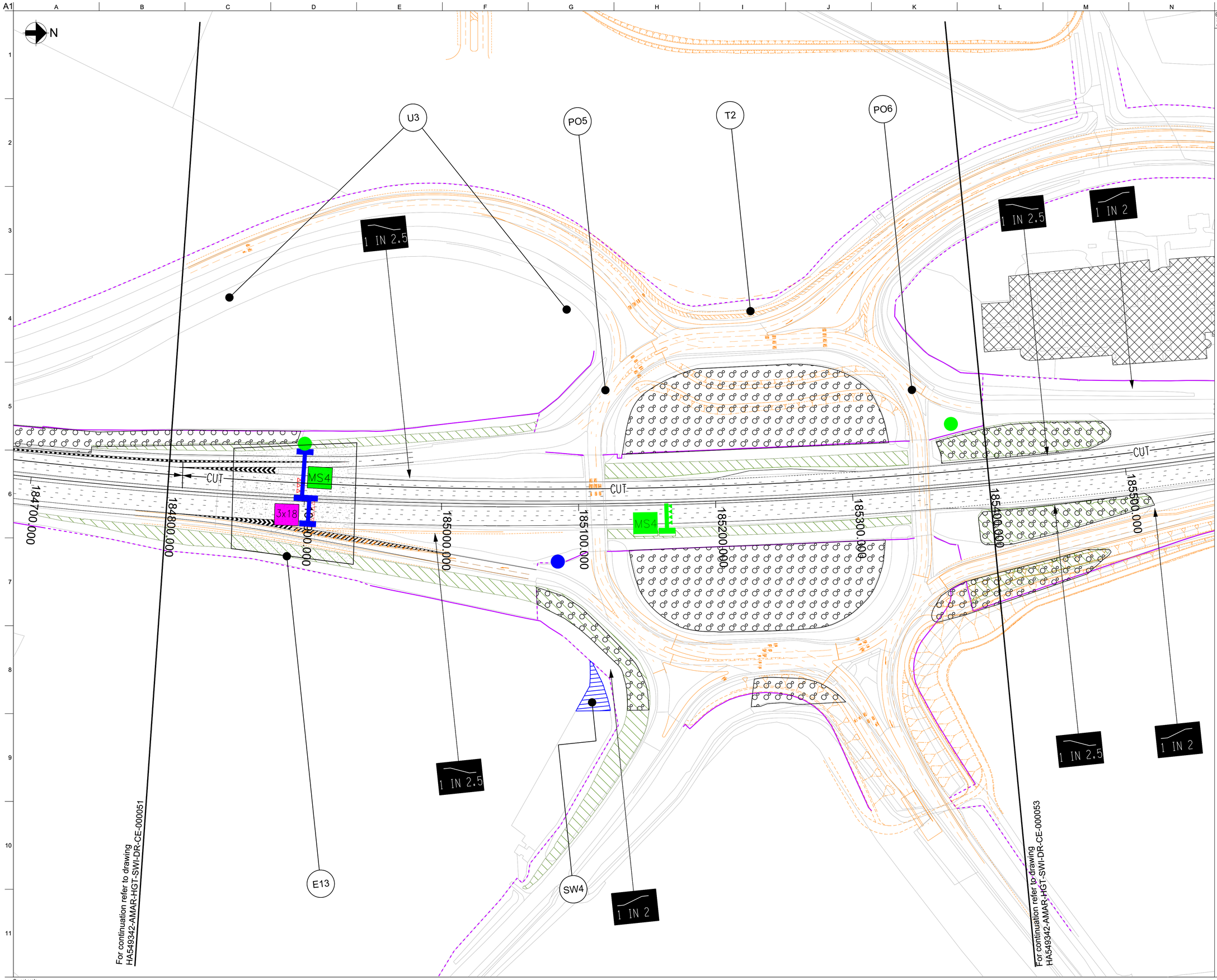
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000052

Feature Number	Feature Description	Source	Comment
U3	27” Gas pipeline	Travers Morgan	
PO5	Pollution Incident to Controlled Waters	Envirocheck	20th November 1997, road accident, diesel spill, minor incident.
PO6	Substantiated Pollution Incident Register	Envirocheck	30th July 2001, general biodegradable pollution.
E13	600mm of unsuitable material removed below formation	Travers Morgan	
T2	Rail Freight Terminal Scheme works		Added in 2015, interaction between proposed slip roads and construction into the motorway scheme.
SW4	Flood prevention lagoon	OS	



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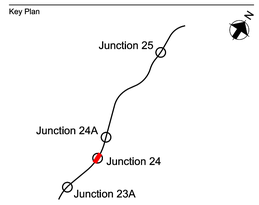
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 184800 - 185400

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No	Rev
244508-00	**P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000052**

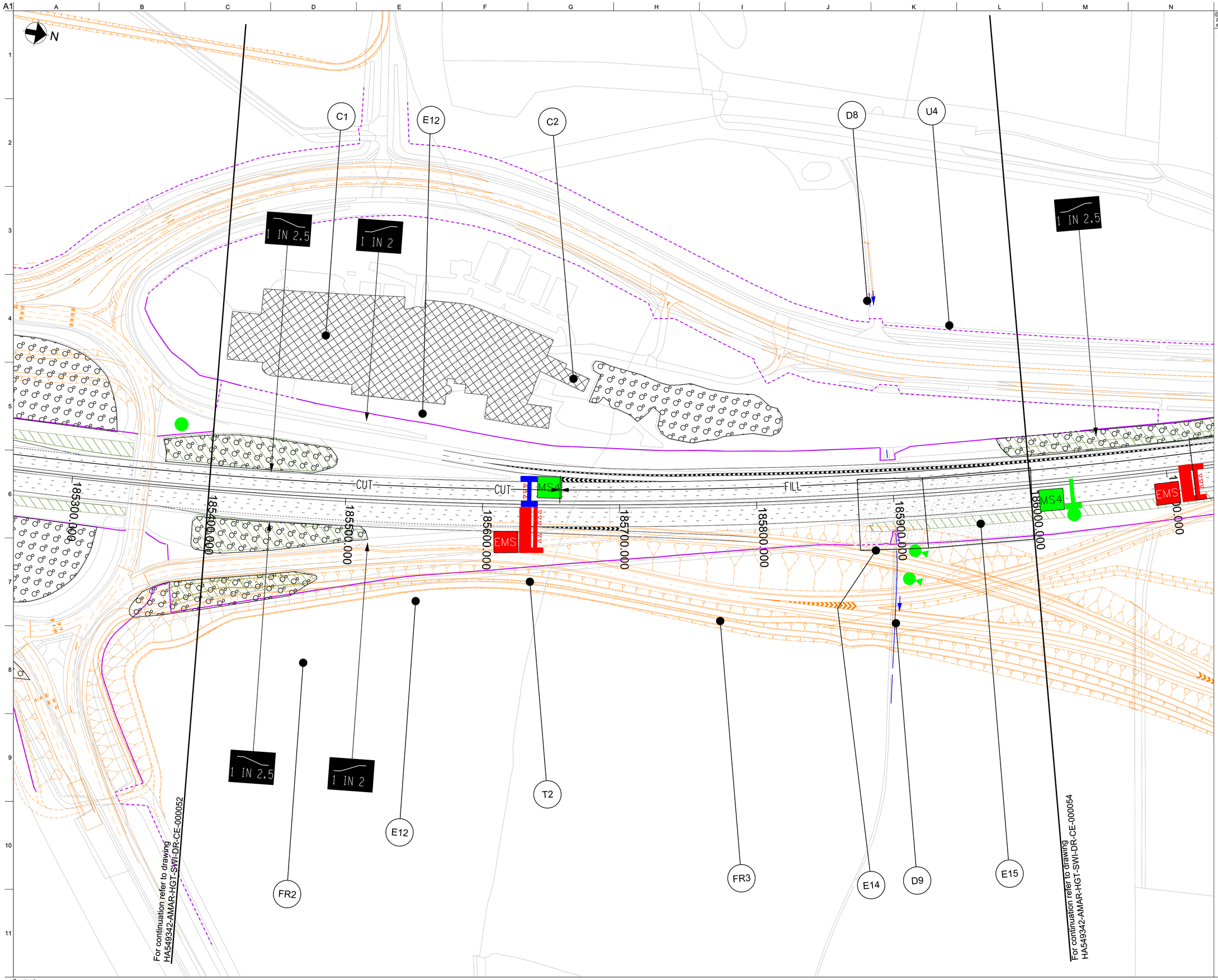
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000053

Feature Number	Feature Description	Source	Comment
C1	East Midlands Airport Hotel	OS, M1 Widening Site Visit	Hotel area includes unspecified substation.
E12	Possible pits in this locality, both sides of the motorway	Gibb	"During construction an old infilled pit was excavated and backfilled with granular material in the vicinity of MP 185/5. Historical plans indicate the possibility of a number of pits in this locality. Any widening in this location would require intensive investigation to ensure that no pits remain untreated within the influence zone of the motorway construction." No visible signs of made ground in the field.
FR2	Medium flood risk along M1, northeast of J24 (Flood zone 3)	Environment Agency	Added in 2015
C2	East Midlands Airport Hotel	OS	
D8	Drain	OS	
U4	27" Gas pipeline	Travers Morgan	
E14	2m of material removed below formation level	Travers Morgan	
D9	Drain	OS	
E15	3m of material removed below formation level	Travers Morgan	
T2	Rail Freight Terminal Scheme works		Added in 2015, interaction between proposed slip roads and construction into the motorway scheme.
FR3	Low to high flood risk (Flood zone 3)	Environment Agency	Added in 2015



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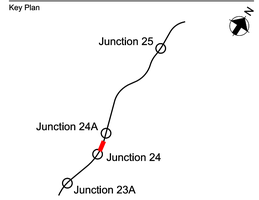
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Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 185400 - 186000

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000053**

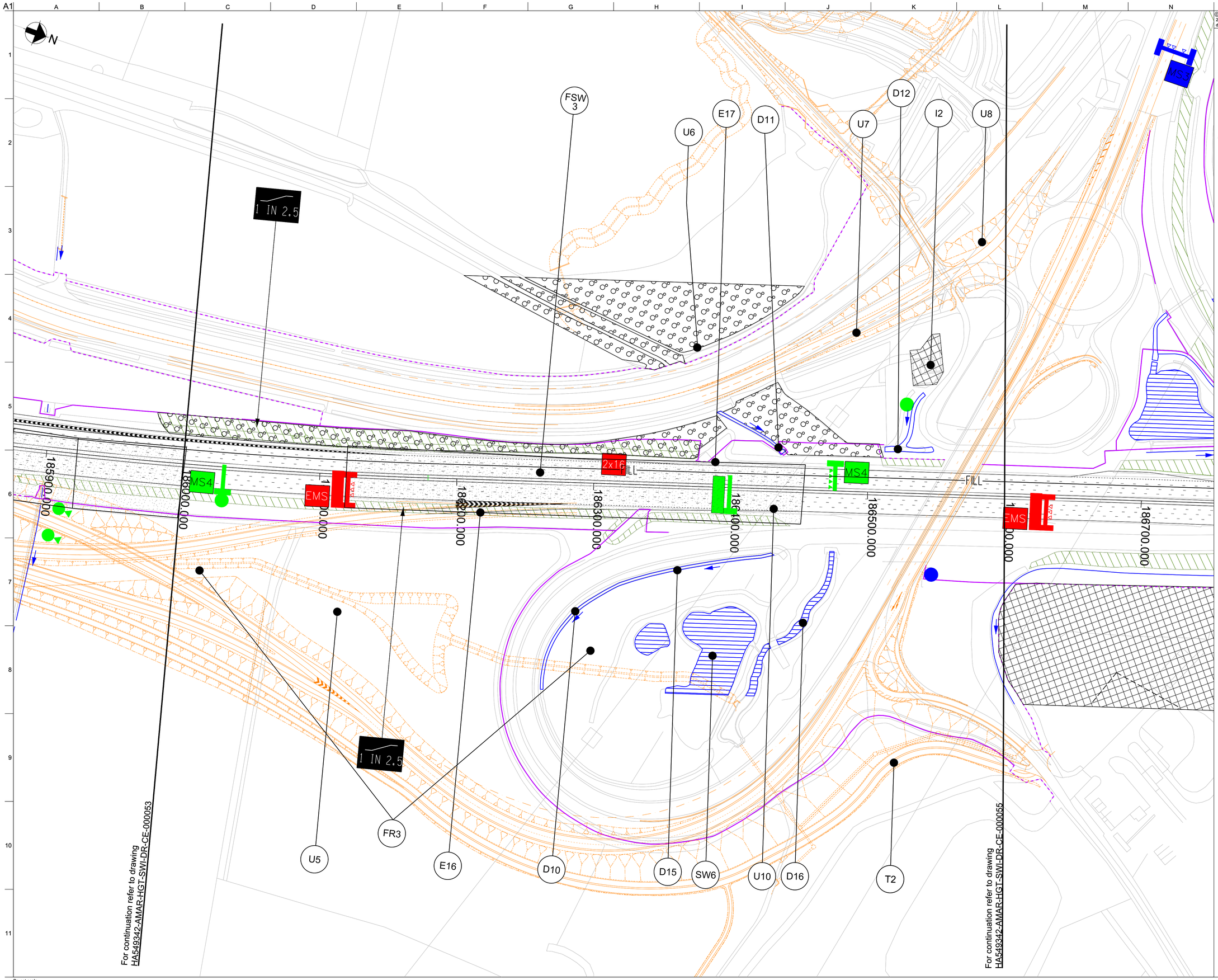
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000054

Feature Number	Feature Description	Source	Comment
FSW3	Site of old ponds infilled with refuse prior to motorway construction 4m of refuse material and unsuitable material removed below formation level	Travers Morgan, M1 Widening Site Visit	Nothing visible.
U5	36” and 33” water mains (Derwent aqueduct)	Travers Morgan, aerial photo	
E16	4m of refuse material and unsuitable material removed below formation level	Travers Morgan	
D10	Drain	OS	
U6	27” gas pipeline	Travers Morgan	
E17	4m of refuse material and unsuitable material removed below formation level	Travers Morgan	
D11	Drain, culverted under main road and motorway	OS	
U7	Sluice valve for water mains	Travers Morgan	
D12	Drain	OS	
I2	Pumping station	OS	
U8	Electricity transmission line	Travers Morgan	
T2	Rail Freight Terminal Scheme works		Added in 2015, interaction between proposed slip roads and construction into the motorway scheme.
FR3	Low to high flood risk (Flood zone 3)	Environment Agency	Added in 2015
D15	Open channel drain	OS	
SW6	Pond	OS	
U10	Electricity transmission line	OS, Travers Morgan	Probably underground.
D16	Open channel drain, culverted under the motorway	OS	



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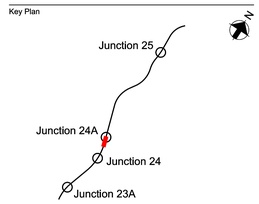
Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 186000 - 186600

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000054**

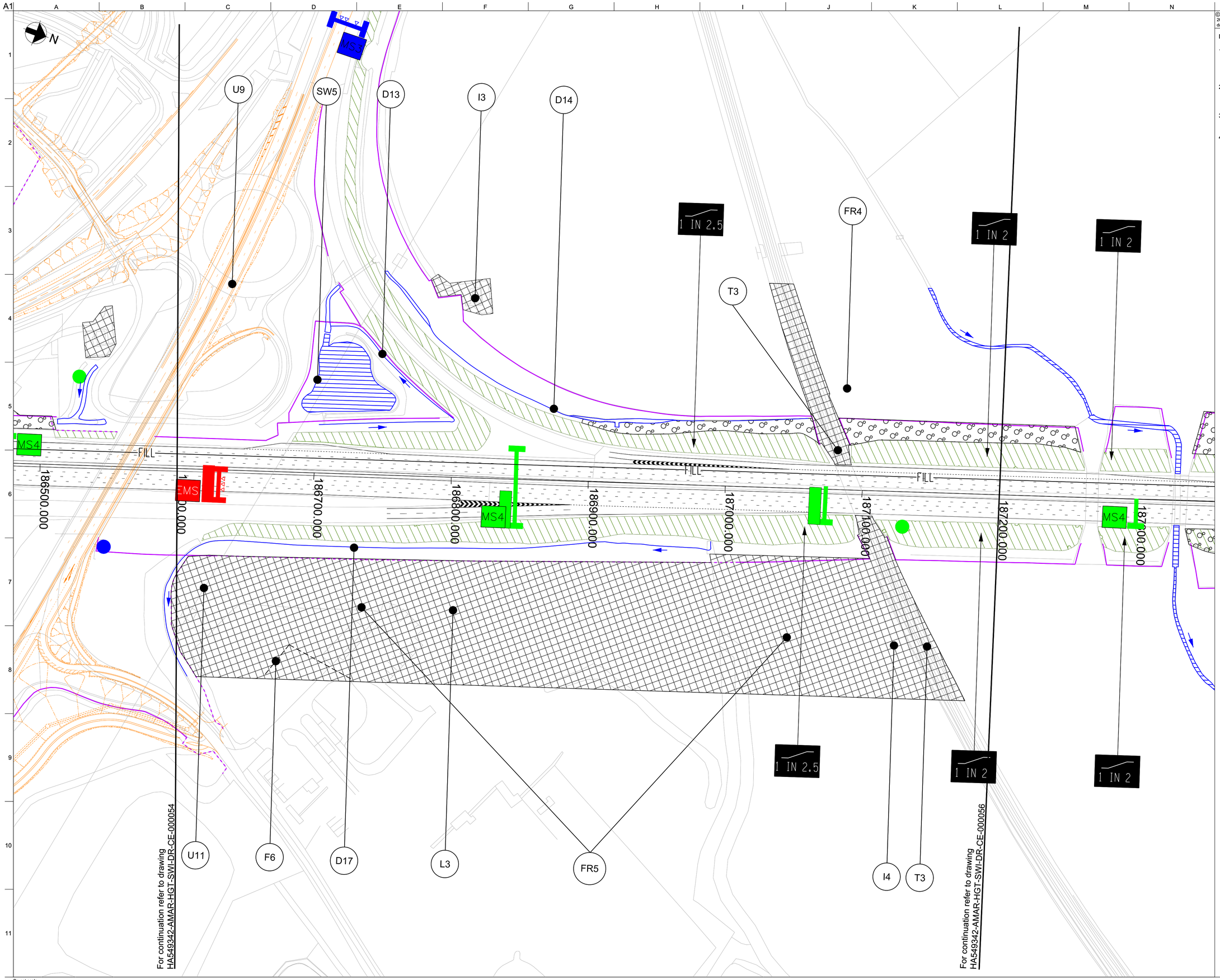
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000055

Feature Number	Feature Description	Source	Comment
U9	36” and 33” water mains (Derwent aqueduct).	Travers Morgan	
SW5	Pond	OS	
D13	Open channel drain	OS	
I3	Pumping station	OS	
D14	Open channel drain	OS	
U11	Electricity transmission line	OS	Probably underground.
F6	Extent of former farmstead	Aerial photo	Dated 1967, removed since. Possible archaeological site.
D17	Open channel drain, culverted under the motorway	OS	
L3	Authorized landfill (Lockington Quarry)	Environment Agency	Added in 2015
FR4	Low flood risk north of M1 (Flood zone 3)	Environment Agency	Added in 2015
FR5	Low to high flood risk east of M1 (Flood zone 3)	Environment Agency	Added in 2015
I4	Proposed sand and gravel operation	Travers Morgan	
T3	Railway line and associated underbridge	OS	Updated 2015, limited ground investigation available for widening design.



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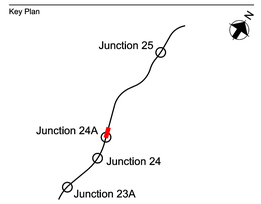
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P01	19/02/16	OY	SA	TB
First Issue				

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Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 186600 - 187200

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

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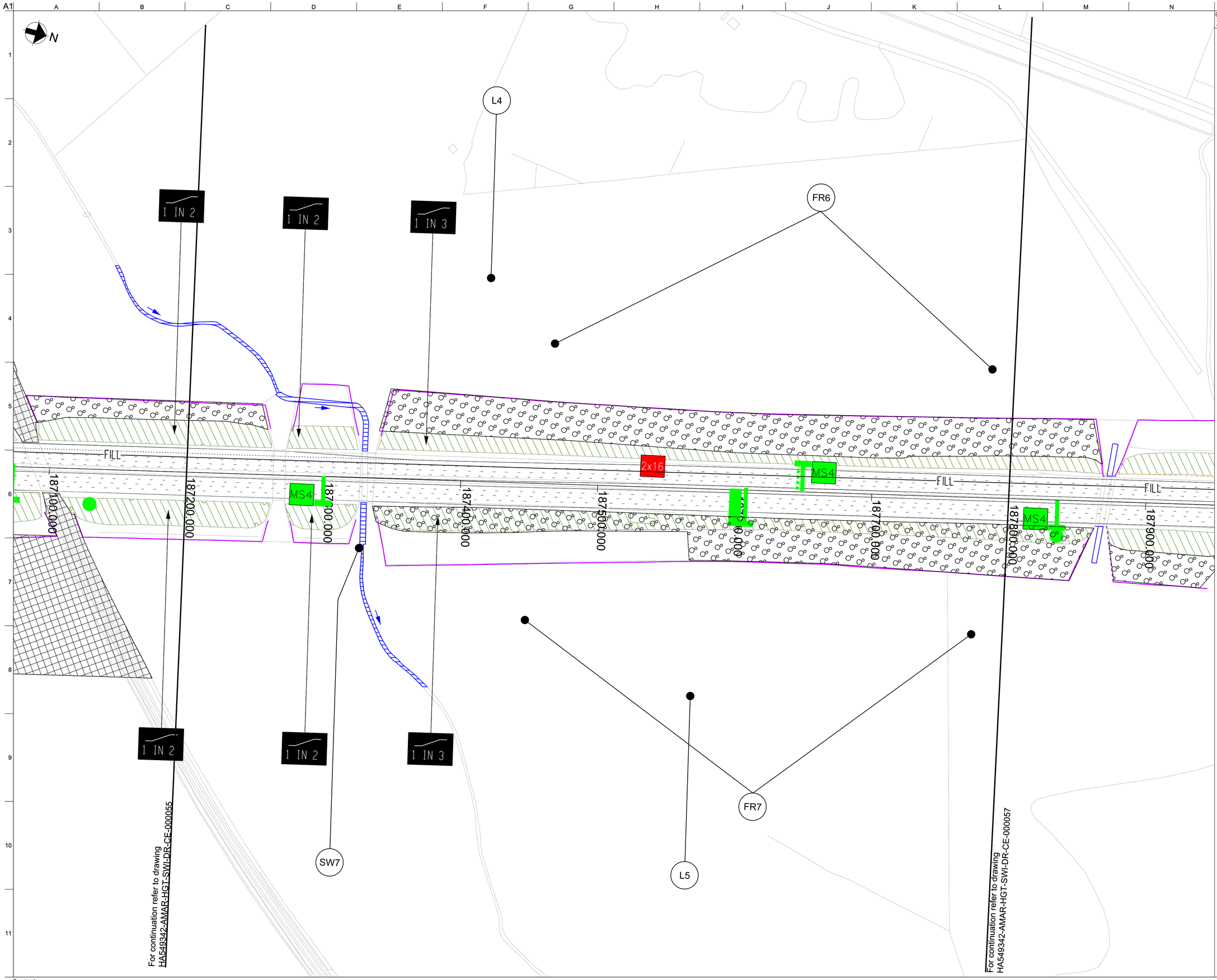
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000056

Feature Number	Feature Description	Source	Comment
L4	Licenced Waste Management Facility: Hemington Gravel Pit	Envirocheck, Travers Morgan, Northwest Leicestershire District Council, M1 Widening Site Visit	Status: Active, Licence Holder: Powergen Plc. According to aerial photos this area was excavated in the late 1960s and, when the gravel extraction ceased, they appeared flooded on photos dated 1971. Later these abandoned gravel pits have been used to tip PFA and spoil from the construction of the motorway. Some of the area has been restored for agricultural use.
SW7	Watercourse, culverted under the motorway	OS	
L5	Local Authority Recorded Landfill Site	Envirocheck, Travers Morgan, Northwest Leicestershire District Council, M1 Widening Site Visit	Status and Licence Holder unknown. According to aerial photos this area was excavated in the late 1960s and, when the gravel extraction ceased, they appeared flooded on photos dated 1971. Later these abandoned gravel pits have been used to tip PFA and spoil from the construction of the motorway. Some of the area has been restored for agricultural use.
FR6	Low Flood Risk Along M1 (Flood Zone 3)	Environment Agency	Added in 2015
FR7	Low To High Flood Risk along M1 (Flood Zone 3)	Environment Agency	Added in 2015



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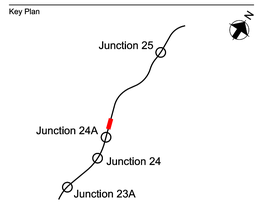
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 187200 - 187800

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000056**

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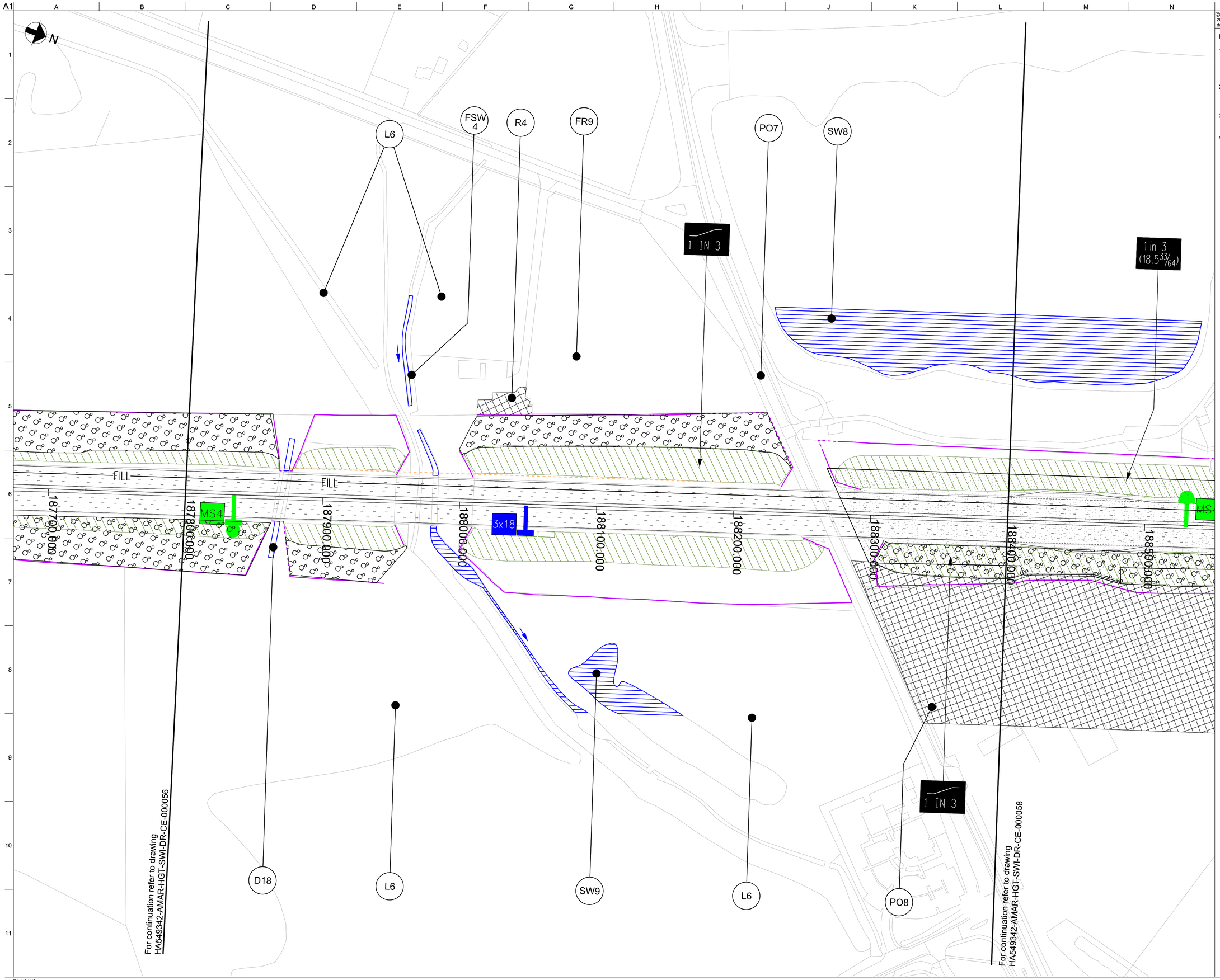
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000057

Feature Number	Feature Description	Source	Comment
D18	Open channel drain, culverted under the motorway	OS	
L6	Licenced Waste Management Facility: Hemington Gravel Pit	Envirocheck, Travers Morgan, Northwest Leicestershire District Council, M1 Widening Site Visit	Status: Active, Licence Holder: Powergen Plc. According to aerial photos this area was excavated in the late 1960s and, when the gravel extraction ceased, they appeared flooded on photos dated 1971. Later these abandoned gravel pits have been used to tip PFA and spoil from the construction of the motorway. Some of the area has been restored for agricultural use.
FSW4	Abandoned channel, crosses motorway through underpass	OS, M1 Widening Site Visit	Line of former channel marked by hedge line and ditch. The axis of the channel was evidently not excavated. Adjacent backfilled gravel pits either rough grazing or unused land.
R4	Buildings adjacent to toe of the embankment	OS	According to Northwest Leicestershire District Council, it may be a substation, but of unspecified nature.
PO7	Pollution Incident to Controlled Waters	Envirocheck	27th September 1996, suspended solids, minor incident.
SW8	Lake	OS, M1 Widening Site Visit	Former gravel pit used for fishing/recreation. The extent of gravel extraction is to be confirmed.
SW9	Pond	OS	
PO8	Substantiated Pollution Incident	Envirocheck	28th November 2002, unspecified pollutant
FR9	Medium to high flood risk all around the area (Flood Zone 3)	Environment Agency	Added in February 2016

A1



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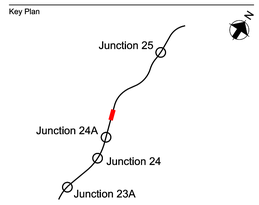
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Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 187800 - 188400

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000057**

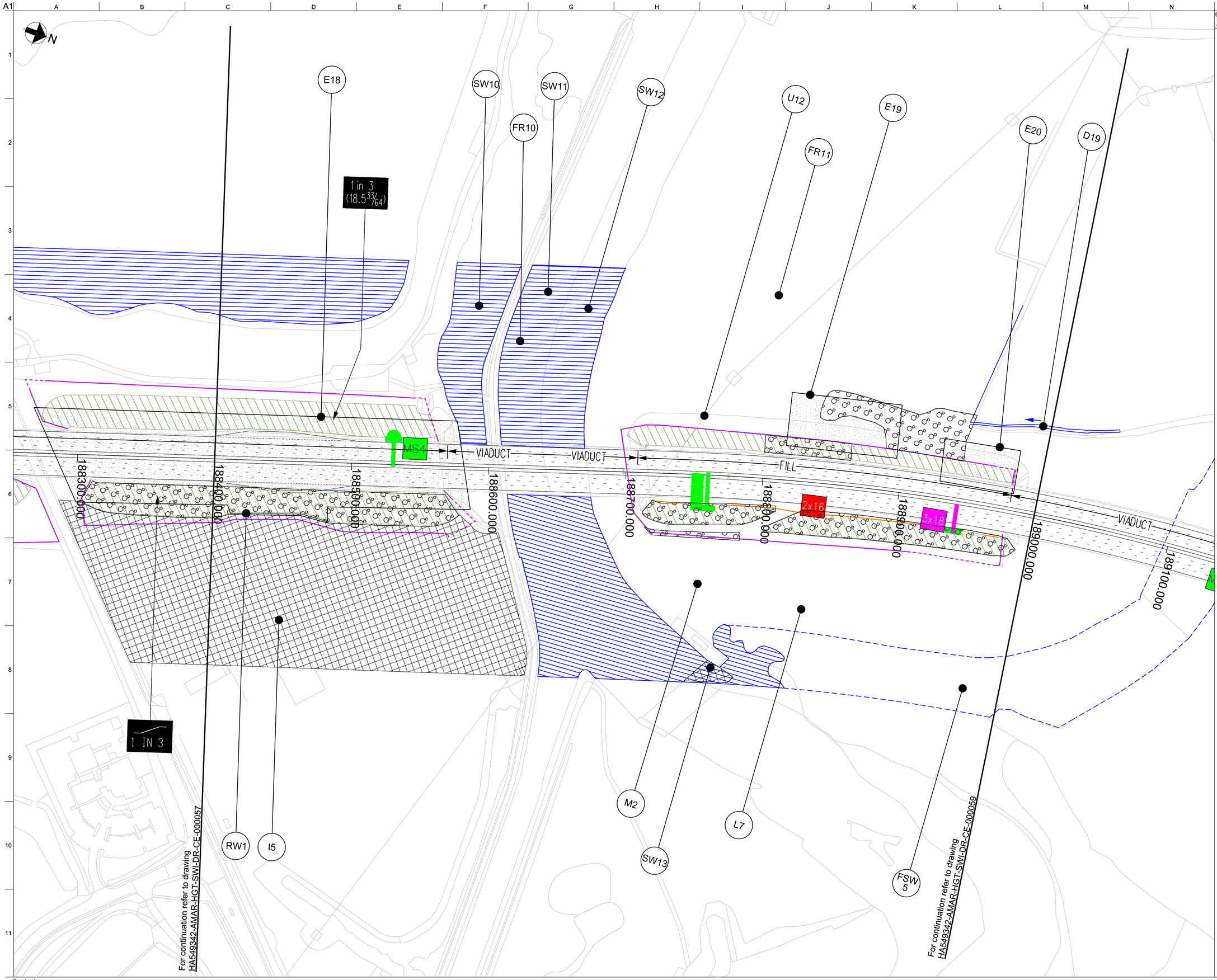
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Do not scale

Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000058

Feature Number	Feature Description	Source	Comment
E18	Sand Trenches at 6m centres beneath embankment	Travers Morgan	
SW10	Pond	OS, M1 Widening Site Visit	
SW11	River Trent	OS, M1 Widening Site Visit	
RW1	1 - 1.5m high retaining wall	Travers Morgan	Wall protecting property.
I5	Industrial area (precast concrete works), Contemporary Trade Directory Entry	OS, Envirocheck, Travers Morgan	Factory manufacturing concrete products. This site includes an unspecified substation according to Northwest Leicestershire District Council.
FR9	Low to High Flood Risk all around the area	Environment Agency	added in 2015
SW12	River Trent	OS, M1 Widening Site Visit	
U12	Overhead electricity transmission line	OS, M1 Widening Site Visit	
D19	Open channel drain	OS	
SW13	Weir on the River Trent	OS, M1 Widening Site Visit	
FSW5	Infilled oxbow lake	Travers Morgan, Erewash Borough Council, aerial photo	Partly vegetated, dating back to 1956.
M2	Possible made ground	M1 Widening Site Visit	A large mound observed during M1 Widening Site Visit. It may be a repository of spent filter material from the water treatment works.
E19	Peat removed beneath embankment and backfilled with bedrock	Travers Morgan	
E20	Peat removed beneath embankment and backfilled with bedrock	Travers Morgan	
L7	Filled Rived Cut	Environment Agency	Historical Landfill - approximately 100m away from M1
FR10	High flood risk all around the area (Flood Zone 3)	Environment Agency	Added February 2016
FR11	High flood risk al around the area (Flood Zone 3)	Environment Agency	Added February 2016



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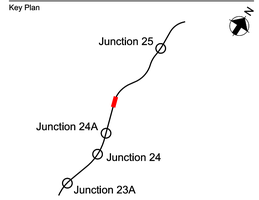
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Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 188400 - 189000

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000058**

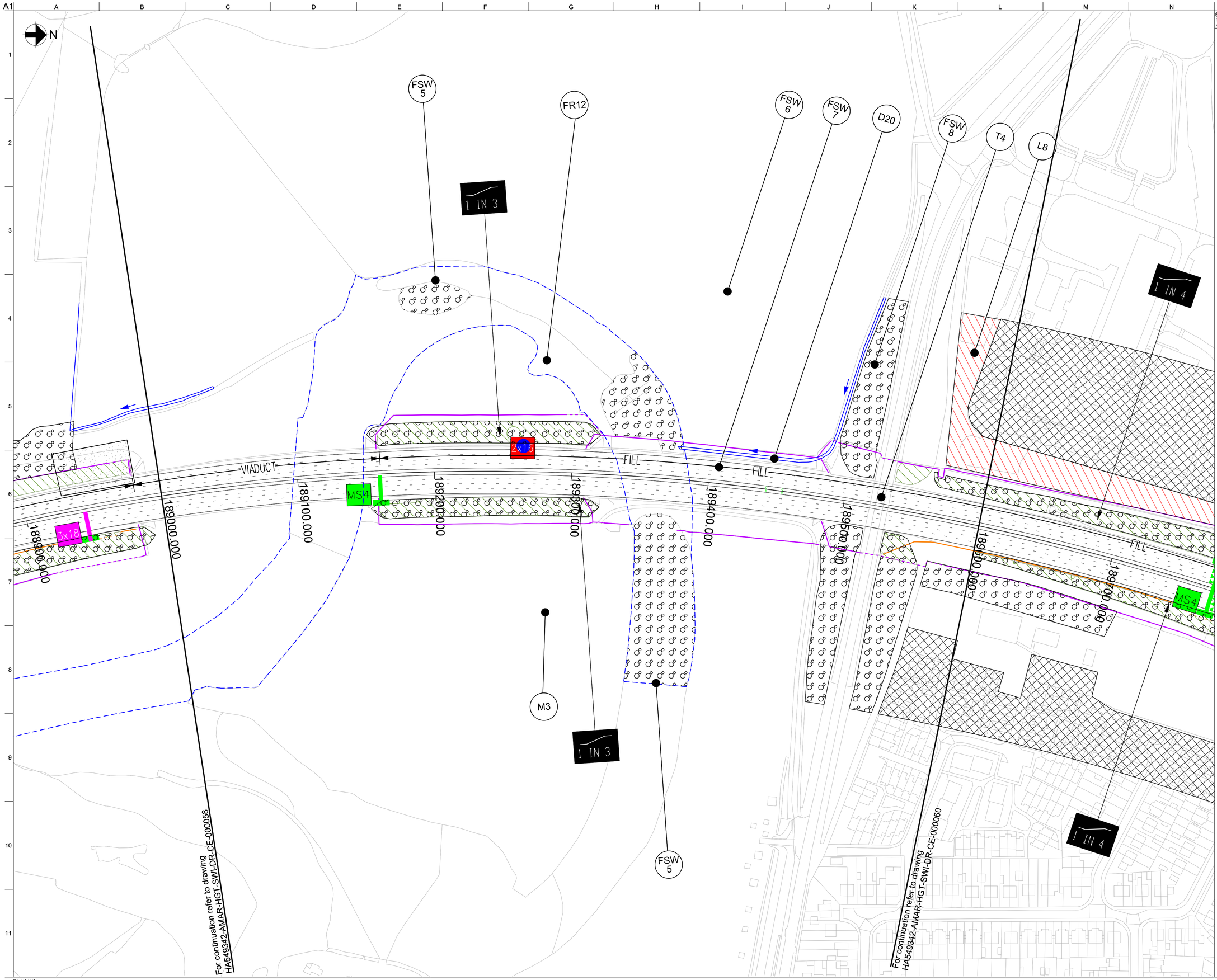
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000059

Feature Number	Feature Description	Source	Comment
FR12	Medium to high flood risk all around the area (Flood Zone 3)	Environment Agency	Added in 2015
FSW6	Unknown filled ground	Erewash Borough Council	Former pond, dating back to 1955.
FSW7	Unknown filled ground	Erewash Borough Council	Former stream, dating back to 1955.
D20	Open channel drain	OS	
FSW8	Unknown filled ground	Erewash Borough Council	Former stream, dating back to 1955.
L8	Registered Landfill Site: Church Wilne Water Treatment Works	Envirocheck, M1 Widening Site Visit	Status: Licence Lapsed or not applicable, Licence Holder: Severn Trent, exact location of landfill not confirmed.
FSW5	Infilled oxbow lake	Travers Morgan, Erewash Borough Council, aerial photo	Partly vegetated, dating back to 1956.
M3	Possible made ground	M1 Widening Site Visit	A large mound observed during M1 Widening Site Visit. It may be a repository of spent filter material from the water treatment works. To be confirmed.
T4	Wilne Road turnaround		Construction of the turnaround not yet confirmed. Limited ground investigation data available for design.



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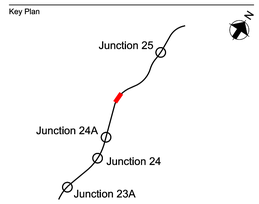
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Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 189000 - 189600

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000059**

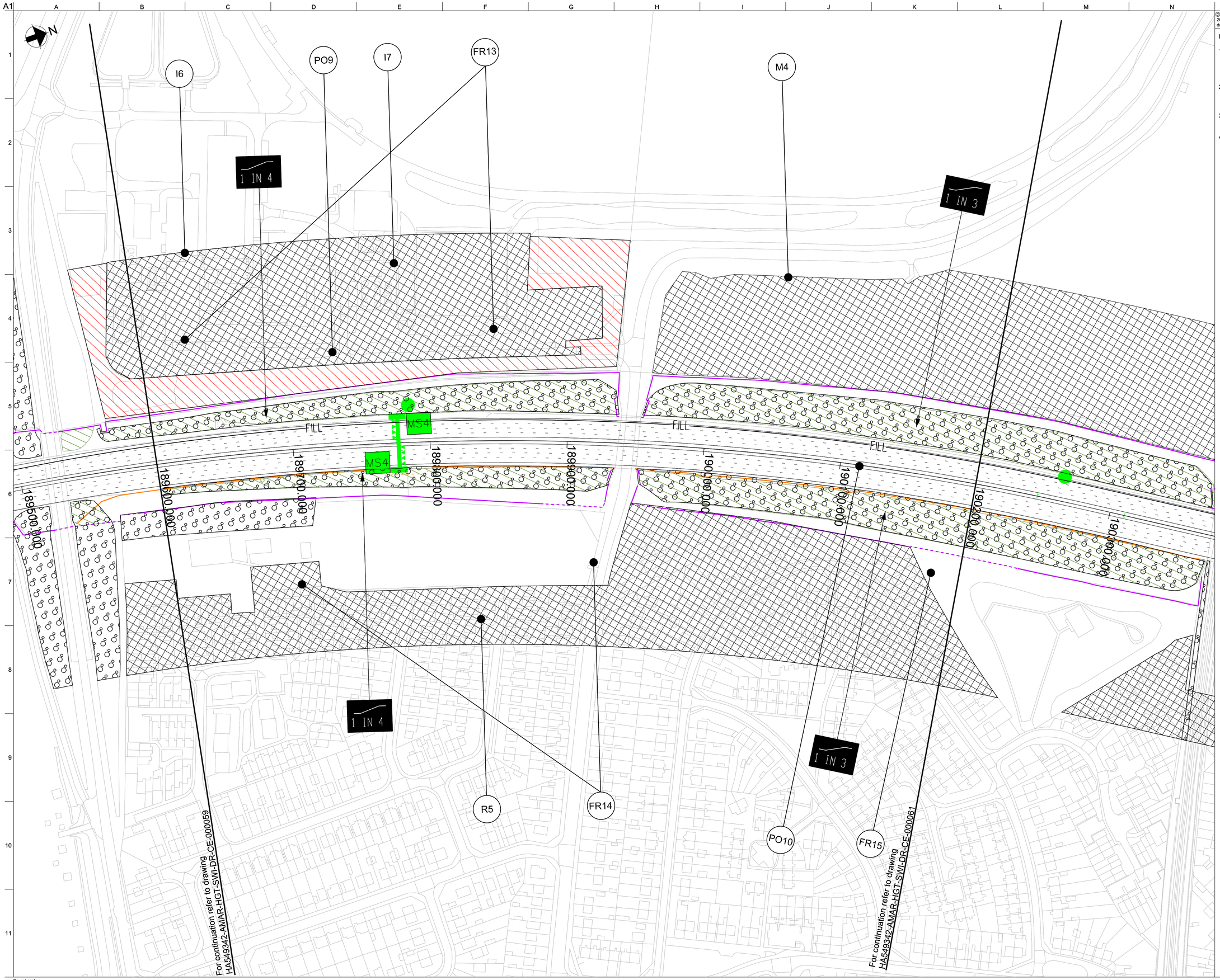
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000060

Feature Number	Feature Description	Source	Comment
I6	Industrial Area: Church Wilne Water Treatment Works	OS, M1 Widening Site Visit	
PO9	Pollution Incident to Controlled Waters	Envirocheck	5th February 1997, chlorinated water, minor incident.
I7	Water Treatment Plant	Envirocheck	Water Treatment Plant.
R5	Residential Area	OS	Added 2015.
FR13	Low flood risk (Flood Zone 2)	Environment Agency	Added 2015.
FR14	Low to medium flood risk (Flood zone 2 and 3)	Environment Agency	Residential area benefited from flood defences
PO10	Pollution Incident to Controlled Waters	Envirocheck	6th October 1998, diesel spill from leaking tank of HGV, minor incident.
FR15	Low to medium flood risk (Flood zone 3)	Environment Agency	Added 2015. Residential area benefited from flood defences.
M4	Possible made ground	M1 Widening Site Visit	A large mound observed during M1 Widening Site Visit. It may be a repository of spent filter material from the water treatment works..



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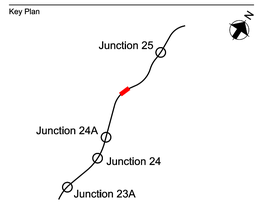
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 189600 - 190200

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000060**

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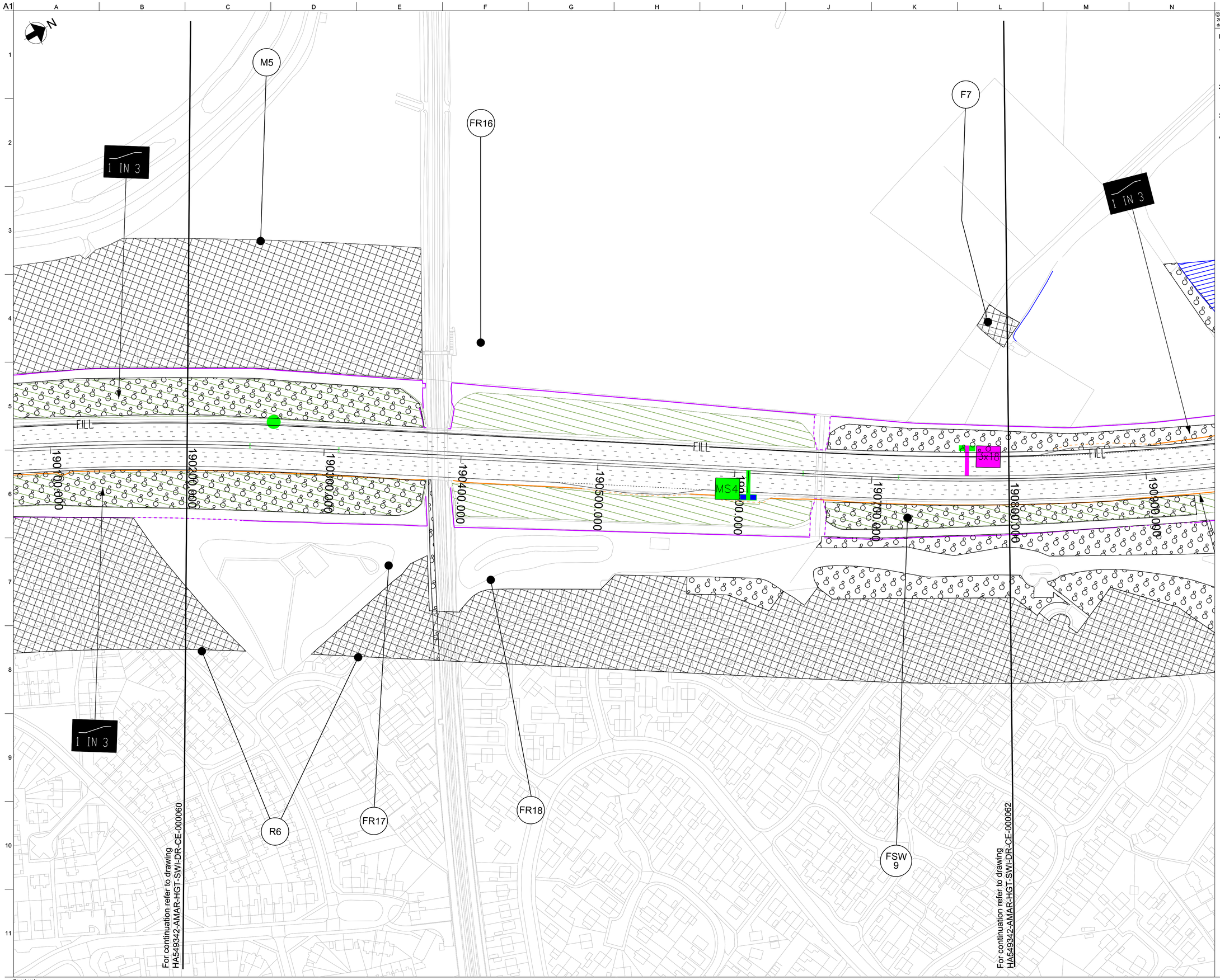
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000061

Feature Number	Feature Description	Source	Comment
M5	Possible made ground	M1 Widening Site Visit	A large mound observed during M1 Widening Site Visit. It may be a repository of spent filter material from the water treatment works.
F7	Farm buildings	OS	
R6	Residential area	OS	
FSW9	Unknown filled ground	Erewash Borough Council	Former pond.
FR17	Low to medium flood risk (Flood zone 3)	Environment Agency	Added 2015. Residential area benefited from flood defences.
FR18	Low flood risk (Flood Zone 2)	Environment Agency	Added 2015.
FR16	High flood risk (Flood Zone 3)	Environment Agency	Added February 2016

A1



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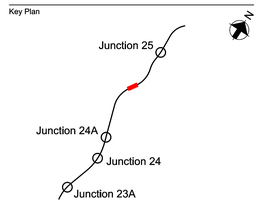
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 190200 - 190800

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
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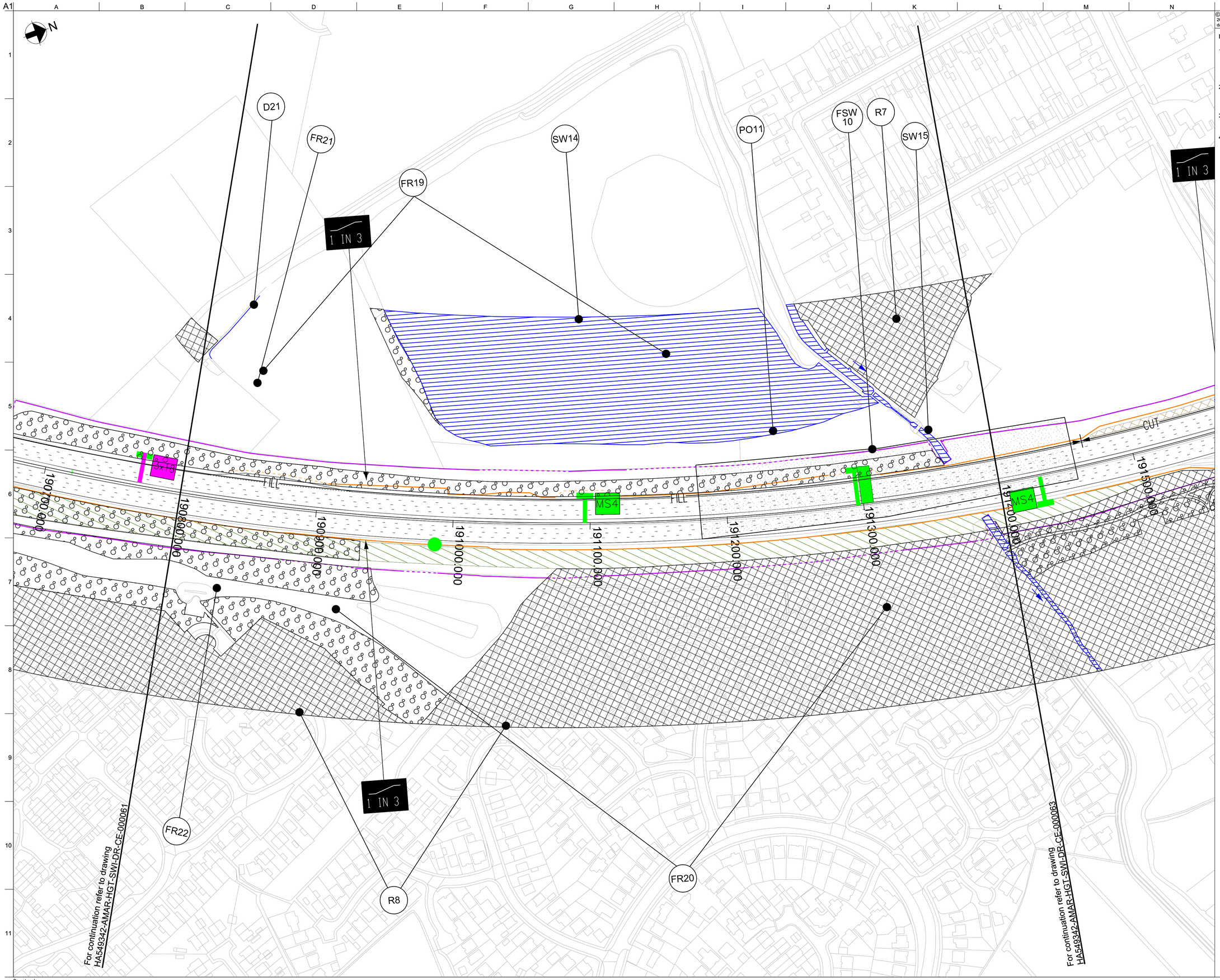
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000062

Feature Number	Feature Description	Source	Comment
D21	Open channel drain	OS	
SW14	Flood prevention lagoon and nature reserve	OS	
PO11	Pollution Incident to Controlled Waters	Envirocheck	1st March 1999, oil spill, minor incident.
FSW10	Sand trenches beneath embankment topped with 1m of imported rock	Travers Morgan, Erewash Borough Council	Former stream.
R7	Residential area	OS	
SW15	Flood protection structure	Travers Morgan	Flood protection an issue in the area due to presence of structure & lagoon.
R8	Residential area	OS	
FR19	Medium flood risk (flood zone 3)	Environment Agency	Flood defences along M1 until golden brook
FR20	Low to medium flood risk (flood zone 2)	Environment Agency	
FR21	Medium to high flood risk along M1 (Flood Zone 3)	Environment Agency	Flood defences along M1 and railway
FR22	Low flood risk (Flood Zone 2)	Environment Agency	



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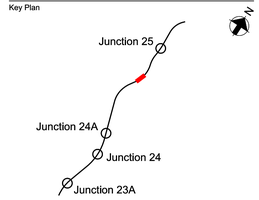
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Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 190800 - 191400

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000062

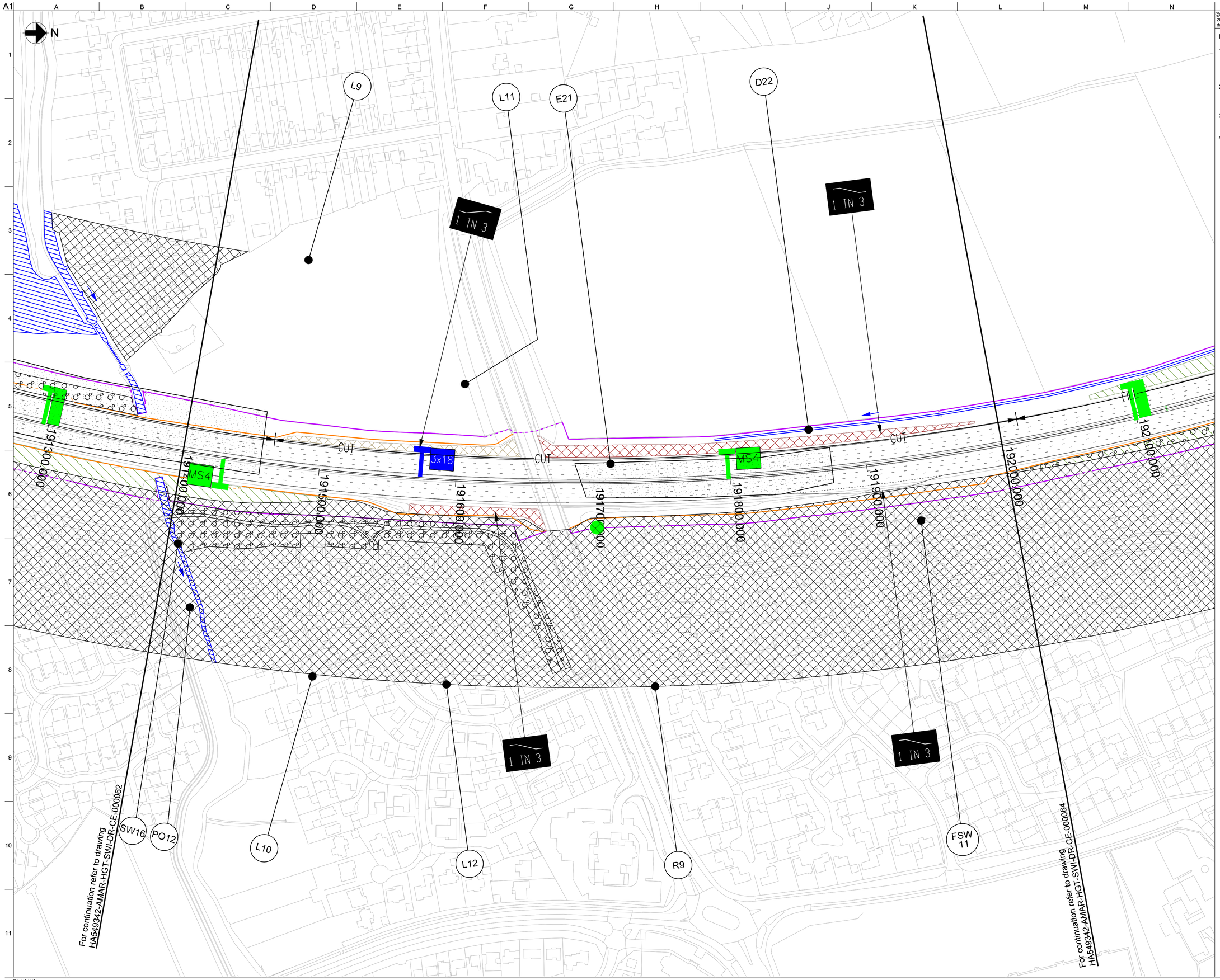
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000063

Feature Number	Feature Description	Source	Comment
L9	Reinstated landfill	Aerial photo	Landfill appeared on aerial photo dated 1967.
SW16	Golden Brook, culverted under the motorway	OS	
PO12	Pollution Incident to Controlled Waters	Envirocheck	8th June 1996, urban runoff, minor incident.
L10	Reinstated landfill	Aerial photo	Landfill in open field appeared on aerial photo dated 1967.
L11	Reinstated landfill	Aerial photo	Landfill appeared on aerial photo dated 1967.
E21	Rock fill at formation level	Travers Morgan	
L12	Reinstated landfill	Aerial photo	Landfill in open field appeared on aerial photo dated 1967.
R9	Residential area	OS	
FSW11	Unknown filled ground	Erewash Borough Council	Former stream.
D22	Open channel drain	OS	



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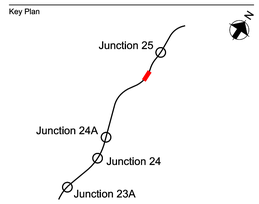
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 191400 - 192000

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00** Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000063**

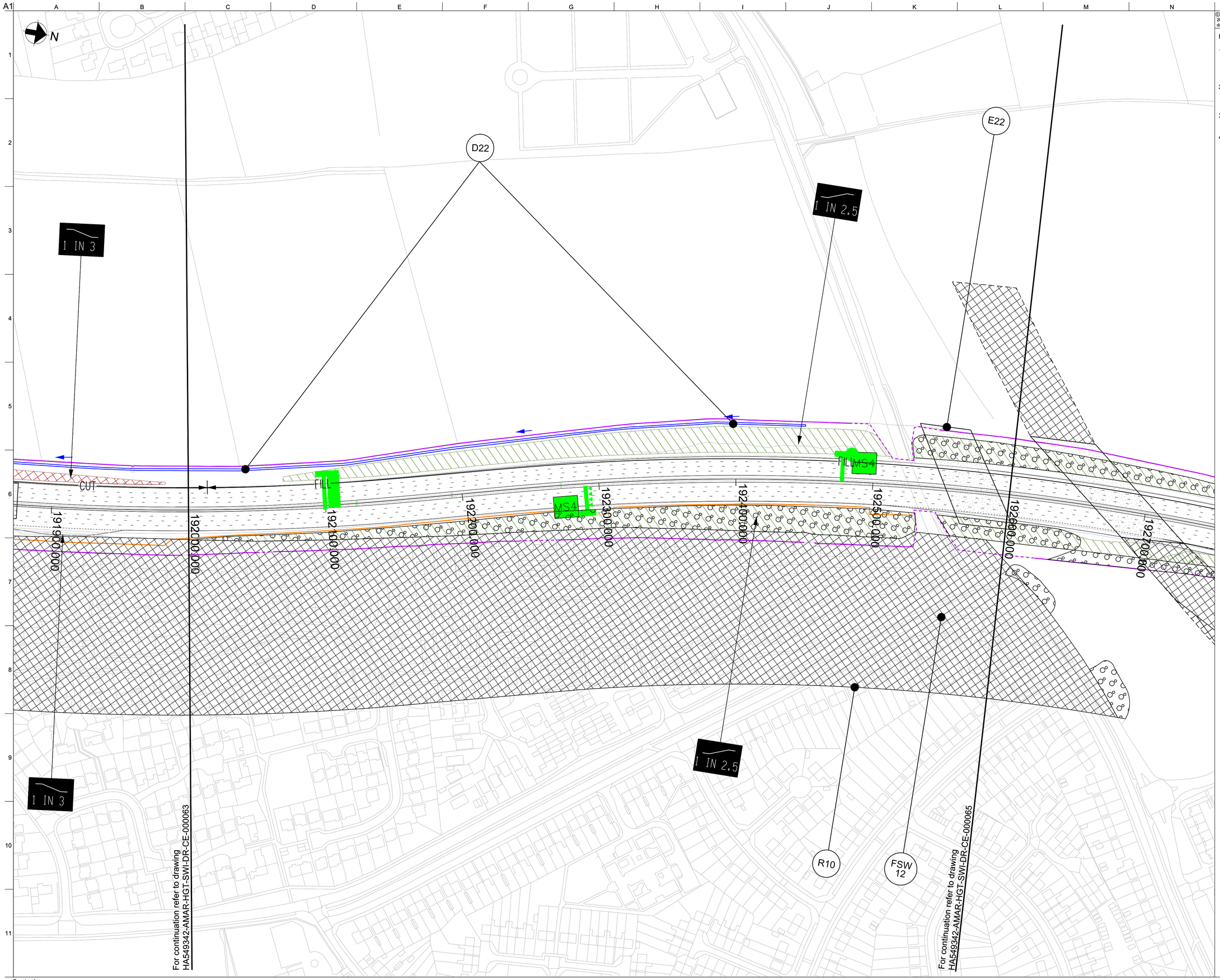
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000064

Feature Number	Feature Description	Source	Comment
D22	Open channel drain	OS	
E22	Boulder clay at formation level removed and filled with imported rock	Travers Morgan	Close to location of proposed MS4.
R10	Residential area	OS	
FSW12	Site of old spring	Travers Morgan	



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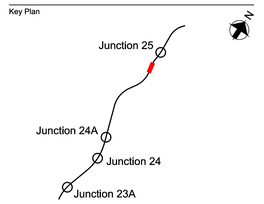
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 192000 - 192600

Scale at A1: 1:1250

Role: Civil - Earthworks and Geotech

Suitability: S2 - Fit for information

Job No: **244508-00**

Rev: **P01**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000064**

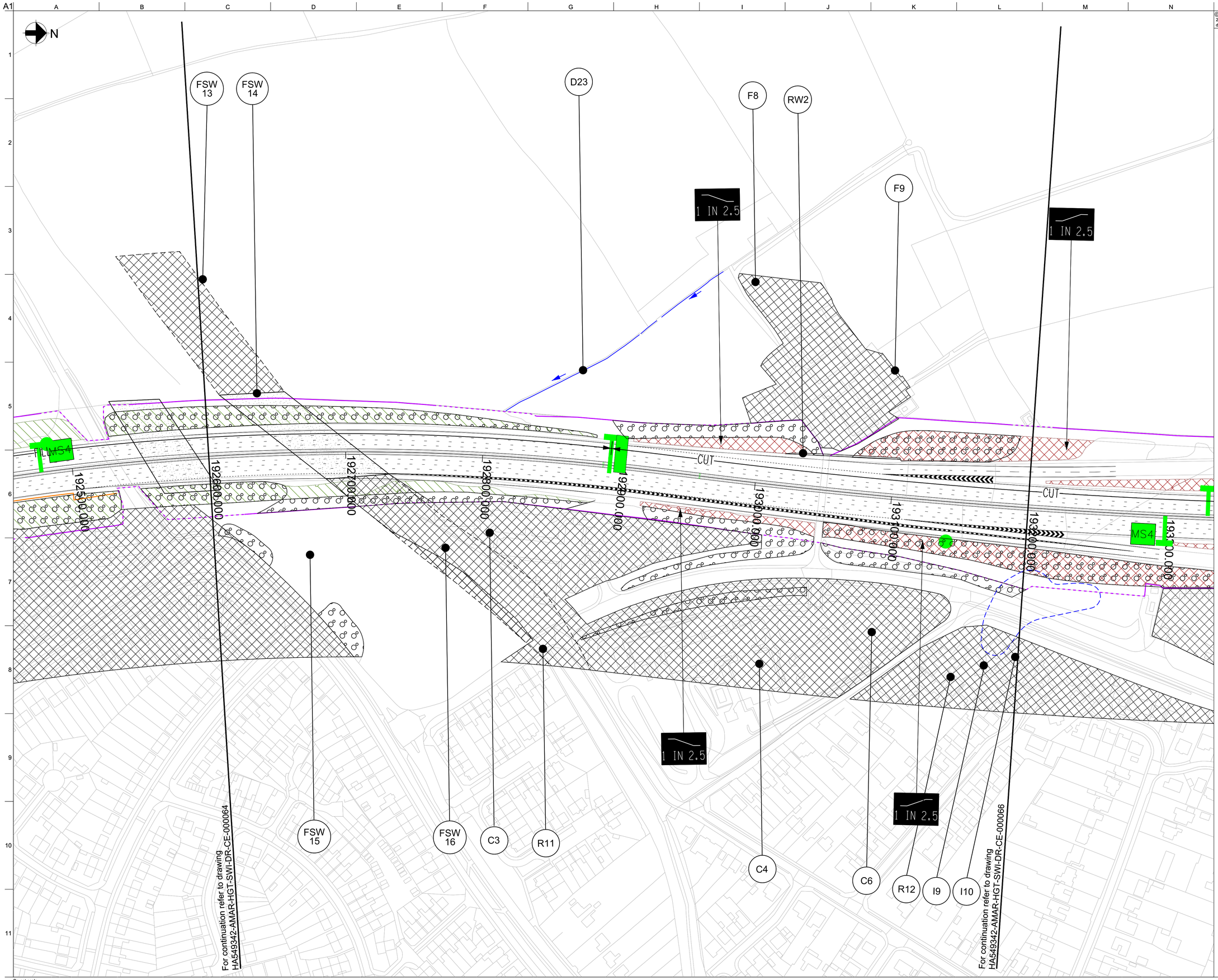
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000065

Feature Number	Feature Description	Source	Comment
FSW13	Backfilled Derby Canal	Travers Morgan, M1 Widening Site Visit Erewash Borough Council	Area restored to agriculture.
FSW14	Disused Derby canal cleaned out and backfilled with suitable material	Travers Morgan, Erewash Borough Council	Backfill material unknown.
D23	Open channel drain	OS	
F8	Farm	OS	
RW2	5m high retaining wall	Travers Morgan, OS, M1 Widening Site Visit	
FSW15	Unknown filled ground	Erewash Borough Council	Former stream.
FSW16	Backfilled Derby Canal	Travers Morgan, M1 Widening Site Visit Erewash Borough Council	Forms a linear open space.
C3	Commercial area (hotel)	OS	
R11	Residential area	OS	
C4	Commercial area (hotel)	OS	
F9	Farm	OS	
C6	Commercial area (hotel)	OS	
R12	Residential area	OS	
I9	Clay bricks and tiles found in this area	Erewash Borough Council	Former brick yard dating back to 1901.
I10	Unknown filled ground	Erewash Borough Council	Former brick yard and associated quarry dating back to 1885.



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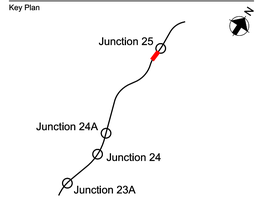
Client

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driving forward

Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 192600 - 193200

Scale at A1 1:1250

Role Civil - Earthworks and Geotech

Suitability S2 - Fit for information

Job No **244508-00**

Rev **P01**

Name **HA549342-AMAR-HGT-SWI-DR-CE-000065**

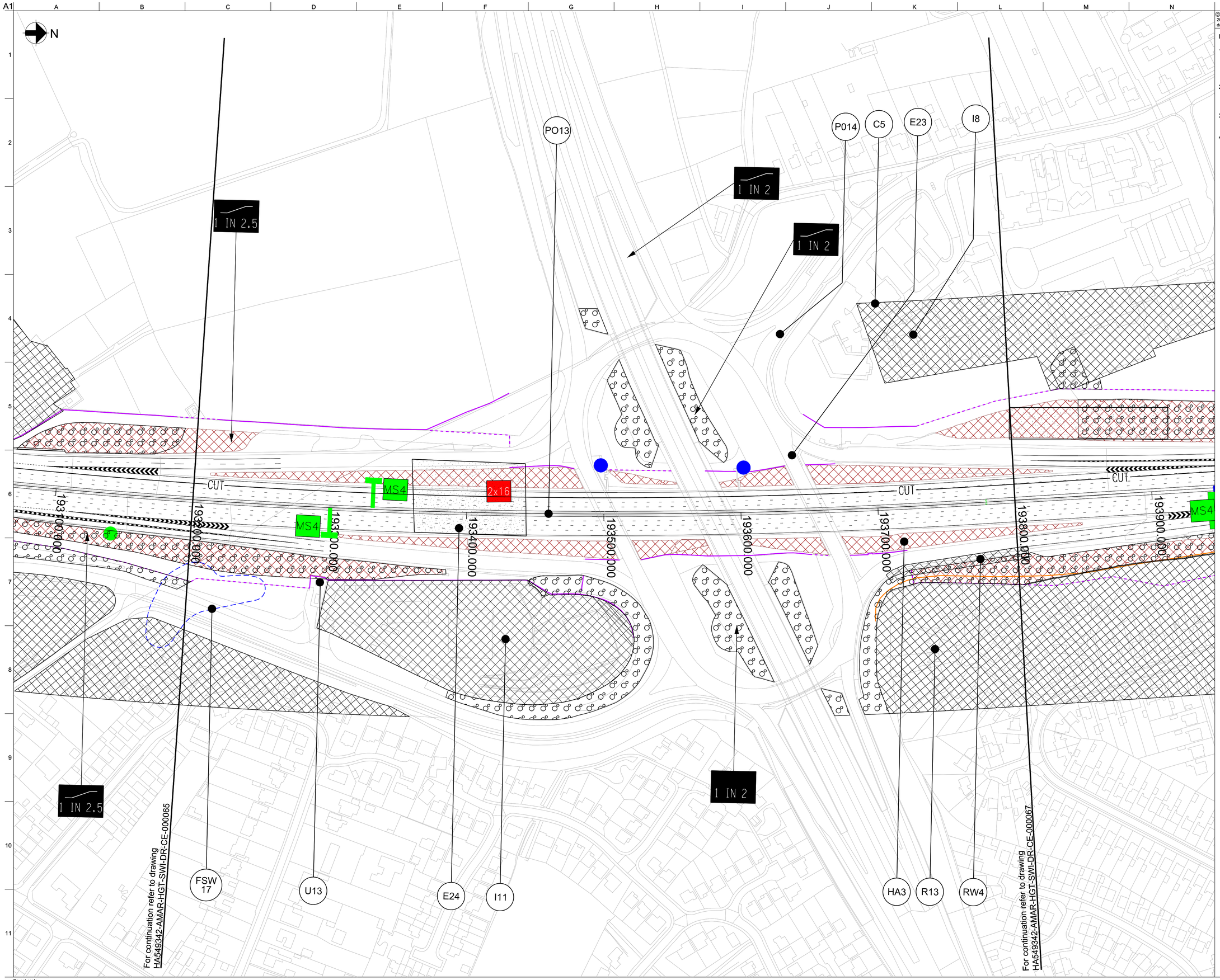
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000066

Feature Number	Feature Description	Source	Comment
PO13	Pollution Incident to Controlled Waters	Envirocheck	8th November 1997, road accident, diesel spill, minor incident.
PO14	Substantiated Pollution Incident	Envirocheck	28th March 2003, agricultural waste.
C5	Commercial area (business park)	OS	
E23	Unknown filled ground mainly under Junction 25	Erewash Borough Council	Dating back to 1956.
I8	Contemporary Trade Directory Entry	Envirocheck	Packaging materials manufacturers.
FSW17	Old pond	Travers Morgan	Backfill material unknown.
U13	Electricity substation	Travers Morgan	
E24	600mm of unsuitable material below formation removed and backfilled with imported rock	Travers Morgan	Close to location of proposed MS4.
I11	Industrial area (motorway maintenance compound)	OS	
R13	Residential area	OS	
RW4	1.5 - 4m retaining wall	Travers Morgan	
HA3	Slope Defect (7_M1_22152_545990)	HAGDMS – October 2015 inspections	Slip. “Slip mid-slope approximately 15cm backscarp. 4m upslope from comms 1m high retaining wall”.



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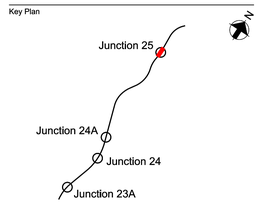
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: Geotechnical Hazard Plan Chainage 193200 - 193800

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000066

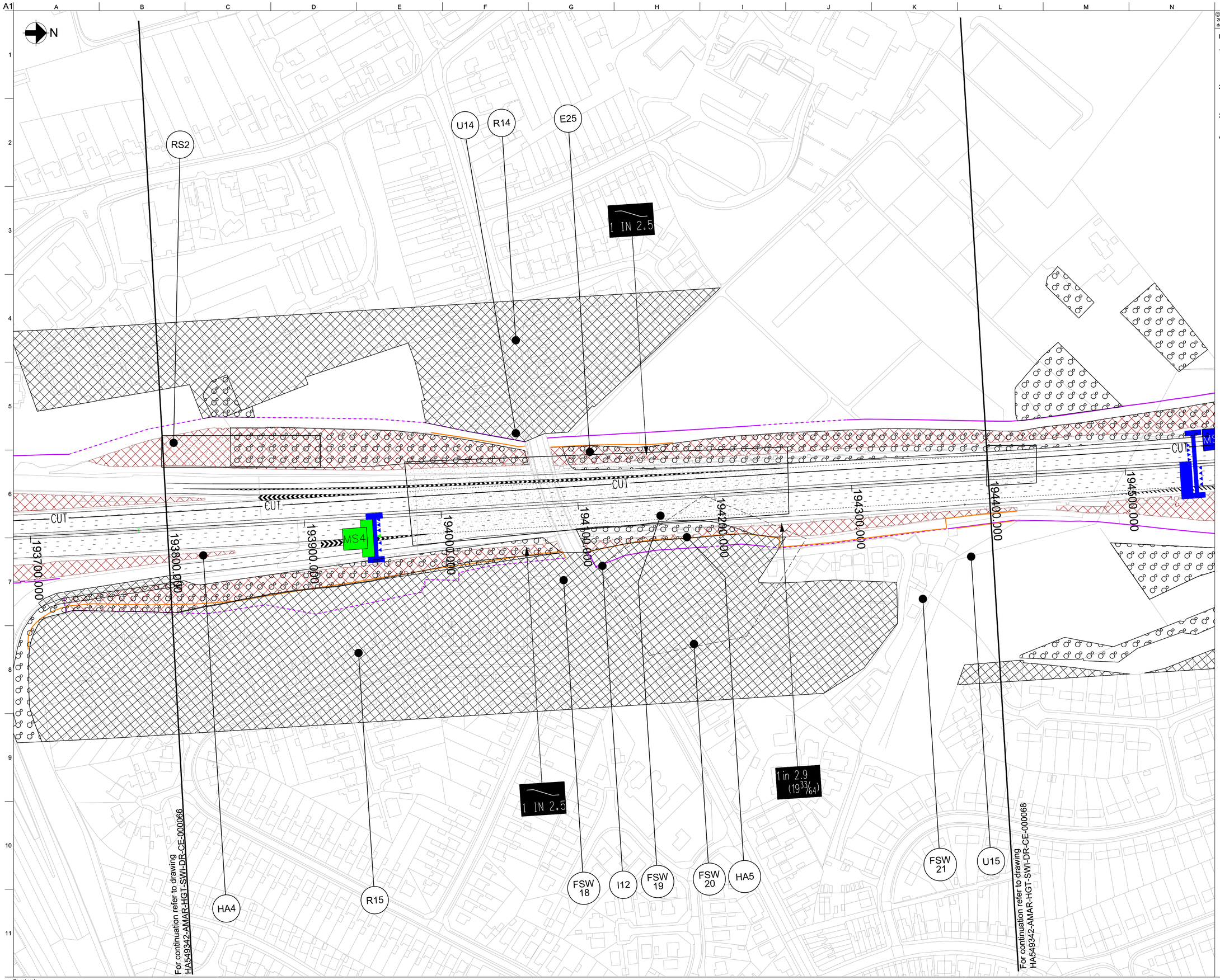
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000067

Feature Number	Feature Description	Source	Comment
RS2	Evidence of repaired slip feature in cutting face Counter fort drains installed in base of side slope	Travers Morgan	
U14	Electricity substation	Travers Morgan	
R14	Residential Area	OS	
E25	300mm of unsuitable material below formation removed and back filled with imported rock	Travers Morgan. Erewash Borough Council	Close to location of proposed MS4.
R15	Residential area	OS	
FSW18	Site of old spring	Travers Morgan	
I12	Pumping station	OS, Travers Morgan	
FSW19	Site of old well	Travers Morgan	M1 Widening Site Visit no evidence of old well
FSW20	Old quarry	Travers Morgan	
FSW21	Site of Old spring	Travers Morgan	
U15	Electricity transmission line overhead	OS	
HA4	Slope Defect (7_M1_22152_535991)	HAGDMS – October 2015 inspections	“Comms retaining wall failure/collapse”.
HA5	Slope Defect (7_M1_57726_536105)	HAGDMS – October 2015 inspections	“No erosion protection matting over geogrid exposing geogrid structure and material free to erode”.

A1



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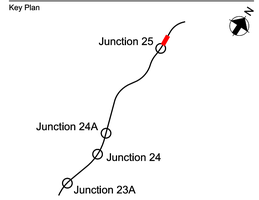
Client

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Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 193800 - 194400

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000067

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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000068

Feature Number	Feature Description	Source	Comment
E26	300mm of unsuitable material below formation removed and back filled with imported rock	Travers Morgan	
R16	Residential Area	OS	
U16	Electricity transmission line , overhead	OS	
L13	Former landfill site - infill material unknown	Travers Morgan, M1 Widening Site Visit	No obvious evidence of landfilling agricultural land. The road is in significant cut at this location.
E27	300mm of unsuitable material below formation removed and back filled with imported rock	Travers Morgan	
R17	Residential Area	OS	
HA6	Slope Defect (7_M1_57726_536107)	HAGDMS – October 2015 inspections	“Erosion protection matting slipped down slope exposing geogrid structure and material free to erode”.
HA7	Slope Defect (7_M1_57726_536108)	HAGDMS – October 2015 inspections	“Erosion protection matting folded over exposing geogrid structure and material free to erode”.
HA8	Slope Defect (7_M1_57736_45384)	HAGDMS – October 2015 inspections	“Erosion protection matting no longer in existence allowing material free to erode”.

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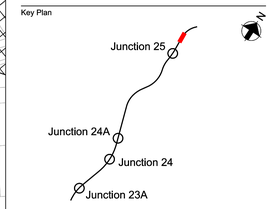
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Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
Geotechnical Hazard Plan
Chainage 194400 - 1950000

Scale at A1 1:1250

Role Civil - Earthworks and Geotech

Suitability S2 - Fit for information

Job No **244508-00**

Rev **P01**

Name **HA549342-AMAR-HGT-SWI-DR-CE-000068**

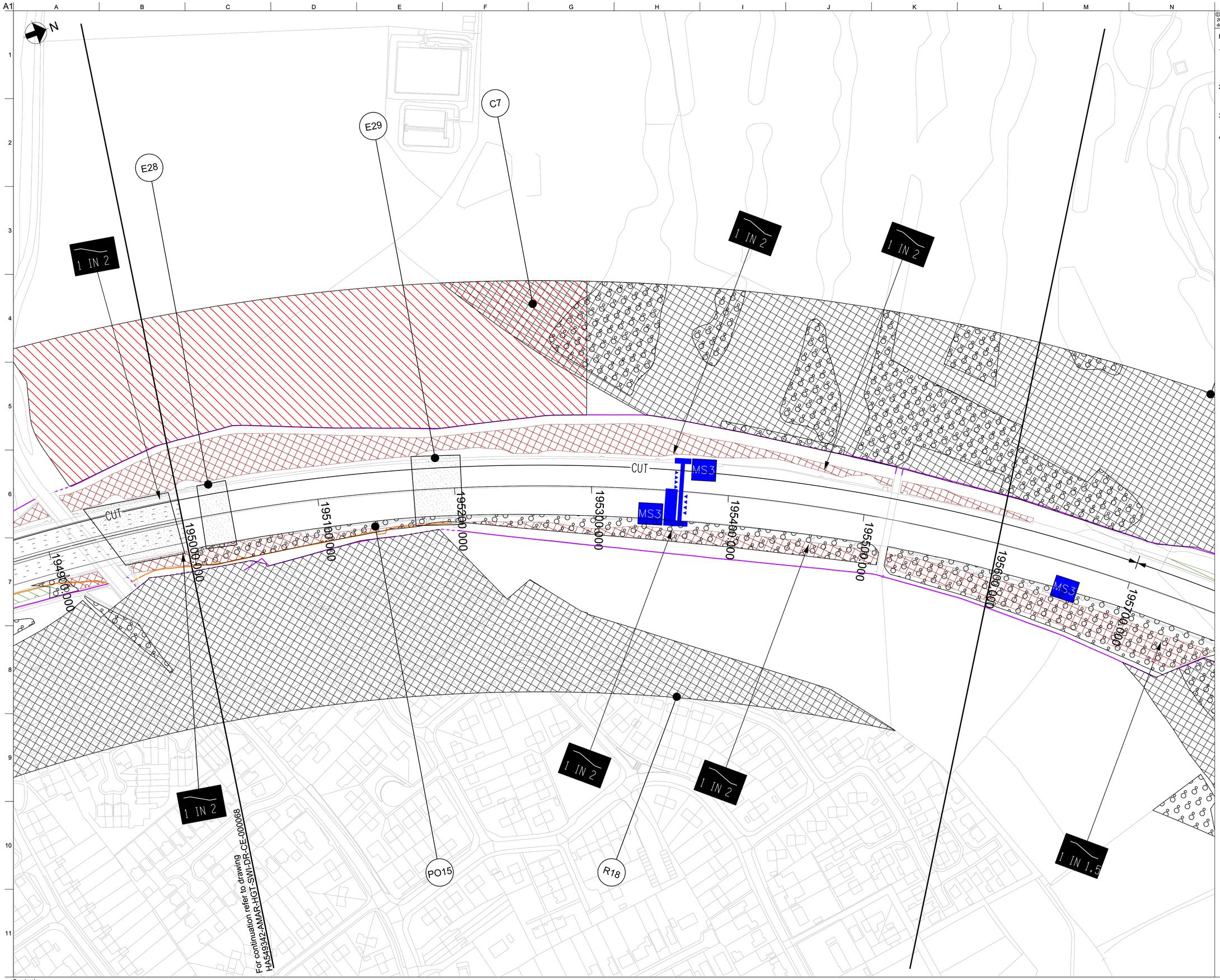
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Geotechnical Hazard Plan

Hazard Table: HA549342-AMAR-HGT-SWI-DR-CE-000069

Feature Number	Feature Description	Source	Comment
E28	300mm of unsuitable material below formation removed and back filled with imported rock	Travers Morgan	
E29	300mm of unsuitable material below formation removed and back filled with imported rock	Travers Morgan	
C7	Commercial area (Erewash Valley Golf Club)	OS	
PO15	Pollution Incident to Controlled Waters	Envirocheck	5th August 1996, road accident, 40 gallons of oil based paint into drain.
R18	Residential Area	OS	



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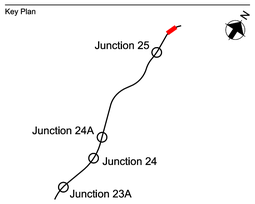
Client

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Project Title

SMP M1 J23a - J25

Key Plan



Drawing Title

Geotechnical Hazard Plan
Chainage 1950000 - 195600

Scale at A1	1:1250
Role	Civil - Earthworks and Geotech
Suitability	S2 - Fit for information
Job No	244508-00
Rev	P01
Name	HA549342-AMAR-HGT-SWI-DR-CE-000069

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Working on behalf of highways england

Contact name
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5th Floor
Colmore Plaza
20 Colmore Circus
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Email: [redacted]
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Fax:

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06 Product Development & Production
Preconstruction and Construction services

Smart Motorways Programme

M1 Junction 23a to 25

Ground Investigation Report

HAGDMS Report No. 28929

Volume 4 of 4 – Appendices C & D

Issue 01 – February 2016

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

Appendix C. HAGDMS Earthworks Summary

Table C-1 – HAGDMS Earthworks Summary

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_42071	Embankment	S/B	L	179611	179572	South J23a	1965	244.90	5.80	26.50	MMG	GSTC
7_M1_42102	Cutting	N/B	L	179810	179780	South J23a	1965	508.40	4.30	26.00	MMG	-
7_M1_42070	Cutting	S/B	L	179832	179787	South J23a	1965	508.40	6.10	27.50	MMG	-
7_M1_42103	Cutting	N/B	L	180537	180459	South J23a	1965	132.00	2.60	24.00	MMG	-
7_M1_42104	Embankment	N/B	L	180659	180704	South J23a	1965	236.30	5.60	28.00	MMG	GSTC
7_M1_42198	Cutting	S/B	L	180389	180363	South J23a	1965	132.50	5.80	30.00	MMG	-
7_M1_42069	Embankment	S/B	L	180532	180489	South J23a	1965	234.40	6.00	30.00	MMG	GSTC
7_M1_42105	Cutting	N/B	L	181204	181196	South J23a	1965	528.60	15.00	30.00	MMG	-
7_M1_42068	Cutting	S/B	L	108734	181308	South J23a	1965	502.50	12.20	24.00	MMG	-
7_M1_42106	Embankment	N/B	L	181396	181323	South J23a	1965	128.50	5.30	26.00	ALV	GSTC
7_M1_42067	Embankment	S/B	L	181288	181310	South J23a	1965	113.90	3.90	23.00	ALV	GSTC
7_M1_42107	Embankment	N/B	L	181346	181423	South J23a	1963	76.00	5.40	26.50	ALV	GSTC
7_M1_42066	Embankment	S/B	L	181516	181442	South J23a	1963	73.80	6.10	25.00	ALV	MMG
7_M1_42108	Embankment	N/B	L	181928	181879	South J23a	1963	439.00	5.30	26.00	ALV	GSTC
7_M1_42065	Embankment	S/B	L	181512	181447	South J23a	1963	65.80	5.10	23.00	ALV	GSTC
7_M1_42197	Embankment	S/B	L	181592	181530	South J23a	1991	282.00	4.50	24.00	ALV	GSTC
7_M1_42153	At Grade	N/B	L	181893	182008	J23a	1991	221.20	2.10	15.00	MM3	-
7_M1_42064	Bund Front	S/B	L	181942	181864	J23a	1991	182.10	3.90	25.00	MM3	MMG
7_M1_54221	At Grade	S/B	R	181896	181878	J23a	1991	222.60	0.08	15.00	MGR	-
7_M1_54222	Bund Front	S/B	L	181798	181816	J23a	1991	278.70	3.80	28.00	MMG	MMG

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_62644	Cutting	N/B	R	182105	182041	J23a	-	85.90	3.10	20.00	-	-
7_M1_42109	At Grade	N/B	L	182340	182317	J23a	1991	261.90	0.00	0.00	MM3	-
7_M1_42196	Cutting	S/B	L	182094	182088	J23a	1991	355.80	3.00	23.00	MM3	-
7_M1_42110	Cutting	N/B	L	182614	182789	J23a	1991	578.30	3.50	23.00	MM3	-
7_M1_62634	At Grade	S/B	R	182628	182710	J23a	-	431.20	5.80	20.00	-	-
7_M1_62645	Cutting	S/B	L	182495	182399	J23a	-	295.00	7.50	20.00	-	-
7_M1_42063	Cutting	S/B	L	182557	182493	J23a	1991	255.50	7.40	30.00	MM3	-
7_M1_54220	At Grade	S/B	L	182843	182787	J23a	1965	254.90	0.00	0.00	MMG	-
7_M1_42111	Cutting	N/B	L	182929	183104	J23a	1965	274.00	3.60	28.00	GSTC	-
7_M1_42062	Embankment	S/B	L	183106	183053	J23a - J24	1965	454.10	11.70	28.00	MM4	MMG
7_M1_42051	Embankment	N/B	L	183097	183467	J23a - J24	1965	370.00	4.00	30.00	MM4	MMG
7_M1_42052	Cutting	N/B	L	183966	184096	J23a - J24	1965	601.70	11.20	26.50	MM4	-
7_M1_42061	Cutting	S/B	L	183523	183506	J23a - J24	1965	604.80	11.40	25.00	MM4	-
7_M1_42053	Cutting	N/B	L	184418	184530	J23a - J24	1965	398.60	2.70	23.00	MM3	-
7_M1_42060	Cutting	S/B	L	184443	184504	J23a - J24	1965	398.60	5.70	27.00	MM4	-
7_M1_42054	At Grade	N/B	L	184830	184806	J23a - J24	1965	284.20	0.00	0.00	RTD	-
7_M1_54218	At Grade	S/B	L	184504	184504	J23a - J24	1965	96.10	0.00	0.00	MMG	-
7_M1_62641	At Grade	S/B	L	184709	184762	J23a - J24	1965	153.70	0.00	0.00	-	-
7_M1_62642	Embankment	S/B	L	184866	184940	J24	-	187.70	2.70	14.00	-	-
7_M1_42055	Embankment	N/B	L	185110	185160	J24	1965	354.80	2.70	23.00	RTD	RTD
7_M1_42056	Embankment	N/B	R	185123	185160	J24	1980	215.30	5.50	30.00	RTD	RTD
7_M1_42059	Embankment	S/B	R	184941	184928	J24	1980	215.70	0.00	26.50	RTD	RTD
7_M1_54219	Embankment	S/B	L	185047	184949	J24	1980	200.90	3.40	21.00	RTD	RTD
7_M1_42057	Embankment	N/B	L	185263	185379	J24	1965	205.60	3.30	24.00	RTD	RTD
7_M1_42058	Embankment	S/B	L	185266	185095	J24	1965	199.60	3.40	25.00	RTD	RTD

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_20912	Embankment	N/B	L	185497	185567	J24	2003	170.90	3.40	30.00	RTD	MGR
7_M1_62640	Embankment	N/B	L	185420	185407	J24	-	207.50	6.80	20.00	-	-
7_M1_62643	Embankment	S/B	L	185599	185590	J24	-	187.40	7.50	19.00	-	-
7_M1_24413	Embankment	S/B	L	185565	185368	J24	1965	305.90	5.60	22.00	RTD	MGR
7_M1_20911	At Grade	N/B	L	185869	185904	J24	1999	333.70	0.00	0.00	RTD	-
7_M1_24407	Embankment	S/B	L	185620	185665	J24	1999	263.30	2.50	20.00	RTD	MGR
7_M1_20910	Embankment	N/B	L	186114	186133	J24 - J24a	1999	216.60	3.10	30.00	ALV	MGR
7_M1_24390	Embankment	S/B	L	185969	185920	J24 - J24a	1999	443.70	3.10	22.00	ALV	MGR
7_M1_24418	Embankment	N/B	L	186433	186435	J24 - J24a	1999	299.50	3.60	24.00	ALV	MGR
7_M1_24405	Embankment	S/B	L	186397	186403	J24 - J24a	1999	93.20	2.70	20.00	ALV	MGR
7_M1_56241	At Grade	N/B	L	186441	186493	J24 - J24a	1967	51.50	0.00	0.00	LMC	-
7_M1_20909	Embankment	N/B	L	186590	186601	J24 - J24a	1999	110.40	2.60	20.00	ALV	MGR
7_M1_47837	At Grade	S/B	L	186469	186499	J24 - J24a	1999	69.40	0.00	0.00	ALV	-
7_M1_62639	Embankment	S/B	L	-	-	J24a	-	27.50	11.00	47.00	-	-
7_M1_21156	Embankment	S/B	L	-	-	J24a	2003	72.00	10.30	30.00	ALV	MGR
7_M1_22207	Embankment	S/B	L	-	-	J24a	1999	654.50	10.00	30.00	ALV	MGR
7_M1_24477	Embankment	S/B	R	-	-	J24a	1999	575.40	8.00	30.00	ALV	MGR
7_M1_24428	Embankment	N/B	L	187000	187078	J24a	1999	581.60	7.00	30.00	ALV	MGR
7_M1_20906	Embankment	N/B	R	186900	186961	J24a	1999	314.70	4.80	26.00	ALV	MGR
7_M1_20908	At Grade	N/B	L	186726	186727	J24a	2003	114.50	0.00	0.00	ALV	-
7_M1_24393	At Grade	S/B	L	186652	186607	J24a	2003	254.90	0.00	0.00	ALV	-
7_M1_22192	Embankment	S/B	L	186655	186592	J24a	2003	61.70	7.90	22.00	ALV	MGR
7_M1_22028	Embankment	N/B	L	186730	186655	J24a	2003	480.80	6.90	24.00	ALV	MGR
7_M1_24427	Embankment	N/B	L	187137	187229	J24a - Railway	1966	92.20	7.90	24.00	ALV	MGR

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_22029	Embankment	S/B	L	187264	187139	J24a - Railway	1966	124.90	5.90	20.00	ALV	MGR
7_M1_24409	Embankment	N/B	L	187329	187326	J24a - Railway	1966	98.40	7.90	24.00	ALV	MGR
7_M1_21152	Embankment	S/B	L	187334	187275	J24a - Railway	1966	58.40	4.70	20.00	ALV	MGR
7_M1_24402	Embankment	N/B	L	187306	187363	J24a - Railway	1966	56.40	6.40	24.00	ALV	MGR
7_M1_24434	Embankment	N/B	L	187856	187893	J24a - Railway	1966	537.60	5.80	24.00	ALV	MGR
7_M1_22215	Embankment	S/B	L	187382	187352	J24a - Railway	1966	128.10	5.20	22.00	ALV	MGR
7_M1_24555	Embankment	S/B	L	187559	187482	J24a - Railway	1966	373.40	3.90	20.00	ALV	MGR
7_M1_22186	Embankment	S/B	L	187890	187884	J24a - Railway	1966	105.40	5.10	20.00	ALV	MGR
7_M1_54198	Embankment	N/B	L	188002	187986	J24a - Railway	1966	86.00	6.20	20.00	ALV	MGR
7_M1_22191	Embankment	N/B	L	188109	188026	J24a - Railway	1966	252.50	7.70	20.00	ALV	MGR
7_M1_24389	Embankment	N/B	L	188146	188246	J24a - Railway	1966	198.80	7.90	20.00	ALV	MGR
7_M1_24431	Embankment	N/B	L	188510	188556	J24a - Railway	1966	244.20	8.60	20.00	ALV	MGR
7_M1_21871	Embankment	S/B	L	188411	188366	J24a - Railway	1966	242.30	6.90	22.00	ALV	MGR
7_M1_54261	Embankment	S/B	L	188824	188776	J24a - Railway	1967	256.70	5.10	20.00	ALV	MGR

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_24430	Embankment	N/B	L	188945	189008	J24a - Railway	1966	250.40	5.10	20.00	ALV	MGR
7_M1_21157	Embankment	S/B	L	189266	189177	J24a - Railway	1966	143.80	3.50	22.00	ALV	MGR
7_M1_22184	Embankment	N/B	L	189302	189345	J24a - Railway	1966	142.20	5.50	20.00	ALV	MGR
7_M1_56242	At Grade	N/B	L	189527	189550	J24a - Railway	1967	22.60	6.40	22.00	HETD	-
7_M1_21044	Bund Front	S/B	L	189563	189544	J24a - Railway	1966	32.30	6.00	28.00	ALV	MGR
7_M1_62637	Embankment	N/B	L	189588	189563	J24a - Railway	-	40.90	6.00	22.00	-	-
7_M1_22136	At Grade	S/B	L	189674	189581	J24a - Railway	1966	394.20	5.70	24.00	ALV	MGR
7_M1_21900	Embankment	N/B	L	189906	189970	J24a - Railway	1966	369.60	9.10	22.00	ALV	MGR
7_M1_21155	Embankment	S/B	L	190027	190003	J24a - Railway	1966	411.40	9.90	24.00	ALV	MGR
7_M1_24420	Embankment	N/B	L	190410	190402	J24a - Railway	1966	382.00	10.10	24.00	ALV	MGR
7_M1_24388	Embankment	N/B	L	190648	190702	Railway - J25	1966	252.10	7.00	22.00	ALV	MGR
7_M1_22134	Embankment	S/B	L	190510	190463	Railway - J25	1966	245.90	6.80	20.00	ALV	MGR
7_M1_24498	At Grade	N/B	L	191322	191423	Railway - J25	1966	697.90	0.00	0.00	ALV	-
7_M1_22054	Embankment	S/B	L	190843	190715	Railway - J25	1966	731.80	4.60	25.00	ALV	MGR

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_24440	Bund Back	N/B	L	191723	191696	Railway - J25	1966	270.70	6.80	24.00	RTD	MGR
7_M1_24568	Bund Front	N/B	L	191723	191702	Railway - J25	1966	275.80	0.00	0.00	RTD	MGR
7_M1_22139	Embankment	S/B	L	191379	191446	Railway - J25	1966	128.60	3.40	18.00	ALV	MGR
7_M1_24508	Cutting	S/B	L	191605	191579	Railway - J25	1966	133.20	4.70	22.00	RTDU	-
7_M1_22235	Cutting	N/B	L	191913	192020	Railway - J25	1966	301.70	3.00	20.00	RTD	-
7_M1_22233	At Grade	S/B	L	191833	191723	Railway - J25	1966	307.30	0.00	0.00	RTD	-
7_M1_21153	At Grade	N/B	L	192020	192050	Railway - J25	1966	27.30	0.00	0.00	RTDU	-
7_M1_22149	Embankment	S/B	L	192076	192033	Railway - J25	1966	535.40	7.50	22.00	RTD	MGR
7_M1_22045	Embankment	N/B	L	192456	192578	Railway - J25	1966	516.40	6.40	24.00	RTD	MGR
7_M1_22183	Embankment	N/B	L	192730	192890	Railway - J25	1966	336.10	7.00	29.00	MMG	MMG
7_M1_21148	Embankment	S/B	L	192644	192560	Railway - J25	1966	183.70	5.80	22.00	MMG	MMG
7_M1_22180	Embankment	S/B	L	192736	192744	Railway - J25	1966	193.00	6.00	22.00	MMG	MGR
7_M1_22261	Cutting	N/B	L	192993	193043	J25	1966	147.70	6.00	30.00	MMG	-
7_M1_21144	Cutting	S/B	L	192948	192936	J25	1966	107.10	4.70	22.00	MMG	-
7_M1_21996	Cutting	S/B	L	193159	193066	J25	1966	342.30	8.50	24.00	BOC	-
7_M1_24435	Cutting	N/B	L	193233	193498	J25	1966	447.10	7.80	22.00	BOC	-

HAGDMS Earthwork Number	Type	C/W	Side	Chainage (from)	Chainage (to)	Location	Age	Length (m)	Max Height (m)	Max Angle (°)	In situ Geology Code	Embankment Geology Code
7_M1_22190	Cutting	N/B	L	193178	193471	J25	1966	296.30	6.60	25.00	BOC	-
7_M1_22179	At Grade	S/B	L	193428	193359	J25	1966	69.70	0.00	0.00	MMG	-
7_M1_22154	Cutting	S/B	L	193507	193428	J25	1966	79.20	3.50	20.00	MMG	-
7_M1_22232	Cutting	N/B	L	193471	193438	J25	1966	279.50	10.70	26.00	MMG	-
7_M1_22216	Cutting	N/B	L	193552	193499	J25	1966	50.20	6.20	25.00	MMG	-
7_M1_22153	Cutting	S/B	L	193545	193492	J25	1966	51.70	4.70	22.00	MMG	-
7_M1_24443	Cutting	N/B	L	193582	193636	J25	1966	51.80	6.80	25.00	MMG	-
7_M1_22238	Cutting	S/B	L	193614	193561	J25	1966	51.50	5.40	12.90	MMG	-
7_M1_22094	At Grade	N/B	L	-	-	J25	1966	85.10	1.30	12.00	MMG	-
7_M1_22247	Cutting	N/B	L	193641	193859	J25	1966	217.90	6.20	24.00	MMG	-
7_M1_22152	Cutting	S/B	L	193857	193630	J25	1966	225.40	5.60	26.00	MMG	-
7_M1_57771	At Grade	N/B	L	193705	193737	J25	2010	30.40	0.00	0.00	MMG	-
7_M1_57772	Cutting	N/B	L	193837	194047	J25	2010	332.50	8.00	24.00	MMG	-
7_M1_57770	Cutting	S/B	L	194163	194117	J25	2010	266.30	6.20	21.00	MMG	-
7_M1_57773	Cutting	N/B	L	194936	194902	J25	2010	856.90	9.70	25.00	MMG	-
7_M1_57726	Cutting	S/B	L	194356	194075	J25	2010	707.30	15.80	33.00	MMG	-
7_M1_57725	Embankment	S/B	L	194796	194780	J25 North	2010	116.20	2.60	36.00	MMG	MGR
7_M1_57744	Cutting	S/B	L	194910	194899	J25 North	2010	26.00	2.50	16.00	MMG	-

Notes
1. C/W = carriageway, S/B = southbound, N/B = northbound.
2. L = left side, R = right side.
3. Geology codes are recorded on HAGDMS: ALV = Alluvium, BOC = Boulder Clay, GSTC = Glacial Silts and Clays, HETD = Hemington Terrace Deposits, LMC = Lower Coal Measures Formation & Middle Coal Measures Formation (Undifferentiated), MGR = Made Ground, MM3 = Mercia Mudstone Unit 3, MM4 = Mercia Mudstone Unit 4, MMG = Mercia Mudstone Group, RTD = River Terrace Deposits, RTDU = River Terrace Deposits (Undifferentiated).

Appendix D. Additional BGS Boreholes

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK42NE137

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

BOREHOLE No. 136
SHEET 1 OF 1
COORDINATES 447223.2 E, 328641.1 N
GROUND LEVEL 31.80 mOD

Field Work by: Soil Mechanics Limited
Method: Cable tool boring
Dates: 22.5.88
Hole Dimensions: 150mm
Casing Dimensions: 150mm

Date	Casing Depth (m)	Water Depth (m)	Samples/Insitu Tests: Depth (m)	Type No.	Test Result	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata	Piezo/ S'pipe
			0.60	J1	*		(0.70)		CONCRETE / Dense HARDCORE (Foreman's description)	
			0.80	J2			0.70	31.10	(MADE GROUND)	
			0.90 - 1.35		C (19)				Firm brown very sandy CLAY with some to much subangular to subrounded gravel	
			0.90 - 2.00	B3			(1.60)		(POSSIBLY MADE GROUND)	
			2.40	J4			2.30	29.50		
			2.50 - 2.95		C (30)				Medium dense brown SAND and subangular to subrounded GRAVEL	
			2.50 - 3.60	B5					(RIVER SANDS AND GRAVELS)	
		3.65					(2.80)			
	4.00	20								
		4.00	4.10	J6						
			4.30 - 4.75		C (21)					
			4.30 - 5.00	B7						
			5.20	J8			5.10	26.70		
			5.40 - 5.85	J9	'48'				Firm becoming very stiff below 6.00m red brown very silty CLAY with occasional light greenish grey patches. And with occasional fine gravel size lithorelicts and relict structure	
			5.90 - 6.35	U10	'60'					
			6.40	J11			(2.90 pen)		(KEUPER MARL : ZONE IVa)	
			6.50 - 7.20	B12						
			7.40	W13 J14						
			7.50 - 7.95	U15						
22.5.88	6.00	4.00	8.00	J16			8.00	23.80		
									BOREHOLE COMPLETE AT 8.00m	

Remarks 1. Hole backfilled with arisings to G.L.

SCALE 1:50

Disturbed Samples: J = Jar; W = Groundwater; B = Bulk
Undisturbed Samples: Soil Sample
Insitu Tests: Depth groundwater struck(ms)and depth water rose to in X minutes; V (30) = vane Shear Strength in KN/m²; C or S = SPT cone or spoon (25) = N value; R = Penetration for seating blows

FIGURE A1

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 42 NE 147
A564 DERBY SOUTHERN BYPASS
AND DERBY SPUR
PRELIMINARY GROUND INVESTIGATION

Fieldwork By Soil Mechanics Limited

Dates: 10.5.88

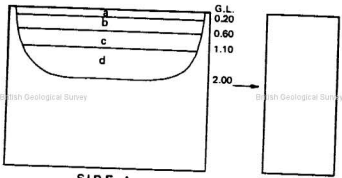
TRIAL PIT LOG

Co-ordinates E. 447203.8 N 328642.2 **Ground Level** 30.75 m A.O.D.

Dimensions [l x b x h] 3.00 x 0.70 x 2.00 **Excavation Plant** JCB 3CX

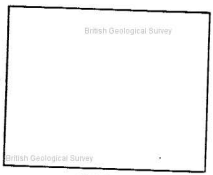
Trial Pit No. 230

ELEVATIONS: All faces similar

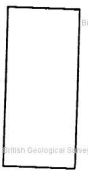


SIDE A

SIDE B

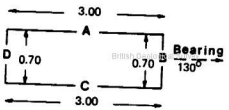


SIDE C



SIDE D

PLAN (Not to Scale)



SAMPLES

No. & Type	Depth m
D1	0.50
D2	1.00
D3	1.30
B4	0.25 – 1.30
W5	1.30
B6	2.00

No.	Depth m	STRATA DESCRIPTION	Cv/Cp kN/m²
	0.00 – 0.20	Firm dark grey organic CLAY (TOPSOIL)	
	0.20 – 0.60	Firm brown and purplish brown slightly sandy CLAY (ALLUVIUM)	
	0.60 – 1.10	Medium dense slightly purplish and orange brown slightly silty fine to medium SAND with much fine to coarse subrounded gravel (RIVER SANDS AND GRAVELS)	
	1.10 – 2.00	Medium dense blusih grey rapidly becoming light grey coarse SAND with much fine to coarse subrounded gravel (RIVER SANDS AND GRAVELS)	

NOTES Cv/Cp Approx. value of undrained shear strength from hand vane/penetrometer
Groundwater: Moderate seepage at 1.30m
Pumping: –
Supports/stability: Terminated due to collapse

FIGURE A3

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 42 NE 148
A564 DERBY SOUTHERN BYPASS
AND DERBY SPUR
PRELIMINARY GROUND INVESTIGATION

Fieldwork By: Soil Mechanics Limited

Dates: 10.5.88

TRIAL PIT LOG

Co-ordinates E 447361.9 N 328129.1

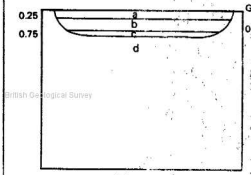
Ground Level 33.32 m A.O.D.

Dimensions (l x b x h) 2.50 x 0.70 x 0.75

Excavation Plant JCB 3CX

Trial Pit No. 231

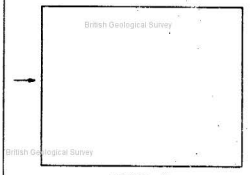
ELEVATIONS : All faces similar



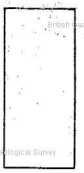
SIDE A



SIDE B



SIDE C



SIDE D

PLAN (Not to Scale)



SAMPLES

No. & Type	Depth m

No.	Depth m	STRATA DESCRIPTION	Cv/Cp kN m²
a.	0.00 – 0.25	Firm grey brown sandy CLAY (TOPSOIL)	
b.	0.25 – 0.60	Firm reddish brown and brown very silty sandy CLAY with some fine to medium subrounded gravel (MADE GROUND)	
c.	0.60 – 0.75	Tarmac	
d.	0.75	Concrete	

Note: Unable to excavate through concrete

NOTES Cv/Cp Approx. value of undrained shear strength from hand vane/penetrometer
Groundwater: –
Pumping: –
Supports/stability: Good

FIGURE A3

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 42 NE 148

A564 DERBY SOUTHERN BYPASS
AND DERBY SPUR
PRELIMINARY GROUND INVESTIGATION

Fieldwork By Soil Mechanics Limited

Dates : 10.5.88

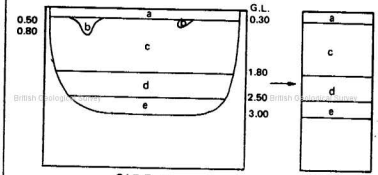
TRIAL PIT LOG

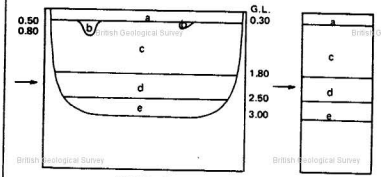
Co-ordinates E. 447351.9 N 328129.1 **Ground Level** 33.32 m A.O.D.

Dimensions [l x b x h] 2.80 x 0.70 x 3.00 **Excavation Plant** JCB 3CX

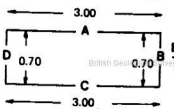
Trial Pit No. 231A

ELEVATIONS :





PLAN [Not to Scale]



SAMPLES

No. & Type	Depth m
D1	0.50
D2	1.00
B3	1.00
D4	1.80
D5	1.90
B6	2.20
D7	2.50
B8	3.00

No.	Depth m	STRATA DESCRIPTION	Cv/Cp kN/m²
a.	0.00 – 0.30	Firm grey brown sandy CLAY (TOPSOIL)	
b.	0.30 – 0.80	Loose orange brown silty fine to medium SAND (MADE GROUND)	
c.	0.80 – 1.80	Firm brown and reddish brown very silty CLAY (RIVER TERRACE DEPOSITS?)	
d.	1.80 – 2.50	Soft to firm slightly reddish brown mottled greyish and greenish brown very silty slightly sandy CLAY. Becoming very sandy in part, with fine to coarse subangular siltstone fragments. (KEUPER MARL : ZONE III – IVa)	
e.	2.50 – 3.20	Reddish brown fine to coarse subangular to subrounded mudstone fragments in a sparse matrix of very silty sandy CLAY (KEUPER MARL : ZONE III)	

NOTES Cv/Cp Approx. value of undrained shear strength from hand vane/penetrometer
Groundwater: –
Pumping: –
Supports/stability: Good

FIGURE A3

ALTERNATIVE LOG

SK/42 NE/15

LE GRAND ADSCO LIMITED

RECORD OF TEST BORING NO. [redacted]

CONTRACT Lockington - Nuthall
ORDER NO. 2247
LABORATORY JOB. NO. 1614
BORING LINED TO DEPTH OF [redacted]

CLIENTS : Ministry of Transport.
(Sir Owen Williams and Partners)
TYPE OF RIG - [redacted]
DIA - [redacted]

Date boring commenced - 21.2.62. completed - 23.2.62.

Description of Strata	Thickness Ft. In.	Depth Ft. In.	Drilling Tools Used.
Top soil.	1 (0.46) 6	1 (0.46) 6	Auger.
Brown clay & stones.	2 (0.61) 0	3 (1.07) 6	Auger.
Sand & gravel & boulders.	13 (4.12) 6	17 (5.18) 0	Chisel & Shell.
Hard reddish marl.	8 (2.44) 0	25 (7.62) 0	Chisel & Shell.
REMARKS :	TOTAL DEPTH	25 0	

SOIL SAMPLES sent to Southall (GIVE DEPTHS)

JARS	BULK SAMPLES	WATER SAMPLES	CORES Depth	Blows for each 6in.	S.P.T's Depth	Blows for each 3in.
1 1'6" 2'0" 5'0" 11'0" 16'0" 20'0" 25'0"	5'/11' 11'/17'	1.Bot.	19'/19'6" 24'6"/25'	13 Jar 17 Samples 15	5'/6'6" 11'/12'6" 15'3"/16'9"	7 9 14 12 17 24 9 11 17 16 23 27 11 12 18 26 25 23
TOTALS 7	2	1.Bot.			3	

Groundwater Observations

Date	Time	Struck	Standing	Date	Time	Struck	Standing
21.2.62.	6.pm.	7'6"	7'0"				

Signed - - - [redacted]

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)

6-inch Map Registered No.

SK/42NE/15

Name of Shaft or Bore given by Geological Survey:

Name and Number given by owner: M1 Motorway Extension No. 402

For whom made: Sir Owen Williams

Town or Village: Lockington County:

Exact site: (Attach a tracing from a map, or a sketch-map, if possible.)

Purpose for which made: Civil

Nat. Grid Reference: 47270. 29060

1"N.S. Map No.	1"O.S. Map No.	Confidential or not
141		

Ground Level at shaft / bore relative to O.D. If not ground level give O.D. of beginning of shaft / bore

Made by: Le Grand Adsco Date of sinking: Feb. 1962

Information from: examination of soil samples Date received: Jun. 1962

Examined by: A. Bayley

SPECIMEN NUMBERS AND ADDITIONAL NOTES

* Samples at

(For Survey use only) Geological Classification	Description of Strata	Thickness Ft	Thickness In.	Depth Ft	Depth In.
	Brown loamy soil	(0	66)	1	6
	Medium gritted sandy marl with pebbles	(6	6)	2	0
	Medium grained brown clean sand with small pebbles	(1	52)	5	0
	Ditto, with larger pebbles up to ½" across	(3	20)	10	6
	Ditto, smaller pebbles	(4	88)	16	0
Keuper Marl	Fragments of silty red-brown marl	(6	10)	20	0
	Ditto	(7	62)	25	0

British Geological Survey

Separately pass on 1961 xl.

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 42 NE 151

A564 DERBY SOUTHERN BYPASS
AND DERBY SPUR
PRELIMINARY GROUND INVESTIGATION

Fieldwork By: Soil Mechanics Limited

Dates: 10.5.88

TRIAL PIT LOG

Co-ordinates E. 447446.1 N 327143.8

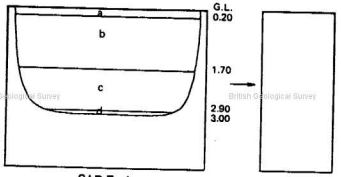
Ground Level 44.60 m A.O.D.

Dimensions (l x b x h) 3.00 x 0.70 x 3.00

Excavation Plant JCB 3CX

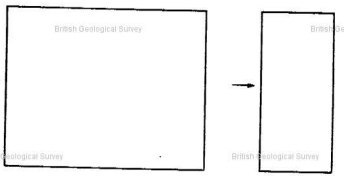
Trial Pit No. 234

ELEVATIONS: All faces similar



SIDE A

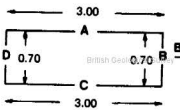
SIDE B



SIDE C

SIDE D

PLAN (Not to Scale)



SAMPLES

No. & Type	Depth m
D1	1.00
B2	1.00
D3	1.90
B4	1.90
D5	2.60
B6	3.00
D7	3.00

No.	Depth m	STRATA DESCRIPTION	Cv/Cp kN/m²
a.	0.00 – 0.20	Firm greyish brown sandy CLAY (TOPSOIL)	
b.	0.20 – 1.70	Firm slightly reddish brown very sandy CLAY tending to SAND in places with a little medium to coarse subrounded gravel (RIVER TERRACE DEPOSIT)	
c.	1.70 – 2.90	Firm to stiff pale greenish grey mottled greenish brown very silty, slightly sandy in part CLAY, closely fissured, with some medium gravel size angular siltstone fragments Becoming with many siltstone fragments (KEUPER MARL – ZONE IV)	
d.	2.90 – 3.00	Greenish grey fine grained well cemented SANDSTONE, moderately weak (KEUPER MARL – SKERRY)	

NOTES Cv/Cp Approx. value of undrained shear strength from hand vane/penetrometer
Groundwater: –
Pumping: –
Supports/stability: Good

FIGURE A3

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)

6-inch Map Registered No. SK/42NE/16

Name of Shaft or Bore given by Geological Survey:

Name and Number given by owner: M1 Motorway Extension No. 404

For whom made: Sir Owen Williams

Town or Village: Hackleton County:

Exact site: Attach a tracing from a map, or a sketch-map, if possible.

Nat. Grid Reference: 47130. 27420

1"N.S.Map No.	1"O.S.Map No.	Confidential or not
141		

Purpose for which made: trial

Ground Level at shaft bore relative to O.D.: If not ground level give O.D. of beginning of shaft bore:

Made by: La Grand Adoco Date of sinking: Feb. 1962

Information from: examination of jar samples Date received:

Examined by:

SPECIMEN NUMBERS AND ADDITIONAL NOTES

* Samples at

(For Survey use only) Geological Classification	Description of Strata	Thickness Ft	Thickness In.	Depth Ft	Depth in.
M	Soil, red-brown, sandy, loamy	(2.61)		2	0
	Gravel, sandy; fine bound with small pebbles	(1.72)		4	0
	Gravel; abundant small pebbles in coarse brown sand matrix	(2.74)		9	0
	Ditto	(4.27)		14	0
Kemper Marl	Clay, red-brown, plastic	(2.18)		17	0
	Marl, red-brown	(3.57)		21	6
	Ditto	(4.05)		26	6
	'Marl', red-brown, hard, compact and silty	(10.36)		34	0
	'Marl', red-brown, slightly sandy	(12.19)		40	0

British Geological Survey

25362(3)) 1968 4m (6/67) XX

ALTERNATIVE LOG

SK/42NE/16

47/30 29420

LE GRAND ADSCO LIMITED

RECORD OF TEST BORING NO. 44 141

CONTRACT Lockington - Nuthall — CLIENTS : Ministry of Transport. (Sir Owen Williams and Partners

ORDER NO. 2247

LABORATORY JOB. NO. 1614 — TYPE OF RIG - - - - - 8" & 6" -

BORING LINED TO DEPTH OF 16'0" & 31'0" - - - - - - - - - - - DIA - - 20.2.62. - 25.2.62.

Date boring commenced - - - - - - - - - - - - - - - completed - - - - - - - -

Description of Strata	Thickness Ft. In.	Depth Ft. In.	Drilling Tools Used.
Top soil.	1 (0.30) 0	1 (0.30) 0	Auger
Boggin.	2 (0.61) 0	3 (0.91) 0	
Sand & gravel.	12 (3.67) 6	15 (4.73) 6	Chisel
Soft red marl.	4 (1.37) 6	20 (6.10) 0	&
Red shaley marl.	10 (3.05) 0	30 (9.14) 0	Shell.
Soft red marl.	3 (0.91) 0	33 (10.06) 0	
Very hard red marl.	7 (2.13) 0	40 (12.19) 0	Clay Circular & Shell.
REMARKS : Unable to take a core at bottom of hole, too hard.	TOTAL DEPTH	40 0	

SOIL SAMPLES sent to Southall (GIVE DEPTHS)

JARS		BULK SAMPLES	WATER SAMPLES	CORES Depth	Blows for each 6in.			S.P.T's Depth	Blows for each 3in.					
2' 4' 9' 14' 17' 21'6" 26'6" 31'0" 34'0"	40'0"	5' 10'		20'/21'6" 25'/26'6" 30'/31'6" 33'/33'9"	10 18 107	26 8 74	23 14	5'/6'6" 10/11'6" Slipped	7 6	8 8	9 8	9 11	12 14	17 17
TOTALS	10	2	1	3-1 slipped.				2						

Groundwater Observations

Date	Time	Struck	Standing	Date	Time	Struck	Standing
21.2.62.	1pm	13'6"	14'6"				
22.2.62.	8.am		9'0"				
"	6.pm		16'6"				
23.2.62.	8.am		9'0"				
"	11.am		7'0" when casing withdrawn.				

Signed - - -

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)
6-inch Map Registered No.
SK/42 NE/17

Name of Shaft or Bore given by Geological Survey:

Name and Number given by owner: M1 Motorway Extension No. 406
For whom made: Sir Owen Williams
Town or Village: Lockington County:
Exact site: (Attach a tracing from a map, or a sketch-map, if possible.)
Purpose for which made: Civil
Ground Level at shaft bore relative to O.D.: If not ground level give O.D. of beginning of shaft bore:
Made by: Le Grand Arbon & Co. Date of sinking: Feb. 1962
Information from: examination of jar samples Date received:
Examined by:

Nat. Grid Reference: 47050 . 29610

1"N.S. Map No.	1"O.S. Map No.	Confidential or not
141		

SPECIMEN NUMBERS AND ADDITIONAL NOTES

(For Survey use only) Geological Classification	Description of Strata	Thickness Ft	Thickness In.	Depth Ft	Depth In.
	Soil, brown, clayey, loamy	(0.46)		1	6
	Clay, brown, firm, silty	(0.76)		2	6
	Gravel, pebbles (v.s. mild gravel) up to 2in across in grey-brown medium-grained sand matrix	(2.29)		7	6
	Ditto, with smaller pebbles	(2.30)		9	6
	Sand, brown, medium-grained	(3.51)		12	6
	Sand, brown, medium to coarse grained with occ. very small pebbles	(5.33)		17	6
Keuper Marl	'Marl', red-brown mottled grey-green, slightly silty	(6.86)		22	6
	'Marl', red-brown	(8.38)		27	6
	Ditto 'Marl', red-brown and grey-green, silty, hard	(10.29)		33	9
	Ditto	(12.19)		40	0

British Geological Survey

ALTERNATIVE LOG

SK/42NE/17

LE GRAND ADSCO LIMITED

47050 29610

141.

RECORD OF TEST BORING NO. 106.

CONTRACT Lockington - Nuthall
ORDER NO. 2247
LABORATORY JOB. NO. 1614
BORING LINED TO DEPTH OF 24'6" DIA 12"
Date boring commenced - 15/2/62. completed 20/2/62.

CLIENTS : Ministry of Transport.
(Sir Owen Williams and Partners
TYPE OF RIG - - 18/2 - - - - -

Description of Strata	Thickness Ft. In.	Depth Ft. In.	Drilling Tools Used.
Topsoil	1 9 (0.53)	1 9 (0.53)	Auger.
Brown Clay	2 6 (0.76)	4 3 (1.30)	
Sandy Gravel and Boulders	15 9 (4.80)	20 0 (6.10)	Chisel and Shell.
Hard Reddish Marl	20 0 (6.10)	40 0 (12.19)	
REMARKS : When Gravel Co. stopped Pumping Water rose to 10' B.S. in Borehole.	TOTAL DEPTH	40 0	

SOIL SAMPLES sent to Southall (GIVE DEPTHS)

JARS	BULK SAMPLES	WATER SAMPLES	CORES Depth	Blows for each 6in.	S.P.T's Depth	Blows for each 3in.
0" 2'6" 7'6" 12'6" 17'6" 22'6" 27'6" 33'6" [illegible]	5'6"/10'6" 10'6"-17'6"	1 Bot.	22'/22'6" 28'/28'6" 33'6"/33'9" 39'6"/40'	12 15 [illegible]	5'6"/7' 11'0"/11'6" 16'6"/17'	8 11 18 17 19 21 14 17 19 27 13 19 14 19 26
TOTALS 9	2	1 Bot.	4		3	

Groundwater Observations

Date	Time	Struck	Standing	Date	Time	Struck	Standing
20/2/62.	6p.m.	-	10'0"				

Signed - [redacted]

SK42NE 402
47299 28944

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

BOREHOLE LOG

Status: **Final** Date: 28/01/93

Project	A564 Derby Southern Bypass Ground Investigation Contract 5			BOREHOLE No
Job No 8 1 1 3 0	Date 30-06-92	Ground Level (m) 38.35	Co-Ordinates () E 67,326.0 N 98,983.5	5711
Contractor	Norwest Holst Soil Engineering Ltd.			Sheet 1 of 3

SAMPLES & TESTS			Water	STRATA				Geology
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	
							Firm red brown, in parts grey brown and light green grey very silty clay with occasional subrounded fine to medium gravel of quartzite. Occasional to some fine to medium gravel sized angular fragments of weak mudstone. (Made Ground)	
1.20-1.65	U	(28)						
1.70	J							
1.80-2.25	S	*15*						
2.30-2.75	U	(40)						
2.80	J							
2.90-3.35	S	*21*					---stiff below 2.90m	
						(6.50)		
3.40-3.85	U	(35)						Mg
3.90	J							
4.00-4.45	S	*17*					---irregular extremely closely spaced fissures below 4.00m	
4.50-4.95	U	(32)NR						
5.00-5.45	U	(38)						
5.50	J							
5.60-6.05	S	*9*					---soft below 5.60m	
6.10-6.55	U	(38)						
				31.85		6.50		
				31.65		(0.20) 6.70	Loose brown medium sand with a little subangular medium gravel of flint and with occasional pockets of soft clay. (Made Ground)	Mg
6.60	J							
6.70-7.15	BS	*10*						
							Firm red brown, grey brown and black sandy clay with much subangular fine to coarse gravel of sandstone and with some cobbles of sandstone. (Made Ground)	
						(2.00)		Mg
7.70-8.15	BC	*26*					---becoming silty sandy gravel with some cobbles below 7.70m.	

Boring Progress and Water Observations

Date	Time	Depth	Casing	Casing Dia	Water Dpt
30/6/92	18:00	1.20	-	-	Dry
1/7/92	am	1.20	-	-	Dry
	pm	9.50	9.00	150mm	Dry
2/7/92	Strike	9.50	9.00	150mm	9.50
	10mins	9.50	9.00	150mm	9.10
	18.30	13.60	12.70	150mm	7.90
3/7/92	08.00	13.60	12.70	150mm	9.10
	12.00	17.86	16.50	150mm	9.10

Chiselling

From	To	Hours
17.20	17.40	30mins
17.50	17.65	30mins

Water Added

From	To
10.80	11.80
13.00	

GENERAL REMARKS

Driller: T. Walsh. Hand dug inspection pit to 1.20m. Falling head permeability test at 9.90m. Gravel pack installed . This holo replaced 5667.

All dimensions in metres Scale 1:50 | Client The Department of Transport | Method Cable Percussion | Logged By [redacted]

Form A1

SK42NE 402

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

BOREHOLE LOG

Status: **Final** Date: 28/01/93

Project	A564 Derby Southern Bypass Ground Investigation Contract 5			BOREHOLE No
Job No 8 1 1 3 0	Date 30-06-92	Ground Level (m) 38.35	Co-Ordinates () E 67,326.0 N 98,983.5	5711
Contractor	Norwest Holst Soil Engineering Ltd.			Sheet 2 of 3

SAMPLES & TESTS			Water	STRATA				
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	Geology
							CLAY (As sheet 1)	Mg
				29.65		8.70		
9.00-9.45	BC	*65*					Very dense brown slightly clayey fine to coarse SAND AND subrounded fine to medium GRAVEL of quartzite, siltstone and sandstone. (Alluvium)	
9.50	W							
9.90-10.40	K							
10.30-10.75	BC	*33*				(3.60)	---dense with no clay below 10.30m	Ag
11.80-12.25	BC	*32*						
				26.05		12.30		
12.80-13.10	UB	(100)NR					Very weak red brown MUDSTONE with much matrix of very stiff slightly sandy silt recovered as angular coarse sand to medium gravel sized lithorelicts with some matrix. ---by 16.10m with some hard matrix. (Highly weathered, GIVa, Mercia Mudstone Group)	
13.10-13.55	S	*39*						
						(4.20)		MMG IVa
14.60-15.05	BS	*59*						

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing	Casing Dia	Water Dpt	From	To	Hours	From	To	
30/6/92	18:00	1.20	-	-	Dry	17.20	17.40	30mins	10.80	11.80	Driller: T. Walsh. Hand dug inspection pit to 1.20m. Falling head permeability test at 9.90m. Gravel pack installed. This hole replaced 5667.
1/7/92	am	1.20	-	-	Dry	17.50	17.65	30mins	13.00		
	pm	9.50	9.00	150mm	Dry						
2/7/92	Strike	9.50	9.00	150mm	9.50						
	10mins	9.50	9.00	150mm	9.10						
	18.30	13.60	12.70	150mm	7.90						
3/7/92	08.00	13.60	12.70	150mm	9.10						
	12.00	17.86	16.50	150mm	9.10						

All dimensions in metres Scale 1:50 | Client The Department of Transport | Method Cable Percussion | Logged By [redacted]

Form A1

SK 42 NE 402

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

BOREHOLE LOG

Status: **Final** Date: 28/01/93

Project	A564 Derby Southern Bypass Ground Investigation Contract 5			BOREHOLE No 5711
Job No 8 1 1 3 0	Date 30-06-92	Ground Level (m) 38.35	Co-Ordinates () E 67,326.0 N 98,983.5	
Contractor Norwest Holst Soil Engineering Ltd.				Sheet 3 of 3

SAMPLES & TESTS			Water	STRATA					
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION	Geologs	Instru-ment Backfill
16.10-16.55	BS	*100*		21.85		16.50	MUDSTONE (As sheet 2)		
						(1.36)	Weak red brown SILTSTONE with a little soft clay matrix along irregular closely spaced fissures. (Moderately weathered, "Skerry Band", Mercia Mudstone Group)	SKM	
17.40-17.54	S	78/135*							
17.65-17.86	S	50/55		20.49		17.86			
							Borehole Complete at 17.86m.		

Boring Progress and Water Observations

Date	Time	Depth	Casing	Casing Dia	Water Dpt
30/6/92	18:00	1.20	-	-	Dry
1/7/92	am	1.20	-	-	Dry
	pm	9.50	9.00	150mm	Dry
2/7/92	Strike	9.50	9.00	150mm	9.50
	10mins	9.50	9.00	150mm	9.10
	18.30	13.60	12.70	150mm	7.90
3/7/92	08.00	13.60	12.70	150mm	9.10
	12.00	17.86	16.50	150mm	9.10

Chiselling

From	To	Hours
17.20	17.40	30mins
17.50	17.65	30mins

Water Added

From	To
10.80	11.80
13.00	

GENERAL REMARKS

Driller: T. Walsh. Hand dug inspection pit to 1.20m. Falling head permeability test at 9.50m. Gravel pack installed. This hole replaced 5667.

All dimensions in metres Scale 1:50 | Client The Department of Transport | Method Cable Percussion | Logged By [redacted]

Form A1

SK42NE 419
427272 28710

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG

Status: **Final**
Date: 14/12/92

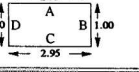
Project	A564 Derby Southern Bypass Ground Investigation Contract 5		TRIAL PIT No 5633
Job No 8 1 1 3 0	Date 22-06-92	Ground Level (m) 31.51	Co-Ordinates 0 E 67,298.8 N 98,748.2
Contractor	Norwest Holst Soil Engineering Ltd.		Sheet 1 of 2

SAMPLES AND TESTS				STRATA					
Depth	Type	Test Result	Water	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION FACE A	No	Geology
				31.41		(0.30)	HUMUS and TOPSOIL.	1	T
0.30 0.40-0.50	J JB(x2)					(0.80)	Loose * orange brown silty fine to medium SAND with some locally much subrounded fine to coarse gravel of quartzite, sandstone and siltstone. Occasional pockets of stiff red brown extremely closely fissured clay. (Made Ground)	2	Mg
0.95	J			30.61		0.90			
1.00 1.05-1.15	HV JB	> 188				(0.55)	Very stiff brown to red brown extremely closely to closely fissured very silty slightly sandy CLAY with rare subrounded fine to medium gravel of quartzite and sandstone (Made Ground)	3	Mg
1.55-1.65	JB(x2)			30.06		1.45	Dense * brown clayey silty fine to medium SAND with some subrounded fine to coarse gravel of quartzite, sandstone and siltstone. In parts light grey mottled and orange brown. (River Terrace Deposits) — locally becoming medium to coarse sand and gravel		
2.55-2.65	B(x2)		1			(2.55)			
3.20	W		2					4	RTg
3.55-3.65	B(x2)								
				27.51		4.00	Trial pit complete at 4.00m.		

NOTES

See sheet 2.

PLAN



Bearing 174°

Shoring / Stability
No support.Spalling below 2.90m.

Groundwater
Encountered as slight seepage at 2.80m. No rise. Water strike at 3.20m. Rose to 2.60m in 20 minutes.

All dimensions in metres Scale	Client The Department of Transport	Plant JCB 3CX Sitemaster	Logged By [redacted]

Form A3

SK 42 NE 419

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG (Sketch)

Status: **Final**
Date: 14/12/92

Project	A564 Derby Southern Bypass Ground Investigation Contract 5																	TRIAL PIT No	
Job No	8	1	1	3	0	Date 22-06-92			Ground Level (m) 31.51			Co-Ordinates () E 67,298.8 N 98,748.2						5633	
Contractor	Norwest Holst Soil Engineering Ltd.																	Sheet 2 of 2	

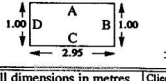
SKETCH OF FACES SHOWING DEPTH

Depth	A	B	C	D

NOTES

1) No significant lateral variation in soil types. 2) Photograph of Face D only. 3) Logged on excavated material below 1.20m. 4) *Engineers visual assessment. 5) Hand vane result is an average of three tests. 6) No watercourse near to pit from which to obtain water sample.

PLAN



Shoring / Stability
No support.Spalling below 2.90m.

Groundwater
Encountered as slight seepage at 2.80m. No rise. Water strike at 3.20m. Rose to 2.60m in 20 minutes.

All dimensions in metres Scale 1:50	Client The Department of Transport	Plant JCB 3CX Sitemaster	Logged By [redacted]

Form A4

British Geological Survey

SK 42 NE 424

471421 28675

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG

Status: **Final** Date: 14/12/92

Project: **A564 Derby Southern Bypass Ground Investigation Contract 5**

TRIAL PIT No: **5665**

Job No	Date	Ground Level (m)	Co-Ordinates ()
8 1 1 3 0	17-06-92	30.48	E 67,449.8 N 98,714.0

Contractor: **Norwest Holst Soil Engineering Ltd.**

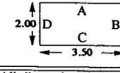
Sheet 1 of 2

SAMPLES AND TESTS			Water	STRATA					
Depth	Type	Test Result		Red'od Level	Legend	Depth (Thick-ness)	DESCRIPTION FACE A	No	Geology
				30.28		(0.28) 0.20	TOPSOIL	1	T
0.20-1.00	Bx2						Loose * light brown fine to coarse SAND with much subrounded fine to coarse gravel of quartzite. (River Terrace Deposits)		
0.50	J					(0.80)			
				29.48		1.00		2	RTg
1.00-1.60	B						Loose * light grey mottled yellow and orange brown silty SAND with much subrounded fine to coarse gravel of quartzite and with some pockets of soft yellow very sandy silty clay. (River Terrace Deposits)		
						(0.60)			
1.50	J			28.88		1.60		3	RTg
1.60-1.80	B		▼	28.68		(0.20) 1.80	Loose * light purple brown silty fine to coarse SAND with a little subrounded fine to medium gravel of quartzite (River Terrace Deposits)	4	RTg
1.70	J								
1.80-2.80	Bx2								
2.00	J					(1.00)	Loose * light purple brown silty very sandy subangular to subrounded fine to coarse GRAVEL of quartzite. (River Terrace Deposits)	5	RTg
				27.68		(0.20) 2.80			
2.80-2.90	JB			27.58		2.90	Soft dark grey speckled black fine sandy CLAY (River Terrace Deposits)	6	RTg
2.90-3.50	B					(0.60)			
3.00	J						Soft red brown mottled light grey green, CLAY with many sand size apparent lithorelicts. (Extremely weathered, GVc, Mercia Mudstone Group)	7	MMGV
				26.98		3.50			
							Trial pit terminated at 3.50m.		

NOTES

See sheet 2.

PLAN



Bearing 90°

Shoring / Stability: **No support. Complete collapse of sides below 1.80m.**

Groundwater: **Encountered as slight seepage at 1.80m.**

All dimensions in metres Scale 1:50	Client: Department of Transport	Plant: JCB 3CX Sitemaster	Logged By: [redacted]

Form A3

SK 42 NE 424

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG (Sketch)

Status: **Final**
Date: 14/12/92

Project: A564 Derby Southern Bypass Ground Investigation Contract 5			TRIAL PIT No: 5665
Job No: 8 1 1 3 0	Date: 17-06-92	Ground Level (m): 30.48	Co-Ordinates (): E 67,449.8 N 98,714.0
Contractor: Norwest Holst Soil Engineering Ltd.			Sheet 2 of 2

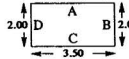
SKETCH OF FACES SHOWING DEPTH

Depth	A	B	C	D

NOTES

1) No significant lateral variation in soil types. 2) Photograph of Face B only. 3) Logged on excavated material below 1.20m. 4) *Engineers visual assessment. 5) Above 1.20m unsuitable for hand vane - granular. 6) Unable to obtain water sample or monitor water level due to collapse of pit. 7) Unable to obtain CBR mould - too granular. 8) Trial pit did not reach scheduled depth due to pit collapse.

PLAN



Bearing 90°

Shoring / Stability: No support. Complete collapse of sides below 1.80m.

Groundwater: Encountered as slight seepage at 1.80m.

All dimensions in metres Scale 1:50	Client: Department of Transport	Plant: JCB 3CX Sitemaster	Logged By: [redacted]

Form A4

SK 42 NE 425
47197 29152

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG

Status: **Final**
Date: 14/12/92

Project	A564 Derby Southern Bypass Ground Investigation Contract 5		TRIAL PIT No 5670
Job No 8 1 1 3 0	Date 19-06-92	Ground Level (m) 32.27	Co-Ordinates 0 E 67,224.5 N 99,191.0
Contractor	Norwest Holst Soil Engineering Ltd.		Sheet 1 of 2

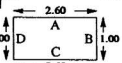
SAMPLES AND TESTS			Water	STRATA						
Depth	Type	Test Result		Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION FACE A	No	Geology
				32.02		(0.25) 0.25	TOPSOIL.	1	T
0.35-0.45 0.50	BJ HV	148				(1.00)	Stiff red brown slightly sandy CLAY with occasional fine to medium gravel sized lithorelicts of very weak mudstone and occasional rounded fine to medium gravel of quartzite. Light grey in parts. (Made Ground)		
1.00	HV	140		31.02		1.25		2	Mg
1.30-1.40	JB(x2)					(0.75)	Dense * orange brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of quartzite, siltstone, sandstone. (Made Ground)	3	Mg
				30.27		2.00			
				29.87		(0.40) 2.40	Dense * angular to subangular COBBLES AND BOULDERS with a little matrix of orange brown medium to coarse sand and fine to coarse gravel. Boulders up to 0.45 by 0.35 by 0.25m. (Made Ground)	4	Mg
2.50-2.60	JB(x2)						Dense * orange brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of quartzite, siltstone, sandstone. Locally becoming very sandy gravel. (River Terrace Deposits)		
3.30-3.40	B(x2)					(1.60)			
				28.27		4.00		5	RTg
							Trial pit complete at 4.00m.		

British Geological Survey

NOTES

See sheet 2.

PLAN



Bearing 250°

Shoring / Stability
No support. Pit remained stable throughout.

Groundwater
Not encountered. Soil wet below 3.30m.

All dimensions in metres Scale 1:50	Client Department of Transport	Plant JCB 3CX Sitemaster	Logged By [redacted]

Form A3

SK42NE 425

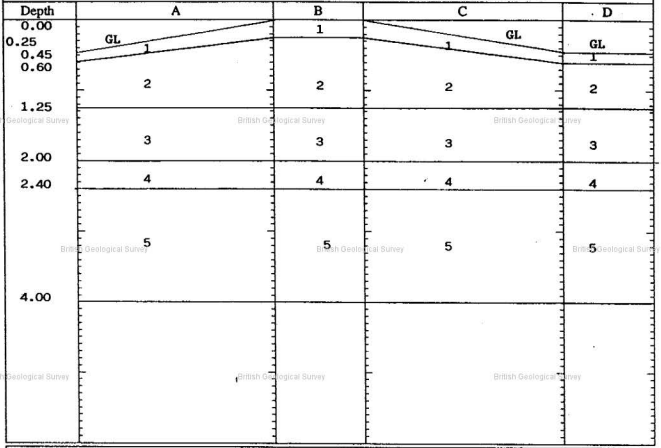
Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG (Sketch)

Status: **Final**
Date: 14/12/92

Project: A564 Derby Southern Bypass Ground Investigation Contract 5			TRIAL PIT No 5670
Job No: 8 1 1 3 0	Date: 19-06-92	Ground Level (m): 32.27	Co-Ordinates: E 67,224.5 N 99,191.0
Contractor: Norwest Holst Soil Engineering Ltd.			Sheet 2 of 2

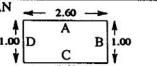
SKETCH OF FACES SHOWING DEPTH



NOTES

1) Trial pit excavated into toe of M1 motorway embankment. 2) Strata description for Face B. Ground level at Face B is approximately 0.50m above ground level at Face D. 3) Photograph of Face B only. 4) Logged on excavated material below 1.20m. 5) •Engineers visual assessment. 6) Hand vane results are an average of three tests at each depth. 7) Very difficult excavation below 1.20m.

PLAN



Bearing 250°

Shoring / Stability: No support. Pit remained stable throughout.

Groundwater: Not encountered. Soil wet below 3.30m.

All dimensions in metres Scale 1:50	Client: Department of Transport	Plant: JCB 3CX Sitemaster	Logged By: [redacted]

Form A4

SK 42 NE 426
47352 28725

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG

Status: **Final**
Date: 14/12/92

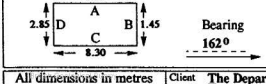
Project	A564 Derby Southern Bypass Ground Investigation Contract 5		TRIAL PIT No 5674
Job No 8 1 1 3 0	Date 24-06-92	Ground Level (m) 30.60	Co-Ordinates () E 67,381.4 N 98,765.6
Contractor	Norwest Holst Soil Engineering Ltd.		Sheet 1 of 2

SAMPLES AND TESTS			Water	STRATA					
Depth	Type	Test Result		Red'cd Level	Legend	Depth (Thickness)	DESCRIPTION FACE A	No	Geology
				30.50		(0.10) 0.10	TOPSOIL.	1	T
0.20-0.30	JB(x2)			30.20		(0.30) 0.40	Dense * orange brown and brown silty very sandy subrounded fine to medium GRAVEL of flint, quartzite, sandstone, siltstone (Made Ground).	2	MG
0.45-0.55	B					(0.70)	Loose * grey brown ashy fine to coarse sand, in parts becoming very soft black organic sandy clay. Some glass bottles, brick and brick fragments, metal fragments. Odorous. (Made Ground)	3	MG
1.05	W			29.50		1.10			
1.10	HV	164				(0.30)		4	Ac
1.20-1.30	BJ			29.20		1.40	Very stiff light grey and orange brown sandy CLAY with a little subrounded fine to coarse gravel of quartzite, sandstone and siltstone		
1.40-1.50	JB(x2)					(0.70)	--- by about 1.30m becoming clayey fine to coarse SAND with much subrounded fine to coarse gravel (Alluvium)	5	RTg
				28.50		2.10			
2.10-2.20	JB(x2)					(0.75)	Dense * grey medium to coarse SAND with some subrounded fine to coarse gravel predominantly of quartzite.		
				27.75		2.85	--- becoming brown by 1.80m (River Terrace Deposits)	6	RTg
							Dense * brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL predominantly of quartzite, sandstone. Grading to sandy GRAVEL by 2.50m. Occasional orange brown fine to coarse sand pockets. (River Terrace Deposits)		
							Trial pit terminated at 2.85m.		

NOTES

See sheet 2.

PLAN



Shoring / Stability
No support. Constant spalling below 1.50m.

Groundwater
Encountered as a strike at 1.05m. Rose from 1.20 to 1.05m in 20 minutes.

All dimensions in metres Scale 1:50	Client The Department of Transport	Plant JCB 3CX Sitemaster	Logged By [redacted]

Form A3

SK42NE 426

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

TRIAL PIT LOG (Sketch)

Status: **Final** Date: 14/12/92

Project: **A564 Derby Southern Bypass Ground Investigation Contract 5**

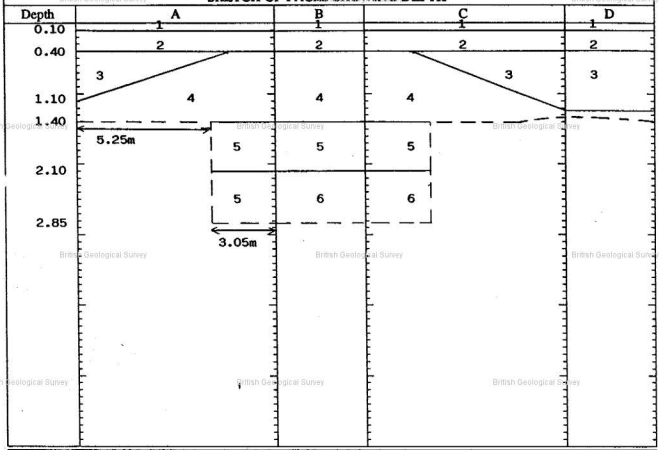
TRIAL PIT No: **5674**

Job No	Date	Ground Level (m)	Co-Ordinates ()
8 1 1 3 0	24-06-92	30.60	E 67,381.4 N 98,765.6

Contractor: **Norwest Holst Soil Engineering Ltd.**

Sheet 2 of 2

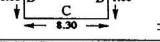
SKETCH OF FACES SHOWING DEPTH



NOTES

1) Significant lateral variation in soil types. 2) Photograph of Faces B and D. 3) Logged on excavation material below 1.00m. 4) *Engineers visual assessment. 5) Hand vane on displaced sample from excavator bucket is an average of three tests. Unable to penetrate very soft clay in made ground due to bottles, glass etc. 6) On instructions of Engineers Representative trial pit terminated before reaching scheduled depth due to repeated spalling below 1.50m and consequent undermining of working area. 7) Acting on the instructions of the Engineers Representative, trial pit was extended northwards to define profile of made ground.

PLAN



Bearing 162°

Shoring / Stability: **No support.Constant spalling below 1.50m.**

Groundwater: **Encountered as a strike at 1.05m. Rose from 1.20 to 1.05m in 20 minutes.**

All dimensions in metres Scale 1:50	Client: The Department of Transport	Plant: JCB 3CX Sitemaster	Logged By: [redacted]

Form A4

GEOLOGICAL SURVEY OF GREAT BRITAIN

RECORD OF SHAFT OR BORE FOR MINERALS

(For Survey use only)

6-inch Map Registered No.

SK/42 SE/10

Name of Shaft or Bore given by Geological Survey: 10

Name and Number given by owner: 171 Extension No. 291

Nat. Grid Reference 4774 · 2217

For whom made Sir Owen Williams

Town or Village Long Whatton County Leics.

Exact site

Attach a tracing from a map, or a sketch-map, if possible.

1"N.S.Map No.	1"O.S.Map No.	Confidential or not
141		

Purpose for which made Investigation

Ground Level at shaft bore relative to O.D. If not ground level give O.D. of beginning of shaft bore

Made by Date of sinking 1961

Information from examination of samples Date received

Examined by [redacted]

SPECIMEN NUMBERS AND ADDITIONAL NOTES

Samples at

(For Survey use only) GEOLOGICAL CLASSIFICATION	DESCRIPTION OF STRATA	THICKNESS Ft	THICKNESS in.	DEPTH Ft	DEPTH in.
	Clay, brown, mottled grey and reddish, silty with occasional small sandstone fragments			(0.61) 2	0
	Clay, ditto			(2.15) 7	0
	Clay, ditto, with sandy fragments			(3.05) 10	0
Boulder Clay	Clay, dark chocolate brown, very silty, stiff with black sandy streaks and pockets of grey sand			(4.57) 15	0
	Clay, red-brown, silty, stiff with small quartz and sandstone fragments			(6.10) 20	0
	Clay, ditto red-brown very silty, friable with few small sandstone fragments			(7.62) 25	0
	Clay, ditto			(9.14) 30	0

C.B.H. 32896 · WT41054 · DF 5.41 · 2000 · 8/59

ALTERNATIVE LOG.

SK/42SE/10
4774 2217
141

LE GRAND ADSCO LIMITED

RECORD OF TEST BORING No. 291 **at** Enderby-Lockington

For Sir Ol Williams & Partners (Ministry of Transport)

O/No. 1941 Boring Completed on 11.9.61 O.D. Level 234

Boring lined to a Depth of 5'0" Diameter 6"

BORING FOREMAN'S STRATA RECORD		THICKNESS Ft	THICKNESS Ins	DEPTH Ft	DEPTH Ins	WATER OBSERVATIONS Date	Time	W.S.	SWL
Top Soil	(0·30)	1	0	1	0	(0·30)	damp at 22'0"		
Brown boulder Clay	(8·84)	29	0	30	0	(9·14)			
TOTAL DEPTH				30	0				

British Geological Survey

Soil Mechanics

BOREHOLE No. 755

Sheet 1 of 1

Equipment & Methods

Hand dug inspection pit from ground level to 1.00m. Cable tool boring, 150mm diameter, from 1.00m to 1.90m.

Location No. 7382 SK42NE101

Location

A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level: -----

Coordinates: 4 7088.0 mE, 2 3239.0 mN

Date: 27.01.88

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
FILL (foreman's description)			(0.20) 0.20					
Very stiff red brown very silty CLAY with medium to coarse gravel occasionally cobble sized lithorelics and occasional pockets and lenses of light grey green silt (KEUPER MARL ?)				0.30 - 0.70	B	1		
Below 1.00m becoming probably moderately weathered MUDSTONE weak to very weak recovered as medium to coarse gravel sized lithorelics in a silty clay matrix			(1.70 pen)	1.00 - 1.25	U	2		120 blows
				1.30	D	3	S	16,28/64 for 75mm
				1.30 - 1.53	D	4	54	Chisselling from 1.30m to 1.75m
				1.75 - 1.90	D	5	S (80)	1.25 hours 29,51 for 75mm
BOREHOLE ENDS AT 1.90 m.			1.90					

Remarks

Logged by: AAC

Scale: 1:50

Fig. 80

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics 14.04.88/14.11 (Ver 3.1.0)

British Geological Survey

Soil Mechanics

BOREHOLE No. 756

Sheet 1 of 2

Equipment & Methods

Hand dug inspection pit from ground level to 0.60m. Cable tool boring from 0.60m to 7.55m

Location No. 7382

SK42SE102

Location

A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)

Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level

57.80 m A.O.D.

Coordinates

4914.0 mE

3759.0 mN

Date

27.01.88

to 28.01.88

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
	57.80							
FILL (Foreman's description)			(0.90)					
light brown clayey fine SAND with some to much angular to sub-rounded fine to medium assorted gravel and frequent root fragments	56.90		0.90	0.60 - 1.05	U	1		44 blows
				1.20	D	2		
				1.20 - 1.65	D	3	S N=9	2,2/2,2,2,3
				2.00 - 2.45	U	4		31 blows
				2.60	D	5		
Very stiff (hard) red brown locally very silty CLAY locally friable with frequent fine to medium gravel sized lithorelics and occasional pockets and lenses of light grey green silt				2.60 - 3.05	D	6	S N=10	2,2/2,3,2,3
(FILL)								
From 1.20m to 2.20m with a little sub-angular medium to coarse occasionally fine assorted gravel				3.50 - 3.95	U	7		26 blows
				4.10	D	8		
Below about 2.20m with frequent medium to coarse occasionally fine gravel sized lithorelics			(6.65 pen)	4.10 - 4.55	D	9	S N=16	3,3/4,3,4,5
Between 3.50m and 5.60m locally firm to stiff				5.00 - 5.45	U	10		29 blows
At 5.60m with occasional inclusions of brown slightly fine sandy CLAY and scattered plant fragments				5.60	D	11		
				5.60 - 6.05	D	12	S N=15	2,3/4,3,4,4
				6.50 - 6.95	U	12		43 blows
				7.10	D	13		
				7.10 - 7.55	D	14	S N=24	3,4/4,6,7,7
BOREHOLE ENDS AT 7.55 m.	50.25		7.55					

Remarks

Logged by

ANC

Scale

1:50

Fig.

81

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 14.04.88/14.14 (Ver 3.1.0)

Soil Mechanics

BOREHOLE No. 756

Sheet 2 of 2

Equipment & Methods

As sheet 1

Location No. 7382

Location SK42SR102 4914·0 2375·0

A42 CASTLE DONINGTON NORTH: GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)

Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level | Coordinates | Date

As sheet 1

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample: Type	Sample: No.	Test	Field Records

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1988					
27.01	-	2.10	1.84	DRY	
27.01	-	4.00	1.84	DRY	
27.01	-	6.95	1.84	DRY	End of shift
28.01	0800	6.05	1.84	DRY	
28.01	-	6.60	6.30	DRY	
28.01	-	7.55	6.30	DRY	End of cable tool boring

Remarks

Logged by: AAC

Scale: 1:50

Fig. 81

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

(c) Soil Mechanics 14.04.88/14.14 (Ver 3.1.0)

British Geological Survey

SK 42 SE/140

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SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

BIRMINGHAM – NOTTINGHAM ROUTE
A42 CASTLE DONINGTON NORTH
MAIN SITE INVESTIGATION
CONTRACT 2

4641 2385

BOREHOLE No **B223**

FIGURE **A1**

Sheet **1** of **2**

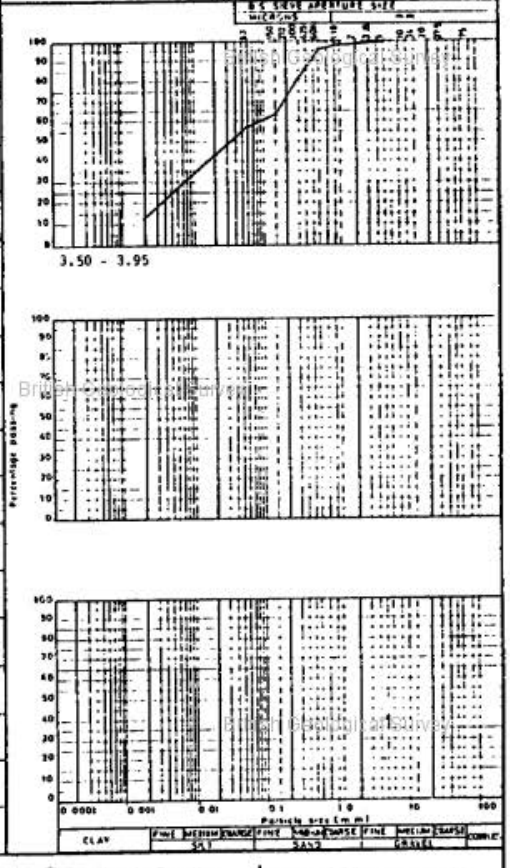
Field Work by: Exploration Associates (Warwick) Limited
Method: Cable Percussion
Dates: 29/30.8.84
Hole Dimensions: 150mm
Casing Dimensions: 150mm

Coordinates: 66431.3 E.
93899.8 N.
Ground Level: 53.43 m OD.

Laboratory Testing by: Dates:

Dates	Depth of Casing	Depth to water	Sample/Insitu Test Depth	Sample/Insitu Test Type & Number	Change of Strata Legend	Depth	Reduced Level	Description of Strata
29.8.84			0.30	J1		0.30	53.13	TOPSOIL
			0.50					Red brown clayey silty SAND with some fine to medium gravel, occasional flint. (GLACIAL TILL)
				(27)2		0.80	52.63	
			0.95					Firm red brown fissured sandy silty CLAY with some fine to medium gravel and flints and traces of carbonaceous material. (GLACIAL TILL)
			1.00	J3				Occasional pockets of silty sand below 1.00m
				S(11)				
			1.45	J4		1.60	51.83	
			1.80	J5				Firm red brown slightly mottled grey green silty CLAY with occasional mudstone lithorelicts. (KEUPER MARL : ZONE III)
			2.00					
				(28)E				
			2.45					Occasional bands of clayey silt with some lithorelcits of siltstone below 2.50m
			2.50	J7				
				S(7)				
			2.95	J8				
			3.30	J9		3.30	50.13	
			3.50					Firm and soft red brown and grey green silty CLAY and very silty CLAY with many lithorelicts of mudstone and siltstone (KEUPER MARL : ZONE III)
				(47)10				
			3.95	J11		4.00	49.43	
			4.00					Red brown fissured clayey silty fine SAND with traces of carbonaceous material and bands of silty clay and sandy clayey silt with some lithorelicts (KEUPER MARL : ZONE III)
				S(10)				
			4.45	J12				
			4.80	J13				
			5.00					
				(45)14				
			5.45					
			5.50	J15				
				S(25)		5.80	47.63	
			5.95	J16				Stiff red brown slightly mottled grey green fissured silty CLAY with some lithorelicts of mudstone and siltstone. (KEUPER MARL : ZONE III) Very stiff in parts. Zones of clayey silty sand at 7.00m
			6.30	J17				
			6.50					
				(65)18				
			6.95					
		7.0	7.00	J19				
				S(35)				
			7.45	J20				
			7.80	J21				
29.8.84	6.00	Dry						
30.8.84	6.00	4.30	8.30	J22				
			8.50					
				(70)23				
			8.95					
			9.00	J24		9.00	44.43	

Standpipe/Piezometer Installation	Sample Number	Natural Moisture Content (%)	Natural Dry Density (kg/m³)	Liquid Limit (%)	Plastic Limit (%)	% passing 425 microns
	1.	9.7				
	4	19				
	6	26	1495	47	21	100
	10			37	19	100
	18	19	1770	32	19	100
	23	18	1780			



Scale 1:

Disturbed Samples : w – Groundwater
J – Jar
S – S.P.T.
B – Bulk
M – Mazi

Undisturbed Samples : Soil Sample

Insitu Tests : V [30] – Vane shear strength in KN /m²

Groundwater first struck

Core Cutter Density
Core Cutter Density/C.B.R

Sandbottle Density
C B R

Cone or S S.P.T. cone or spoon
(25) – N value

British Geological Survey

SK42SE/140

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BIRMINGHAM – NOTTINGHAM ROUTE
A42 CASTLE DONINGTON NORTH
MAIN SITE INVESTIGATION
CONTRACT 2

4641 2385

BOREHOLE No B223

FIGURE A1

Sheet 2 of 2

Field Work by:
Method :
Dates :
Hole Dimensions
Casing Dimensions

Coordinates: E. N.
Ground Level: m OD

Laboratory Testing by: Dates:

Dates	Depth of Casing m	Depth to Water m	Sample/Insitu Test: Depth m	Sample/Insitu Test: Type & Number	Change of Strata: Legend	Change of Strata: Depth m	Change of Strata: Reduced Level
			9.00	S(26)			
			9.50	J25			
		▼ 9.6	9.80	J26,J27			
			10.00	(70)28			
			10.45				
			10.50	J29			
				S(37)			
			10.95	J30			
			11.30	J31			
			11.50	(110)32#			
			11.95				
			12.00	J33			
				S(54)			
			12.45	J34			
			12.80	J35			
			13.00	(130)36			
			13.45				
			13.50	J37			
				S(55)#			
			13.95	J38			
			14.30	J39			
			14.50	S(57)			
30.8.84	13.50	7.20	14.95	J40		15.00	38.43

Description of Strata

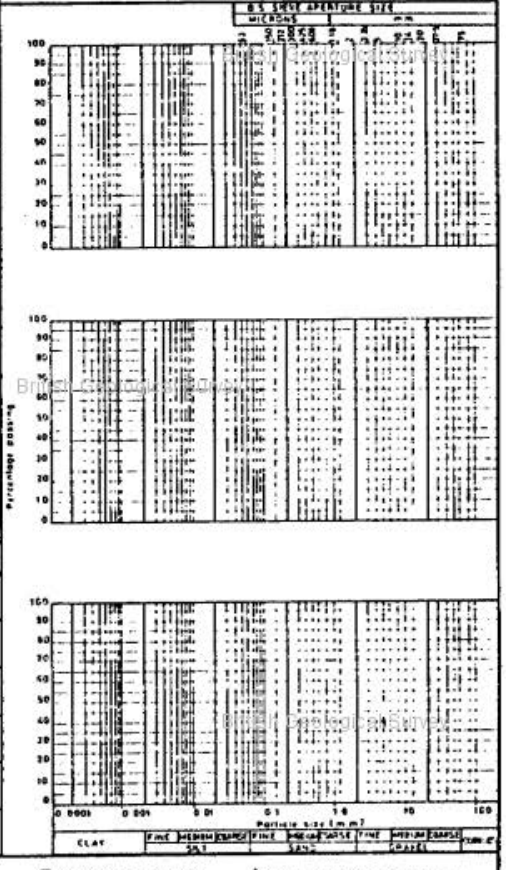
Stiff red brown and grey green very silty CLAY tending to very clayey silt with many mudstone, siltstone lithorelicts and bands of weak and very weak siltstone.
(KEUPER MARL : ZONE II/III)

Band of weak and very weak siltstone at 13.50.
Becoming very stiff below 13.60m

End of Shell and Auger Hole.

Samples taken in water.

Standpipe/Piezometer Installation	Sample Number	Natural Moisture Content (%)	Natural Dry Density (kg/m³)	Liquid Limit (%)	Plastic Limit (%)	% passing 425 microns	Sulphate g/ltr / pH
	25	23					
	27	—					0.15 / 7.1
	30	14					
	40	17		34	18	100	



Scale 1:

Disturbed Samples: W – Groundwater; ● J – Jar, ● S – S.P.T., ● B – Bulk, ● M – Maxi

Undisturbed Samples: Soil Sample

Insitu Tests: V C30] – Vane shear strength in KN /m²; ▼ Groundwater first struck; □ Core Cutter Density; ■ Core Cutter Density/C.B.R; ▽ Sandbottle Density; ▲ C.B.R.; [Cor S – S.P.T. cone or spoon; [(25) – N value

British Geological Survey

SK12SE/10

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BIRMINGHAM - NOTTINGHAM ROUTE
A42 CASTLE DONINGTON NORTH
MAIN SITE INVESTIGATION
CONTRACT 2

DRILLHOLE Nº B223

FIGURE A2

Sheet 1 of 3

Field Work by : Exploration Associates (Warwick) Limited
Method : Rotary Coring Air Flush with Water Injection
Dates : 12.10.84
Core Diameter : 76mm
Casing Dimensions :

Coordinates : 66431.3 E
93899.8 N
Ground Level : 53.43 m O.D

Laboratory Testing by :
Dates :

Drilling								Water or Fl (mm)	Change of Strata			Description of Strata		Field Records and Standpipe / Piezometer Installation Details	Sample Number	Depth (m)	Natural Moisture Content %	Liquid Limit %	Plastic Limit %	Natural Dry Density (kg/m³)		
Dates	Depth of casing (m)	Depth to water (m)	Depth (m)	Run	CR %	RQD %			Legend	Depth (m)	Reduced Level	Detail	Main									
12.10.84												Rotary Open Holed through overburden alongside Shell and Auger Hole previously drilled to 14.00m (No Drillers Description)										

Scale 1 :

Disturbed Samples :
W - Groundwater
J - Jar
S - S.P.T.
B - Bulk
M - Maxi

Core Runs
Core recovery %

Groundwater first struck

C or S - S.P.T. cone or spoon
(25) - N value

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SK12SE/140

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BIRMINGHAM - NOTTINGHAM ROUTE
A42 CASTLE DONINGTON NORTH
MAIN SITE INVESTIGATION
CONTRACT 2

DRILLHOLE Nº 3223

FIGURE A2

Sheet 2 of 3

Field Work by :
Method :
Dates :
Core Diameter :
Casing Dimensions :

Coordinates : E
N
Ground Level : mO.D.

Laboratory Testing by : Dates :

Drilling								Test or Fr (mm)	Change of Strata			Description of Strata		Field Records and Standpipe / Piezometer Installation Details	Sample Number	Depth (m)	Natural Moisture Content %	Liquid Limit %	Plastic Limit %	Natural Dry Density (kg/m³)
Dates	Depth of casing (m)	Depth to water (m)	Depth (m)	Run	CR %	RQD %			Legend	Depth (m)	Reduced Level	Detail	Main							
		Seepage 13.5																		
												See Sheet 1 of 3								
										14.00	39.43		Moderately weathered very weak friable dark red brown mottled grey green calcareous micaceous SILTSTONE with extremely closely spaced discontinuities thinly bedded with some silty clay along sub-horizontal discontinuities. (KEUPER MARL : ZONE II)							
			14.00					NI 40 110		14.45	38.98		Slightly weathered moderately weak to weak light grey green SILTSTONE with some low amplitude ripple bedding very weak closely spaced discontinuities. (KEUPER MARL : ZONE I)							
					95%	11%				14.60	38.83	Occasional thin very weak siltstone bands throughout.								
			15.00		95%	54%		NI 40 540					Dark red brown mottled grey green SILTSTONE (degraded to very stiff clay) (KEUPER MARL:ZONE III)							
			16.00							16.00	37.43									
					95%	23%		NI 40 230					Moderately weathered very weak friable dark red brown SILTSTONE thinly bedded with extremely closely spaced discontinuities (KEUPER MARL : ZONE II)							
			17.00					CP1			(90)									
			17.45		92%	30%		NI 60 240		17.45	35.98		Slightly to moderately weathered very weak and weak SILTSTONE thinly bedded with some low amplitude ripple bedding in places with very closely spaced horizontal discontinuities (KEUPER MARL : ZONE I)							

Scale 1:

Disturbed Samples : W - Groundwater
J - Jar
S - S.P.T.
B - Bulk
M - Mcal

Core Runs
core recovery %

Groundwater first struck

C or S - S.P.T. cone or spoon
(25) - N value

British Geological Survey

SK12SE/140

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BIRMINGHAM - NOTTINGHAM ROUTE
A42 CASTLE DONINGTON NORTH
MAIN SITE INVESTIGATION
CONTRACT 2

DRILLHOLE Nº B223

FIGURE A2

Sheet 3 of 3

Field Work by :
Method :
Duties :
Core Diameter :
Casing Dimensions :

Coordinates : E
N
Ground Level : m O.D.

Laboratory Testing by :

Dates :

Drilling: Dates	Depth of Casing (m)	Depth to Water (m)	Depth (m)	Run	CR %	RQD %	Test or Id (mm)	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata: Depth	Description of Strata: Main	Field Records and Standpipe / Piezometer Installation Details	Sample Number	Depth (m)	Natural Moisture Content %	Liquid Limit %	Plastic Limit %	Natural Dry Density (kg/m³)
												See sheet 2 of 3							
									18.10	35.33		Highly weathered siltstone degraded to very stiff friable dark red brown silty CLAY with many lithorelicts tending to a very weak siltstone in places. (KEUPER MARL : ZONE III)			18.24 18.49	13			1975
			19.00																
					97%	52%	NI 30 520		19.60	33.83									
12.10.84									20.00	33.43		Moderately weathered weak light grey green mottled red brown SILTSTONE with very closely spaced sub-horizontal discontinuities containing some silty clay. (KEUPER MARL : ZONE II)							
			20.00									End of Rotary Hole							
												NI = Not Intact.							

Scale 1:

Disturbed Samples : • J - Jar • S - S.P.T. • B - Bulk • M - Maxi
W - Groundwater

Core Runs: 50 / 100
core recovery %

▼ Groundwater first struck

C or S - S.P.T. cone or spoon
(25) - N value

British Geological Survey

BOREHOLE LOG

SK42SE 222

SITE: Long Whatton Sewer Renewals 4695 2375			BOREHOLE No: 3
CLIENT: N.W.L.DISTRICT COUNCIL	CO-ORDS: E- N-	LOGGED BY: NH / SCALE: 1:50	
DRILLING METHOD: Light Cable Percussion Vertical	BORING DIAMETER: 150mm to 2.30m.	DATE: 20/10/93	
	CASING DIAMETER:	GROUND LEVEL: 50.60 m. A.O.D.	SHEET: 1 of 1

SAMPLE DEPTH(m)	TYPE	N	WATER DEPTH (m)	THICKNESS (m)	DESCRIPTION OF STRATUM	DEPTH (m)	REDUCED LEVEL (m AOD)	LEGEND
0.00 - 0.35	D1			0.35	FILL - dark brown clayey topsoil with rock fragments			
0.35 - 0.70	B2					0.35	50.25	
					FILL - firm red brown very silty clay			
0.70 - 1.00	D4							
1.00 - 1.45	U5	(37)		1.25				
1.00	D5							
1.60 - 1.70	D6					1.60	49.00	
1.70 - 2.15	U7	(32)			Firm brown friable very silty sandy slightly gravelly CLAY with traces of black organic material			
				0.70				
2.30	D8					2.30	48.30	
					END OF BOREHOLE			

GROUNDWATER AND CASING DETAILS:

No groundwater seepages encountered

REMARKS:

1. Hand dug service pit to 1.00m

NICHOLLS COLTON AND PARTNERS

LR: 46789

British Geological Survey

BOREHOLE LOG

SK62SE 223

SITE: Long Whatton Sewer Renewals 4684 2376			BOREHOLE No: 4
CLIENT: N.W.L.DISTRICT COUNCIL	CO-ORDS: E- N-	LOGGED BY: NH / SCALE: 1:50	
DRILLING METHOD: Light Cable Percussion Vertical	BORING DIAMETER: 150mm to 4.00m.	DATE: 20/10/93	
	CASING DIAMETER:	GROUND LEVEL: 52.05 m. A.O.D.	SHEET: 1 of 1

SAMPLE: DEPTH(m)	TYPE	N	WATER DEPTH (m)	THICKNESS (m)	DESCRIPTION OF STRATUM	DEPTH (m)	REDUCED LEVEL (m A.O.D)	LEGEND
0.00 - 0.20	D1							
0.20 - 1.00	B2			0.20	FILL - dark brown clayey topsoil with rock fragments	0.20	51.85	
					FILL - stiff red brown and brown silty sandy gravelly clay with rock fragments and topsoil			
1.00 - 1.45	D3	(21)		1.40				
1.60	D4							
1.60 - 2.00	D5				FILL - dark brown gravelly topsoil	1.60	50.45	
2.00 - 2.45	D6	(21)		0.20	Firm, locally firm to stiff, brown silty sandy gravelly CLAY	1.80	50.25	
2.60	D7			1.20				
2.60 - 3.00	D8							
3.00 - 3.45	D9	(51)			Very stiff red brown very silty CLAY with grey green sandstone bands and mudstone lithorelicts	3.00	49.05	
3.60	D10			1.00				
3.60 - 4.00	D11							
						4.00	48.05	
					END OF BOREHOLE			

GROUNDWATER AND CASING DETAILS:
No groundwater seepages encountered

REMARKS:
1. Hand dug service pit to 1.00m

NICHOLLS COLTON AND PARTNERS

LR: 46789

British Geological Survey

BOREHOLE LOG

SKW2SE 223

SITE: Long Whatton Sewer Renewals 4684 2376			BOREHOLE No: 4
CLIENT: N.W.L.DISTRICT COUNCIL	CO-ORDS: E- N-	LOGGED BY: NH	SCALE: 1:50
DRILLING METHOD: Light Cable Percussion Vertical	BORING DIAMETER: 150mm to 4.00m.	DATE: 20/10/93	
	CASING DIAMETER:	GROUND LEVEL: 52.05 m. A.O.D.	SHEET: 1 of 1

SAMPLE: DEPTH(m)	TYPE	N	WATER DEPTH (m)	THICKNESS (m)	DESCRIPTION OF STRATUM	DEPTH (m)	REDUCED LEVEL (m AOD)	LEGEND
0.00 - 0.20	D1							
0.20 - 1.00	D2			0.20	FILL - dark brown clayey topsoil with rock fragments	0.20	51.85	
					FILL - stiff red brown and brown silty sandy gravelly clay with rock fragments and topsoil			
1.00 - 1.45	D3	(21)		1.40				
1.40 - 1.50	D4							
1.50 - 2.00	D5				FILL - dark brown gravelly topsoil	1.60	50.45	
2.00 - 2.45	D6	(21)		0.20	Firm, locally firm to stiff, brown silty sandy gravelly CLAY	1.80	50.25	
2.00	D7			1.20				
2.00 - 3.00	D8							
3.00 - 3.45	D9	(51)			Very stiff red brown very silty CLAY with grey green sandstone bands and mudstone lithorelicts	3.00	48.05	
3.00	D10			1.00				
3.00 - 4.00	D11							
						4.00	48.05	

END OF BOREHOLE

GROUNDWATER AND CASING DETAILS:
No groundwater seepages encountered

REMARKS:
1. Hand dug service pit to 1.00m

NICHOLLS COLTON AND PARTNERS

LR: A6783

British Geological Survey

RECORD OF BOREHOLE B258

SCALE: 1 to 100

LOCATION:- BRIDGE 117 - M1 MOTORWAY BRIDGE WIDENING

Ground level: [illegible] above O.D.

Dia. of boring: 0.20m SK 42 SE/55 478 222

Method of boring: Shell and Auger

Lining tubes: 0.20m to 7.50m

Daily Progress	Samples Depth	Samples Type	Change of Strata Legend	Depth	O.D. Level	Description of Strata
				0.30	68.30	TOPSOIL
	1.50 – 1.95	U(4)				
	1.95	D				
	2.25	D				
						Stiff to very stiff red-brown sandy silty CLAY with fine to medium gravel and occasional pockets of sand.
	3.00 – 3.45	U(4)				
	3.45	D				
	3.75	D				
	4.50 – 4.95	U(4)				
	4.95	D				
	5.25	D				
	6.00 – 6.45	U(4)				
	6.45	D				
21.5.73	6.75	D		6.90	62.10	
	7.50 – 7.95	U(4) * †		7.00	61.60	Fissured red-brown calcareous clayey silty MUDSTONE
	7.50 – 7.65	BD				
	8.00 – 8.50	BD				Light green-grey silty fine to medium SANDSTONE
22.5.73	8.50	D		8.80	57.80	
	8.80 – 8.83	C(50) ●		8.85	59.75	Green-grey sandy SILTSTONE with bands of red-brown mudstone and gypsum patches

Key to type of sample:

- U(4) — 102mm (4in.) dia. undisturbed sample
- D — disturbed sample
- BD — bulk disturbed sample
- V — vane test
- S ( ) — standard penetration test
- C ( ) — dynamic cone penetration test

Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).

Remarks: (Observations on ground-water, etc.)

Before commencement of boring a pit was excavated to 1.00m depth to locate underground services. Water was added to assist boring throughout. Ground-water was first encountered at a depth of 3.00m below ground level and rose slowly before being sealed off by the lining tubes at 4.50m depth.

The borehole was chiselled from 7.50m to 8.80m.

* Full penetration not attained

† Unable to recover undisturbed sample

● Seating blows only.

Lab. Ref. No. S/[illegible]

M64 - DERBY SPUR

FIG. 266

British Geological Survey