East Midlands Gateway
Phase 2 (EMG2)

Document DCO 6.14E/MCO 6.14E (Part 3)

ENVIRONMENTAL STATEMENT

Technical Appendices

Appendix 14E

Preliminary Sources Study Affecting Leicestershire County Council

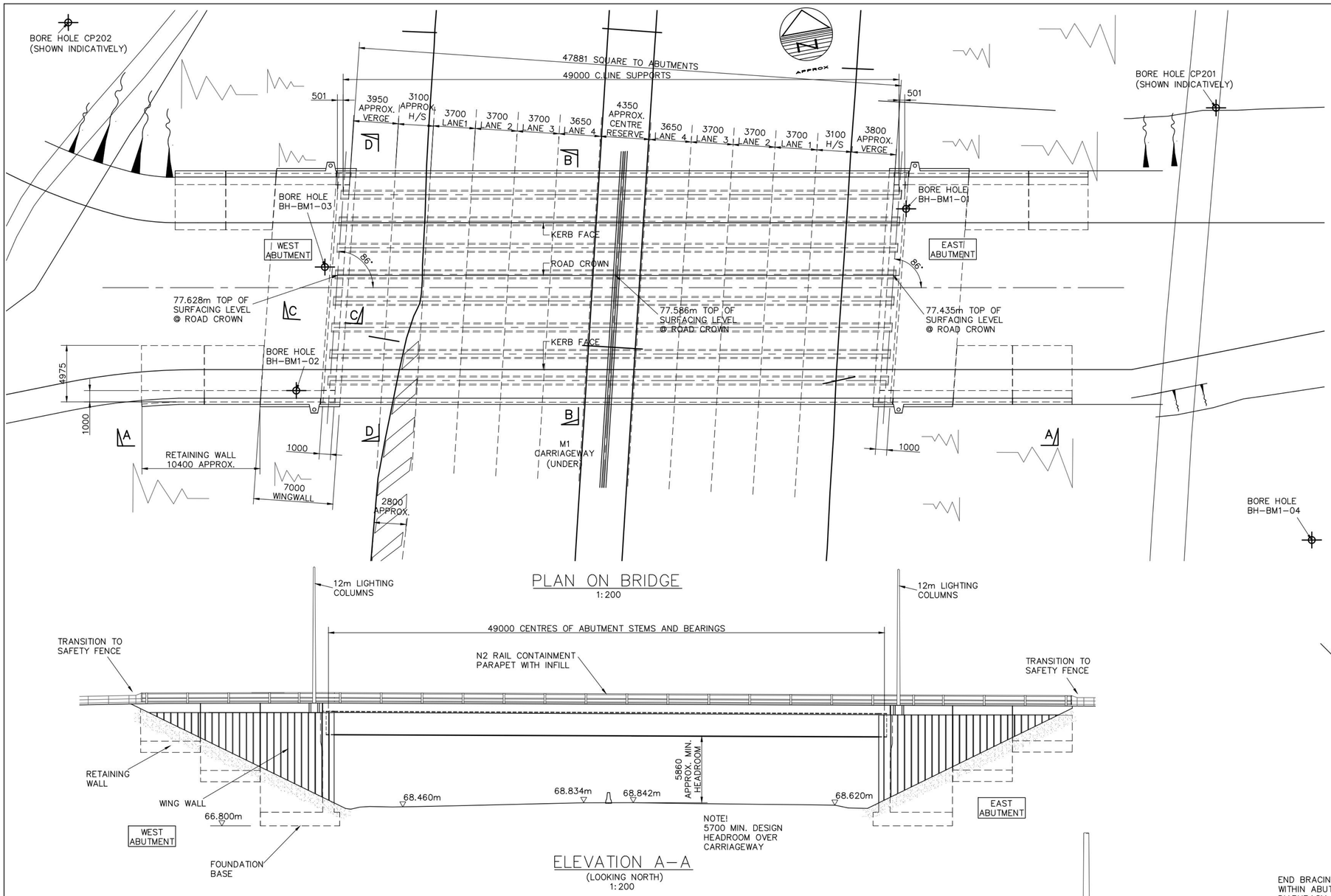
August 2025

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

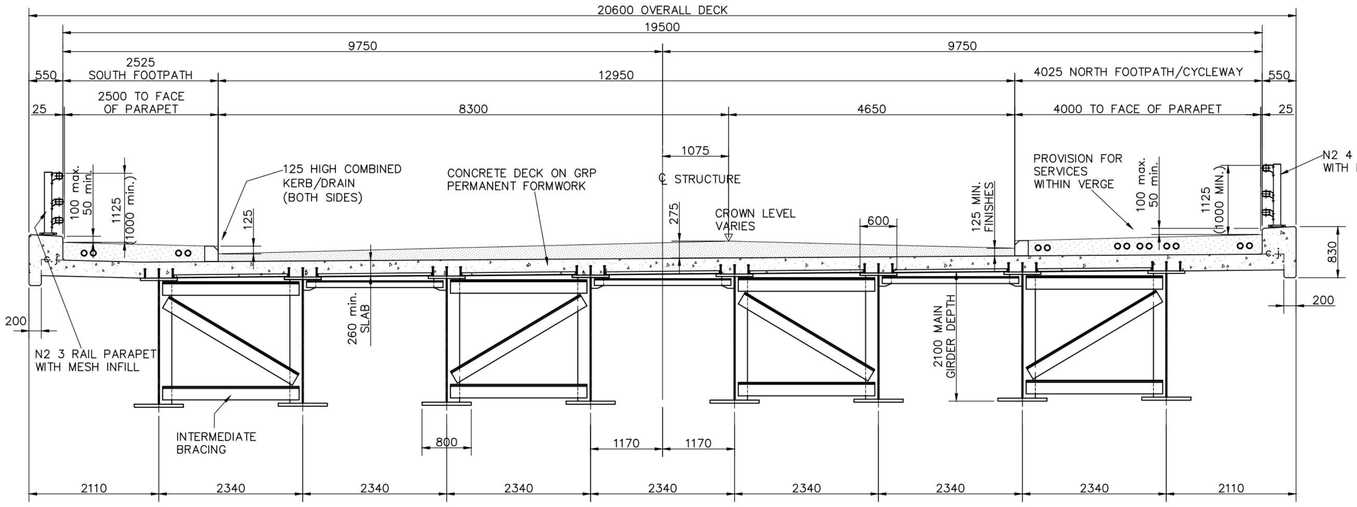
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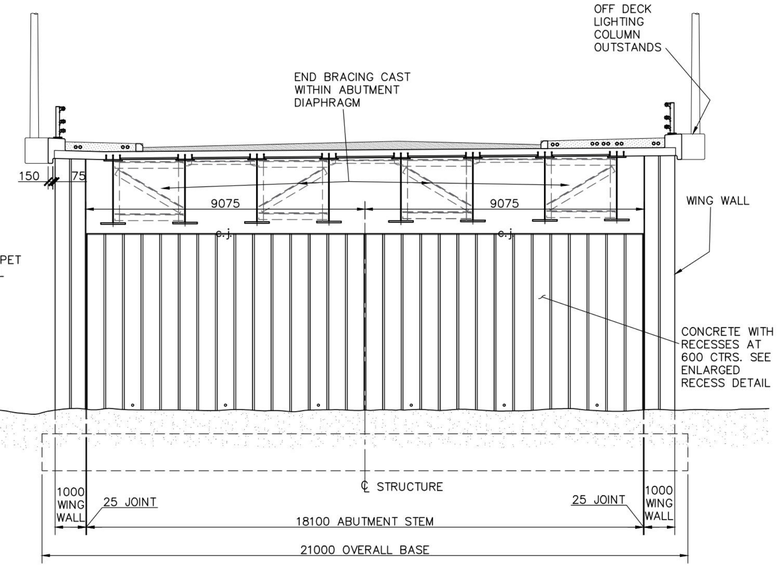


PLAN ON BRIDGE
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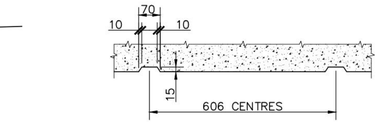
ELEVATION A–A
(LOOKING NORTH)
1:200



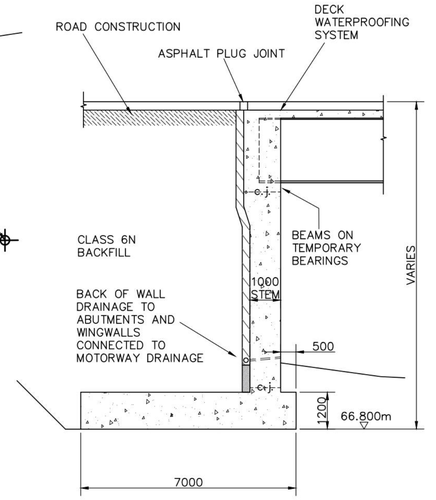
SECTION B–B
1:50



SECTION D–D – WEST ABUTMENT (EAST ABUTMENT SIMILAR)
1:100



ENLARGED DETAIL AT ABUTMENT/WINGWALL/RET WALL RECESS



SECTION C–C
1:100

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

2. ALL LEVELS IN METRES A.O.D. UNLESS NOTED OTHERWISE.

3. STEELWORK TO BE WEATHERING STEEL. (S355 J2W+N)

4. BOREHOLE LOCATIONS :

CP201	E 447442.7	N 326387.9
CP202	E 447336.8	N 326442.1
BH–BM1–01	E 447400	N 326389
BH–BM1–02	E 447344	N 326386
BH–BM1–03	E 447349	N 326396
BH–BM1–04	E 447432	N 326361

5. BRIDGE GEOMETRY BASED ON PROPOSED OVERBRIDGE ROAD GEOMETRY FILE EMG–BWB–SM7–XX–M3–C–102_Kegworth 3D Design–S0–P4.dwg

Rev	Date	Details of issue / revision	Drw	Chk
P04	18/07/17	Updated to suit design development	DRT	JDP
P03	02/06/17	LIGHTING COLUMNS INDICATED	DRT	JDP
P02	28/03/17	MINOR CORRECTION	RPF	JDP
P01	28/02/17	FIRST ISSUE	RPF	JDP

ISSUES & REVISIONS

CASS HAYWARD CONSULTING ENGINEERS

ROXHILL

THE EAST MIDLANDS GATEWAY RAIL FREIGHT INTERCHANGE

Drawing Title

Structure Key 35229
Structure Number M1//183.90.//
KEGWORTH BYPASS
M1 OVERBRIDGE
GENERAL ARRANGEMENT

Scale	As Shown	Drawn	RPF
Size	A1	Reviewed	JDP
Regulation		Document	-

Drawing Status

FOR APPROVAL

Drawing No.	Revision
EMG-CH-SBR-HW21-DR-CB-6001-S4	P04

List B: List of Documents Brought into the Contract by Reference
East Midlands Gateway Strategic Rail Freight Interchange: Zone 1 Main Development Plateau and Rail Freight Terminal. Preliminary Ground Investigation Report, prepared by RSK, reference 312494/1 – 03 (00) on behalf of Roxhill Developments Ltd, dated December 2013.
East Midlands Gateway Strategic Rail Freight Interchange: Zone 3 Main Trunk Road Improvements. Preliminary Sources Study Report, prepared by RSK, reference 312494/3-02 (00), on behalf of Roxhill Developments Ltd, dated December 2013
East Midlands Gateway Strategic Rail Freight Interchange: Zone 3 Main Trunk Road Improvements. Factual Ground Investigation Report, prepared by RSK, reference 312494-03-03 (00), on behalf of Roxhill Developments Ltd, dated December 2013.
East Midlands Gateway Strategic Rail Freight Interchange: Zone 3 Main Trunk Road Improvements. Preliminary Ground Investigation Report, prepared by RSK, reference 312494/3-04 (00), on behalf of Roxhill Developments Ltd, dated December 2013.
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BRAJA. M. DAS & NAGARATNAM SIVAKUGAN, 2007. Settlements of shallow foundations on granular soil – an overview, International Journal of Geotechnical Engineering, IJGE.2007.01.01.19-29
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BRITISH STANDARDS INSTITUTION. 1990. Method of tests for soils for civil engineering purposes. BS 1377. Parts 1 – 9. BSI, London
BRITISH STANDARDS INSTITUTION. 2004. Eurocode 7 – Geotechnical Design, Part 1 General rules, BS EN 1997-1. BSI, London
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BRITISH STANDARDS INSTITUTION. 1999. Code of practice for Site Investigations. BS 5930. BSI, London
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BRITISH STANDARDS INSTITUTION. 2015. Foundations, BS 8004. BSI, London
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List B: List of Documents Brought into the Contract by Reference
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BRITISH STANDARDS INSTITUTION. Geotechnical investigation and testing – Identification and classification of soil. BS EN ISO 14688. BSI London
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BRITISH STANDARDS INSTITUTION. 2003. Aggregates for unbound and hydraulically bound materials for use in civil engineering works and road construction. Guidance on the use of BS EN 13242. PD 6682-6: 2003. BSI, London.
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CIRIA. 2001. Engineering in Mercia Mudstone. CIRIA C570. CIRIA London 2001. ISBN 0 86017 570 7.
CLAYTON, C. R. I. 2001. Managing Geotechnical Risk. Improving productivity in UK building and construction. Thomas Telford, London. 80 pp
THE HIGHWAYS AGENCY. 1991. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 1, HA 44/91, Design and preparation of contract documents. HA 44/91
THE HIGHWAYS AGENCY. 2008. Design Manual for Roads and Bridges. Volume 4, Geotechnics and Drainage. Section 1 Earthworks, Part 2, Managing Geotechnical Risk. HD 22/08
THE HIGHWAYS AGENCY. 2009. Design guidance for road pavement foundations (Draft HD 25). Interim Advice Note 73/06 Revision 1. IAN 73/06 Rev 1

List B: List of Documents Brought into the Contract by Reference
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THE HIGHWAYS AGENCY. 1994. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 5, HA 70/94, Construction of Highway earthworks. HA 70/94.
THE HIGHWAYS AGENCY. 1995. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 7, HA 73/95, Site investigation for Highway works on contaminated land. HA 73/95
THE HIGHWAYS AGENCY. 2007. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 6, HA 74/07, Treatment of Fill & Capping Materials Using Either Lime or Cement or Both. HA 74/07.
HIGHWAYS ENGLAND. 2016. Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1. SHW
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THORBURN, S. 1975. Building Structures supported by stabilised ground. Thorburn & Partners. Geotechnique 1975
TOMLINSON. M.J. 2001. Foundation Design & Construction (6th Edition & 7th Edition). Prentice Hall Press
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APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR

Table 1/5.1 – Earthworks testing requirements

CLAUSE	WORK, GOODS OR MATERIAL		TEST	FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600	Earthworks					
601, 631 to 637, 640	Acceptable Limits				Required	[1] Only required where the use of hydraulic binders is proposed Test frequency relates to the class of material from each source. See Table 6/1 (Specification app 6/1) for specific testing requirements for individual material subclasses. Where Table 6/1 does not a test requirement Refer to Clause 612 for in situ testing requirements during the placement and compaction of fill. All Made Ground shall be tested in accordance with the requirements of Appendix 6/14 and 6/15 for chemical testing requirements. Refer to SHW Clause 601 for TPS Sulphate suite
	Class	General Description				
	1	General Granular Fill	MC, Grading and UC (U)	1 per 500m³		
			TPS Sulphate suite	1 per 500m², min 5 per source		
			OMC/MDD (Vib Hammer)	1 per 1,000m³		
			CBR at OMC (U)	1 per 1,000m³		
	2	General Cohesive Fill	MC, PI, Grading (U)	1 per 500m³		
			OMC/MDD (U) with Hand Vane at each compaction point. Particle Density (2.5kg for 2A, 2C or 4.5kg for 2B)	1 per 1000m³		
			TPS Sulphate Suite	1 per 500m³, min 5 per source		
			Undrained Triaxial Shear Strength at OMC (U)	1 per 1,000m³		
	4	Fill to Landscape Area	MC (U) & HSV	1 per 500m³		
			Grading (U)	1 per 1,000m³		
	6	Selected granular fill	Grading/uniformity coefficient/mc (U)	1 per 500m³		
			OMC/MDD (Vib Hammer)	1 per 1,000m³, min 3 per source		
			CBR at OMC (U)	1 per 1,000m³, min 3 per source		
			PL/LL (U)	1 per 1,000m³, min 3 per source		
			Los Angeles Coefficient LA (U)	1 per source as delivered to site		
			Organic matter / water soluble sulphate (WS) content (U)	1 per 500m³, min 5 per source		
			Oxidisable sulphides (OS), total sulphur and total potential sulphate (TPS) content (U)	1 per 500m³, min 5 per source		
			Bitumen content (U)	1 per 1,000m³		
			Drained Shear Parameters SHW Clause 636 & 639	1 per source		
	7	Selected cohesive fill	MC, PI, Grading (U)	1 per 500m³		
			OMC/MDD (U) with Hand Vane at each compaction point. Particle Density (4.5kg Rammer)	1 per 1,000m³, min 3 per source		
			Undrained Triaxial Shear	1 per 1,000m³, min 3 per		

CLAUSE	WORK, GOODS OR MATERIAL		TEST	FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600	Earthworks					
			Strength at OMC (U)	source		
			Organic matter / water soluble sulphate (WS) content (U)	1 per 500m³, min 5 per source		
			Oxidisable sulphides (OS), total sulphur and total potential sulphate (TPS) content (U)	1 per 500m³, min 5 per source		
			Ph/Chloride ion content (U)	1 per 500m³, min 5 per source		
			Drained Shear Parameters (U)	1 per source		
			Permeability (U)	1 per source		
	9	Stabilised Material	Pulverisation	1 per 625m²		
			Bearing Ratio [CBR] recompacted 2.5kg Rammer (U)	1 per day		
			MCV (U)	1 per 250m³, max 5 per day		
602	Earthworks material beneath the surface of a road or paved area, if within 450mm of finished surface		Frost Heave (U)	Source Approval	Required	For ALL material within 450mm finished level.
612	Compaction of Fills				Required	Compaction Trial to be completed in accordance with App 6/3 and be witnessed by the Client and/or Client's Representative. Plate load testing to be carried out in accordance with DMRB IAN 73/06 Rev 1 for equivalent CBR at the formation of each & every class of fill material. Refer to Appendix 6/1 and 6/3 for minimum compaction requirements to be met.
		Method Compaction	Field Dry Density	1 per 400m³ per layer		
			CBR (Mexe, TRL DCP, ect), granular fill only	1 per 400m³ per layer		
			HSV undrained shear strength, cohesive fill only	1 per 400m³ per layer		
			Compaction Trial	1 per method per source. To be witnessed by Hydrock		
			Dual Cycle Static Plate Load Test using 0.60m Diameter	1 per 20m x v 2m per 1.0m of fill, base of foundation and at final formation		
		End Product	Field Dry Density	1 per 200m³ per layer		
			CBR (Mexe, TRL DCP, ect), granular fill only	1 per 200m³ per layer		
			HSV undrained shear strength, cohesive fill only	1 per 200m³ per layer		
			Compaction Trial	1 per method per source. To be witnessed by Hydrock		
			Dual Cycle Static Plate Load Test using 0.60m Diameter	1 per 20m x20m per 1.0m of fill, base of foundation and at final formation		
		Drainage layers	Grading	1 per 400 tonnes or 200m³ whichever is the lesser		

Notes to Table 1/5-1:

1. The minimum number of tests will be 3 per source, before the course can be approved by Hydrock for use. 2.(U) indicates that a UKAS test report or certificate is required.

3. Unless otherwise shown in this Appendix, tests and test certificates for works, goods or materials as scheduled under any one clause are required for all such work, goods or materials in the works.

4. Frequency of testing applies to each separate earthworks material within each of the earthworks material class.

5. Unless specifically stated to the contrary, all samples used in the testing shall be taken from materials after delivery to the site for incorporation into the works.

6. The Contractors attention is drawn to the requirements of the relevant Specification Appendices for the form of all deliverables, storage of test records and storage of records of materials imported to and exported from site.

7. Where source approval is specified, source testing shall be carried out at each quarry or stockpile used for supply to site and at each location of borrow/site winnings used for on-site material.

8. Definitions of abbreviations:

    - mc: natural moisture content.
    - Organic Matter: Organic Matter Content.
    - OMC: Optimum Moisture Content.
    - MDD: Maximum Dry Density.
    - CBR: California Bearing Ratio.
    - HSV: Hand Shear Vane for assessment of undrained shear strength.
    - IDD: Intact Dry Density.
    - ACM: Asbestos and Asbestos Containing Materials.
    - MEXE: In situ assessment of equivalent CBR by MEXE Probe
    - TRL DCP: Transport Research Laboratory Dyanmic Cone Penetrometer for in situ assessment of equivalent CBR.

9. All Made Ground shall be tested in accordance chemical testing requirements as defined in the relevant Appendix for class of material and the requirements of Appendix 6/14 and 6/15.

APPENDIX 1/23: RISKS TO HEALTH AND SAFETY FROM MATERIALS OR SUBSTANCES

1.0 GENERAL

1.1 In connection with substances hazardous to health the Contractor shall be responsible for taking all reasonable steps to secure the safety of his employees, members of the Employers team and members of the public through the carrying out of all reasonable steps in connection with:-

i) Restrictions in relation to traffic management measures

ii) Restrictions in relation to working practices

iii) Measures to be taken to protect members of the public

iv) Monitoring to be undertaken by the Contractor

v) Traffic management proposals

1.2 The Contractor's attention is also drawn to the Construction, Design and Management Regulations which shall apply to the Works.

2.0 DUST MITIGATION, HAUL ROADS AND MUD/DUST ON HIGHWAY

2.1 The Contractor shall provide to the Council for prior written approval a scheme for the provision of wheel cleansing facilities for heavy commercial vehicles and any mobile plant which has an operating weight exceeding three tonnes, or such other tonnage that may be agreed in writing with the Council.

2.2 Such approved wheel cleansing facilities shall be installed in accordance with a timescale approved in writing by the Council and shall be maintained throughout the period of Construction works by the Contractor unless any variation has been approved in writing by the Council.

2.3 All heavy commercial vehicles or other mobile plant which has an operating weight exceeding three tonnes, or other such tonnage that may be agreed in writing with the Council, associated with the construction of the Development leaving the Site, shall on each occasion, prior to leaving, pass through the wheel cleansing facilities.

2.4 Appropriate measures shall be implemented at all times to minimise any dust emissions.

2.5 Temporary haul roads shall be maintained for the duration of their use to minimise any build-up of loose spoil etc. Any damage to the existing site haul roads shall be repaired at the contractor's expense.

2.6 Traffic both entering and working on site shall obey a maximum speed limit of 10 mph.

2.7 Mobile water bowsers and sprayers shall be available on site at all times to water unpaved haul roads and working areas. The water spray may include chemical dust suppressants or wetting agents to improve dust control.

2.8 All open bodied Heavy Commercial Vehicles carrying dry or loose aggregate, cement or soil into and

out of the site, shall be sheeted or sealed so as to prevent the release of such material into the local environment.

2.9 An adequate supply of water shall be maintained on site at all times to allow for dust suppression activities to be carried out at short notice.

2.10 Where mobile water bowsers are no effective in suppressing dust then vapour masts shall be used. Such vapour masts shall be deployed at 20m centres on the downwind side of haul roads or excavations giving rise to significant dust or emissions of odour.

2.11 Regular inspections of the public highway adjacent to the site shall be carried out. If deemed necessary by the Contractor or the Supervisor, the highway shall be swept regularly to remove any mud, slurry or dust deposited by vehicles entering or departing the site. If the Supervisor considers that significant amounts of any detritus have been deposited on the public highway then operations shall be temporarily suspended until appropriate cleaning operations have been undertaken.

2.12 The Contractor shall, as soon as reasonably practicable, but no later than the end of each working day, sweep or otherwise clear away any mud or similar material which may be carried onto the public highway by vehicles leaving the Site during the period of the Development.

3.0 ODOUR

3.1 In general terns the excavation works are not considered likely to give rise to any significant odour problems.

3.2 If highly odorous materials are encountered, which may give rise to nuisance to neighbouring properties, vapour masts shall be deployed to provide odour control.

3.3 Any odorous materials shall be covered at the end of each working day and any stockpiles will be located away from any sensitive areas.

3.4 Plant and machinery shall be serviced regularly to ensure that exhaust fumes are not excessive.

3.5 Compliance with Legislation and Regulatory Approvals

APPENDIX 1/24: QUALITY MANAGEMENT SYSTEMS

1.0 GENERAL

1.1 The Contractor shall institute and operate a quality management system complying with BS EN ISO 9001 and SHW Clause 104. The quality management system shall be described in a Quality Plan that shall be submitted to the Employers Representative for their acceptance before the commencement of any site works.

1.2 The Quality Plan shall cover the following items:

i) Contractor's organisation and management;

ii) Contractor's method statements and construction procedures

iii) Contractor's construction quality control

iv) Organisation's Quality Plans.

1.3 The Quality Plan shall conform to the requirements of Sections 2.0, 3.0 and 4.0 of this appendix.

1.4 Items i) and ii) of the Quality Plan shall be submitted to the Employers Representative for its acceptance not later than 28 days after award of contract.

1.5 Method statements are required for each major activity to be undertaken by the Contractor. The Contractor shall agree in writing with the Employers Representative the full scope of activities which require the production of individual Method Statements.

2.0 CONTRACTOR'S ORGANISATION AND MANAGEMENT

2.1 This section of the Quality Plan shall include:

i) Definition of the Contract and its documentation.

ii) The organisation of the Contract, including the line of command and communication and communication links between parties involved in the Contract.

iii) Names, roles responsibilities and authority of the principals and key personnel.

iv) Control of liaison and meetings with third parties.

v) Identification of the Contractors own staff responsible for overseeing each major activity.

vi) The Contractors control systems for any sub-contractors to be appointed by them.

vii) Document control.

viii) Programme for submission of Method Statements and Organisations Quality Plans.

ix) The quality plans for subcontractors and suppliers of work, goods and materials which are the subject of quality management schemes.

x) Procedure for the preparation, review and adjustment of programmes for the effective progression of the Works and the recording of this.

xi) Control and approval of purchases of materials.

xii) Control of off-site activities (where appropriate).

xiii) Procedures for the regular review and recording by the Contractor of the quality of the works.

xiv) Control of personnel selection, based on their care, skill and experience.

xv) Management review/audits to monitor and exercise adequate control over the implementation of the Quality Plan.

xvi) Any other relevant item, specific to the methods of work proposed by the Contractor.

3.0 CONTRACTOR'S METHOD STATEMENTS AND CONSTRUCTION PROCEDURES

3.1 This section of the Quality Plan shall include:

i) Detailed method statements for each major activity whether directly controlled or subcontracted.

ii) The method statements for all activities that might affect the quality of the permanent and temporary works shall identify hold points and invoke:

(1) Work instructions.

(2) Quality control procedures.

(3) Compliance testing and inspection arrangements.

(4) Work acceptance procedures.

ii) Identify the relevant construction procedures in the Contractor's own Quality Management System, and provide copies on request.

4.0 CONTRACTOR'S CONSTRUCTION QUALITY CONTROL

4.1 This section of the Quality Plan shall include:

i) Statement of the Contractors organisation for quality control.

4.2 The Quality Plan shall identify procedures (which may be part of the Contractors general procedures) that cover the topics listed below:

i) Arrangements for 'receiving' and 'in-process' testing.

ii) Control of test laboratories.

iii) Control of test, measuring and inspection equipment.

iv) Document control.

v) Procedures for monitoring and recording the inspection, test and approval status of the constructed/installed work.

vi) Procedures for tests and inspections for the purpose of the Contractor certifying that prior to covering up, each part of the Works is complete and conforms to the Contract.

vii) Procedures for the review of work submitted for review but not accepted as conforming to the Contract.

viii) Procedure for the collation of quality records as identified in BS EN ISO 9001 and provision of copies when requested by the Employers Representative.

5.0 ORGANISATION QUALITY PLANS

5.1 The Quality Plan shall include:

i) Definition of the product or service to be provided.

ii) The organisation organogram shall describe the line of command and state the name of the senior manager responsible for the contracted Work and the name of the Organisations on-site Management representative. Contact addresses, telephone numbers etc. shall be provided.

iii) Identification of the relevant parts of the Organisations quality system relevant to the product or service being provided. Copies to be provided to the Employers Representative on request.

iv) The control of personnel selection (at works and on site), including special requirements for skilled personnel e.g. certification of welders, training of operatives, experience requirements etc.

5.2 Specific procedures shall be provided for the following:

i) Receipt and examination of certificates of conformity and test results for purchased products.

ii) Product identification and traceability.

iii) Handling, storage, packaging and delivery to site and storage and handling on site.

iv) Quality records.

6.0 TESTING

6.1 The Contractor shall undertake all compliance testing required during the course of the filling operation to check the material classification, acceptance limits and, the method of compaction control as defined by Appendix 6/1. The minimum frequency of testing is defined in Appendix 1/5 of the specification with the material acceptance and compliance limits set out in Appendix 6/1 and specifically in Table 6/1.

6.2 The compliance testing of the earthworks materials shall be carried out by a laboratory which holds UKAS (for geotechnical tests) or MCERTS (for chemical and contaminations tests) accreditation for

the specific test. Where it is not possible to obtain the testing of a material for a specific property to a UKAS or MCERTS accredited method, the Contractor shall obtain permission from the Employers Representative for the test that is to be completed by the proposed laboratory, before the test is undertaken.

6.3 The Contractor shall provide to the Supervisor, by mid-day on the first working day of each week, an updated electronic summary (Microsoft Excel 2010 or earlier) of all testing which has been completed up to the end of works for the previous week.

6.4 The testing summary shall be in a form agreed with the Supervisor, and shall include the results of all *in situ* test results (if the final validated report has not been issued by the appointed laboratory, these results shall be denoted with a draft to show that they are not final results). The summary shall also include a list of all samples submitted for laboratory testing, and provide the results of those laboratory tests where report certificates have been issued.

6.5 The information to be included for the summary of testing shall include, but not be limited to, the following:

i) sequential test number,

ii) date of test;

iii) coordinated position to include easting & northing, correct to National Grid Reference;

iv) reduced level, correct to m OD;

v) site reference;

vi) test grid reference;

vii) layer number (during placement of fill);

viii) test type;

ix) whether results are Draft (before the issue of certificate) or Final (certificate issued and received by Contractor); and

x) the results of the testing, compliance with the Specification and any comments relating to the test .

6.6 The contractor is to make available on site at all times a file containing all test certificates in addition to the testing summary, for inspection by the Supervisor.

6.7 The results of all testing shall be submitted to the Supervisor as soon as they are reported, and no more than 1 day after issue of the test certificate to the Contractor. It is recognised that different tests may take different time to complete; however the Contractor shall advise the Supervisor of any delay that they are aware of regarding the completion of any tests (e.g. a sample is being re-tested and the report will be delayed). The Supervisor shall be given sufficient time to review the content of the testing and the associated test results.

6.8 If in the opinion of the Supervisor, the material alters in classification or becomes unacceptable for whatever reason during the course of the filling operations, the Contractor will be required to repeat the compliance testing as required by the Supervisor. Equally, if the Contractor considers the classification of a material to have changed from that given in Appendix 6/1 they shall inform the Supervisor immediately.

6.9 The Contractor shall be responsible for removing from site any unacceptable material to suitably licensed facilities before the completion of their works.

7.0 SUPERVISOR

7.1 In addition to the detailed description of the role of the Supervisor, as defined by the NEC 3 Engineering and Construction Contract (ISBN 978 07277 3382 5), the Supervisor shall be on site with regular attendance and undertake the following role:

i) Liaison with the Contractor, Project Manager and Employers Representative.

ii) Reviewing of testing activities, this does not replace or absolve the Contractor from the responsibilities set out in the Specification requirements.

iii) Observing and commenting on the quality of the earthworks activities. This does not replace or absolve the Contractor from the responsibilities set out in the Specification requirements.

iv) Reviewing of soil/fill sampling as required under the specification and advising the Contractor of the results in order to allow the satisfactory progress of the works.

8.0 CONTRACTOR'S VALIDATION AND VERIFICATION REPORT

8.1 The Contractor will maintain records of the works to include, but not be limited to, the following:

i) daily record sheets to include a summary of the day's activities;

ii) progress photographs (not less than weekly);

iii) weather conditions;

iv) plant, personnel and visitors present;

v) aspects relating to Health and Safety, Environmental Control; and

vi) test results (refer to Sections 7.0).

8.2 The Contractor will ensure that the requirements of this Specification are complied with. Upon receipt of satisfactory demonstration that all of the works have been undertaken in accordance with the Specification, the Contractor shall provide a validation report. This report will include relevant site records and illustrate that the remedial and ground preparation works have been carried out in accordance with the Specification.

8.3 During the works and in areas of excavation, compaction or fill placement the Contractor will be required to undertake weekly topographical survey of the earthworks profile to provide a continuous record of the earthworks operations.

8.4 A verification report in accordance with the RMS and MMP is required to be prepared by the Contractor on those aspects of the works they have completed and are responsible for. The Contractor's report will include, where appropriate, the following:

i) daily record sheets to include a summary of the day's activities;

ii) progress photographs;

iii) general description of the works completed, including any earthworks, excavations (including excavations of hard obstructions or foundations), placement and compaction methodology and plant used;

iv) detailed weather conditions;

v) formation and foundation treatment, including drainage and treatment of soft areas;

vi) plant, personnel and visitors present;

vii) aspects relating to Health and Safety, Environmental control;

viii) waste transfer notes;

ix) application of acceptability criteria and summary of control test results for each specific earthworks material placed during the earthworks operations;

x) chemical and geotechnical test certificates and monitoring data including location and level with associated drawings;

xi) as built surveys, including base of excavations to include drawings;

xii) coordinates, levels, invert levels and diameters of services remaining on site;

xiii) drawings showing the location and level of each specific earthworks material placed during the earthworks operations, any feature or operation relevant to the earthworks including any instrumentation and the location of trial areas and control tests; and

xiv) all correspondence with Statutory Authorities.

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

1.0 ACCEPTABLE LIMITS FOR FILLS

Earthworks materials are to comply in general with the 600 series of the Highways Agency 'The Manual of Contract Documents for Highway Works', BS 6031:2009 and with the specific requirements of this appendix. Permitted classes of construction materials are defined in the following tables:

- Table 6/1 Acceptable Earthworks Materials: Classification and Compaction Requirements
- SHW Table 6/2 Grading Requirements for Acceptable Earthworks Materials.
- Table 6/7 Material Sources and Source Codes for Imported Materials.

All earthworks materials are to meet the acceptability limits as set out in Table 6/1 and SHW Table 6/2

In general, engineered fill to raise site levels are to be constructed of Class 1 or Class 2 General Fill, Class 6 or Class 7Selected Fill with an upper 0.60m of hydraulically modified Class 9D unless otherwise indicated on the Drawings. Where relevant any restrictions on the use of Class 2 materials are detailed in Specification Appendix 6/3, 6/14 and 6/15.

1.1 Processed Class U1A or U1B material may be used as earthworks materials subject to meeting the target acceptability limits as set out in Table 6/1, SHW Table 6/2, Appendix 6/14, 6/15 and site specific requirements.

1.2 The Drawings show the general approach to where each Class of fill is to be used, including the requirements for zoning of general fill, selected fill and processed fill.

1.3 Earthworks materials derived from processed Class U1B material and used in the works are to be identified separately on the Contractor's drawings.

1.4 Where undrained shear strength is specified as the method of acceptability testing, the Contractor may use a hand vane provided that it is initially calibrated against the unconsolidated undrained shear strength laboratory triaxial test to BS 1377:Part 7, clause 8 on 100mm nominal diameter samples, and the MCV test in accordance with BS 1377:Part 4. Otherwise, shear strength testing requirements is to be as set out in 633 of the SHW.

1.5 Where 'recycled aggregate' is used in this Specification, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with SHW Clause 710, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

1.6 Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with SHW Clause 710. Content of asphalt (mineral aggregate with a bituminous binder) shall not exceed 2% by mass, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

2.0 SPECIAL REQUIREMENTS FOR DETERMINING ACCEPTABILITY, WHO CLASSIFIES WHERE, AND WHETHER TRIAL PITTING IS REQUIRED

2.1 Acceptability testing is to be the responsibility of the Contractor and be carried out in accordance with Specification Appendix 6/1 and at the frequencies given in Appendix 1/5 in a UKAS accredited testing laboratory. The Contractor is to include the location for each sampling point or in situ test position with the relevant test result which shall have a unique identification number.

2.2 Where source approval of imported material is shown, the testing is to be the responsibility of the Contractor and be carried out in accordance with Specification Appendix 6/1. Source approval will comprise (as a minimum) 3 sets of the relevant test on each sub-unit of material to be used in the Contract.

2.3 The Contractor is to maintain full records on each sub-unit of imported materials including but not limited to, the location of the sources, the suppliers details, the acceptability testing and the location it has been incorporated within the works.

2.4 On completion of each site specific earthworks operations a Geotechnical Feedback Report (GFR) is to be prepared by the Contractor and submitted to the Project Manager and is to comply with the requirements of HD 22/08 and shall include as a minimum the following information:

a) General description of the earthworks, excavations, placement and compaction methodology and plant used;

b) Detailed weather conditions;

c) Formation and foundation treatment including ground improvement, drainage measures and treatment of soft areas;

d) Application of acceptability criteria and summary of the control test results for each specific earthworks material placed during the earthworks operations;

e) A copy of all relevant test results including grid location and level;

f) Drawings showing the location of each specific earthworks material placed during the earthworks operations, any feature or operation relevant to the earthworks including instrumentation and the location of the trial areas and control tests; and

g) An electronic copy of all the test results and monitoring associated with the earthworks operations

2.5 Should any material be placed which has not been given prior written approval from Hydrock, the Contractor will have done this at their own risk and they will be responsible for any and all remedial works required to rectify the situation. All costs associated with this remedial work are to be borne by the Contractor.

3.0 RENDERING UNACCEPTABLE MATERIAL ACCEPTABLE

3.1 The Engineer must be informed if Class U1B material is to be processed to meet the target acceptability limits as set out in Table 6/1 so that appropriate acceptability criteria for the control of contamination can be set and agreed upon by all parties before the commencement of such remedial works.

3.2 Earthworks materials generated by demolition works or from excavation of concrete hardstanding/foundations/piles, not classified as Class U1B or Class U2, are to be classified as Class U1A and be processed to meet the 'recycled aggregate' requirements of Clause 601.12 of SHW and the target acceptability limits as set out in Table 6/1, Table 6/2 and site specific requirements. As far as it is practical, the Contractor should process Class U1A Made Ground material or excavated material into Selected Fill in preference to General Fill.

3.3 Rendering Class U1A material acceptable by lime (quicklime) modification is permitted, subject to the requisite testing being completed and permissible values for sulfate (including Total Potential Sulfate, TPS) being achieved. For the purposes of this Specification, soils with a TPS content in excess of 1% shall be deemed to be unsuitable for treatment with hydraulic binders, including lime & quicklime.

4.0 REQUIREMENTS FOR GROUNDWATER LOWERING OR OTHER TREATMENT

4.1 The Contractor is responsible for all groundwater lowering where this is required for the purposes of the construction works. Based upon the available geotechnical records, it is not perceived that there will be a requirement for de-watering, however the underlying geology is known to contain relatively high permeability soils, therefore during periods of inclement weather temporary measures may be required for the control of groundwater.

4.2 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.

4.3 Where earthworks operations or ground improvement measures result in the expelling of groundwater into drainage layers or onto earthworks surfaces the discharged water shall be collected, treated if necessary and disposed of by the Contractor.

5.0 REQUIREMENTS FOR REMOVAL OFF SITE OF EXCAVATED ACCEPTABLE MATERIAL OR UNACCEPTABLE MATERIAL REQUIRING PROCESSING OR RETENTION OF SURPLUS MATERIAL ON SITE

5.1 No material is to be removed off site without the agreement of the Employer or NR.

5.2 Surplus material is to be temporarily stockpiled in areas designated for spoil storage. The earthworks design of the temporary stockpile is the responsibility of the Earthworks Contractor's Temporary Works Designer.

6.0 PERMITTED USE OF ACCEPTABLE MATERIAL OR UNACCEPTABLE MATERIAL REQUIRED TO BE PROCESSED FOR PURPOSES OTHER THAN GENERAL FILL

6.1 Earthworks materials derived from processed Class U1B material is to be used in the works only where shown on the Drawings or where agreed with the NR.

7.0 REQUIREMENTS FOR IN SITU RESISTIVITY TESTS

7.1 Where required, the determination of resistivity is to be measured by in situ testing.

8.0 REQUIREMENTS FOR IN SITU REDOX POTENTIAL TESTS

8.1 Where required, the determination of redox potential is to be measured by in situ testing.

9.0 REQUIREMENTS FOR THE ASSESSMENT OF THE EFFECTS OF WATER SOLUBLE (WS) SULPHATE, OXIDISABLE SULPHIDES AND TOTAL POTENTIAL SULPHATE IN ACCORDANCE WITH TRL 447, TEST NOS. 1 TO 5

9.1 Where required as part of any lime modification or improvement works, the water soluble (WS) sulphate, oxidisable sulphides (OS) and total potential sulphate (TPS) are to be determined in accordance with Clause 644 of SHW and HA 74/07.

10.0 RESPONSIBILITY FOR THE WORKS

10.1 The Contractor is be responsible for the works covered by the specification and is permitted to self certify the works, in accordance with the requirements of the specification. The right of self certification is not to be delegated or extended to any of the following parties:

- Subcontractors, employed by the Contractor,
- Service owners contractors undertaking backfilling of diverted service trenches,
- Other third party contractors undertaking works on the site.

11.0 COMPACTION COMPLIANCE ENVELOPES

11.1 Table 6/1 defines the acceptability limits for the earthworks material to be used for this project. In order to clarify the requirements for the placement and compaction of the material, a series of compaction compliance envelopes have been developed for each of the major classes of fill material described in Table 6/1, including:

- Figure 6/3-1: Compaction Compliance Envelope for Class 1A, Class 1B and Class 1C;
- Figure 6/3-2: Compaction Compliance Envelope for Class 2A, and Class 2C;
- Figure 6/3-3: Compaction Compliance Envelope for Class 2B;
- Figure 6/3-4: Compaction Compliance Envelope for Class 6F1 and Class 6F2; and
- Figure 6/3-5: Compaction Compliance Envelope for Class 6I, 6N and Class 6P.

TABLE 6/1: ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Acceptable limits Within: Upper				
GENERAL GRANULAR FILL	1	A	-	Well graded granular material	General fill	Any material, or combination of material designated as Class 3 in the Contract. Recycled aggregate	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 2 modified as required to ensure minimum 95% of MDD OMC/MDD determined using Vibrating Hammer	1	A	-
							(ii) uniformity coefficient	See note 5	10	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC +2%				
							(iv) OMC / MDD	BS 1377-4	-	-				
							(v) CBR at OMC	BS 1377-4	5%	-				
	1	B	-	Uniformly graded granular material	General fill	Any material, or combination of material designated as Class 3 in the Contract. Recycled aggregate	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 3 modified as required to ensure minimum 95% MDD OMC/MDD determined using Vibrating Hammer	1	B	-
							(ii) uniformity coefficient	See note 5	-	10				
							(iii) mc	BS 1377-2	OMC -2%	OMC +2%				
							(iv) OMC / MDD	BS 1377-4	Declared	Declared				
							(v) CBR at OMC	BS 1377-4	5%	-				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	A	-	Wet cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 1 modified as required to ensure minimum 95% MDD or C of 50kN/m² whichever is the most onerous OMC/MDD determined using 2.5kg Rammer Except for materials with liquid limit greater than 50, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used	2	A	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc	BS 1377-2	105% MDD	Min c of 50kN/m²				
							(iv) undrained shear strength I	SHW Clause 633	50 kN/m²	-				
							(v) OMC/MDD	BS 1377-4	-	-				
							(vi) Particle Density	BS 1377-2	-	-				
	2	B	-	Dry cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 2 modified as required to ensure 95% MDD or minimum C of 80kN/m² whichever is the most onerous OMC/MDD determined using 4.5kg Rammer	2	B	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc & MCV	BS 1377-2	105% MDD	Min c of 80kN/m²				
							(iv) undrained shear strength I	SHW Clause 633	80 kN/m²	-				
							(vi) OMC/MDD	BS 1377-4	-	-				
							(vi) Particle Density	BS 1377-2	-	-				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	C	-	Stony cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 2 modified as required to ensure 95% MDD or C of 50KN/m² whichever is the most onerous OMC/MDD determined using 2.5kg Rammer.	2	C	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc	BS 1377-2	105% MDD	Min c of 50KN/m²				
							(v) undrained shear strength I	SHW Clause 633	50 KN/m²	-				
							(vi) OMC/MDD	BS 1377-4	-	-				
							(vii) Particle Density	BS 1377-2	Declared	Declared				
	2	D	-	Silty cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading & sedimentation analysis	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 3 modified as required to ensure 95% MDD or C of 50KN/m² whichever is the most onerous OMC/MDD determined using 2.5kg Rammer.	2	D	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc	BS 1377-2	105% MDD	Min c of 50KN/m²				
							(v) undrained shear strength I	SHW Clause 633	50 KN/m²	-				
							(vi) OMC/MDD	BS 1377-4	-	-				
							(vii) Particle Density	BS 1377-2	-	-				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
LANDSCAPE FILL	4	-	-	Various	Fill to landscape areas	Any material, or combination of materials	(i) grading	BS 1377-2	-	-	SHW Clause 620 Material to be placed to an appropriate method so as to ensure a minimum undrained shear of 45KN/m² is achieved in the placed and compacted material	4	-	-
							(ii) MC	BS 1377-2	-	Equivalent of C of 45KN/m²				
							(iii) undrained shear strength by HSV	Manufacturers Instruction	45KN/m²	150 KN/m²				
TOPSOIL	5	A	-	Topsoil, or turf, or existing on site	Topsoiling	Topsoil designated as Class 5A in the Contract	(i) grading	SHW Clause 618	-	SHW Clause 618	-	5	A	-
	5	B	-	Imported topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-	5	B	-

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
	6	F	1	Selected granular material (fine grading)	Capping	Any material, or combination of materials (other than colliery spoil, argillaceous rock or chalk). Recycled aggregate	(i) grading	BS 1377-2	Table 6/2	Table 6/2	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined using Vibrating Hammer	6	F	1
							(ii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC				
							(iii) Los Angeles coefficient	SHW Clause 635	-	50				
	6	F	2	Selected granular material (fine grading)	Capping	Any material, or combination of materials (other than colliery spoil, argillaceous rock or chalk). Recycled aggregate	(i) grading	BS 1377-2	Table 6/2	Table 6/2	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined using Vibrating Hammer	6	F	2
							(ii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC				
							(iii) Los Angeles coefficient	SHW Clause 635	-	50				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	F	3	Selected granular material	Capping (Not to be used below structures)	Recycled bituminous road planings and granulated asphalt, but excluding materials containing tar or tar-bitumen binders. Recycled aggregates	(i) grading and constituent parts	BS 1377-2 (on-site)	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined using the Vibrating Hammer Maximum compacted layer thickness shall be 200mm Constituent materials determined in accordance with SHW Clause 710	6	F	3
								BS EN 933-2 (Off-site)	SHW Table 6/5	SHW Table 6/5				
							(ii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC				
							(iv) bitumen content	BS 598-102	-	10%				
	6	F	4	Selected granular material (fine grading)	Imported Capping	Unbound mixtures complying with BS EN 13285	Size designation and overall category	BS EN 13285- 0/31.5 and G_E	SHW Table 6/5	SHW Table 6/5	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined in accordance with BS EN 13285-5.3	6	F	4
						Any material or combination of materials – including recycled aggregate, but excluding colliery spoil, argillaceous rock, chalk, recycled bituminous planings and granulated asphalt	Maximum fines and oversize categories	BS EN 13285- UF_{15} and OC_{75}	SHW Table 6/5	SHW Table 6/5				
							Los Angeles coefficient	BS EN 13242-LA_{60}	-	60				
							Volume stability of blast furnace slag	BS EN 13242	Free from dicalcium silicate and iron disintegration					
							Volume stability of steel (BOF) and EAF slag	BS EN 13242 – V_5	-	-				
							Other aggregate requirements	BS EN 13242	Category $_{NR}$ (no requirement)					
							Laboratory dry density and OMC	BS EN 13285-Clause 5.3 -	-	-				
							Water content	BS EN 1097-5	OMC-2%	OMC				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	F	5	Selected granular material (fine grading)	Imported Capping	Unbound mixtures complying with BS EN 13285	Size designation and overall category	BS EN 13285- 0/80 and G_E	SHW Table 6/5	SHW Table 6/5	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC to be determined in accordance with BS EN 13285-5.3	6	F	5
						Any material or combination of materials – including recycled aggregate, but excluding colliery spoil, argillaceous rock, chalk, recycled bituminous planings and granulated asphalt	Maximum fines and oversize categories	BS EN 13285- UF_{12} and OC_{75}	SHW Table 6/5	SHW Table 6/5				
							Los Angeles coefficient	BS EN 13242-LA_{50}	-	50				
							Volume stability of blast furnace slag	BS EN 13242	Free from dicalcium silicate and iron disintegration					
							Volume stability of steel (BOF) and EAF slag	BS EN 13242 – V_5	-	-				
							Other aggregate requirements	BS EN 13242	Category $_{NR}$ (no requirement)					
							Laboratory dry density and OMC	BS EN 13285-Clause 5.3 -	-	-				
							Water content	BS EN 1097-5	OMC-2%	OMC-2%				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	I	-	Selected well graded granular material	Fill to reinforced soil and anchored earth 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.	(i) grading	BS EN 933-2	SHW Tab 6/5	SHW Tab 6/5	End product 95% MDD OMC/MDD determined using Vibrating Hammer	6	I	-
							(ii) uniformity coefficient	See note 5	10	-				
							(iii) Los Angeles coefficient	Clause 635	-	40				
							(iv) Effective angle of internal friction (ϕ')	Clause 636	$\phi' = 38º$	-				
							(v) Coefficient of Friction & adhesion	Clause 639	$\delta = 15º$	-				
							(vi) MC	BS 1377-2	OMC -2%	OMC +1%				
							(vii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(viii)CBR at OMC	BS 1377-4	12%	-				
							(ix) Chloride, water soluble sulfate (WS), oxdisable sulfate (OS), total sulphur (S) and Total Potential Sulphate (TPS)	BS EN 1744-1	-	SHW Table 6/3				
							(x) Organic content	BS 1377-3	-	SHW Table 6/3				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	N	-	Selected well graded granular material	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.	(xi) grading	BS1377-2	SHW Tab 6/2	SHW Tab 6/2	End product 95% MDD OMC/MDD determined using Vibrating Hammer	6	N	-
							(xii) uniformity coefficient	See note 5	10	-				
							(xiii) Los Angeles coefficient	Clause 635	-	40				
							(xiv) Effective angle of internal friction (ϕ')	Clause 636	ϕ'_{pk} 37.5º ϕ'_{crit} 31.5º	$\phi'_{pk} \leq$ 44º $\phi'_{crit} \leq$ 38º				
							(xv) MC	BS 1377-2	OMC -2%	OMC +1%				
							(xvi) OMC/MDD	BS 1377-4: 3.7	-	-				
							(xvii) CBR at OMC	BS 1377-4	12%	-				
							(xviii) Sulphate (SO_4) total sulphur (S) and Total Potential Sulphate (TPS)	TRL 447	-	SHW Clause 601				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	P	-	Selected granular material	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.	(i)grading	BS1377-2	SHW Tab 6/2	SHW Tab 6/2	End product 95% MDD OMC/MDD determined using Vibrating Hammer	6	P	-
							(ii) uniformity coefficient	See note 5	5	-				
							(iii) Los Angeles coefficient	Clause 635	-	60				
							(iv) Effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	ϕ' = 38º	-				
							(v) MC	BS 1377-2	OMC -2%	OMC +1%				
							(vi) OMC/MDD	BS 1377-4: 3.7	-	-				
							(vii) CBR at OMC	BS 1377-4	8%	-				
							(viii) Sulphate (S04) total sulphur (S) and Total Potential Sulphate (TPS)	TRL 447	-	SHW Clause 601				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED COHESIVE FILL	7	A	-	Selected cohesive material	Fill to structures	Any material, or combination of materials, other than argillaceous rock, chalk or colliery spoil	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	End product of 95% of MDD and/or minimum undrained shear strength of 80 KN/m² (whichever is the more onerous) with less than 5% air voids MDD to be determined using 4.5kg Rammer and to include measurement of particle density ² Where the Liquid Limit and/or plasticity index are in excess of the values defined in this Table, the Contractor shall inform Hydrock for further guidance on the use of this material.	7	A	-
							(ii) mc	BS 1377-2	Equivalent to 110% MDD and maximum of 5% air voids	Equivalent to 100% MDD and/or c of 80 KN/m²				
							(iii) Sulphate (S04) total sulphur (S) and Total Potential Sulphate (TPS)	TRL 447	-	SHW Clause 601				
							(iv) undrained shear parameters (c and ϕ)	SHW Clause 633	c = 80 KN/m²	-				
							(v) effective angle of friction (ϕ') and effective cohesion (c')	SHW Clause 636	c' = 2 kPa ϕ' = 25º	-				
							(vi) liquid limit	BS 1377-2	-	² 45				
							(vii) plasticity index	BS 1377-2	-	² 25				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED COHESIVE FILL	7	E	-	Selected cohesive material	For stabilisation with lime to form capping (9D) and for the upper 0.60m of engineered fill below carriageway where Class 3 foundation is required	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	Not applicable	7	E	-
							(ii) mc	BS 1377-2	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) MCV	SHW Clause 632	As per Contractors Mix Design	-				
							(iv) plasticity index	BS 1377-2	10	-				
							(v) organic matter	BS 1377-3	-	2%				
							(vi) water soluble (WS) sulfate content	BS EN 1744-1 clause 10	-	300 mg/l				
							(vii) Oxidisable sulphides (OS)	BS EN 1744-1 clause 13	-	0.06 %				
							(viii) total potential sulfate (TPS) content	BS EN 1744-1 clause 11	-	1.0 %				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED COHESIVE FILL	7	I	-	Selected cohesive material	For stabilisation with lime and cement to form capping (Class 9E)	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	Not applicable	7	E	-
							(ii) mc	BS 1377-2	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) MCV	SHW Clause 632	As per Contractors Mix Design	-				
							(iv) plasticity index	BS 1377-2	10	-				
							(v) organic matter	BS 1377-3	-	2%				
							(vi) water soluble (WS) sulfate content	BS EN 1744-1 clause 10	-	300 mg/l				
							(vii) Oxidisable sulphides (OS)	BS EN 1744-1 clause 13	-	0.06 %				
							(viii) total potential sulfate (TPS) content	BS EN 1744-1 clause 11	-	1.0 %				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
STABILISED MATERIALS	9	D	-	Lime stabilised cohesive material	Capping and the upper 0.60m of earthworks fill below Class 3 foundation	Class 7E with addition of lime according to SHW Clause 615	(i) pulverisation	BS EN 13286-48	30%	-	SHW Table 6/4 Method 7, modified as required to achieve minimum 95% MDD	9	D	-
							(ii) MCV immediately before compaction	SHW Clause 632	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) bearing ratio	BS EN 13286-47	10% -upper 0.60m fill 15% - Capping	-				
							(iv) mc	BS EN 13286-2	As per Contractors Mix Design	As per Contractors Mix Design				
	9	E	-	Lime and cement stabilised cohesive material	Capping	Class 7I with addition of lime and cement according to SHW Clause 643	(i) pulverisation	BS EN 13286-48	30%	-	SHW Table 6/4 Method 7, modified as required to achieve minimum 95% MDD	9	E	-
							(ii) MCV immediately before compaction	SHW Clause 632	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) bearing ratio	BS EN 13286-47	15%	-				
							(iv) mc	BS EN 13286-2	As per Contractors Mix Design	As per Contractors Mix Design				

Footnotes to Table 6/1:

1. App = Appendix
2. Tab = Table
3. Where in the Acceptable Limits column reference is made to App 6/1, only those properties having limits ascribed to them in Appendix 6/1 shall apply. Where Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply.
4. Where BS 1377:Part 2 is specified for mc, this shall mean BS 1377:Part 2 or BS EN 1097-5 as appropriate.
5. Uniformity coefficient is defined as the ratio of the particle diameters D60 to D10 on the particle-size distribution curve, where: D60 = particle diameter at which 60% of the soil by weight is finer and D10 = particle diameter at which 10% of the soil by weight is finer.
6. The limiting values for Class U1B material are given in Appendix 6/14 and Appendix 6/15.
7. Where undrained shear strength is specified as the method of acceptability testing, the Contractor may use a hand vane provided that it is initially calibrated against the unconsolidated undrained shear strength laboratory triaxial test to BS 1377:Part 7, clause 8 on 100mm nominal diameter samples, and the MCV test in accordance with BS 1377:Part 4. Otherwise, shear strength testing requirements is to be as set out in 633 of the Specification.
8. The contents of this table may be revised following periodic engineering assessments and design by the Project Manager.
9. Where supplementary clauses and tables are reference in Table 6/1 above, they shall refer to the equivalent clause or table from the Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1: (SHW).

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

1.0 General

1.1 Unacceptable material, Class U2 shall be defined as in SHW Clause 601.3. The Contractor is referred to the site specific earthworks and remediation method statements and specifications for the requirements regarding Class U1B and Class U2 Unacceptable Material.

1.2 If unacceptable material is encountered within the works, a risk assessment will be carried out and the contractor shall make all necessary arrangements for their safe handling and disposal after consultation with the appropriate environmental authority in accordance with SHW Clause 602. As such the Contractor shall put in place contingency measures to deal with U2 materials if encountered during the earthworks.

1.3 The Contractor shall make all necessary enquiries and arrangements for the transfer of U1B and U2 materials for their disposal off-site and shall liaise with the relevant regulatory bodies prior to initiating removal of any material from site.

1.4 Where Class U1B material is identified and are unsuitable for treatment on site, the Contractor shall undertake appropriate testing including Waste Acceptance Criteria (WAC) Tests to determine the waste type and whether the waste will comprise U2 material, i.e. Hazardous Waste.

1.5 The Contractor shall inform the Engineer immediately of the discovery of U1B or U2 materials, asbestos or other gross contamination. The Contractor shall define in their Method Statement the procedures for handling asbestos, U1B or U2 materials or other waste.

1.6 No groundwater or surface water encountered during excavation shall be discharged to foul or storm sewer, nor to watercourses without the prior written approval of the Sewer provider or the Environment Agency respectively.

1.7 The Contractor shall ensure at all times that:

- The exposure of site personnel and the general public to hazards is avoided; and
- Contamination or pollution migrating within the site or beyond the site boundaries is prevented.

20.8 Throughout the Works the Contractor shall pay particular attention to the following:

Handling and disposal of contaminated soils and water

a) Keep the waste safe. Holders should protect the waste both whilst in their possession and for its future handling requirements. Security precautions where waste is to be held prior to removal from site should prevent theft, vandalism, waste scavenging and fly tipping. Waste shall be removed from site in appropriate containers.

b) Transfer to the correct person. Waste may only be handed on to authorised persons or to persons authorised for transport purposes. The Contractor shall pay due regard to Duty of Care and associated regulations.

c) The Contractor shall ensure that waste is collected regularly. The maximum volume of material in a single stockpile on site at any time shall not exceed 500m^3.

d) The Contractor shall ensure that all waste is stockpiled in accordance with a method statement approved by the Engineer and shall as a minimum included for bunding, basal membrane and top cover membrane to prevent rainfall infiltration and run-off.

e) The Contractor shall comply with Duty of Care Regulations and shall keep records of waste dispatched from site, including waste transfer notes. All records are to be made available to the Engineer and/or Regulator upon request. The Contractor shall ensure that all landfill gate receipts are copied to the Engineer within two working days of dispatch from site.

(f) The Contractor shall ensure that all waste is taken to a disposal facility which is licensed to receive that specific waste type (as determined by chemical analyses and WAC tests).

g) All waste leaving the site shall be sheeted, without holes or tears in the sheeting fabric. Where possible, the Contractor shall use self sheeting lorries to haul waste from the site. Where these are not available, the Contractor shall take appropriate measures to construct a safe and suitable sheeting gantry. Where sheets are to be laid over the container, they shall be secured in place. In the event of any loss of waste during transit, the Contractor shall ensure that the lost waste is collected and transported correctly to the receiving facility.

h) The Contractor shall supply the Engineer with a schedule containing vehicle registration number, owner, weight (unladen and gross maximum permitted) and driver details of each vehicle used for transport of materials off-site.

Sub-contracting

20) In order to ensure compliance with the Duty of Care Regulations, the Contractor must nominate all Sub-Contractors before a contract is entered into for undertaking this work.

Site Monitoring

a) The Contractor shall be responsible for all documentation of waste leaving the site and for validation of the chemical composition of waste.

b) A designated person must be made responsible for co-ordinating and ensuring that all appropriate precautions are taken against the escape of hazardous substances. This designated person shall maintain an up to date site record. The Contractor shall demonstrate the competence of this person to the satisfaction of the Engineer.

c) Only authorised persons shall be allowed access to the site. All site personnel shall be required to attend a site safety induction prior to commencement of works on the site.

d) All persons entering the site must be made fully aware of the hazards and risks on site prior to entering the site. Instructions shall be issued by the Contractor regarding Health and

Safety precautions required. All persons will be required to sign a declaration of understanding and acceptance of site instructions. This is to protect both the individual and other personnel on the site. Non-compliance with this regime must in all cases result in refused entry to site.

e) If any person fails to comply with the health and safety precautions that person is to be removed from site immediately. Return to site would be at the discretion of the Engineer. The Contractor shall ensure that any individual who deliberately flaunts the health and safety precautions is dismissed from site and not permitted to return to the site.

f) In the instance of a possible danger occurring, safety on site shall be of utmost priority. Immediate action must be taken for the health and safety of all personnel on site. The location of the danger and any exclusion zone shall be evacuated immediately. The Contractor shall produce a method statement to set out the measures and steps to be followed in the event of such an occurrence and shall include, where applicable, for notification of emergency services, HSE, Planning Co-ordinator and the like.

g) All persons entering the site shall wear appropriate Personal Protective Equipment (PPE), which is to include but not be limited to: safety Wellingtons or boots (steel mid-sole and toe caps); overalls and/or impermeable outer garments; nitrile or other suitable gloves; safety goggles; and ear defenders.

h) First Aid facilities and suitably competent personnel shall be available at clearly identifiable locations on site.

i) A Site Safety Officer shall be appointed by the Contractor and shall be responsible for health surveillance on the site.

j) The Contractor shall take appropriate measures to avoid and prevent cross contamination of plant and personnel and also to ensure that all plant and personnel are free from contaminants and mud upon exiting the site.

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

1.0 EARTHWORKS GENERAL

1.1 Earthworks requirements including constraints on earthworks in relation to structures and water courses are shown on Drawings. The earthworks associated with the highways are part of a wider scheme, and as such any additional fill requirements are to be provided from cut materials from within the development plateaus, as identified on the drawings.

1.2 No ground disturbing activities, including any earthmoving activities, are to commence prior to the Contractor obtaining any necessary permits or licences relating to protected species or habitats. If a licence or permit for such works is granted, those works shall only be undertaken during the periods as stated on the licence or permit under the direction of the licence or permit holder. A copy of the licence and/or permit shall be provided to the Employer prior to commencement of the relevant activities.

1.3 Material excavated and designated for processing shall be transported to the appropriate process area for stockpiling and treatment. Clearly defined segregated stockpiles are required for different sub-classes of processed material. The maximum permitted height of stockpiles, excluding topsoil Class 5, shall be 5.0 m unless otherwise agreed. The maximum volume of any single stockpile shall not exceed 500m³ unless otherwise agreed.

1.4 For temporary storage of earthworks materials, except topsoil Class 5, maximum permitted height of stockpiles shall be 5.0 metres unless otherwise agreed, subject to other restrictions noted elsewhere in this specification. Earthworks materials requiring to be stockpiled shall be stored in individual stockpiles for each earthworks class and end-use.

1.5 On completion of a stockpile the slopes shall be trimmed to falls to shed rain water and the surface sealed to limit infiltration. Temporary drainage shall be provided at the base of the stockpile to collect runoff from the stockpile and to carry any surface water away from the base of the stockpile.

1.6 The Contractor shall provide and maintain such measures as necessary to eliminate the production of dust from the stockpile during the life of the stockpile.

2.0 CUTTING FACES

2.1 No specific limitations or restrictions on undercutting are included, but the Contractor shall comply with the Temporary Works Designer requirements when excavating trenches at the toe of any slopes.

2.2 Clearing loose material from cutting slopes by airline hose is not permitted.

2.3 The Contractor shall provide additional drainage measures to intercept and discharge seepages from cutting slopes in general accordance with the details provided in the Drawings. The Contractor is responsible for all drainage required to carry out the works and to protect them upon completion, which will include, where necessary, temporary drainage measures.

2.4 Cutting faces which are to have topsoil shall be made good prior to topsoil placement as shown on the Drawings. If the drawings do not show details then any of the methods set out in Clause 603.7 of SHW shall be used as required except that the use of concrete, grout, masonry infill and sprayed concrete is not permitted.

3.0 WATER COURSES

3.1 Details of regrading existing water courses, construction of new water courses and earthworks drainage ditches are shown on the Drawings.

3.2 Redundant watercourses shall be drained and cleaned as described on the Drawings. Excavated arisings are to be treated as described in Appendix 6/2. Watercourses shall be filled with earthworks materials as shown on the Drawings.

3.3 The Contractor shall provide for such measures as may be necessary to ensure that water, whether ground water, from precipitation or any other source does not accumulate in excavations or on sub-grades.

3.4 The Contractor shall arrange for the rapid dispersal of water shed on to the surface of earthworks or completed formation during construction or which enters the earthworks from any other source.

3.5 The Contractor shall provide where necessary temporary watercourses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provision shall include carrying out the work of forming the earthworks in such a manner that their surfaces have at all times a sufficient minimum cross-fall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding. This shall include the provision of temporary measures to remove water expelled from the ground due to the change in imposed load from the construction or construction activities (including ground improvement).

3.6 All works and associated costs relating the control and management of water on site, from existing, proposed or redundant watercourses or from any other sources including groundwater, rainfall and surface water is the responsibility of the Contractor. All costs are to be borne by the Contractor and the Contractor is deemed to have read, understood and fully accounted for these costs within their Tender submission. Any uncertainty over the issues associated with water or groundwater control should be submitted to the Engineer for clarification, as soon as any such issue is noted or identified by any party.

4.0 CONSTRUCTION GENERAL REQUIREMENTS

4.1 Location of fill types are shown on the Drawings. In addition to this, General fill is only to be used in areas outside of the influence of the proposed structures. Any fill placed within the influencing zone of structures shall comply with the requirements of Class 6.

4.2 The Contractor is responsible for agreeing with the Supervising Engineer the extents of the General Fill and Selected Fill.

4.3 Locations of starter layers are shown on the BWB Drawings presented under a separate cover.

4.4 Details of benching are to be a maximum of 0.50m in height with the length of the bench cut to meet the profile of the excavation. In addition to this, where structural loads may span across an excavation where benching has been employed, the length of each bench must be at least twice the height.

4.5 The height of each bench shall reflect the thickness of the compacted layer, and shall be no more than 2 compacted layers in height.

4.6 All bench details shall be agreed with the Engineer.

4.7 Over-steepening of embankment side slopes shall only be permitted with the approval of the Engineer.

5.0 CONSTRUCTION OF FILL

5.1 Embankment slopes shall not be constructed steeper than that shown on the Drawings. Temporary over-widening or steepening to achieve adequate compaction of the shoulders of the embankment is permitted.

5.2 Any areas requiring staged construction of fills, the details for the staged construction and hold periods are to be shown on the Drawings and are to be under the direction of the Engineer.

5.3 Any areas requiring surcharging, the relevant details including levels, time periods for surcharging, type of surcharge material are to be shown on the Drawings.

5.4 Any areas requiring protection of the formation or sub-formation against weather, shall be carried out in accordance with Clause 608.9(ii) of SHW, are shown on the Drawings.

5.5 Any areas requiring starter layer, together with class type and thicknesses are shown on the Drawings.

5.6 The proposed staged process of earthworks are as detailed within this Specification.

5.7 Formation for earthworks construction and cutting formations shall be proof-rolled using a minimum compactive effort as detailed in Specification Clause 613.11 and 613.12. This minimum compactive effort shall be increased for cutting formations where different compactive efforts, dependent on the type of follow-on earthworks operations, are required by the Specification. The identification of a ‘soft spot’ is qualitative and depends on the response of the ground to the compactive effort during the proof-rolling.

5.8 For the purposes of this contract, the definition of a soft area will correspond to a CBR of less than 2%. As a minimum excessive mattressing, bow-waving or ground heave shall be indicative of a ‘soft spot’ which will then require testing by the contractor to determine the CBR of the subgrade. The Contractor is to agree with the Supervising Engineer the extent of ‘soft spot’ treatment.

5.9 It is considered likely that localised 'soft spots' may occur during the during the proof rolling exercise and as such detailed discussion and agreement will be required with the Supervising Engineer at the outset in order to adopt a standardised procedure for dealing with this occurrence.

5.10 Where a soft-spot is identified, the sequence of activities shall include the following:

- Delineation at the current formation the extent of soft spot.
- Excavation of soft spot.
- Inspection of the area of the soft spot post removal of affected material by the Geotechnical Supervisor (Hydrock).
- In situ assessment on strength (hand vane shear strength in the case of cohesive soils) at the base and sides of the excavation.
- Survey of the extent of the soft spot excavation by the Contractor.
- Replacement of affected material with suitable engineered fill, compliant with the requirements of Appendix 1/5 and Table 6/1.
- Where the depth of the soft spot exceeds 0.50m, the sides of the excavation shall be benched in, in accordance with Hydrock Drawing EMG-HYD-ZZ-XX-DR-GE-0649.
- Records of extent of soft spots to be presented in accordance with the requirements set out in Appendix 1/24.

6.0 COMPACTION

General

6.1 It is envisaged that most of the fill to be used on this site will be derived from site won materials which will either be classed as general fill to external areas, or as selected fill to form the capping below the sub base in the highway pavement. Requirements for compaction of earthworks materials shall comply with Clause 612 of SHW and HA 70. Compaction requirements shall be as described below.

Method Compaction

6.2 For method compaction of earthworks materials extra compaction in the top 600mm is required and this shall comprise an improved/modified material with a minimum subgrade stiffness modulus at the top of the material of 77 Mpa. Requirements for compaction of drainage material, if a geocomposite is not used, are shown on the Drawings. The frequency of field dry density testing shall be as set out in Appendix 1/5.

6.3 A series of Compaction Compliance Envelopes, presented as figures, have been produced which represent the requirements from Table 6/1 on the compaction requirements for the main types of fill to be used in this project. Reference shall be made to these figures and a source specific envelope shall be provided by the Contractor based upon the results of the classification testing for each material and shall be used in the assessment of compliance.

6.4 The *in situ* testing shall be undertaken in accordance with the frequency defined in Appendix 1/5 and shall demonstrate that the adopted method achieves the minimum end product performance detailed in Table 6/1. Where the testing identifies that the minimum end product performance is not being met, then the method of compaction shall change, and a new compaction trial shall be undertaken

End Product Compaction

6.6 Where the compaction requirements specified in Table 6/1 state that End Product Compaction is required, the fill shall be tested in accordance with the frequency defined in Appendix 1/5.

6.7 The minimum compliance requirements to be met by fill placed to either Method Placement to End Product Compaction are defined in Section 6.26 of this Appendix.

Figure 6/3-1
Compaction Compliance Envelope - Class 1A, Class 1B and Class 6C

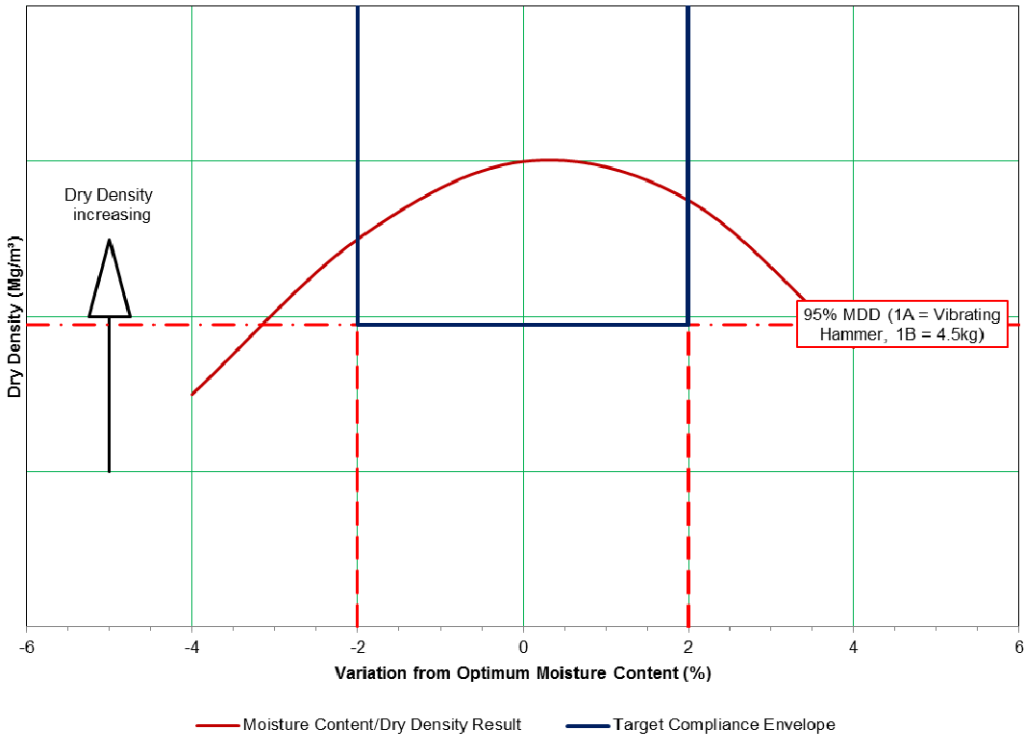


Figure 6/3-2
Compaction Compliance Envelope - Class 2A and Class 2C

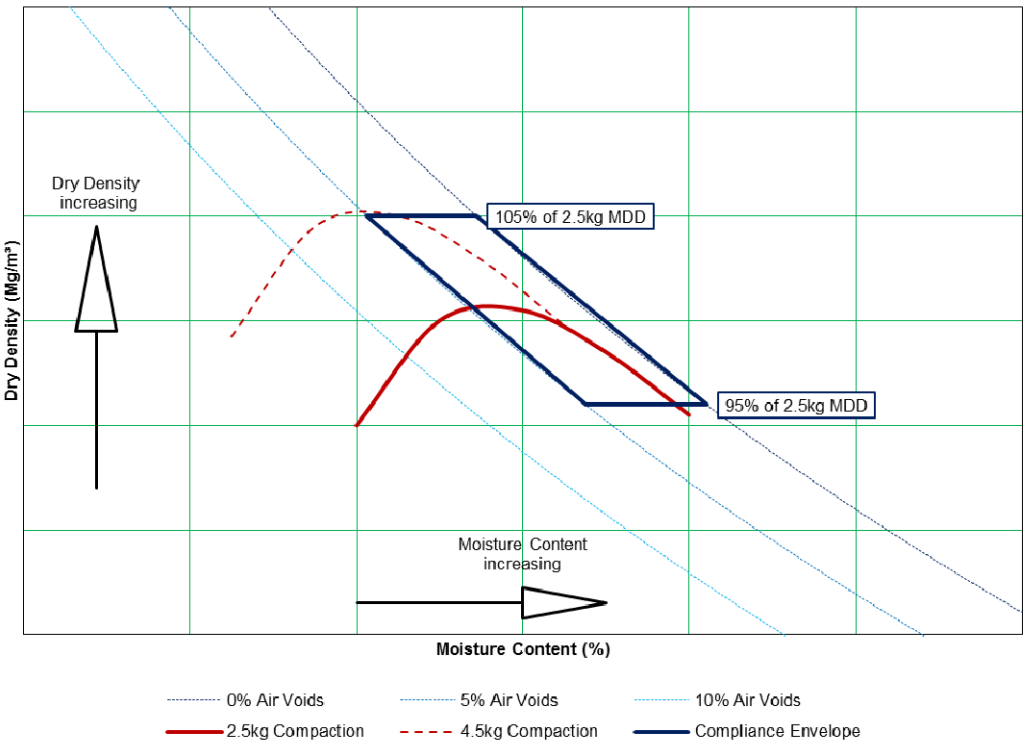


Figure 6/3-3
Compaction Compliance Envelope - Class 2B

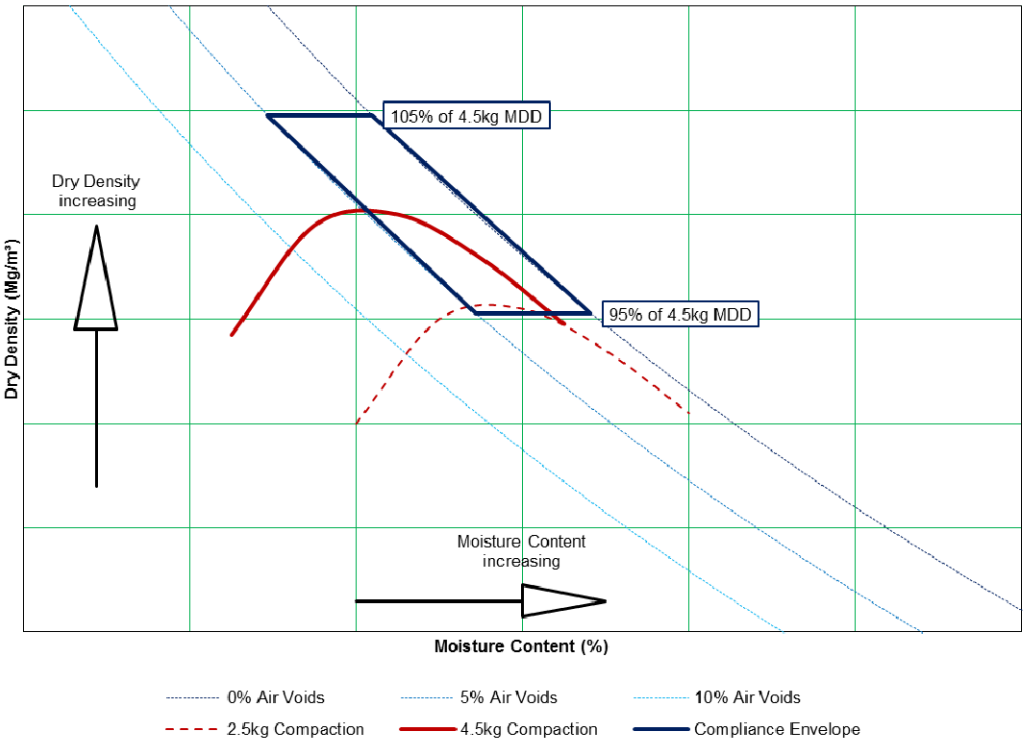


Figure 6/3-4
Compaction Compliance Envelope - Class 6F1 and Class 6F2

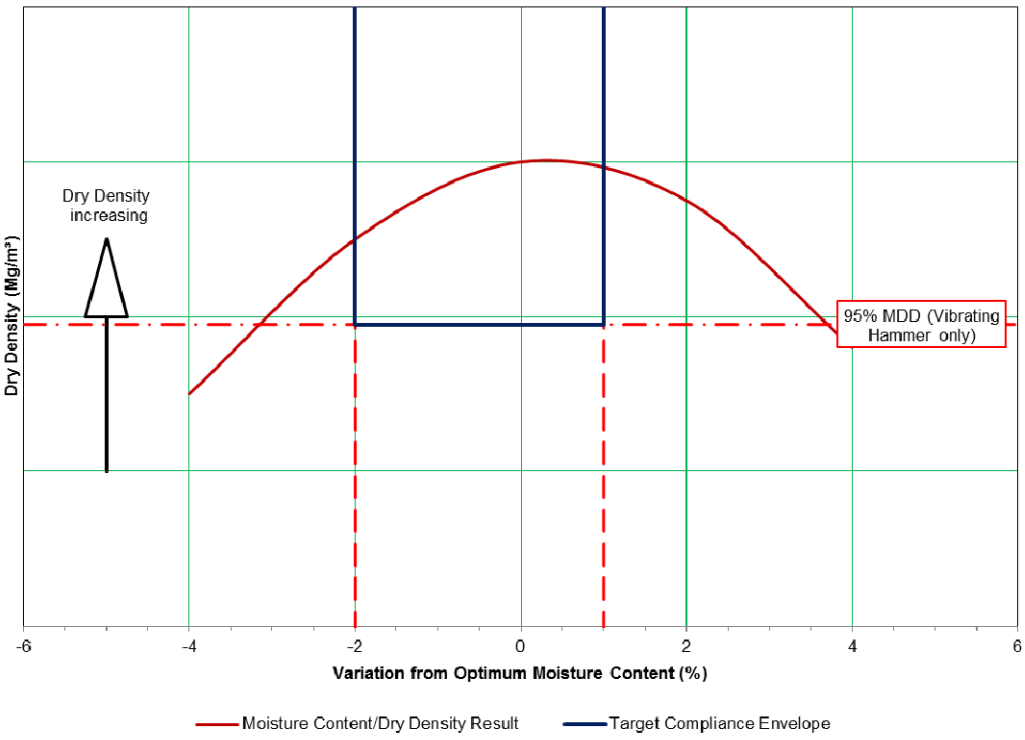
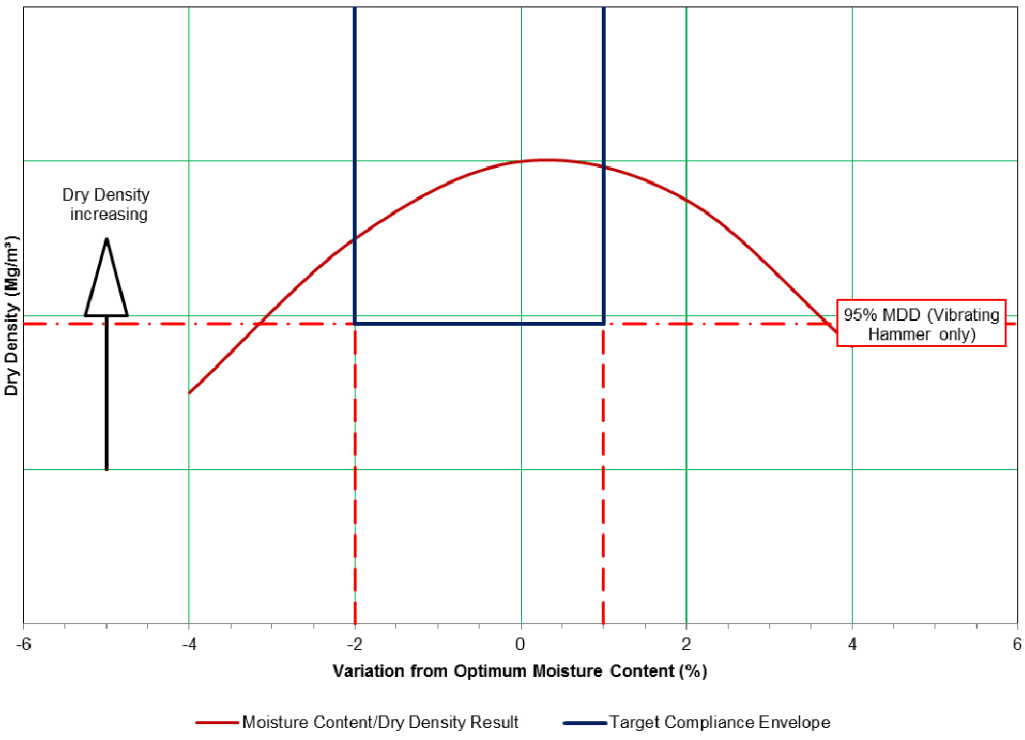


Figure 6/3-5
Compaction Compliance Envelope - Class 6N and 6P



Compaction Trial

6.8 A compaction trial is required to be completed for each compaction method to be used and for each source of material. Prior to undertaking the trial, the Contractor shall confirm to the Hydrock the following:

- What method of compaction is to be used in the trial and whether or not it has been based upon the guidance from SHW Table 6/4.
- What compaction plant is to be used, including but not limited to the type of equipment, manufacture, mass per meter width and any other relevant information which can be used to assess its suitability for the material to be compacted.
- Confirmation of the source of material to be used, and whether or not there are any geotechnical results available from source suitability testing prior to the commencement of the trial.
- Confirmation that they understand the minimum specification requirements for end-performance of the fill which are to be assessed and demonstrated during the trial.
- The methodology for assessing fill, including test type and frequency and who will be undertaking the testing both on site and for the subsequent laboratory analysis.
- Confirmation that all parties who are to attend the trial have been informed of when and where the trial will be undertaken.

6.9 For each Class of material as defined in Table 6/1, and each proposed compaction method, a number of test panels shall be constructed in order to allow a full assessment to be completed. Key criteria to identify during the compaction trial will be:

- Change in density and air voids against number of passes.
- Change in density and air voids against depth of layer.
- Change in engineering performance against compactive effort.
- Identification of point of over-compaction/softening of fill.
- Comparative analysis between different plant [where more than one roller is proposed]
- Suitability of material for use on site for the proposed end-use.
- Confirmation of classification and engineering performance of material, including sampling, laboratory testing and classification of the material.
- Comparison of actual performance of material against specification design values.
- Calibration of testing equipment, in particular where the use of a Nuclear Density Gauge [NDG] is proposed for the monitoring of earthworks operation.

Selection of End Product Requirements to be Demonstrated during Compaction Trial

6.10 Reference shall be made to the Compaction Compliance Envelopes, presented as Figures 6/3-1 to 6/3-5 inclusive.

6.11 For the Class 1 General Fill material, it shall be placed and compacted at a moisture content equivalent to the OMC-2% to the OMC+2% and that it should achieve an *in situ* dry density greater than 95% of the MDD when determined using the Vibrating Hammer.

6.12 For Class 2A, 2C, 2D and 2E General Fill, it shall achieve an *in situ* dry density of at least 95% of the MDD determined using the 2.5kg Rammer and have a minimum undrained shear strength in accordance with Table 6/1 of this Specification.

6.13 For Class 2B and Class 7 selected fill, the degree of compaction shall be either 100% of the MDD from the 2.5kg Rammer or 95% of the MDD determined from the 4.5kg Rammer. The Contractor is to confirm with the Engineer/NR which method of laboratory compaction is to be used for Class 2B material before it is tested. Additional requirements for the fill such as strength, bearing capacity and settlement are shown on the Drawings.

6.14 This degree of compaction and additional requirements from Table 6/1 shall form the basis of the compaction specification of Class 1, Class 2, Class 6 and Class 7 fill used as part of the earthworks operation.

6.15 The Contractor shall carry out a compaction trial for each type of material and compaction method to be used to demonstrate that the required degree of compaction and additional requirements can be met. The site of the trials shall be clearly marked and levels taken to determine the thickness of each layer before and after compaction.

Construction of Compaction Trial Test Panels

6.16 For each material type, a number of test panels may be required in order that a full assessment of the material and compaction method can be completed, which would then constitute the Compaction Trial. Although the size of each panel will need to reflect the size of the compaction plant and methodology of work proposed, a minimum width of 8m by 20m in length is recommended, with a number of different layer depths as indicated in Figure 6/3-6.

6.17 Each test panel should be laid out and clearly identified and defined separately from any other test panel to avoid cross-contamination, accidental influence from adjacent works and located on site away from other works.

6.18 The depth of each layer forming the test panel should reflect the likely depth of compacted material, post completion of the compaction trial, i.e. sufficient material should be placed so that the final depth of the compacted layer is in accordance with the guidance provided in Table 6/4 of the SHW. In the unlikely event that a material is proposed to be compacted and it is not possible to classify the material in order to identify the most likely method of compaction, a significantly higher number of test panels will be required in order to identify the optimum plant, layer thickness and number of passes.

Compaction of Test Panels

6.19 Unless specifically instructed within the site specific documentation, earthmoving plant shall not be accepted as compaction equipment, nor the use of lighter compaction plant to provide any preliminary compaction prior to the use of heavier equipment.

6.20 Although the guidance from Table 6/4 of the SHW may indicate the optimum number of passes of the appropriate plant, it is important that the progression of improvement of the material is monitored throughout the compaction process. Therefore, after each and every two passes of the appropriate roller, *in situ* assessment of the density of the material is to be undertaken. One pass of the roller is defined as a single movement of the compaction plant, in one direction, over a given strip of the test panel.

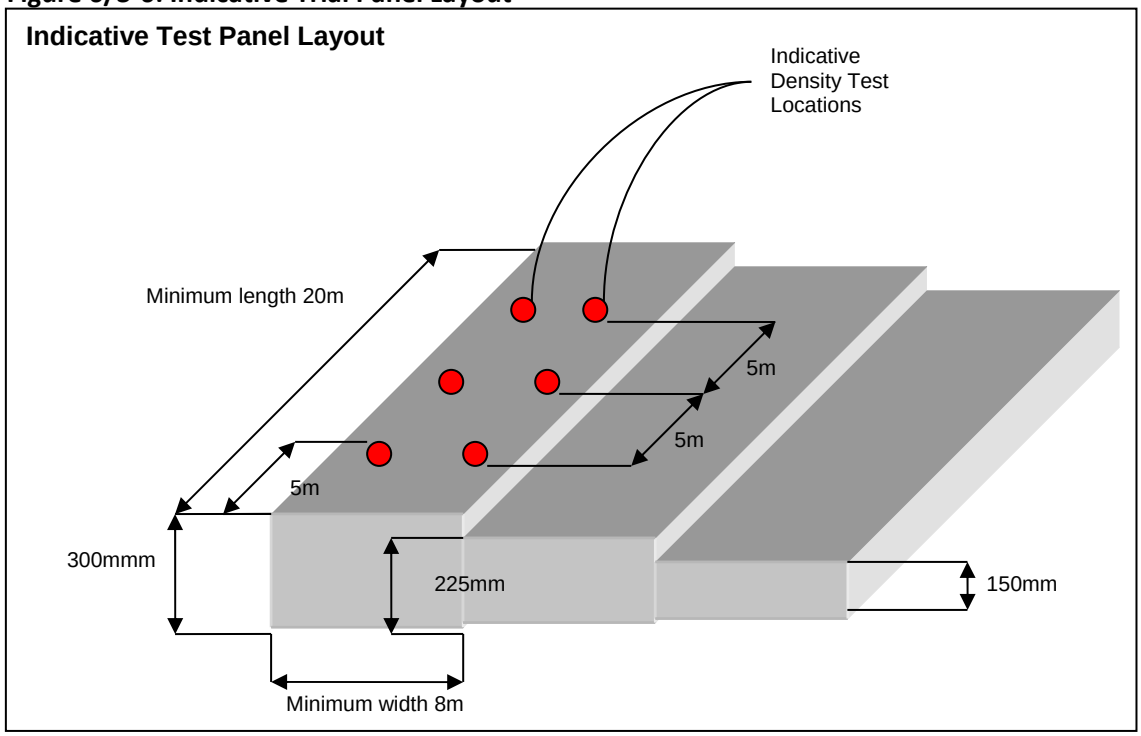
6.21 Where the width of the test panel or roller requires a number of passes in order to ensure the full width of the surface is compacted, it is acceptable for the roller to overlap the previous strip by a small margin (no more than 25% of the maximum roller width). However it should be ensured that no in situ testing is undertaken in this zone to prevent the effect of over-compaction influencing the assessment of the performance of the plant and material.

6.22 The compaction of the test panel should continue incrementally until a clear indication has been obtained to show that the soil has either achieved a maximum density, i.e. where after a number of repeat passes is completed no change is identified or has been over compacted and the performance of the material begins to deteriorate. The exception to this will be where the final performance of the test panel is required to be confirmed using plate load testing, and in this instance it is recommended that a separate panel is constructed, to the same specification as has been identified during the compaction trial, in order that the assessment of the performance can be completed without the detrimental influence of over-compacted material.

6.23 Guidance on the point of over compaction may be readily identifiable on site from a number of key parameters:

- Reduction in bulk density/dry density with increasing compaction.
- Increase in moisture content, where the over-compaction of the material drives moisture up through the material to the surface [mobilisation of excess pore pressure]. This may also be observed during the passage of the roller, with material adhering to the roller, and/or the surface of the compacted layer beginning to tear.
- Reduction in engineering performance of the material with increasing compaction.
- Visible movement of the surface of the material during the passage of the compaction plant, typically exhibited as a ‘bow wave’ in front of the roller.

Figure 6/3-6: Indicative Trial Panel Layout



6.24 The importance of identifying the point at which the materials become over-compacted is important for a number of reasons. Should the material not be competent to undergo additional compaction and/or trafficking, then an engineering decision will be required by the Supervising Engineer prior to the commencement of the main earthworks program.

Assessment of Test Panels

6.25 In order to assess the compaction trials fully, a stringent series of *in situ* testing is to be undertaken after each incremental compactive effort. The type and nature of the tests which can be used to achieve this will be dependent upon the material type/class, proposed end-use of the material and the adopted specification requirements as detailed within this site documentation.

6.26 For each compaction increment the determination of in situ density should be completed with a minimum of 6 number of tests evenly spaced in two rows at distances of 5m, 10m and 15m along the test panel. Each row shall be separated by sufficient distance in order to prevent accidental influence from overlapping roller passes and adjacent test panels. Given the high number of tests that this requires and unless the nature of the material precludes its use, testing shall be undertaken using a Nuclear Density Gauge [NDG]. The results of this test are to be used to assess the following key engineering parameters:

- Bulk Density;
- Moisture Content;
- Dry Density;

- Air Void Content; and
- Degree of Compaction, compared against the MDD.

6.27 In conjunction with the assessment of the density of the material, the following tests shall be included as part of the compaction trial:

- 2 no bulk samples for lab classification, 1 to be sampled prior to compacting the test panel and 1 post completion of the test panel. In order to confirm the engineering characteristics of the material, each source should be sampled and submitted to the laboratory and the scope of testing shall be to determine the grading before and after compaction as well as the MDD using the using the method defined in Table 6/1.
- For Class 1 General Granular Fill & Class 6 Selected Granular Fill, measurement of the CBR using the Mexe Probe equipment, completed at each and every location of the in situ density measurement.
- For Class 2 General Cohesive Fill & Class 7 Selected Cohesive Fill, measurement of the undrained shear strength using the hand vane equipment, completed at each and every location of the in situ density measurement.
- Plate Load Testing, to be completed at the end of the trial in order to define the following:
    - Equivalent CBR;
    - Modulus of Subgrade Reaction, k; and
    - Modulus of Subgrade Reaction, k_{760} based on 760mm diameter plate.

6.28 For the purposes of the compaction trials only, the plate load tests should be completed in accordance with IAN 73/06 in order to determine the Modulus of Sub-grade Reaction and Equivalent CBR value. This testing will require multiple cycles to be completed and as such consideration of the time element to complete each test should be taken.

6.29 In order to adopt a standard procedure for assessing compaction trials, Table 6/3-1 summarises the recommended testing requirements.

6.30 The purpose of the compaction trials will be to prove the engineering performance of the placed and compacted fill and the suitability of the method to be adopted by the Contractor. The method to be adopted for the main earthworks program should satisfy the following key criteria, which will be further reviewed upon receipt of the results of the compaction trials:

- No single dry density result shall be less than 92% of the MDD, and no more than 20% of results of any one layer shall fall between 92% and 95% MDD. Where the 2.5kg rammer is used for Class 2B, the compliance requirement shall increase to no results less than 98% of the MDD and no more than 20% of results of any one layer shall fall between 98% and 100% MDD.
- For Class 1 granular fill, the compliance criteria for CBR is no single result shall be less than 3% CBR, and no more than 20% of results of any one layer shall fall between 3% and 5% CBR.

- For Class 6 granular fill, the compliance criteria for CBR is no single result shall be less than 8% and no more than 20% of results of any one layer shall fall between 8% and 12% CBR.

- For Class 2A and Class 2C Cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 45KN/m², and no more than 20% of results of any one layer shall fall between 45KN/m² and 50KN/m².

- For Class 2B and Class 7 cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 70KN/m², and no more than 20% of results of any one layer shall fall between 70KN/m² and 80KN/m².

- For Class 2 and Class 7 Cohesive fill, no single air void content result shall be greater than 10%, and no more than 20% of results of any one layer shall fall between 5% and 10%.

- For Class 9D fill, minimum degree of compaction of 95% MDD.

6.31 Plate load test completed in accordance with IAN 73/06 Rev 1 and HD25/94 using cyclic loading and shall be used to assess the equivalent CBR value and compared against the data recorded using the other *in situ* apparatus.

Table 6/3-1 Compaction Trial Testing Requirements

Test Property	Recommended Frequency of Testing
Bulk Sample before compaction	1 sample per material for MC, PSD, OMC and particle density
Bulk Sample post compaction	1 sample per material for MC, PSD, OMC and particle density
Bulk Sample for MC/MCV Calibration	1 sample per cohesive material
Bulk Density	6 tests per compaction increment per layer using NDG
Moisture Content	6 tests per compaction increment per layer using NDG
Dry Density	6 tests per compaction increment per layer using NDG
NDG Calibration	1 per material/test panel.
CBR by Mexe Probe (Granular Fill)	1 test per density location.
Cu by Hand Vane (Cohesive Fill)	1 test per density location.
Plate Load Test to IAN 73/06	1 per trial panel, multiple cycles as defined in IAN 73/06

Earthworks Testing

6.32 The Contractor will be required to undertake material acceptability testing of all earthworks materials used in the Works. The testing requirements, including the test type and frequency of testing, are described Appendix 1/5, 6/1 & 6/3 of the Earthworks Specification.

6.33 It should be noted that *in situ* testing will be required even where Method Placement is to adopted by the Contractor, in order to monitor and check that the adopted method is achieving the requisite end-performance. The testing to be undertaken is to demonstrate the method achieves the minimum requirements as detailed in Table 6/1 of this Specification.

6.34 The *in situ* measurement of the material will be required to confirm the applied loadings on the ground and the suitability of the imported material for subsequent inclusion within the permanent works.

6.35 The selected method of placement, depth of layer and selection of compaction plant may be derived initially from Table 6/1 and SHW Table 6/4 but will be subject to confirmation following site compaction trials to prove this method can achieve the required end-performance. Any necessary amendments to the guidance from SHW Table 6/4 to ensure the requisite end-performance of the fill material will be made and issued as part of the adopted earthworks specification.

Placing and Compacting Fill

6.36 Where different classes of fill material are to be employed, they shall be deposited in such a way that all parts of the fill area receive roughly equal amounts of a given material in roughly the same sequence, thus ensuring a uniform distribution of fill types over the whole fill thickness unless otherwise shown on the Drawings.

6.37 The Contractor shall take all necessary steps to ensure that the fill is placed at the moisture content necessary to achieve the compaction specification and shall, where necessary, add water to or dry the fill, in order to obtain this value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.

6.38 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all work shall be performed in such a way as to ensure that their stability is not impaired. Any restrictions on size of compaction plant shall be shown on the Drawings. Each compaction method shall only be approved through the completion of a satisfactory compaction trial which can demonstrate that the minimum engineering performance can be met.

6.39 If the results of control tests indicate that the fill is being placed and compacted in such a way that the desired end product is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.

6.40 If the results of control tests indicate that antecedent weather conditions (such as frost or heavy rain) have caused deterioration of finished work such that the work no longer meets specification, the Contractor shall take such steps as are necessary to bring the fill to the specification requirements.

Control Testing

6.41 The compliance of the fill meeting the compaction specification shall be demonstrated by undertaking the *in situ* and laboratory testing as detailed in Appendix 1/5 and meet the requirements of Table 6/1 and Appendix 6/3.

6.42 Plate bearing tests (in accordance with BS1377-9, 1990 method 4.1) shall be undertaken to demonstrate compliance with the additional requirements for the fill shown on the Drawing EMG-HYD-C4-M1OB-DR-GE-0654. The test requirements for the plate loading tests are shown on the Drawings.

6.43 Test locations shall be evenly distributed throughout the fill area at the frequency defined in Table 1/5. The earthworks fill shall comply with the following minimum requirements:

- No single dry density result shall be less than 92% of the MDD, and no more than 10% of results of any one layer shall fall between 92% and 95% MDD. Where the 2.5kg rammer is used for Class 2B, the compliance requirement shall increase to no results less than 98% of the MDD and no more than 10% of results of any one layer shall fall between 98% and 100% MDD.

- For Class 1 granular fill, the compliance criteria for CBR is no single result shall be less than 3% CBR, and no more than 10% of results of any one layer shall fall between 3% and 5% CBR or where the fill is placed below adoptable highways, this shall be increased to no result below 12% and no more than 105 of the results for any layer between 12% and 15%.

- For Class 6I and 6N granular fill, the compliance criteria for the Mexe Probe CBR is no single result shall be less than 8% and no more than 10% of results of any one layer shall fall between 8% and 12% CBR. For Class 6P, this shall be reduced to no single CBR below 5% and no more than 10% of results of any one layer shall be between 5% and 8%.

- For Class 2A and Class 2C Cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 45KN/m², and no more than 10% of results of any one layer shall fall between 45KN/m² and 50KN/m².

- For Class 2B and Class 7 Cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 70KN/m², and no more than 10% of results of any one layer shall fall between 70KN/m² and 80KN/m².

- For Class 2 and Class 7 Cohesive fill, no single air void content result shall be greater than 10%, and no more than 10% of results of any one layer shall fall between 5% and 10%.

- For Class 9D fill to the upper 0.60m, the minimum degree of compaction shall be 95% of the MDD, and a minimum subgrade surface stiffness at the top of the final layer of 77 Mpa.

6.44 All earthworks materials used shall comply with the earthworks specification. Prior to the commencement of the placement of the bulk fill, for each and every compaction method and each material source a compaction trial will be required to be completed.

7.0 ADDITIONAL LIMITATIONS OF DEPOSITION OF MATERIALS REFERRED TO IN 601.13, 601.14 AND 601.17

7.1 Cobbles having an equivalent diameter of more than 150mm shall not be deposited within 1.3 m of the finished surface at any location.

8.0 RESTRICTIONS ON BATTERING OF EXCAVATIONS FOR FOUNDATIONS AND TRENCHES AND REQUIREMENTS FOR BENCHING

8.1 No specific limitations or restrictions are included for the battering of excavations for foundations, but the Contractor shall comply with the Temporary Works Designer's requirements. Battered excavations are to be benched prior to backfilling. Benching requirements are shown on the Drawings.

9.0 EXCAVATION SUPPORTS TO BE LEFT IN PLACE

9.1 No excavation supports are to be left in place.

10.0 BENCHING OR SHAPING OF EARTHWORKS SLOPE FACES TO RECEIVE FILL

10.1. Where existing embankments are to be extended and where embankments are to be constructed on ground with a slope steeper than one in eight, such slope being measured at right angles across the width of the embankment, benching of the existing slope shall be formed as shown on the Drawings. Bench heights are to be a multiple of the relevant compaction layer thickness.

10.2 Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the upright steps of the benching.

10.3 Placing and compaction of the fill material shall continue to a level above an adjacent bench before material is placed upon that bench.

10.4 Four additional passes of the roller shall be made on the area within two metres each side of the upright face immediately following the compaction of the first layer of fill material on each bench.

11.0 MIXING OF EXCAVATED MATERIALS

11.1 Mixing of acceptable and unacceptable excavated material is not permitted. All excavated material are to be stored in individual stockpiles, not exceeding 500m^3.

12.0 FILL TO EXCAVATED VOIDS OR NATURAL VOIDS IN FOUNDATION EXCAVATIONS

12.1 Areas of inadequate strength shall be removed and backfilled. For small areas and depths, blinding concrete class ST1 shall be used. For more extensive areas and depths, backfill shall be 6N granular material compacted to Table 6/1 of the Specification unless otherwise shown on the drawings.

13 FILL TO LANDSCAPE AREAS

13.1 Where landscape fill material (Class 3D or Class 4) is to be used within approved locations on site, the material shall be placed in accordance with Clause 620 of the SHW.

APPENDIX 6/6: FILL TO STRUCTURES AND FILL ABOVE STRUCTURAL FOUNDATIONS

1. FILL TO STRUCTURES

1.1 Requirements and material classes for fill to structures and fill above structural foundations are shown on the relevant Cass Hayward substructure drawings (presented under a separate cover) and Hydrock drawing EMG-HYD-C4-M1OB-DR-GE-0654.

1.2 Prior to placing blinding concrete at the design foundation level, or immediately prior to filling the excavation where no blinding layer is required, the formation shall be investigated by the Contractor in the presence of the Supervising Engineer to confirm that the design assumptions with regard to formation strength have been met as follows:

i) Cohesive Soils: by use of a shear vane test to prove that the undrained shear strength value at a depth of 0.2m below excavation formation level is greater than the minimum stated on the substructure drawings.

ii) Granular Soils: by use of a Dynamic Probe to prove that the equivalent SPT 'N' value is greater than the minimum stated on the substructure drawings.

iii) Plate Load Testing using 600mm diameter plate, to the loads defined in Appendix 1/5 and on the drawings and to achieve the associated settlement requirements.

1.3 The tests referred to above shall be taken at representative locations across the formation in accordance with Appendix 1/5 or as directed by the Supervising Engineer. The tests shall undertake using suitably calibrated equipment. Additional tests shall be undertaken at any apparent areas of inadequate strength identified visually by the Supervisor.

1.4 The locations, results and correlation of the equipment used shall be recorded. The Contractor shall keep records of the inspections, testing and any subsequent remedial measures, including the test locations, test values and calibrations of the equipment used.

2. FULL SCALE DETERMINATION OF SLOPE STABILITY

2.1 Material for use as 'Fill to Structures' does not require full scale determination of slope stability in accordance with Clause 610.6 of SHW unless this is a specific requirement of the Contractors alternative design.

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

20.8 TREATMENT OF FORMATION

GENERAL REQUIREMENTS

1.1 The locations and required thickness of capping and/or sub-base thickness are shown on the Engineer's Drawings.

1.2 Cut to fill transitions zones shall be constructed as shown on the Engineer's Drawings.

1.3 Final preparation of the sub-formation and formation shall only be carried out after installation of the scheduled drainage at that location.

1.4 The minimum California Bearing Ratio (CBR) or undrained shear strength of the subgrade for each location is given on the Engineer's Drawings and in Table 6/1. Areas of subgrade that are below the minimum shall be improved by the methods shown on the Engineer's Drawings.

1.5 The CBR of the subgrade shall be determined at the frequency shown on the Drawings and as required by the Supervising Engineer. The Contractor shall test the subgrade to determine the CBR value using one of the following test methods appropriate to the subgrade material being tested in accordance with IAN 73/06 Rev 1:

- Dual Cycles Static Plate Load Test (PLT)
- Dynamic Plate Load Test.

2.0 ALLOWED SURFACE LEVEL TOLERANCES

2.1 Surface level tolerances shall comply with Clause 616.1

3.0 CAPPING MATERIALS

3.1 The permitted capping materials are shown as described in Clause 613.3 of SHW.

3.2 Material used within 450mm of the designated final road or external surface level shall not be frost susceptible.

4.0 PROCEDURE FOR CONSTRUCTION OF CAPPING FOR CUTTINGS AND EMBANKMENTS

4.1 The procedures for construction of capping for cuttings and embankments are as stated in Clauses 613.11 and 613.12 respectively of SHW unless otherwise shown on the Drawings.

5.0 DEMONSTRATION AREA AND TESTING

5.1 The Contractor shall provide a demonstration area to trial the proposed capping materials. If the trial area is outside the location of the permanent works the trial area formation shall be of similar strength and characteristics as to the permanent works formation. The laying and compaction methods used within the trial area shall be the same as those proposed for the permanent works.

5.2 The demonstration area may form part of the permanent works but shall only be accepted if the results of testing comply with the Specification.

6.0 SUB-FORMATION SHAPING

6.1 The sub-formation shall be shaped as Clause 613.8 of SHW unless shown otherwise on the Drawings.

7.0 LIME STABILISATION

7.1 Modification and stabilisation is permitted but shall not be undertaken without the prior written approval of the Supervising Engineer, and testing undertaken to demonstrate that the maximum permissible TPS is not exceeded.

8.0 TREATMENT OF FORMATION

8.1 Treatment of soft spots shall be completed prior to final preparation of sub-formation. Replacement of soft materials, to formation level, shall be with either additional approved Class 6F or Class 9 Selected Capping Material or as agreed with the Supervising Engineer using selected granular material with geosynthetic reinforcement.

8.2 Areas of formation that do not have a surface tolerance within the limits stated in Clause 616.1 of SHW are to be excavated to depths given on the Drawings and infilled with either additional approved capping or as agreed with the Supervising Engineer using selected granular material with geosynthetic reinforcement.

8.3 Details and locations of formation treatment and removal of soft material are to be kept by the Contractor.

9.0 RATE OF SPREAD OF LIME

9.1 Testing for the rate of lime spreading shall be in accordance with Clause 615.6 of SHW.

10.0 CHEMICAL ANALYSIS REPORTS

10.1 Chemical analysis reports for ‘available lime’ are to be provided weekly in accordance with Clause 615.4 of SHW.

11.0 PREPARATION OF FORMATION ON EXISTING SUB-BASE MATERIAL

11.1 Preparation of formation on existing sub-base material shall be in accordance with Clause 616 of SHW.

12.0 REQUIREMENTS FOR CEMENT TYPE IN LIME AND CEMENT STABILISATION

12.1 The level of sulphates is to be confirmed before the use of hydraulic binders can be approved. Modification and stabilisation shall not be undertaken without the prior written approval of the Supervising Engineer.

13.0 REQUIREMENTS FOR ALTERNATIVE THICKNESS OF LAYERS TO BE STABILISED

13.1 The layer thickness shall comply with the requirements of Clause 643.9 of SHW.

14.0 ALTERNATIVE TREATMENT REQUIREMENTS FOR LAYERS TO BE STABILISED

14.1 The treatment of layers to be stabilised shall comply with the requirements of Clauses 643.10 and 643.16 of SHW.

APPENDIX 6/8: TOPSOILING

1. Topsoiling shall be carried out using Class 5 material complying with Table 6/1 and in accordance with the requirements of the Written Landscape Scheme, Barry Chinn Associates document reference 148/14-RP01, presented under a separate cover.

2. The topsoil depth shall be as specified in .Written Landscape Scheme.

3. Imported topsoil shall comply with BS 3882:1994, General Purpose Grade.

4. No topsoil shall be supplied from any source until a sample of the topsoil from each source has been inspected and approved by the Engineer. All topsoil supplied must be of the same quality as the approved sample(s).

5. Topsoil shall be spread, graded and consolidated by hand or mechanical means.

6. Any materials deemed unsuitable by the Engineer, that are brought to the surface by the spreading, grading and consolidation of topsoil shall be collected up disposed of off site.

7. Topsoiled areas shall not be traversed by machinery or used for storage purposes

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

20. EARTHWORK ENVIRONMENTAL BUNDS

Location and types of construction

1.1 Requirements for Earthwork Environmental Bunds are shown on the Drawings.

1.2 Earthwork Environmental Bunds are to be constructed of materials as shown on the Drawings.

Requirements for etermine

1.3 Environmental Bunds that are to be topsoiled are shown on the Drawings and in agreement with the requirements of the Ecological Consultant and the Written Landscape Scheme, Barry Chinn Associates document reference 1484/14-TP01, presented under a spate cover.

1.4 All imported topsoil shall comply with the requirements for General Purpose in accordance with BS 3882.

2. LANDSCAPE AREAS

Locations

2.1 Locations of Landscape Areas are shown on the Drawings.

Requirements for Compaction

2.2 Class 4 material shall be compacted in accordance with Clause 620 of SHW.

Construction requirements

2.3 Construction requirements and contouring of Landscape Areas are shown on the Drawings.

Requirements for etermine

2.4 The requirements for etermine Landscape Areas are shown on the Drawings.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

1 LOCATION OF INSTRUMENTATION

1.1 All instrumentation and associated equipment shall be approved by the Hydrock and shall be suitable for installation at the locations described, notably where the thickness of fill is in excess of 2.50m. The alignment of each settlement marker shall be such that it falls within the verge of the final embankment, in the area of deepest fill.

1.2 Instrumentation shall be installed to measure vertical displacement of the subsoil and where the thickness of fill exceeds 2.50m a second installation shall be installed at mid-depth of the fill. Instrumentation shall remain operational during the construction contract.

1.3 The Contractor shall be responsible for and shall follow the manufacturers' instructions and the requirements of this Specification in the installation, calibration and testing of all measuring instruments and equipment, which shall be carried out in the presence of Hydrock.

1.4 The Contractor shall inform Hydrock at least 2 working days prior to undertaking installation of the equipment. The Contractor shall make due allowances in his construction programme for delays which may arise on account of the installation of the instruments and of their maintenance.

1.5 The Contractor shall provide suitably qualified and competent staff to take readings of instruments during construction and provide measurements/data at the time the instruments are read. The Contractor shall submit names and evidence of competence of personnel to carry out the instrumentation installation and commissioning for the approval of the Engineer before the commencement of the Works.

1.6 The Contractor shall maintain the instrumentation in working order throughout the Contract or until Hydrock informs them that monitoring is no longer required. The Contractor shall ensure that the frequency of monitoring is adequate and in compliance with all requirements for control of construction and associated monitoring of constructions, as detailed on the Drawings.

1.7 The Contractor shall agree with Hydrock the tolerances for the installation, and the instrument's calibration, accuracy and repeatability.

1.8 The Contractor shall be responsible for preparing a factual report (paper and pdf copy) of the instrumentation, installation and monitoring, and including graphical plots of the monitoring results. A draft report shall be forwarded to Hydrock for comment within 2 weeks following substantial completion of the Contract or Section of the Contract. All details of the instrumentation, installation and monitoring results shall be provided to the Supervisor electronically in AGS format with the factual report.

1.9 Details of instrumentation are given on the Drawings.

2 INSTRUMENTATION SCHEDULE

2.1 Details of the type, number and location of instruments are given on the Drawings.

3 HOUSING DETAILS

3.1 Housing details are given on the Drawings.

4 INSTALLATION DETAILS

4.1 The instruments shall be installed in accordance with this Appendix and the Drawings.

4.2 All instruments shall be labelled with their reference number at the location where readings or measurements are to be taken. The labelling shall be permanent using a method or material to be agreed with the Engineer.

Survey Equipment

4.3 All surveying equipment used in conjunction with the monitoring of instrumentation, including measuring tapes, levels and EDM shall be maintained and calibrated as required by the manufacturers and good surveying practice. Levels shall be checked every four weeks. Where the rate of settlement reduces to below 2mm per week, or as directed by the Engineer on site, the Contractor shall undertake all further levelling of instrumentation by precise levelling techniques.

Rod Settlement Gauges and Settlement Markers

4.4 The details of the Rod Settlement Gauges and Settlement Markers shall be as shown on the Drawings and the Contractor shall be responsible for the installation of all gauges and markers as works proceed. The Rod Settlement Gauge base plate and first length of rod shall be placed as early as possible during the earthworks, i.e. before any significant filling has taken place. Extension lengths shall be installed when the level of the compacted embankment is 250mm below the top of the preceding level.

4.5 Should a Rod Settlement Gauge or Settlement Marker be damaged or should the Contractor fail to extend the gauge when required, he shall stop all works in the vicinity of the gauge until the necessary remedial works have been completed. The Contractor shall be liable for any delay in his programme or any additional work that has to be done as a result of such damage.

4.6 Rod Settlement Gauges and Settlement Markers shall be monitored by levelling techniques as defined by this Appendix. Levels shall be taken of the top of the rod and the fill adjacent to the gauge on each occasion. When rods are extended, levels shall be measured immediately before and immediately after adding the extension. Good levelling practice should be observed.

Permanent Datum

4.7 Permanent datum is required to provide a reference for measurement of ground and instrument levels in areas of soft ground. The datum itself is to be fixed into deeper, competent ground and isolated from soft and compressible strata at shallower depth.

4.8 The Contractor shall be responsible for establishing a permanent datum at locations, and with depths and details, as specified and agreed with the Engineer. The installation of a permanent datum shall be completed prior to the installation of instruments and the commencement of earthworks.

4.9 A permanent datum shall consist of a 25mm galvanised steel pipe fixed into competent ground with a cement ground and shall penetrate the competent stratum by at least 3m. The datum pipe shall be isolated from the overlying soft ground by a 75mm diameter galvanised steel outer pipe bedded into the top 500mm of the cement grout.

4.10 The datum pipe shall, where necessary, be connected by screw threaded couplings, shall have a domed top and shall protrude 30mm to 50mm above the outer pipe. The outer pipe shall also be connected where necessary by screw threaded couplings. The portion of the outer pipe which passes through the soft ground shall be surrounded by a sand backfill from the top of the cement grout to the underside of the concrete plinth to be cast at ground level.

4.11 The plinth shall comprise a square concrete slab of not less than 0.06m3 of concrete (approximately 0.4m x 0.4m x 0.4m). The surface of the concrete plinth shall be scored with the reference for the individual permanent datum.

4.12 The level of the permanent datum shall be established by the levelling techniques set out in Section 8.0 of this Appendix, with reference to agreed benchmarks in the vicinity. Levelling shall be closed back to the benchmarks to check accuracy.

4.13 The level value and co-ordinate position shall be measured three times soon after installation of the datum and shall be checked at intervals to be established by the Engineer.

Installation Records

4.14 All records produced for the instrumentation must include the following data:

- Project name.
- Contract name and number.
- Instrument reference number and type.
- Dates of installation, reading or summary.
- Times of installation or reading.
- Chainage and offset (or co-ordinates if appropriate).
- Personnel responsible for undertaking the monitoring.
- Any relevant comments or remarks.

4.15 The Contractor shall prepare an installation record sheet for each instrument installed. The format of the sheet shall be prepared by the Contractor and submitted to the Engineer for approval at least one week before installation commences. The record sheet shall include the following information in addition to the general information required:

- Existing ground level at the time of installation, measured at 5m intervals in the case of hydrostatic profile gauges.
- Location in plan and elevation – Planned and 'As Built'.
- Orientation – Planned and 'As Built'.
- Lengths, widths, diameters, depth and volumes of backfill – Planned and 'As Built'.
- Type of backfill used.
- Weather conditions.
- Space for notes, including problems encountered, delays, unusual features of the installation and any events that may have a bearing on instrument behaviour.
- A record of commissioning information and readings.
- Any colour coding used.

4.16 The Contractor shall submit to the Engineer three copies of each installation report sheet within one working day of completion of the installation, including taking of base readings.

4.17 The following data shall be recorded for the Settlement Gauges and similar settlement monitoring equipment:

- Original ground level at the gauge location (m OD).
- Reduced level of the top of the rod (m OD).
- Reduced level of the ground adjacent to the gauge (m OD).
- A record of the height of fill placed and the start/finish dates of filling.
- The total thickness of the fill (m).
- A record of extensions to the gauge, including before/after reduced levels of the gauge.
- The settlement of the plate relative to base readings and previous readings (m).

4.18 The following data shall be recorded for a permanent datum/s:

- Reduced level of datum (m OD).
- Plan position.

5 CALIBRATION REQUIRMENTS

5.1 The Contractor shall test the whole instrumentation installation by taking three sets of base readings at suitable intervals and shall provide two copies of the results for the CGD and shall satisfy the CGD that all instruments are functioning correctly and readings are repeatable before the associated earthworks are commenced.

5.2 In cases where instruments are installed during earthworks, three sets of readings shall be taken in quick succession and the results compared. These results shall be used to provide base readings in a manner to be agreed with the Engineer

6 INSTRUMENTATION PROTECTION

6.1 The Contractor shall take measures to prevent damage to underground services and drains during boring, excavation and trenching for the installation of all instruments.

6.2 The Contractor shall take all necessary precautions to protect the instruments and maintain the instruments in good working order after commissioning. For all instruments which project through and above the fill, special precautions shall be taken to provide protection from vehicles and plant, including substantial and readily visible barriers at a distance of no less than 750mm around each instrument

6.3 Heavy compaction equipment shall not approach within 1.5m of projecting instruments. Any damage to instruments shall be reported to the Engineer within one working day of the damage occurring. Damaged instruments shall be replaced or repaired by the Contractor at his own expense within seven days of its reported damage.

6.4 Adequate protection measures shall be provided for all new and existing instrumentation to protect it from vandalism or damage during construction. All damaged instrumentation shall be replaced by the Contractor as soon as possible.

7.0 ELECTRICAL POWER REQUIREMENTS

7.1 The electric power requirements if required, are to be shown on the relevant Contractor's Drawings.

8.0 MONITORING FREQUENCY AND REPORTING REQUIREMENTS

8.1 The Contractor shall monitor the instruments and supply Hydrock with records of all readings and graphical plots thereof.

8.2 All earthworks instrumentation shall be installed, surveyed and monitored at least two weeks ahead of adjacent earthworks construction.

8.3 All equipment, shall be professionally monitored, including levelling of the surface of the fill, levelling of the settlement plates and settlement markers in accordance with Table 6/12-1, as required by the Supervising Engineer and as shown on the drawings.

8.4 All monitoring records shall be provided to the Supervising Engineer electronically as soon as they become available and at the request of the Supervising Engineer.

Table 6/12-1: Minimum frequency of levelling and monitoring

Period	Monitoring Frequency	Comments
Before Fill Placed	Immediately after installation of Settlement Plates	Determination of base line ground level
During Fill Placement	Every week Before and after any extension added to settlement plate	Assessment of Immediate Settlement Accurate measurement of any extension rod
Week 1 to Week 4	Every week	Assessment of commencement of Primary Settlement
Week 4 to Week 16	Every two weeks	Profile of Primary Settlement, compared to model settlement curves
> Week 16	As agreed with Hydrock	End of Primary Settlement Stage and commencement of onset of Secondary Settlement

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

1.0 GENERAL

1.1 All Made Ground and secondary materials shall be assessed for contamination, at a rate of 1 test per 500m³ unless otherwise agreed with Hydrock, for the contamination suite defined in Table 6/14-1.

Table 6/14-1 Contaminant Suite

Source	Determinant	Maximum Permitted Concentration (ml/kg)
SGV report + CLEA 1.07	Arsenic	640
LQM/CIEH + CLEA 1.07	Beryllium	390
LQM/CIEH + CLEA 1.07	Boron	190000
SGV report + CLEA 1.07	Cadmium	220
LQM/CIEH + CLEA 1.07	Chromium (III)	8400
LQM/CIEH + CLEA 1.07	Chromium (VI)	33
LQM/CIEH + CLEA 1.07	Copper	69000
C4SL	Lead	2330
SGV report + CLEA 1.07	Mercury, inorganic	3600
Hydrock + CLEA 1.07	Nickel	1700
SGV report + CLEA 1.07	Selenium	13000
LQM/CIEH + CLEA 1.07	Vanadium	9000
LQM/CIEH + CLEA 1.07	Zinc	670000
Hydrock + CLEA 1.07	Cyanide (free)	16000
SGV report + CLEA 1.07	Phenol (total)	1500
LQM/CIEH + CLEA 1.07	Acenaphthene	97000
LQM/CIEH + CLEA 1.07	Acenaphthylene	97000
LQM/CIEH + CLEA 1.07	Anthracene	540000
LQM/CIEH + CLEA 1.07	Benz(a)anthracene	91
LQM/CIEH + CLEA 1.07	Benzo(a)pyrene	14
LQM/CIEH + CLEA 1.07	Benzo(b)fluoranthene	98
LQM/CIEH + CLEA 1.07	Benzo(ghi)perylene	640
LQM/CIEH + CLEA 1.07	Benzo(k)fluoranthene	140
LQM/CIEH + CLEA 1.07	Chrysene	140
LQM/CIEH + CLEA 1.07	Dibenz(a,h)anthracene	12
LQM/CIEH + CLEA 1.07	Fluoranthene	23000
LQM/CIEH + CLEA 1.07	Fluorene	68000
LQM/CIEH + CLEA 1.07	Indeno(1,2,3,cd)pyrene	59
LQM/CIEH + CLEA 1.07	Naphthalene	460
LQM/CIEH + CLEA 1.07	Phenanthrene	22000
LQM/CIEH + CLEA 1.07	Pyrene	54000
LQM/CIEH + CLEA 1.07	Aliphatics EC5-EC6	560
LQM/CIEH + CLEA 1.07	Aliphatics >EC6-EC8	320
LQM/CIEH + CLEA 1.07	Aliphatics >EC8-EC10	190

Source	Determinant	Maximum Permitted Concentration (ml/kg)
LQM/CIEH + CLEA 1.07	Aliphatics >EC10-EC12	120
LQM/CIEH + CLEA 1.07	Aliphatics >EC12-EC16	59
LQM/CIEH + CLEA 1.07	Aliphatics >EC16-EC35	1000000
LQM/CIEH + CLEA 1.07	Aliphatics >EC35-EC44	1000000
LQM/CIEH + CLEA 1.07	Aromatics EC5-EC7	2300
LQM/CIEH + CLEA 1.07	Aromatics >EC7-EC8	1900
LQM/CIEH + CLEA 1.07	Aromatics >EC8-EC10	1500
LQM/CIEH + CLEA 1.07	Aromatics >EC10-EC12	900
LQM/CIEH + CLEA 1.07	Aromatics >EC12-EC16	37000
LQM/CIEH + CLEA 1.07	Aromatics >EC16-EC21	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC21-EC35	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC35-EC44	28000

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

1.0 GENERAL

1.1 All Made Ground and secondary materials shall be assessed for contamination, at a rate of 1 test per 500m³ unless otherwise agreed with Hydrock, for the contamination suite defined in Table 6/15-1.

Table 6/15-1 Contaminant Suite.

Source	Determinant	Maximum Permitted Concentration (mg/kg)
SGV report + CLEA 1.07	Arsenic	640
LQM/CIEH + CLEA 1.07	Beryllium	390
LQM/CIEH + CLEA 1.07	Boron	190000
SGV report + CLEA 1.07	Cadmium	220
LQM/CIEH + CLEA 1.07	Chromium (III)	8400
LQM/CIEH + CLEA 1.07	Chromium (VI)	33
LQM/CIEH + CLEA 1.07	Copper	69000
C4SL	Lead	2330
SGV report + CLEA 1.07	Mercury, inorganic	3600
Hydrock + CLEA 1.07	Nickel	1700
SGV report + CLEA 1.07	Selenium	13000
LQM/CIEH + CLEA 1.07	Vanadium	9000
LQM/CIEH + CLEA 1.07	Zinc	670000
Hydrock + CLEA 1.07	Cyanide (free)	16000
SGV report + CLEA 1.07	Phenol (total)	1500
LQM/CIEH + CLEA 1.07	Acenaphthene	97000
LQM/CIEH + CLEA 1.07	Acenaphthylene	97000
LQM/CIEH + CLEA 1.07	Anthracene	540000
LQM/CIEH + CLEA 1.07	Benz(a)anthracene	91
LQM/CIEH + CLEA 1.07	Benzo(a)pyrene	14
LQM/CIEH + CLEA 1.07	Benzo(b)fluoranthene	98
LQM/CIEH + CLEA 1.07	Benzo(ghi)perylene	640
LQM/CIEH + CLEA 1.07	Benzo(k)fluoranthene	140
LQM/CIEH + CLEA 1.07	Chrysene	140
LQM/CIEH + CLEA 1.07	Dibenz(a,h)anthracene	12
LQM/CIEH + CLEA 1.07	Fluoranthene	23000
LQM/CIEH + CLEA 1.07	Fluorene	68000
LQM/CIEH + CLEA 1.07	Indeno(1,2,3,cd)pyrene	59
LQM/CIEH + CLEA 1.07	Naphthalene	460
LQM/CIEH + CLEA 1.07	Phenanthrene	22000
LQM/CIEH + CLEA 1.07	Pyrene	54000
LQM/CIEH + CLEA 1.07	Aliphatics EC5-EC6	560
LQM/CIEH + CLEA 1.07	Aliphatics >EC6-EC8	320
LQM/CIEH + CLEA 1.07	Aliphatics >EC8-EC10	190

Source	Determinant	Maximum Permitted Concentration (mg/kg)
LQM/CIEH + CLEA 1.07	Aliphatics >EC10-EC12	120
LQM/CIEH + CLEA 1.07	Aliphatics >EC12-EC16	59
LQM/CIEH + CLEA 1.07	Aliphatics >EC16-EC35	1000000
LQM/CIEH + CLEA 1.07	Aliphatics >EC35-EC44	1000000
LQM/CIEH + CLEA 1.07	Aromatics EC5-EC7	2300
LQM/CIEH + CLEA 1.07	Aromatics >EC7-EC8	1900
LQM/CIEH + CLEA 1.07	Aromatics >EC8-EC10	1500
LQM/CIEH + CLEA 1.07	Aromatics >EC10-EC12	900
LQM/CIEH + CLEA 1.07	Aromatics >EC12-EC16	37000
LQM/CIEH + CLEA 1.07	Aromatics >EC16-EC21	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC21-EC35	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC35-EC44	28000
-	Asbestos	<0.001%

ANNEX B

GEOSTRUCTURAL ANALYSIS REPORTS

ANNEX B.1
GEOTECHNICAL PARAMETERS

GEOLOGICAL LAYER						CHARACTERISITIC DESIGN VALUE - GEOSTRUCTURAL ANALYSIS									
Mercia Mudstone Group - Weathering Grade	Reduced Ground Level m OD			Depth below Ground Level m BEGL From top of Embankment		Bulk Unit Weight	Satruated Unit Weigth	Undrained Shear Strength	Effective Cohesion	Effective Angle of Internal Friction	Adhesion Strcut-soil	Angle of Friction Struct-Soil	Oedometric Modulus E_{oed}	Elastic Modulus Small Strain E_s	Poisson's Ratio
	From	To	Avergae	From	To	γ_b	γ_{sat}	S_u	c'	ϕ'	α	δ	E_{oed}	E_s	υ
						kN/m³	kN/m³	kN/m²	kN/m²	°	kN/m²	°	MPa	MPa	
IVB	78.00 mOD	77.00 mOD	77.50 mOD	0.00 m BEGL	1.00 m BEGL	19.50 kN/m³	20.50 kN/m³	33 kN/m²	2 kN/m²	25 °	23 kN/m²	8.3 °	5.53 MN/m²	13.33 MN/m²	0.40
IVB	77.00 mOD	76.00 mOD	76.50 mOD	1.00 m BEGL	2.00 m BEGL	19.50 kN/m³	20.50 kN/m³	67 kN/m²	2 kN/m²	25 °	47 kN/m²	8.3 °	11.07 MN/m²	26.67 MN/m²	0.40
IVB	76.00 mOD	75.00 mOD	75.50 mOD	2.00 m BEGL	3.00 m BEGL	19.50 kN/m³	20.50 kN/m³	100 kN/m²	2 kN/m²	25 °	58 kN/m²	8.3 °	16.60 MN/m²	40.00 MN/m²	0.40
IVA	75.00 mOD	74.00 mOD	74.50 mOD	3.00 m BEGL	4.00 m BEGL	20.50 kN/m³	21.00 kN/m³	133 kN/m²	4 kN/m²	32 °	63 kN/m²	10.7 °	22.13 MN/m²	53.33 MN/m²	0.40
IVA	74.00 mOD	73.00 mOD	73.50 mOD	4.00 m BEGL	5.00 m BEGL	20.50 kN/m³	21.00 kN/m³	167 kN/m²	4 kN/m²	32 °	67 kN/m²	10.7 °	27.67 MN/m²	66.67 MN/m²	0.40
IVA	73.00 mOD	72.00 mOD	72.50 mOD	5.00 m BEGL	6.00 m BEGL	20.50 kN/m³	21.00 kN/m³	200 kN/m²	4 kN/m²	32 °	71 kN/m²	10.7 °	33.20 MN/m²	80.00 MN/m²	0.40
IVA	72.00 mOD	71.00 mOD	71.50 mOD	6.00 m BEGL	7.00 m BEGL	20.50 kN/m³	21.00 kN/m³	233 kN/m²	4 kN/m²	32 °	74 kN/m²	10.7 °	38.73 MN/m²	93.33 MN/m²	0.40
III	71.00 mOD	70.00 mOD	70.50 mOD	7.00 m BEGL	8.00 m BEGL	22.00 kN/m³	22.00 kN/m³	267 kN/m²	10 kN/m²	32 °	77 kN/m²	10.7 °	44.27 MN/m²	106.67 MN/m²	0.30
III	70.00 mOD	69.00 mOD	69.50 mOD	8.00 m BEGL	9.00 m BEGL	22.00 kN/m³	22.00 kN/m³	300 kN/m²	10 kN/m²	32 °	80 kN/m²	10.7 °	49.80 MN/m²	120.00 MN/m²	0.30
III	69.00 mOD	68.00 mOD	68.50 mOD	9.00 m BEGL	10.00 m BEGL	22.00 kN/m³	22.00 kN/m³	333 kN/m²	10 kN/m²	32 °	82 kN/m²	10.7 °	55.33 MN/m²	133.33 MN/m²	0.30
III	68.00 mOD	67.00 mOD	67.50 mOD	10.00 m BEGL	11.00 m BEGL	22.00 kN/m³	22.00 kN/m³	367 kN/m²	10 kN/m²	32 °	85 kN/m²	10.7 °	60.87 MN/m²	146.67 MN/m²	0.30
III	67.00 mOD	66.00 mOD	66.50 mOD	11.00 m BEGL	12.00 m BEGL	22.00 kN/m³	22.00 kN/m³	400 kN/m²	10 kN/m²	32 °	87 kN/m²	10.7 °	66.40 MN/m²	160.00 MN/m²	0.30
III	66.00 mOD	65.00 mOD	65.50 mOD	12.00 m BEGL	13.00 m BEGL	22.00 kN/m³	22.00 kN/m³	433 kN/m²	10 kN/m²	32 °	89 kN/m²	10.7 °	71.93 MN/m²	173.33 MN/m²	0.30
II	65.00 mOD	64.00 mOD	64.50 mOD	13.00 m BEGL	14.00 m BEGL	22.50 kN/m³	22.50 kN/m³	505 kN/m²	16 kN/m²	42 °	93 kN/m²	14.0 °	83.83 MN/m²	202.00 MN/m²	0.25
II	64.00 mOD	63.00 mOD	63.50 mOD	14.00 m BEGL	15.00 m BEGL	22.50 kN/m³	22.50 kN/m³	615 kN/m²	16 kN/m²	42 °	98 kN/m²	14.0 °	102.09 MN/m²	246.00 MN/m²	0.25
II	63.00 mOD	62.00 mOD	62.50 mOD	15.00 m BEGL	16.00 m BEGL	22.50 kN/m³	22.50 kN/m³	725 kN/m²	16 kN/m²	42 °	103 kN/m²	14.0 °	120.35 MN/m²	290.00 MN/m²	0.25
II	62.00 mOD	61.00 mOD	61.50 mOD	16.00 m BEGL	17.00 m BEGL	22.50 kN/m³	22.50 kN/m³	835 kN/m²	16 kN/m²	42 °	107 kN/m²	14.0 °	138.61 MN/m²	334.00 MN/m²	0.25
II	61.00 mOD	60.00 mOD	60.50 mOD	17.00 m BEGL	18.00 m BEGL	22.50 kN/m³	22.50 kN/m³	945 kN/m²	16 kN/m²	42 °	111 kN/m²	14.0 °	156.87 MN/m²	378.00 MN/m²	0.25
I	60.00 mOD	59.00 mOD	59.50 mOD	18.00 m BEGL	19.00 m BEGL	23.00 kN/m³	23.00 kN/m³	1097 kN/m²	25 kN/m²	42 °	116 kN/m²	14.0 °	182.14 MN/m²	438.89 MN/m²	0.25

Notes

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014 Table 2.1 for Bulk and Saturated unit weights for each weathering grade

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014 Table 2.1 and Figure 2.1 for derivaiton of Effective Angle of Friction and Effectice Cohesion for each weathering grade

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014 Table 2.3 for regression analysis factors for conversion of reduced ground level in m OD to equivalent Undrained Shear Strength

Derivation of Adhesion between Structure and Soil based upon either $\alpha = S_u \times 0.7$ or $\alpha = S_u \times (15.346 \times (S_u \text{ ^-0.7108}))$, as derived from Tomlinson *et al.* which ever is the lesser.

Derivation of Angle of Friction between Strcuture and Soil is based on a lower bound value of $\delta = 1/3\ \phi'$ where δ is typically in the range of $1/3\ \phi'$ to $2/3\ \phi'$.

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014, Annex C for the derivation of equivalent Oedometric Modulus E_{oed} is based upon $S_u \times 0.166$, where S_u is in kN/m² and E_{oed} is in MN/m².

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014, Annex C for the derivation of equivalent Elastic Modulus E_s is based upon $S_u \times 0.400$, where S_u is in kN/m² and E_s is in MN/m².

Derivation of equivalent Poisson's Ratio is based upon the guidnace from CIRIA C570, Engineering in Mercia Mudstone

ANNEX B.2

EMG-HYD-C4-M1OB-CA-GE-0649

Spread footing verification

Input data

Settings

United Kingdom - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	γ_G =	1.35 [–]	1.00 [–]	1.00 [–]	1.00 [–]

Partial factors for soil parameters (M)

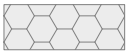
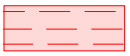
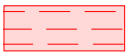
Permanent design situation

		Combination 1	Combination 2
Partial factor on internal friction :	γ_ϕ =	1.00 [–]	1.25 [–]
Partial factor on effective cohesion :	γ_c =	1.00 [–]	1.25 [–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00 [–]	1.40 [–]
Partial factor on unconfined strength :	γ_v =	1.00 [–]	1.40 [–]

Basic soil parameters - (effective stress-state)

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60
19	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
20	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
21	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
22	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
23	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
24	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
25	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
26	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
27	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
28	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
29	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
30	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
31	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00	12.00	10.70

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
32	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
33	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
34	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
35	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
36	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50	12.50	14.00

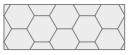
Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	γ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00
37	Redcued Level 60 - 59 m OD - MMG I		1097.00	116.00	23.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-

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No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-
19	Redcued Level 78 - 77 m OD - MMG IVB		cohesive	-	0.40	-	-
20	Redcued Level 77 - 76 m OD - MMG IVB		cohesive	-	0.40	-	-
21	Redcued Level 76 - 75 m OD - MMG IVB		cohesive	-	0.40	-	-
22	Redcued Level 75 - 74 m OD - MMG IVA		cohesive	-	0.40	-	-
23	Redcued Level 74 - 73 m OD - MMG IVA		cohesive	-	0.40	-	-
24	Redcued Level 73 - 72 m OD - MMG IVA		cohesive	-	0.40	-	-
25	Redcued Level 72 - 71 m OD - MMG IVA		cohesive	-	0.40	-	-
26	Redcued Level 71 - 70 m OD - MMG III		overconsolidated	-	-	2.00	-
27	Redcued Level 70 - 69 m OD - MMG III		overconsolidated	-	-	2.00	-
28	Redcued Level 69 - 68 m OD - MMG III		overconsolidated	-	-	2.00	-
29	Redcued Level 68 - 67 m OD - MMG III		overconsolidated	-	-	2.00	-
30	Redcued Level 67 - 66 m OD - MMG III		overconsolidated	-	-	2.00	-
31	Redcued Level 66 - 65 m OD - MMG III		overconsolidated	-	-	2.00	-
32	Redcued Level 65 - 64 m OD - MMG II		overconsolidated	-	-	2.00	-

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No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
33	Redcued Level 64 - 63 m OD - MMG II		overconsolidated	-	-	2.00	-
34	Redcued Level 63 - 62 m OD - MMG II		overconsolidated	-	-	2.00	-
35	Redcued Level 62 - 61 m OD - MMG II		overconsolidated	-	-	2.00	-
36	Redcued Level 61 - 60 m OD - MMG II		overconsolidated	-	-	2.00	-
37	Redcued Level 60 - 59 m OD - MMG I		overconsolidated	-	-	2.00	-

Soil parameters

Topsoil/Subsoil

Unit weight :	γ	=	16.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	24.50 °
Cohesion of soil :	c_{ef}	=	14.00 kPa
Oedometric modulus :	E_{oed}	=	2.50 MPa
Saturated unit weight :	γ_{sat}	=	18.50 kN/m^3

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	44.00 MPa
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Stiff red brown silty CLAY - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Oedometric modulus :	E_{oed}	=	68.00 MPa
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Weathered Mudstone - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Oedometric modulus :	E_{oed}	=	120.00 MPa
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Weathered Mudstone - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Oedometric modulus :	E_{oed}	=	200.00 MPa
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Intact Mudstone - MMG I

Unit weight :	γ	=	23.00 kN/m^3

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Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	25.00 kPa
Oedometric modulus :	E_{oed}	=	400.00 MPa
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	8.00 kPa
Oedometric modulus :	E_{oed}	=	250.00 MPa
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

Existing Highway General Fill

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	17.50 MPa
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Class 2 Fill (Site Won MMG IV)

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	8.50 MPa
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Class 6F Capping/Subbase/Surfacing

Unit weight :	γ	=	21.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	γ	=	20.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	1.00 kPa
Oedometric modulus :	E_{oed}	=	8.50 MPa
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Terrace Sands & Gravels

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	65.00 MPa
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Class 7A Selected Cohesive Fill

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	20.00 MPa
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

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Class 7C Selected Cohesive Fill

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	20.00 MPa
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Pre-existing Made Ground

Unit weight :	γ	=	19.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	17.50 MPa
Saturated unit weight :	γ_{sat}	=	19.50 kN/m^3

Culvert

Unit weight :	γ	=	2.40 kN/m^3
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	2.40 kN/m^3

Granular Backfill to Culvert

Unit weight :	γ	=	18.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	18.00 kN/m^3

Class 6N Selected Backfill to Structures

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

Redcued Level 78 - 77 m OD - MMG IVB

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	10.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Redcued Level 77 - 76 m OD - MMG IVB

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	20.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Redcued Level 76 - 75 m OD - MMG IVB

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Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	30.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	40.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	50.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	60.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	70.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	80.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	90.00 MPa
Poisson's ratio :	ν	=	0.30

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Saturated unit weight : γ_{sat} = 22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight : γ = 22.00 kN/m^3
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 100.00 MPa
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight : γ = 22.00 kN/m^3
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 110.00 MPa
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

Redcued Level 67 - 66 m OD - MMG III

Unit weight : γ = 22.00 kN/m^3
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 120.00 MPa
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

Redcued Level 66 - 65 m OD - MMG III

Unit weight : γ = 22.00 kN/m^3
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 130.00 MPa
Poisson's ratio : ν = 0.30
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

Redcued Level 65 - 64 m OD - MMG II

Unit weight : γ = 22.50 kN/m^3
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Deformation modulus : E_{def} = 151.50 MPa
Poisson's ratio : ν = 0.25
Saturated unit weight : γ_{sat} = 22.50 kN/m^3

Redcued Level 64 - 63 m OD - MMG II

Unit weight : γ = 22.50 kN/m^3
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Deformation modulus : E_{def} = 184.50 MPa
Poisson's ratio : ν = 0.25
Saturated unit weight : γ_{sat} = 22.50 kN/m^3

Redcued Level 63 - 62 m OD - MMG II

Unit weight : γ = 22.50 kN/m^3
Angle of internal friction : φ_{ef} = 42.00 °

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Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	217.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 62 - 61 m OD - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	250.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	283.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I

Unit weight :	γ	=	23.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	25.00 kPa
Deformation modulus :	E_{def}	=	329.17 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	10.30 m
Depth of footing bottom	d	=	1.75 m
Foundation thickness	t	=	1.50 m
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Unit weight of soil above foundation = 22.00 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	21.00 m
Strip footing width (x)	=	7.00 m
Column width in the direction of x	=	0.10 m
Volume of strip footing	=	10.50 m^3/m

Inserted loading is considered per unit length of continuous footing span.

Material of structure

Unit weight γ = 23.50 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 35/45

Cylinder compressive strength	f_{ck}	=	35.00 MPa
Tensile strength	f_{ctm}	=	3.20 MPa

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Elasticity modulus E_{cm} = 34000.00 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500.00 MPa

Transverse steel: B500
Yield strength f_{yk} = 500.00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1.00	Redcued Level 77 - 76 m OD - MMG IVB	
2	1.00	Redcued Level 76 - 75 m OD - MMG IVB	
3	1.00	Redcued Level 75 - 74 m OD - MMG IVA	
4	1.00	Redcued Level 74 - 73 m OD - MMG IVA	
5	1.00	Redcued Level 73 - 72 m OD - MMG IVA	
6	1.00	Redcued Level 72 - 71 m OD - MMG IVA	
7	1.00	Redcued Level 71 - 70 m OD - MMG III	
8	1.00	Redcued Level 70 - 69 m OD - MMG III	
9	1.00	Redcued Level 69 - 68 m OD - MMG III	
10	1.00	Redcued Level 68 - 67 m OD - MMG III	
11	1.00	Redcued Level 67 - 66 m OD - MMG III	
12	1.00	Redcued Level 66 - 65 m OD - MMG III	
13	1.00	Redcued Level 65 - 64 m OD - MMG II	
14	1.00	Redcued Level 64 - 63 m OD - MMG II	
15	1.00	Redcued Level 63 - 62 m OD - MMG II	
16	1.00	Redcued Level 62 - 61 m OD - MMG II	
17	1.00	Redcued Level 61 - 60 m OD - MMG II	
18	1.00	Redcued Level 60 - 59 m OD - MMG I	
19	-	Redcued Level 60 - 59 m OD - MMG I	

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Load

No.	Load new	Load change	Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
1	Yes		LC 1	Design	3929.41	2763.85	-297.39
2	Yes		LC 2	Design	3447.81	3242.51	-482.42
3	Yes		LC 3	Design	3447.81	3206.42	-391.43
4	Yes		LC 4	Design	3447.81	3206.42	-391.43
5	Yes		LC 5	Service	3447.81	2977.85	-316.43

Surface surcharges in the vicinity of footing

No.	Surcharge new	Surcharge change	Name	x_s [m]	y_s [m]	x [m]	y [m]	q [kPa]	α [°]	h [m]
1	Yes		Embankment Backfill	10.50	0.00	20.00	21.00	212.50	0.00	0.00

Ground water table

The ground water table is at a depth of 11.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0.76	0.00	769.48	8207.39	9.38	Yes
LC 1	No	-0.76	0.00	769.48	8207.39	9.38	Yes
LC 2	Yes	-1.06	0.00	765.67	6754.32	11.34	Yes
LC 2	No	-1.06	0.00	765.67	6754.32	11.34	Yes
LC 3	Yes	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 3	No	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 4	Yes	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 4	No	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 5	Yes	-0.92	0.00	724.75	3051.66	23.75	Yes
LC 5	No	-0.92	0.00	724.75	3051.66	23.75	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed self weight of strip foundation $G = 246.75$ kN/m
Computed weight of overburden $Z = 37.95$ kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 5. (LC 5)

Parameters of slip surface below foundation:
Depth of slip surface $z_{sp} = 13.31$ m
Length of slip surface $l_{sp} = 43.81$ m

Design bearing capacity of found.soil $R_d = 3051.66$ kPa

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Extreme contact stress σ = 724.75 kPa

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.152<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.152<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 2. (LC 2)

Earth resistance: not considered

Horizontal bearing capacity R_{dh} = 2381.08 kN
Extreme horizontal force H = 482.42 kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation G = 246.75 kN/m
Computed weight of overburden Z = 37.95 kN/m

Settlement of mid point of longitudinal edge = 14.6 mm
Settlement of mid point of transverse edge 1 = 20.6 mm
Settlement of mid point of transverse edge 2 = 13.7 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 262.10 MPa
Foundation in the longitudinal direction is rigid (k=1.28)
Foundation in the direction of width is rigid (k=437.81)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.132<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.132<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 18.2 mm
Depth of influence zone = 29.60 m

Rotation in direction of width = 0.978 (tan*1000); (5.6E-02 °)

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ANNEX B.3

EMG-HYD-C4-M1OB-CA-GE-0661

Slope stability analysis

Input data

Project

Task : EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part : M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description : M1 OVERBRIDGE LONG-TERM STABILITY - EXISTING M1 CUTTING
Customer : ROXHILL KEGWORTH LTD
Author : Ian Gardner
Date : 08/07/2017 16:38:13
Project ID : C14792
Project number : EMG-HYD-C4-M1OB-CA-GE-0661-S4-P1

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

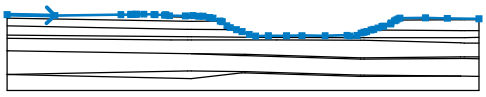
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)

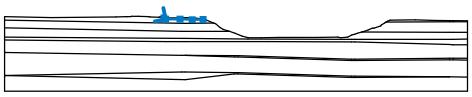
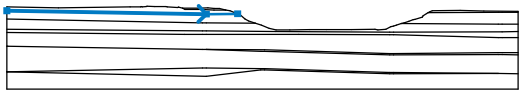
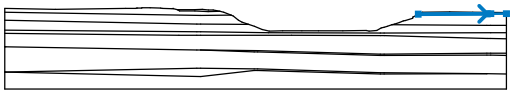
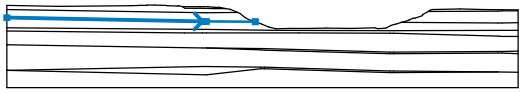
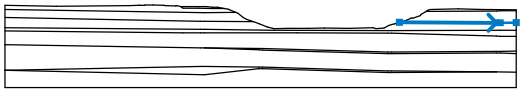
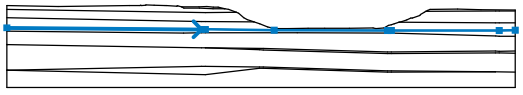
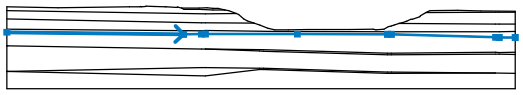
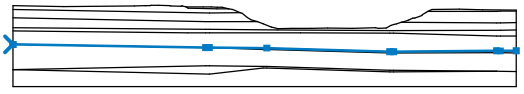
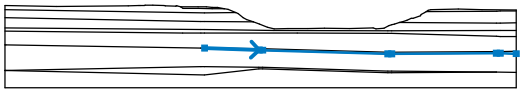
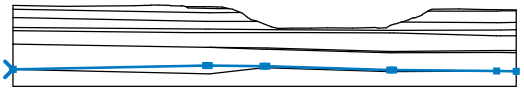
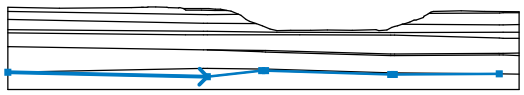
Permanent design situation

		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	27.19	20.20	26.82	48.22	27.14
		52.38	27.21	52.62	27.28	53.00	27.22
		54.50	27.26	54.81	27.38	57.90	27.36
		62.22	27.24	62.77	27.12	66.74	26.97
		67.08	27.09	67.31	27.06	68.81	26.70
		75.55	26.66	78.71	26.77	81.20	26.53
		83.12	26.53	85.72	25.98	87.25	25.67
		90.29	24.48	91.14	24.15	93.15	22.46
		94.54	21.65	97.22	20.81	99.55	20.01
		102.64	18.75	105.37	18.10	110.76	18.16
		118.47	18.25	125.01	18.28	134.80	18.25
		144.04	18.41	145.20	18.13	148.32	18.35
		150.11	19.37	151.27	19.68	152.44	19.98
		154.30	20.61	155.43	20.89	157.30	21.51
		158.91	22.21	159.63	22.26	162.52	23.22
		162.76	23.66	164.19	24.50	164.83	24.88

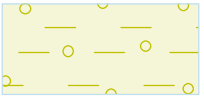
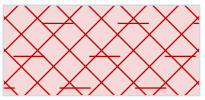
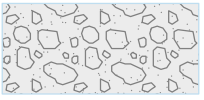
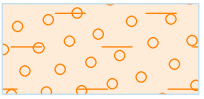
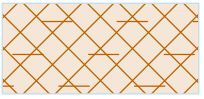
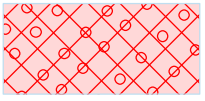
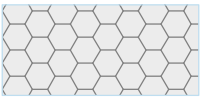
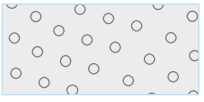
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No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
		165.61	25.34	166.50	25.65	177.34	25.78
		186.58	25.59	200.01	25.44		
2		68.81	26.70	69.64	26.15	75.82	26.13
		81.08	25.91	85.72	25.98		
3		0.00	25.63	78.07	24.35	90.29	24.48
4		164.83	24.88	192.34	24.99	193.71	25.04
		200.01	25.05				
5		0.00	22.41	76.57	20.90	78.07	20.90
		97.22	20.81				
6		154.30	20.61	192.23	20.38	193.71	20.39
		200.01	20.43				
7		0.00	18.42	76.57	17.80	78.07	17.81
		105.15	17.50	149.75	17.34	151.25	17.34
		193.71	17.40	200.01	17.50		
8		0.00	17.17	69.49	16.39	76.58	16.43
		78.07	16.45	114.29	16.43	149.75	16.34
		151.25	16.34	192.26	15.17	193.71	15.10
		200.01	15.09				
9		0.00	11.78	0.01	11.78	76.57	10.55
		78.07	10.55	100.86	10.36	149.75	8.89
		151.25	8.89	192.15	9.24	193.71	9.23
		200.01	9.28				
10		78.07	10.55	99.39	9.77	100.86	9.74
		149.75	8.34	151.25	8.34	192.23	8.53
		193.71	8.53	200.01	8.37		
11		0.00	1.78	0.01	1.78	76.58	3.30
		78.07	3.30	99.36	3.06	100.86	3.06
		149.75	1.54	151.25	1.54	192.23	1.16
		200.01	1.02				
12		0.00	1.78	78.07	0.00	99.36	2.46
		100.86	2.46	149.75	0.94	151.25	0.94
		192.23	1.16				

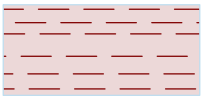
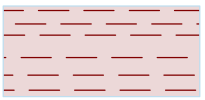
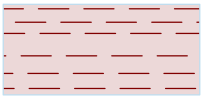
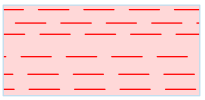
Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50
2	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
3	Weathered Mudstone - MMG III		32.00	10.00	22.00
4	Weathered Mudstone - MMG II		42.00	16.00	22.50
5	Intact Mudstone - MMG I		42.00	25.00	23.00
6	Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50
7	Existing Highway General Fill		25.00	2.00	19.50
8	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50
9	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00
10	Terrace Sands & Gravels		35.00	0.00	22.00
11	Class 7A Selected Cohesive Fill		25.00	2.00	20.50
12	Class 7C Selected Cohesive Fill		25.00	2.00	20.50
13	Pre-existing Made Ground		25.00	0.00	19.00
14	Culvert		41.50	0.00	2.40
15	Granular Backfill to Culvert		41.50	0.00	18.00
16	Class 6N Selected Backfill to Structures		41.50	0.00	22.50

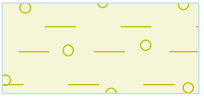
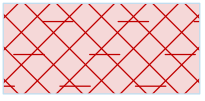
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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
17	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50
18	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50
19	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50
20	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50
21	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50
22	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50
23	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50
24	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00
25	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00
26	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00
27	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00
28	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00
29	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00
30	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50

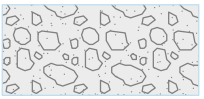
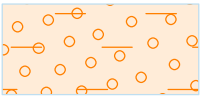
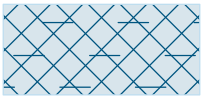
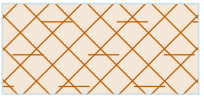
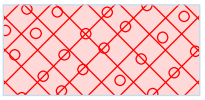
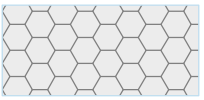
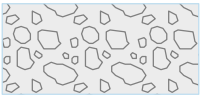
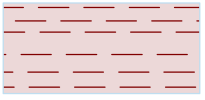
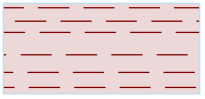
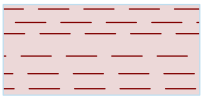
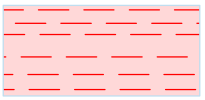
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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
31	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50
32	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50
33	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50
34	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50
35	Redcued Level 60 - 59 m OD - MMG I		42.00	25.00	23.00

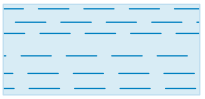
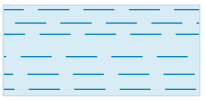
Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Firm to stiff red brown silty CLAY - MMG IVB		20.50		
2	Stiff red brown silty CLAY - MMG IVA		21.00		
3	Weathered Mudstone - MMG III		22.00		
4	Weathered Mudstone - MMG II		22.50		
5	Intact Mudstone - MMG I		23.00		
6	Sandstone - Interbedded Mudstone & Sandstone		23.00		
7	Existing Highway General Fill		20.50		
8	Class 2 Fill (Site Won MMG IV)		20.50		

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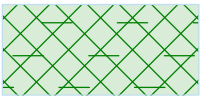
No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
9	Class 6F Capping/Subbase/Surfacing		21.50		
10	Terrace Sands & Gravels		22.50		
11	Class 7A Selected Cohesive Fill		21.00		
12	Class 7C Selected Cohesive Fill		21.00		
13	Pre-existing Made Ground		19.50		
14	Culvert		2.40		
15	Granular Backfill to Culvert		18.00		
16	Class 6N Selected Backfill to Structures		23.00		
17	Redcued Level 78 - 77 m OD - MMG IVB		20.50		
18	Redcued Level 77 - 76 m OD - MMG IVB		20.50		
19	Redcued Level 76 - 75 m OD - MMG IVB		20.50		
20	Redcued Level 75 - 74 m OD - MMG IVA		21.00		
21	Redcued Level 74 - 73 m OD - MMG IVA		21.00		
22	Redcued Level 73 - 72 m OD - MMG IVA		21.00		

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No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
23	Redcued Level 72 - 71 m OD - MMG IVA		21.00		
24	Redcued Level 71 - 70 m OD - MMG III		22.00		
25	Redcued Level 70 - 69 m OD - MMG III		22.00		
26	Redcued Level 69 - 68 m OD - MMG III		22.00		
27	Redcued Level 68 - 67 m OD - MMG III		22.00		
28	Redcued Level 67 - 66 m OD - MMG III		22.00		
29	Redcued Level 66 - 65 m OD - MMG III		22.00		
30	Redcued Level 65 - 64 m OD - MMG II		22.50		
31	Redcued Level 64 - 63 m OD - MMG II		22.50		
32	Redcued Level 63 - 62 m OD - MMG II		22.50		
33	Redcued Level 62 - 61 m OD - MMG II		22.50		
34	Redcued Level 61 - 60 m OD - MMG II		22.50		
35	Redcued Level 60 - 59 m OD - MMG I		23.00		

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Soil parameters - total stress state

No.	Name	Pattern	c_u [kPa]	γ [kN/m^3]
1	Topsoil/Subsoil		35.00	16.50
2	Landscape Fill - Class 4		50.00	20.00

Soil parameters

Topsoil/Subsoil
Unit weight : γ = 16.50 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 35.00 kPa

Firm to stiff red brown silty CLAY - MMG IVB
Unit weight : γ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

Stiff red brown silty CLAY - MMG IVA
Unit weight : γ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 4.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

Weathered Mudstone - MMG III
Unit weight : γ = 22.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m^3

Weathered Mudstone - MMG II
Unit weight : γ = 22.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m^3

Intact Mudstone - MMG I
Unit weight : γ = 23.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 25.00 kPa
Saturated unit weight : γ_{sat} = 23.00 kN/m^3

Sandstone - Interbedded Mudstone & Sandstone
Unit weight : γ = 22.50 kN/m^3

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Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 8.00 kPa
Saturated unit weight : γ_{sat} = 23.00 kN/m^3

Existing Highway General Fill
Unit weight : γ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

Class 2 Fill (Site Won MMG IV)
Unit weight : γ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

Class 6F Capping/Subbase/Surfacing
Unit weight : γ = 21.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 21.50 kN/m^3

Landscape Fill - Class 4
Unit weight : γ = 20.00 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 50.00 kPa

Terrace Sands & Gravels
Unit weight : γ = 22.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m^3

Class 7A Selected Cohesive Fill
Unit weight : γ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

Class 7C Selected Cohesive Fill
Unit weight : γ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

Pre-existing Made Ground
Unit weight : γ = 19.00 kN/m^3

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Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 19.50 kN/m^3

Culvert
Unit weight : γ = 2.40 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 2.40 kN/m^3

Granular Backfill to Culvert
Unit weight : γ = 18.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m^3

Class 6N Selected Backfill to Structures
Unit weight : γ = 22.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 23.00 kN/m^3

Redcued Level 78 - 77 m OD - MMG IVB
Unit weight : γ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

Redcued Level 77 - 76 m OD - MMG IVB
Unit weight : γ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

Redcued Level 76 - 75 m OD - MMG IVB
Unit weight : γ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : γ_{sat} = 20.50 kN/m^3

Redcued Level 75 - 74 m OD - MMG IVA
Unit weight : γ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 4.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

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Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	γ =	20.50 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	γ =	20.50 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	γ =	20.50 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	γ =	22.00 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	γ =	22.00 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m3

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	γ =	22.00 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m3

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	γ =	22.00 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m3

Redcued Level 67 - 66 m OD - MMG III

Unit weight :	γ =	22.00 kN/m3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa

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Saturated unit weight : γ_{sat} = 22.00 kN/m3

Redcued Level 66 - 65 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Saturated unit weight : γ_{sat} = 22.00 kN/m3

Redcued Level 65 - 64 m OD - MMG II
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Redcued Level 64 - 63 m OD - MMG II
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Redcued Level 63 - 62 m OD - MMG II
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

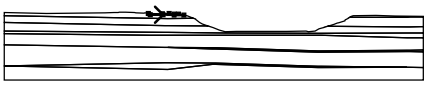
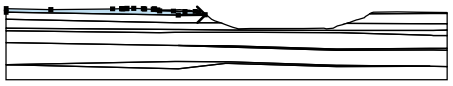
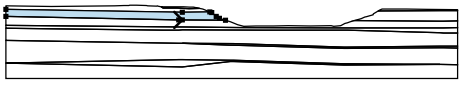
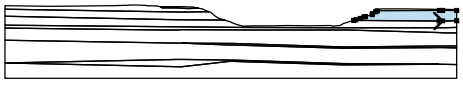
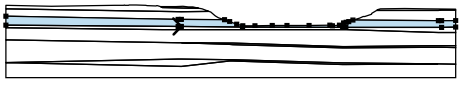
Redcued Level 62 - 61 m OD - MMG II
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Redcued Level 61 - 60 m OD - MMG II
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

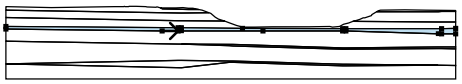
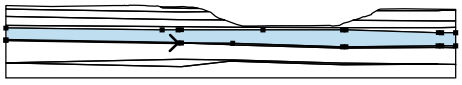
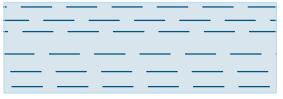
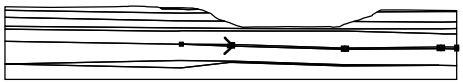
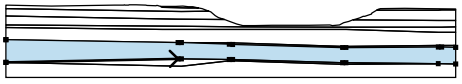
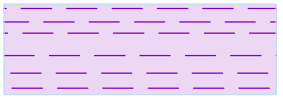
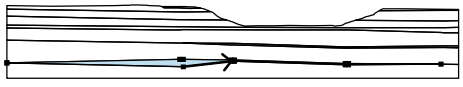
Redcued Level 60 - 59 m OD - MMG I
Unit weight : γ = 23.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 25.00 kPa
Saturated unit weight : γ_{sat} = 23.00 kN/m3

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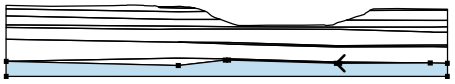
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		69.64	26.15	75.82	26.13	Topsoil/Subsoil
		81.08	25.91	85.72	25.98	
		83.12	26.53	81.20	26.53	
		78.71	26.77	75.55	26.66	
		68.81	26.70			
2		192.34	24.99	193.71	25.04	Firm to stiff red brown silty CLAY - MMG IVB
		200.01	25.05	200.01	25.44	
		186.58	25.59	177.34	25.78	
		166.50	25.65	165.61	25.34	
		164.83	24.88			
3		78.07	24.35	90.29	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		87.25	25.67	85.72	25.98	
		81.08	25.91	75.82	26.13	
		69.64	26.15	68.81	26.70	
		67.31	27.06	67.08	27.09	
		66.74	26.97	62.77	27.12	
		62.22	27.24	57.90	27.36	
		54.81	27.38	54.50	27.26	
		53.00	27.22	52.62	27.28	
		52.38	27.21	48.22	27.14	
		20.20	26.82	0.00	27.19	
		0.00	25.63			
4		76.57	20.90	78.07	20.90	Stiff red brown silty CLAY - MMG IVA
		97.22	20.81	94.54	21.65	
		93.15	22.46	91.14	24.15	
		90.29	24.48	78.07	24.35	
		0.00	25.63	0.00	22.41	
5		192.23	20.38	193.71	20.39	Stiff red brown silty CLAY - MMG IVA
		200.01	20.43	200.01	25.05	
		193.71	25.04	192.34	24.99	
		164.83	24.88	164.19	24.50	
		162.76	23.66	162.52	23.22	
		159.63	22.26	158.91	22.21	
		157.30	21.51	155.43	20.89	
		154.30	20.61			
6		76.57	17.80	78.07	17.81	Weathered Mudstone - MMG III
		105.15	17.50	149.75	17.34	
		151.25	17.34	193.71	17.40	
		200.01	17.50	200.01	20.43	
		193.71	20.39	192.23	20.38	
		154.30	20.61	152.44	19.98	
		151.27	19.68	150.11	19.37	
		148.32	18.35	145.20	18.13	
		144.04	18.41	134.80	18.25	
		125.01	18.28	118.47	18.25	
		110.76	18.16	105.37	18.10	
		102.64	18.75	99.55	20.01	
		97.22	20.81	78.07	20.90	

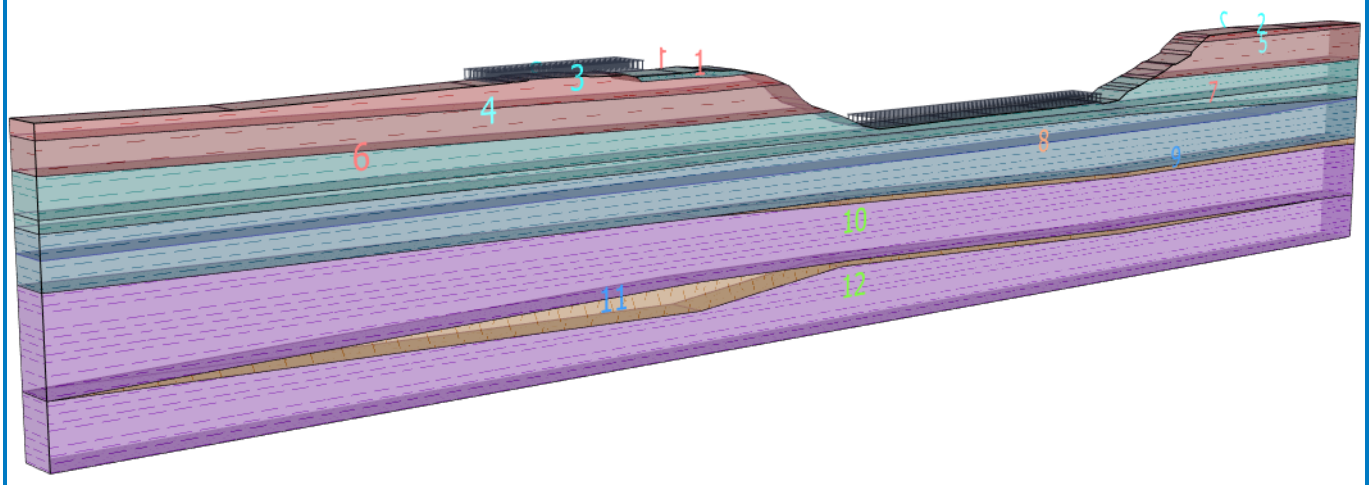
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
		76.57	20.90	0.00	22.41	
		0.00	18.42			
7		69.49	16.39	76.58	16.43	Weathered Mudstone - MMG III
		78.07	16.45	114.29	16.43	
		149.75	16.34	151.25	16.34	
		192.26	15.17	193.71	15.10	
		200.01	15.09	200.01	17.50	
		193.71	17.40	151.25	17.34	
		149.75	17.34	105.15	17.50	
		78.07	17.81	76.57	17.80	
		0.00	18.42	0.00	17.17	
8		0.01	11.78	76.57	10.55	Weathered Mudstone - MMG II
		78.07	10.55	100.86	10.36	
		149.75	8.89	151.25	8.89	
		192.15	9.24	193.71	9.23	
		200.01	9.28	200.01	15.09	
		193.71	15.10	192.26	15.17	
		151.25	16.34	149.75	16.34	
		114.29	16.43	78.07	16.45	
		76.58	16.43	69.49	16.39	
		0.00	17.17	0.00	11.78	
9		99.39	9.77	100.86	9.74	Sandstone - Interbedded Mudstone & Sandstone
		149.75	8.34	151.25	8.34	
		192.23	8.53	193.71	8.53	
		200.01	8.37	200.01	9.28	
		193.71	9.23	192.15	9.24	
		151.25	8.89	149.75	8.89	
		100.86	10.36	78.07	10.55	
10		0.01	1.78	76.58	3.30	Intact Mudstone - MMG I
		78.07	3.30	99.36	3.06	
		100.86	3.06	149.75	1.54	
		151.25	1.54	192.23	1.16	
		200.01	1.02	200.01	8.37	
		193.71	8.53	192.23	8.53	
		151.25	8.34	149.75	8.34	
		100.86	9.74	99.39	9.77	
		78.07	10.55	76.57	10.55	
		0.01	11.78	0.00	11.78	
		0.00	1.78			
11		78.07	0.00	99.36	2.46	Sandstone - Interbedded Mudstone & Sandstone
		100.86	2.46	149.75	0.94	
		151.25	0.94	192.23	1.16	
		151.25	1.54	149.75	1.54	
		100.86	3.06	99.36	3.06	
		78.07	3.30	76.58	3.30	
		0.01	1.78	0.00	1.78	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
12		151.25	0.94	149.75	0.94	Intact Mudstone - MMG I
		100.86	2.46	99.36	2.46	
		78.07	0.00	0.00	1.78	
		0.00	-5.00	200.01	-5.00	
		200.01	1.02	192.23	1.16	

Name : Soils and assignment **Stage : 1**



Surcharge

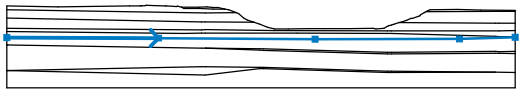
No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	Magnitude q_2	Magnitude unit
1	strip	permanent	on terrain	x = 50.00	l = 20.00		0.00	20.00		kN/m²
2	strip	permanent	on terrain	x = 105.00	l = 40.00		0.00	20.00		kN/m²

Surcharges

No.	Name
1	A453 Highway UDL
2	M1 Highway UDL

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	14.74	59.68	14.51	121.33	14.05
		178.10	14.16	200.01	14.86		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

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Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	94.61	[m]	Angles :	α_1 =	-61.23	[°]
	z =	28.23	[m]		α_2 =	-0.05	[°]
Radius :	R =	6.60	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1
Sum of active forces : F_a = 54.40 kN/m
Sum of passive forces : F_p = 83.53 kN/m

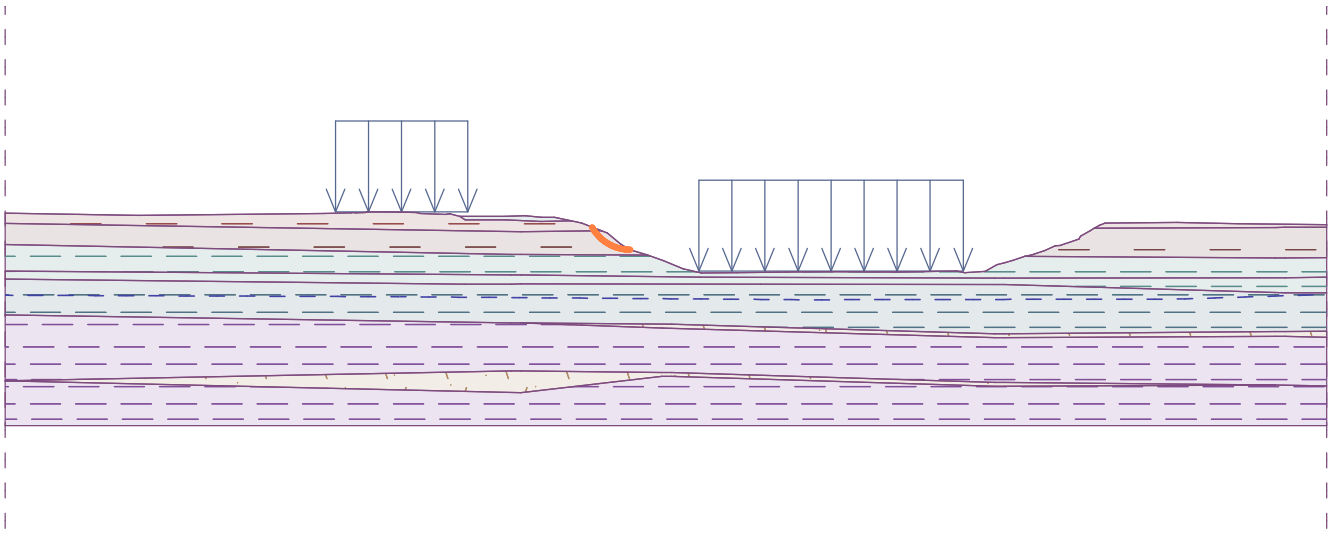
Sliding moment : M_a = 299.19 kNm/m
Resisting moment : M_p = 459.44 kNm/m
Utilization : 65.1 %

Slope stability ACCEPTABLE
Combination 2
Sum of active forces : F_a = 50.42 kN/m
Sum of passive forces : F_p = 68.44 kN/m

Sliding moment : M_a = 332.76 kNm/m
Resisting moment : M_p = 451.69 kNm/m
Utilization : 73.7 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 1 - 1



Analysis 2

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
86.83	25.75	89.24	23.96	90.05	23.40	90.82	22.87	91.78	22.26
92.75	21.84	93.74	21.65	94.55	21.65				
The slip surface after optimization.									

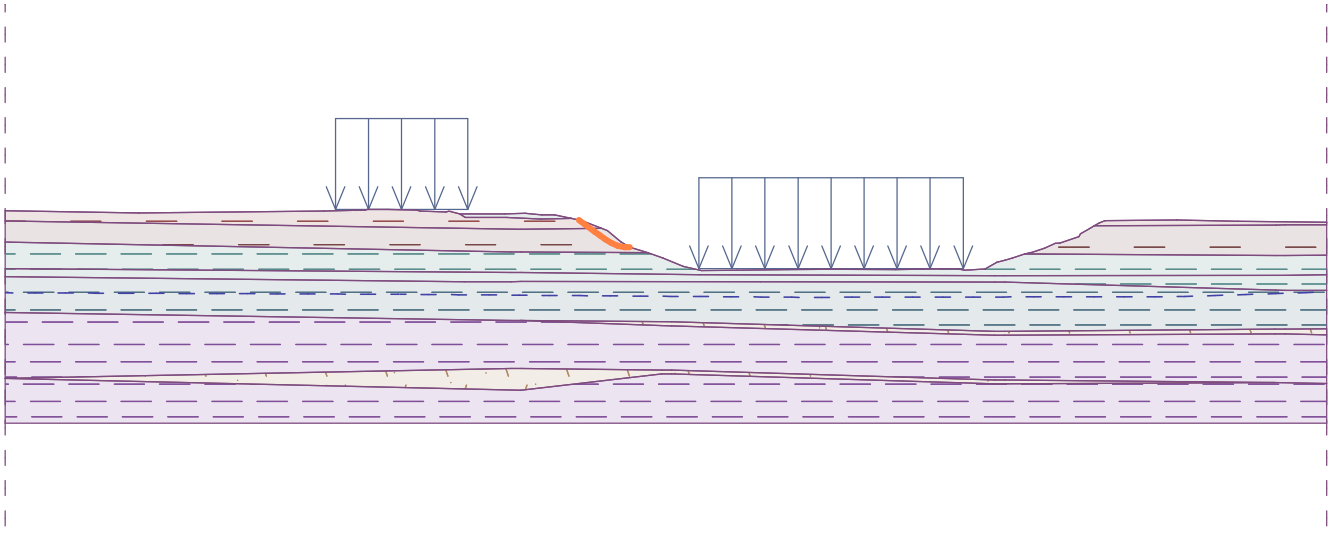
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Slope stability verification (Sarma)
Combination 1
Utilization : 66.6 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 74.6 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 1 - 2



Analysis 3

Circular slip surface

Slip surface parameters							
Center :	x =	161.90	[m]	Angles :	α_1 =	-1.26	[°]
	z =	28.83	[m]		α_2 =	57.18	[°]
Radius :	R =	5.86	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1
Sum of active forces : F_a = 38.05 kN/m
Sum of passive forces : F_p = 65.24 kN/m

Sliding moment : M_a = 195.57 kNm/m
Resisting moment : M_p = 335.33 kNm/m
Utilization : 58.3 %

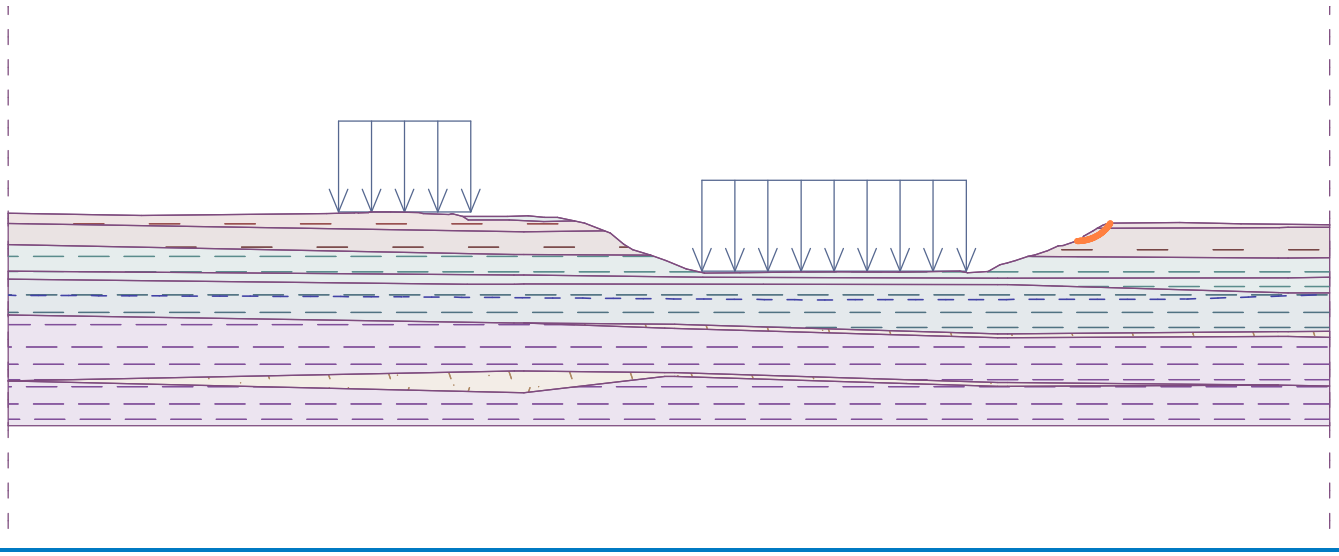
Slope stability ACCEPTABLE
Combination 2
Sum of active forces : F_a = 34.52 kN/m
Sum of passive forces : F_p = 52.39 kN/m

Sliding moment : M_a = 202.27 kNm/m
Resisting moment : M_p = 306.98 kNm/m
Utilization : 65.9 %

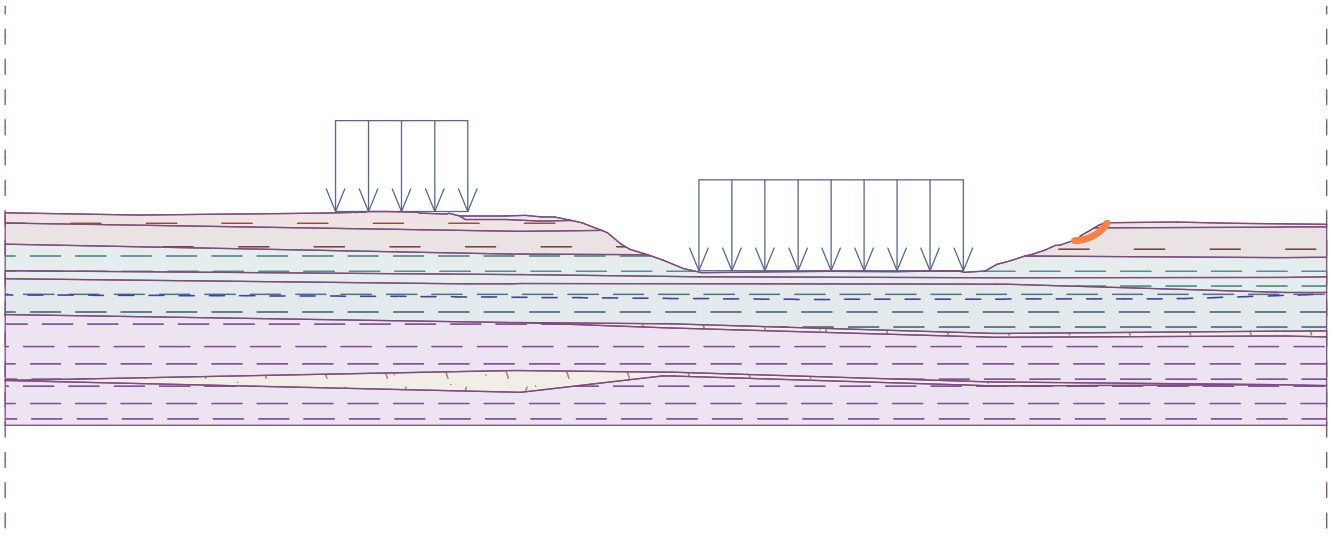
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

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Name : Analysis	Stage - analysis : 1 - 3



Name : Analysis	Stage - analysis : 1 - 3



Analysis 4

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
161.82	22.99	162.56	22.91	163.44	23.16	164.18	23.48	164.92	23.91
165.62	24.43	166.33	25.06	166.96	25.66				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 59.0 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 66.4 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

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ANNEX B.4

EMG-HYD-C4-M1OB-CA-GE-0662

Slope stability analysis

Input data

Project

Task : EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part : M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description : M1 OVERBRIDGE SHORT-TERM STABILITY - DURING CONSTRUCTION
Customer : ROXHILL KEGWORTH LTD
Author : Ian Gardner
Date : 03/08/2017 16:38:13
Project ID : C14792
Project number : EMG-HYD-C4-M1OB-CA-GE-0662-S4-P2

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

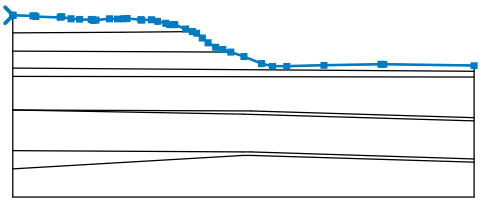
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)

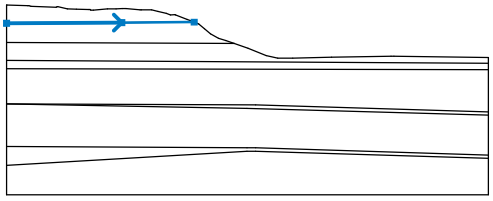
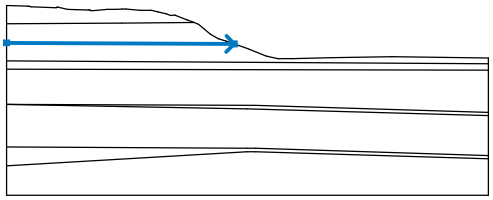
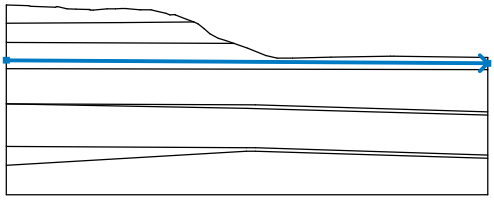
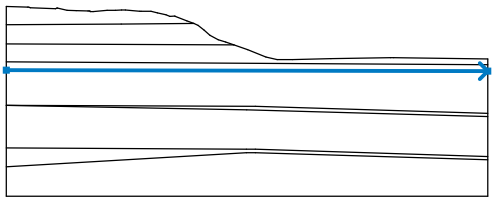
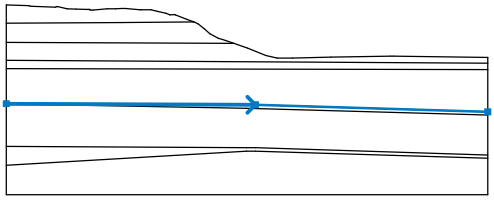
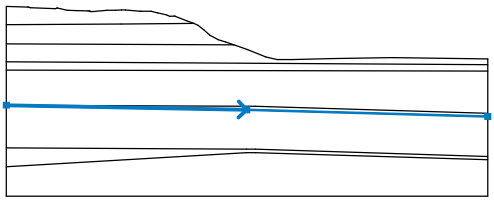
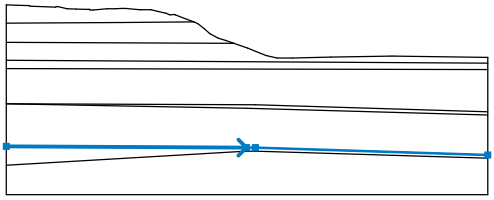
Permanent design situation

		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]

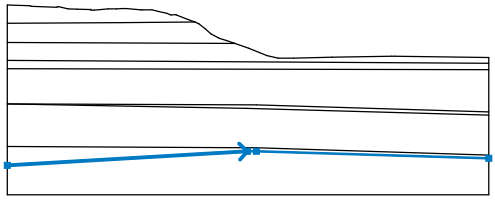
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	27.29	0.06	27.29	3.58	27.18
		3.80	27.20	4.10	27.06	8.41	26.92
		8.59	27.04	8.71	27.03	10.35	26.65
		11.86	26.58	13.90	26.52	14.05	26.55
		14.20	26.52	14.29	26.40	14.76	26.43
		17.15	26.66	18.60	26.64	19.64	26.68
		20.28	26.71	22.71	26.48	22.91	26.46
		24.63	26.48	25.72	26.22	27.16	25.88
		27.85	25.61	28.65	25.64	28.76	25.62
		30.70	24.86	31.90	24.38	32.65	24.10
		33.65	23.25	34.66	22.41	36.05	21.60
		37.30	21.23	38.73	20.76	41.06	19.96
		44.15	18.70	46.09	18.23	48.68	18.23
		55.24	18.40	65.36	18.58	65.88	18.57
		81.92	18.34				

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No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		0.00	24.19	19.58	24.30	31.90	24.38
3		0.00	20.94	38.73	20.76		
4		0.00	17.89	81.92	17.36		
5		0.00	16.44	81.92	16.30		
6		0.00	10.49	42.37	10.31	81.92	9.12
7		0.00	10.49	40.90	9.72	81.92	8.55
8		0.00	3.24	40.87	3.01	42.37	3.01
		81.92	1.76				

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No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
9		0.00	0.00	40.87	2.41	42.37	2.41
		81.92	1.19				

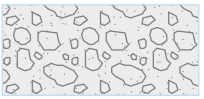
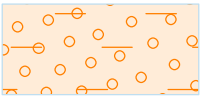
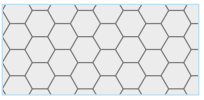
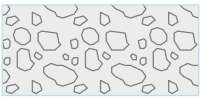
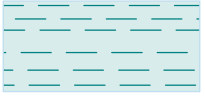
Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Intact Mudstone - MMG I		42.00	25.00	23.00
2	Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50
3	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00
4	Terrace Sands & Gravels		35.00	0.00	22.00
5	Culvert		41.50	0.00	2.40
6	Granular Backfill to Culvert		41.50	0.00	18.00
7	Class 6N Selected Backfill to Structures		41.50	0.00	22.50
8	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50
9	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50
10	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50
11	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50
12	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
13	Redcued Level 60 - 59 m OD - MMG I		42.00	25.00	23.00

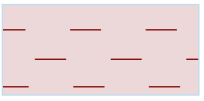
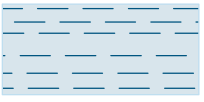
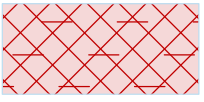
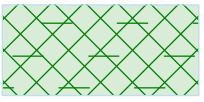
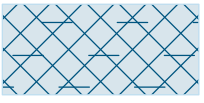
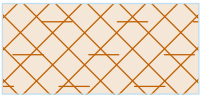
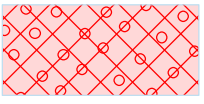
Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Intact Mudstone - MMG I		23.00		
2	Sandstone - Interbedded Mudstone & Sandstone		23.00		
3	Class 6F Capping/Subbase/Surfacing		21.50		
4	Terrace Sands & Gravels		22.50		
5	Culvert		2.40		
6	Granular Backfill to Culvert		18.00		
7	Class 6N Selected Backfill to Structures		23.00		
8	Redcued Level 65 - 64 m OD - MMG II		22.50		
9	Redcued Level 64 - 63 m OD - MMG II		22.50		
10	Redcued Level 63 - 62 m OD - MMG II		22.50		
11	Redcued Level 62 - 61 m OD - MMG II		22.50		
12	Redcued Level 61 - 60 m OD - MMG II		22.50		

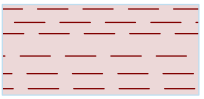
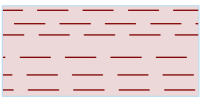
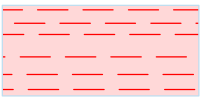
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No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
13	Redcued Level 60 - 59 m OD - MMG I		23.00		

Soil parameters - total stress state

No.	Name	Pattern	c_u [kPa]	γ [kN/m^3]
1	Topsoil/Subsoil		35.00	16.50
2	Firm to stiff red brown silty CLAY - MMG IVB		65.00	19.50
3	Stiff red brown silty CLAY - MMG IVA		90.00	20.50
4	Weathered Mudstone - MMG III		150.00	22.00
5	Weathered Mudstone - MMG II		225.00	22.50
6	Existing Highway General Fill		60.00	19.50
7	Class 2 Fill (Site Won MMG IV)		50.00	19.50
8	Landscape Fill - Class 4		50.00	20.00
9	Class 7A Selected Cohesive Fill		100.00	20.50
10	Class 7C Selected Cohesive Fill		100.00	20.50
11	Pre-existing Made Ground		50.00	19.00
12	Redcued Level 78 - 77 m OD - MMG IVB		33.00	19.50

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No.	Name	Pattern	c_u [kPa]	γ [kN/m^3]
13	Redcued Level 77 - 76 m OD - MMG IVB		67.00	19.50
14	Redcued Level 76 - 75 m OD - MMG IVB		100.00	19.50
15	Redcued Level 75 - 74 m OD - MMG IVA		133.00	20.50
16	Redcued Level 74 - 73 m OD - MMG IVA		167.00	20.50
17	Redcued Level 73 - 72 m OD - MMG IVA		200.00	20.50
18	Redcued Level 72 - 71 m OD - MMG IVA		233.00	20.50
19	Redcued Level 71 - 70 m OD - MMG III		267.00	22.00
20	Redcued Level 70 - 69 m OD - MMG III		300.00	22.00
21	Redcued Level 69 - 68 m OD - MMG III		333.00	22.00
22	Redcued Level 68 - 67 m OD - MMG III		367.00	22.00
23	Redcued Level 67 - 66 m OD - MMG III		400.00	22.00
24	Redcued Level 66 - 65 m OD - MMG III		433.00	22.00

Soil parameters

Topsoil/Subsoil

Unit weight : γ = 16.50 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 35.00 kPa

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight : γ = 19.50 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 65.00 kPa

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Stiff red brown silty CLAY - MMG IVA

Unit weight :	γ =	20.50 kN/m^3
Stress-state :		total
Cohesion of soil :	c_u =	90.00 kPa

Weathered Mudstone - MMG III

Unit weight :	γ =	22.00 kN/m^3
Stress-state :		total
Cohesion of soil :	c_u =	150.00 kPa

Weathered Mudstone - MMG II

Unit weight :	γ =	22.50 kN/m^3
Stress-state :		total
Cohesion of soil :	c_u =	225.00 kPa

Intact Mudstone - MMG I

Unit weight :	γ =	23.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Saturated unit weight :	γ_{sat} =	23.00 kN/m^3

Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	γ =	22.50 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	40.00 °
Cohesion of soil :	c_{ef} =	8.00 kPa
Saturated unit weight :	γ_{sat} =	23.00 kN/m^3

Existing Highway General Fill

Unit weight :	γ =	19.50 kN/m^3
Stress-state :		total
Cohesion of soil :	c_u =	60.00 kPa

Class 2 Fill (Site Won MMG IV)

Unit weight :	γ =	19.50 kN/m^3
Stress-state :		total
Cohesion of soil :	c_u =	50.00 kPa

Class 6F Capping/Subbase/Surfacing

Unit weight :	γ =	21.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	35.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	γ =	20.00 kN/m^3
Stress-state :		total
Cohesion of soil :	c_u =	50.00 kPa

Terrace Sands & Gravels

Unit weight :	γ =	22.00 kN/m^3
Stress-state :		effective

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Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Class 7A Selected Cohesive Fill
Unit weight : γ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

Class 7C Selected Cohesive Fill
Unit weight : γ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

Pre-existing Made Ground
Unit weight : γ = 19.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 50.00 kPa

Culvert
Unit weight : γ = 2.40 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 2.40 kN/m3

Granular Backfill to Culvert
Unit weight : γ = 18.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m3

Class 6N Selected Backfill to Structures
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 23.00 kN/m3

Redcued Level 78 - 77 m OD - MMG IVB
Unit weight : γ = 19.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 33.00 kPa

Redcued Level 77 - 76 m OD - MMG IVB
Unit weight : γ = 19.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 67.00 kPa

Redcued Level 76 - 75 m OD - MMG IVB
Unit weight : γ = 19.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

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Redcued Level 75 - 74 m OD - MMG IVA
Unit weight : γ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 133.00 kPa

Redcued Level 74 - 73 m OD - MMG IVA
Unit weight : γ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 167.00 kPa

Redcued Level 73 - 72 m OD - MMG IVA
Unit weight : γ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 200.00 kPa

Redcued Level 72 - 71 m OD - MMG IVA
Unit weight : γ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 233.00 kPa

Redcued Level 71 - 70 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 267.00 kPa

Redcued Level 70 - 69 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 300.00 kPa

Redcued Level 69 - 68 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 333.00 kPa

Redcued Level 68 - 67 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 367.00 kPa

Redcued Level 67 - 66 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 400.00 kPa

Redcued Level 66 - 65 m OD - MMG III
Unit weight : γ = 22.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 433.00 kPa

Redcued Level 65 - 64 m OD - MMG II
Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

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Redcued Level 64 - 63 m OD - MMG II

Unit weight :	γ =	22.50 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	γ_{sat} =	22.50 kN/m^3

Redcued Level 63 - 62 m OD - MMG II

Unit weight :	γ =	22.50 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	γ_{sat} =	22.50 kN/m^3

Redcued Level 62 - 61 m OD - MMG II

Unit weight :	γ =	22.50 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	γ_{sat} =	22.50 kN/m^3

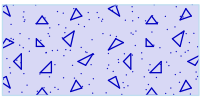
Redcued Level 61 - 60 m OD - MMG II

Unit weight :	γ =	22.50 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	γ_{sat} =	22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I

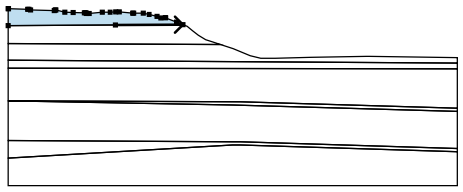
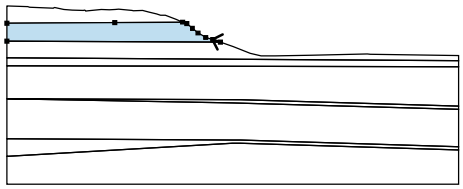
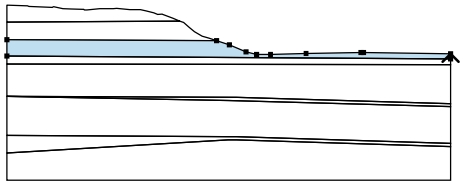
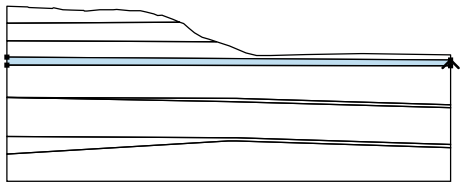
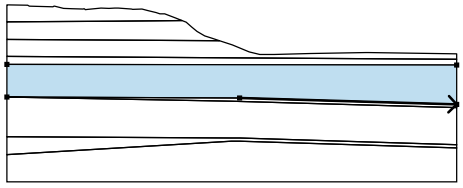
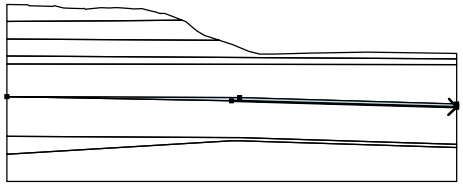
Unit weight :	γ =	23.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Saturated unit weight :	γ_{sat} =	23.00 kN/m^3

Rigid bodies

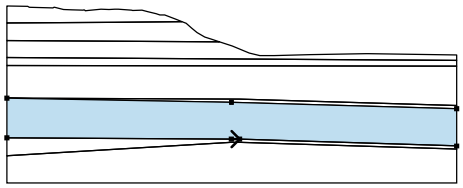
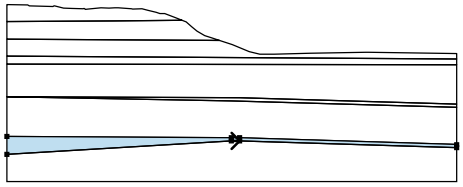
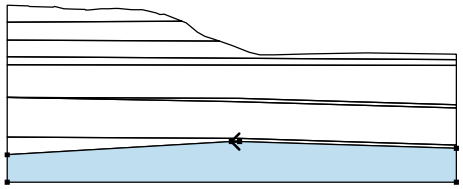
No.	Name	Sample	γ [kN/m^3]
1	CONCRETE FOOTING		24.00
2	WING WALL		24.00
3	BRIDGE ABUTMENT		24.00

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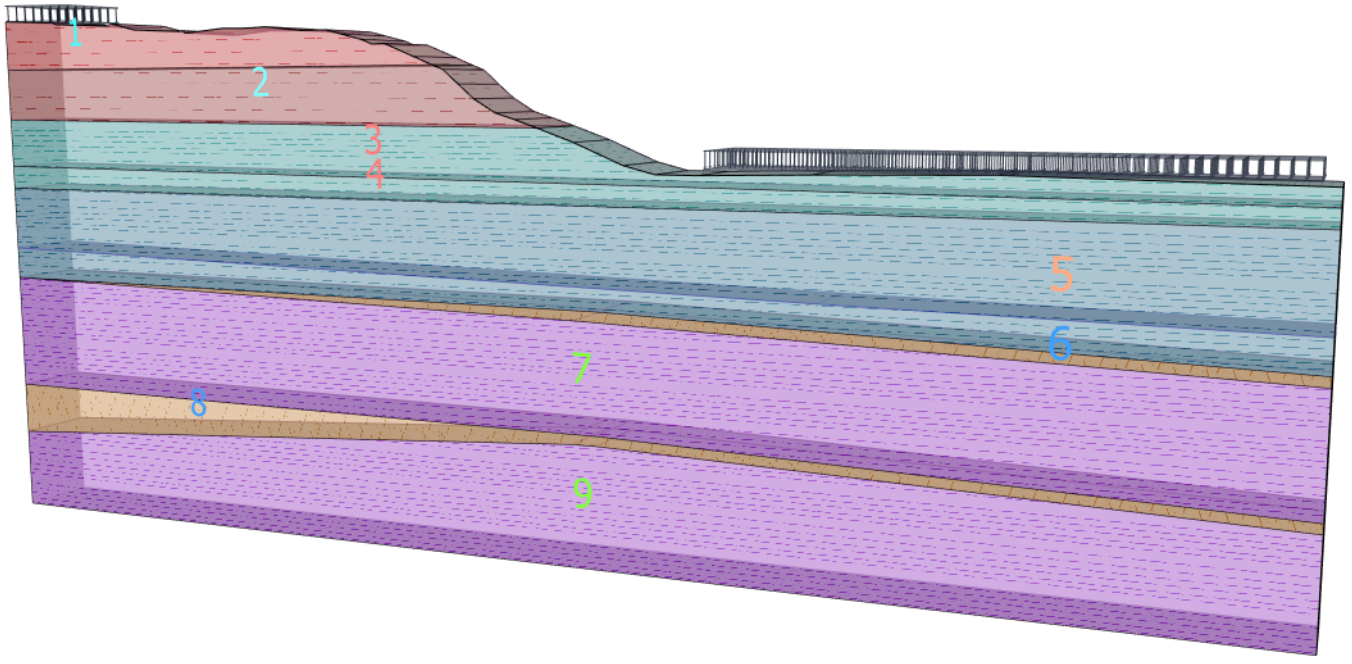
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		19.58	24.30	31.90	24.38	Firm to stiff red brown silty CLAY - MMG IVB
		30.70	24.86	28.76	25.62	
		28.65	25.64	27.85	25.61	
		27.16	25.88	25.72	26.22	
		24.63	26.48	22.91	26.46	
		22.71	26.48	20.28	26.71	
		19.64	26.68	18.60	26.64	
		17.15	26.66	14.76	26.43	
		14.29	26.40	14.20	26.52	
		14.05	26.55	13.90	26.52	
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		38.73	20.76	37.30	21.23	Stiff red brown silty CLAY - MMG IVA
		36.05	21.60	34.66	22.41	
		33.65	23.25	32.65	24.10	
		31.90	24.38	19.58	24.30	
		0.00	24.19	0.00	20.94	
3		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	44.15	18.70	
		41.06	19.96	38.73	20.76	
		0.00	20.94	0.00	17.89	
4		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		0.00	17.89	0.00	16.44	
5		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
6		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
8		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
9		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 1**



Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	Magnitude q_2	Magnitude unit
1	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

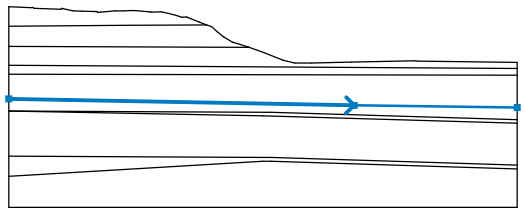
Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

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Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters							
Center :	x =	36.82	[m]	Angles :	α_1 =	-57.88	[°]
	z =	38.31	[m]		α_2 =	24.20	[°]
Radius :	R =	21.94	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 1004.21 kN/m
Sum of passive forces : F_p = 4076.13 kN/m

Sliding moment : M_a = 20556.08 kNm/m
Resisting moment : M_p = 83438.43 kNm/m
Utilization : 24.6 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : F_a = 735.47 kN/m
Sum of passive forces : F_p = 2969.75 kN/m

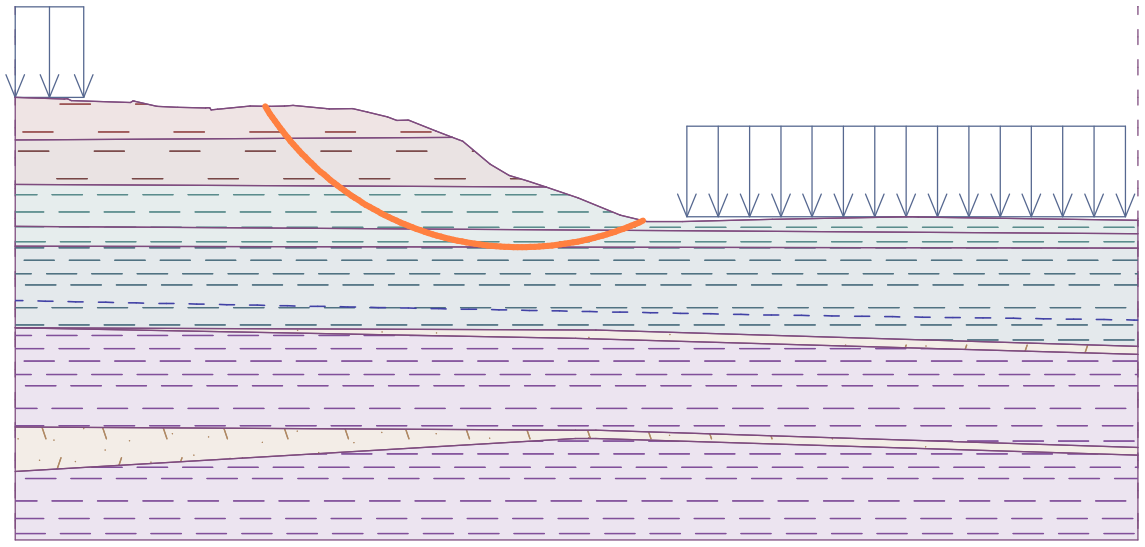
Sliding moment : M_a = 16136.29 kNm/m
Resisting moment : M_p = 65156.35 kNm/m
Utilization : 24.8 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

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Name : Analysis	Stage - analysis : 1 - 1



Analysis 2 (stage 1)

Polygonal slip surface

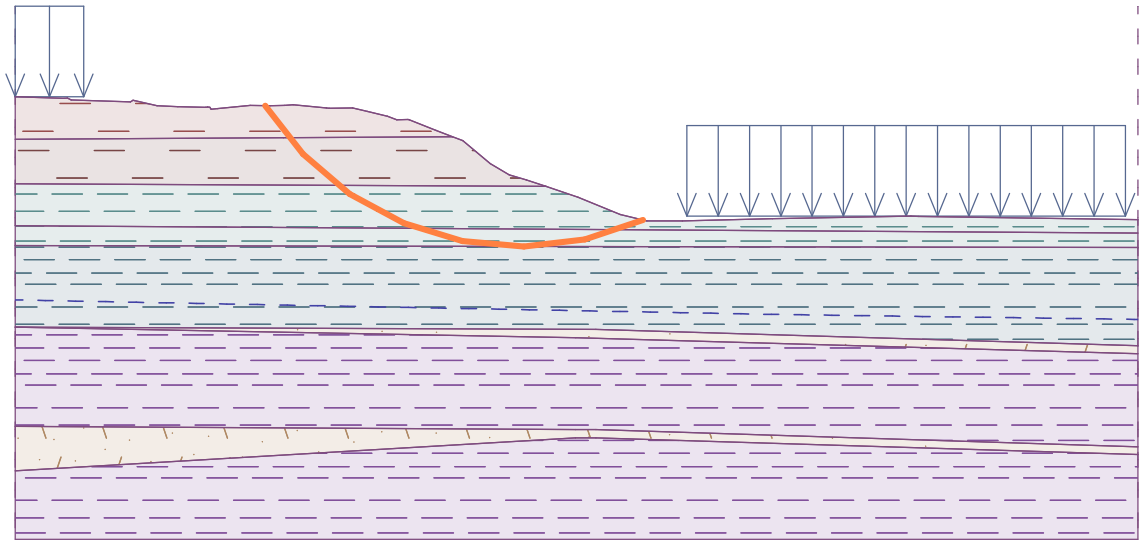
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
18.24	26.64	21.00	23.11	24.41	20.21	28.35	18.07	32.64	16.77
37.11	16.37	41.56	16.89	45.81	18.30				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 23.6 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 23.8 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

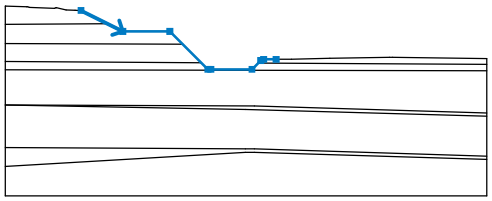
Name : Analysis	Stage - analysis : 1 - 2



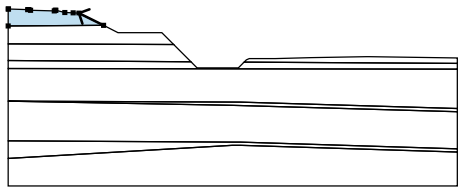
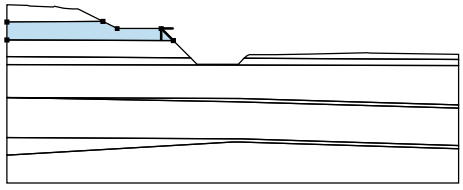
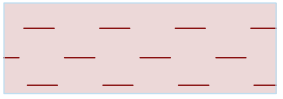
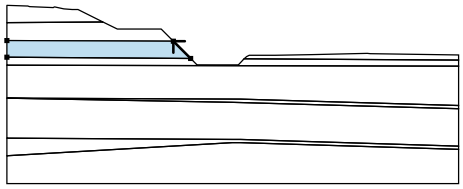
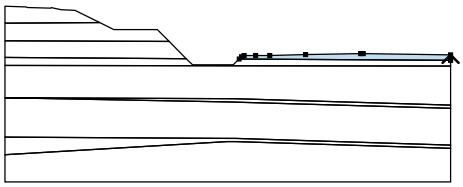
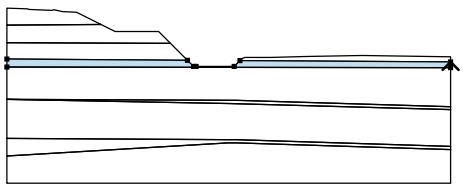
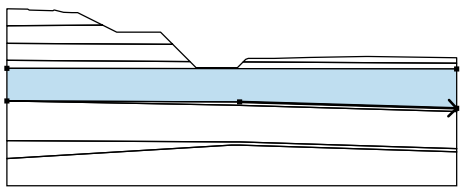
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Input data (Stage of construction 2)

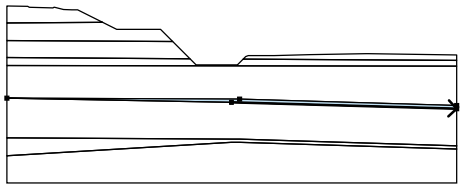
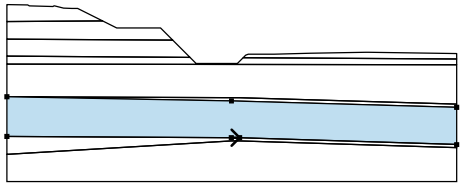
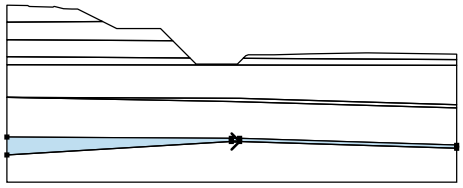
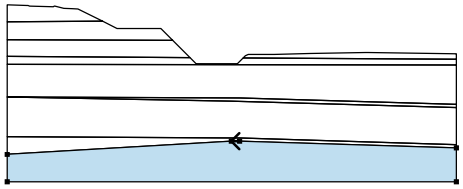
Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		12.89	26.55	20.01	22.99	28.01	22.99
		34.47	16.53	34.97	16.53	41.97	16.53
		43.47	18.03	43.97	18.23	46.09	18.23

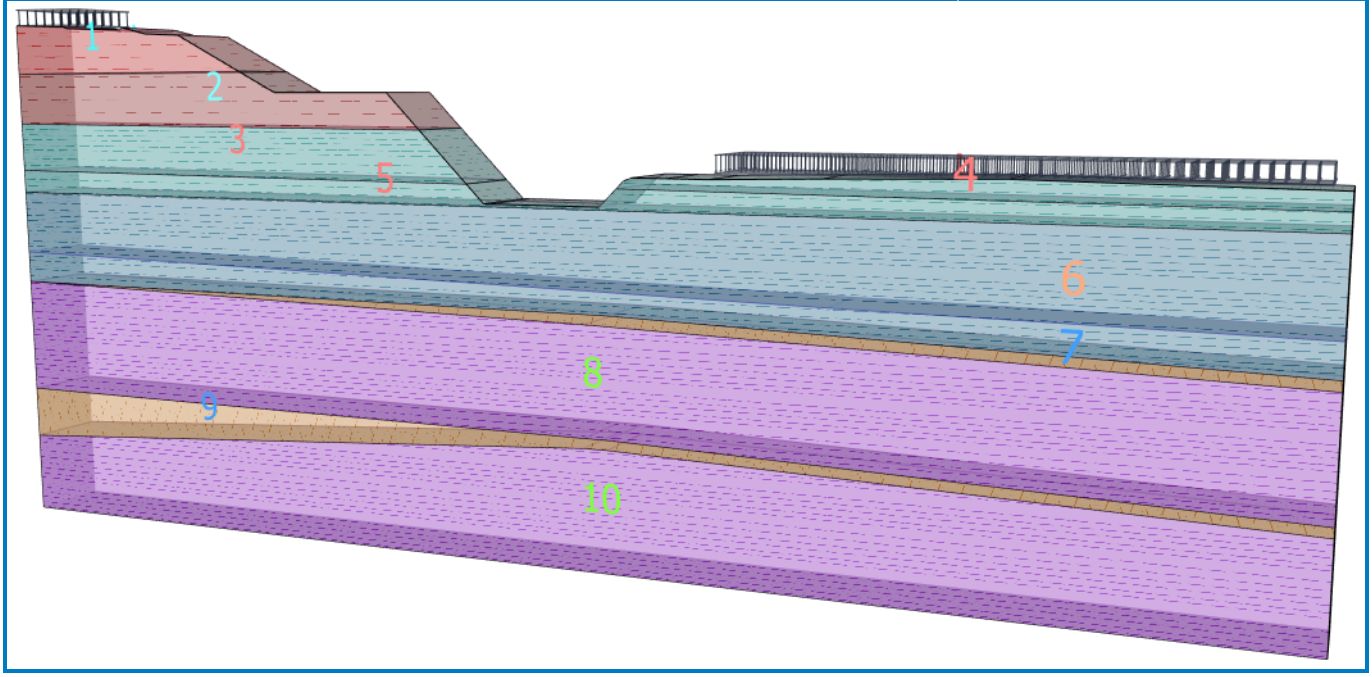
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
4		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.47	18.03	43.05	17.61	
5		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.05	17.61	41.97	16.53	
		34.97	16.53	34.47	16.53	
		33.33	17.67	0.00	17.89	
		0.00	16.44			
6		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
8		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
9		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
10		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 2**



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Surcharge

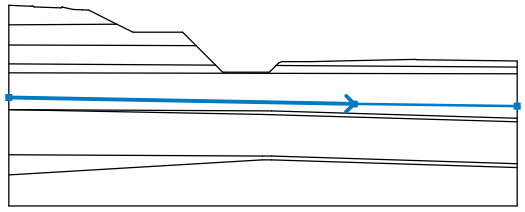
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
0.21	27.29	4.48	23.54	8.47	21.28	13.01	18.74	17.39	16.85
19.39	16.46	33.00	16.40	34.45	16.55				
The slip surface after optimization.									

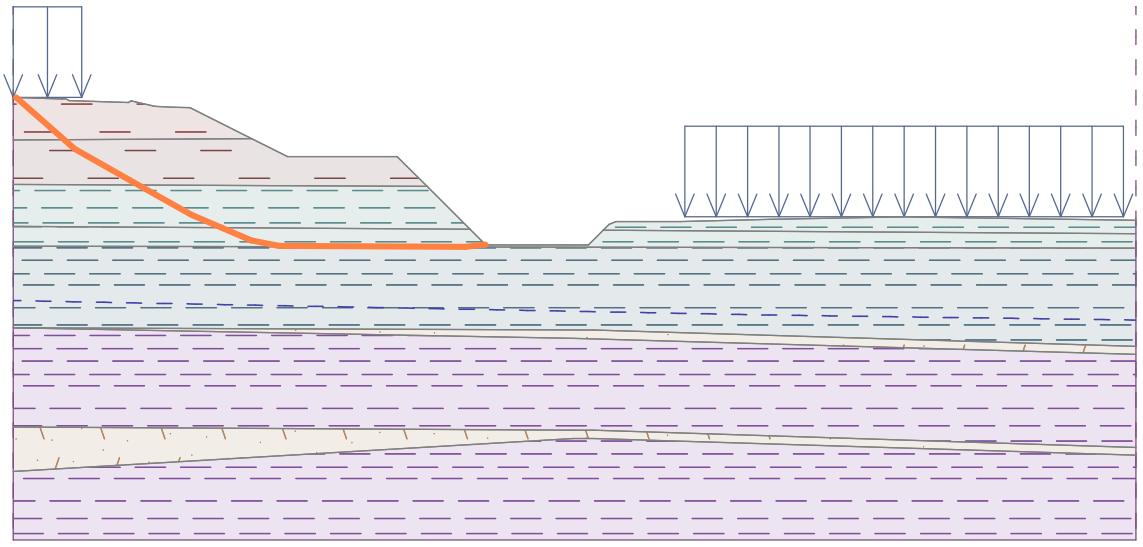
Slope stability verification (Sarma)
Combination 1
Utilization : 27.8 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 27.9 %

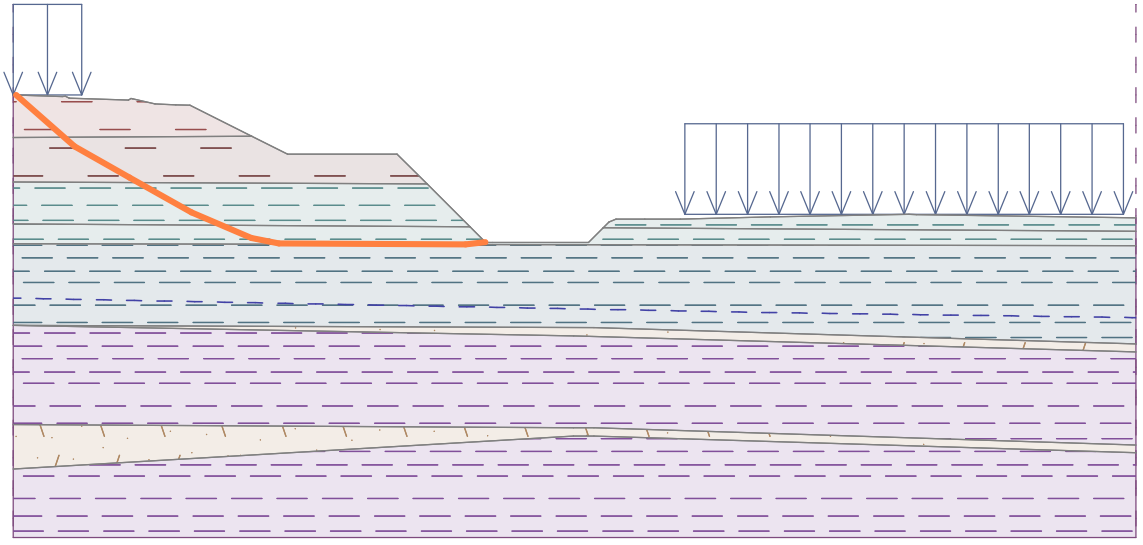
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

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Name : Analysis	Stage - analysis : 2 - 1

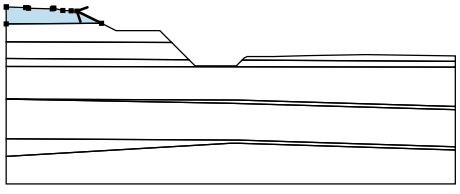


Name : Analysis	Stage - analysis : 2 - 1

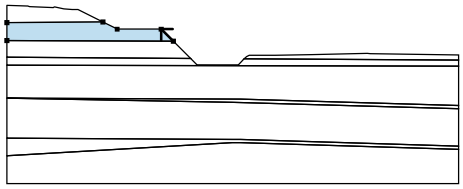
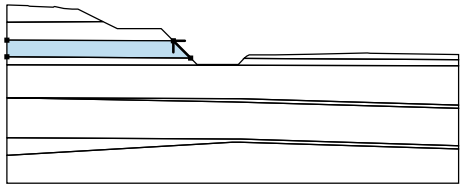
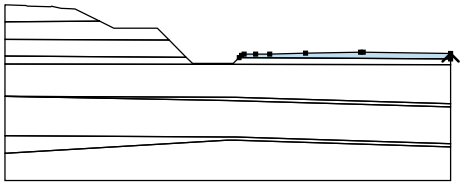
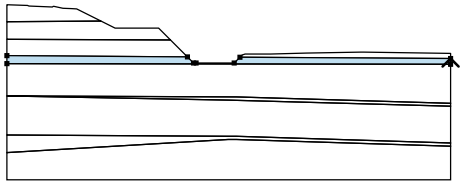
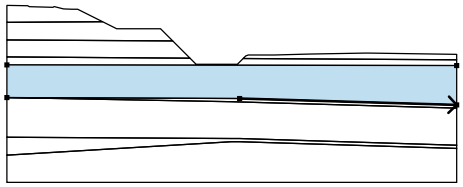
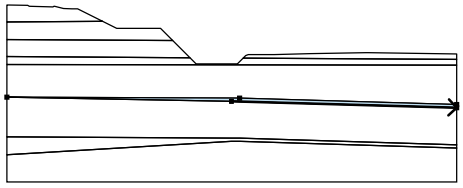
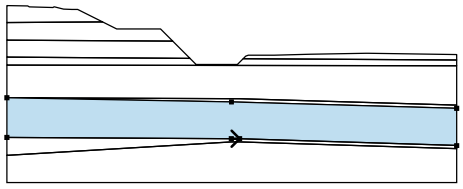
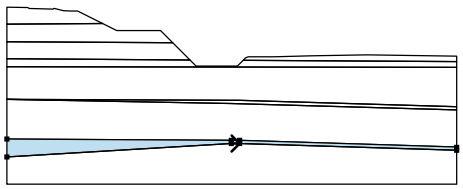


Input data (Stage of construction 3)

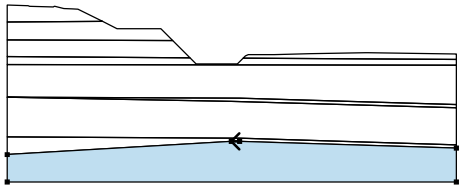
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			

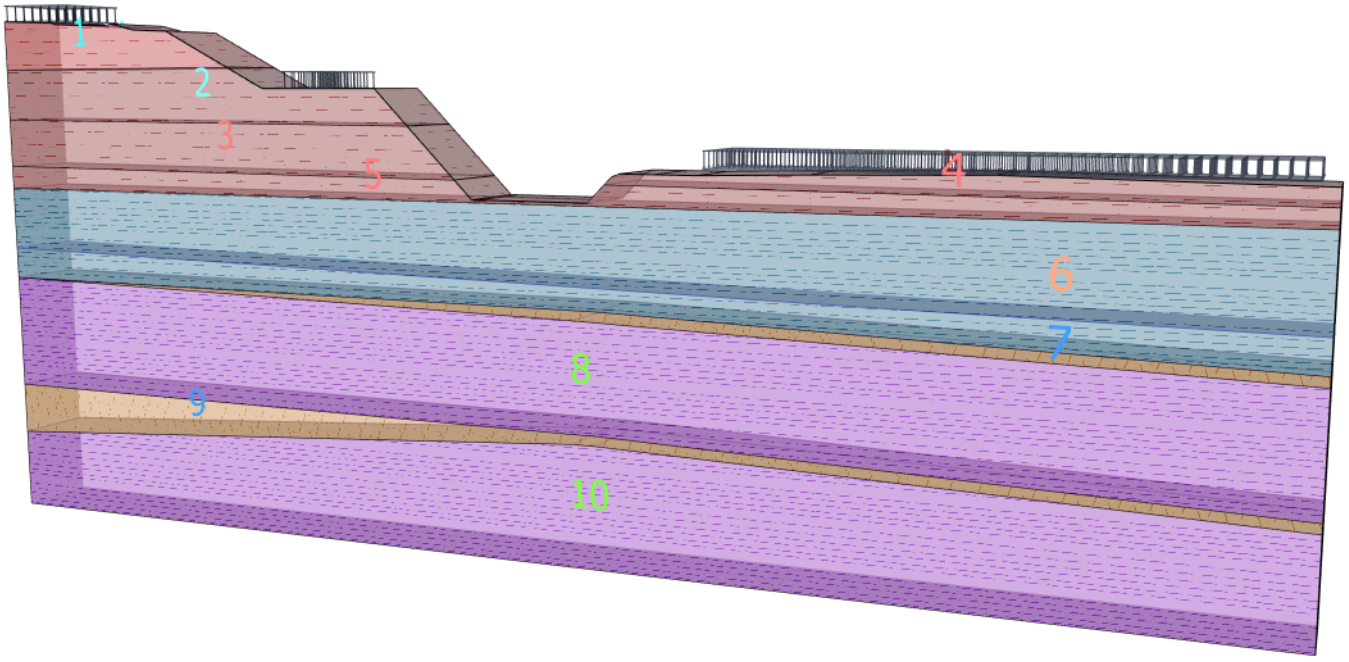
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
4		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.47	18.03	43.05	17.61	
5		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.05	17.61	41.97	16.53	
		34.97	16.53	34.47	16.53	
		33.33	17.67	0.00	17.89	
		0.00	16.44			
6		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
7		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
8		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
9		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
10		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 3**



Surcharge

No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2
3	No	No	strip	permanent	on terrain	x = 21.50	l = 3.50		0.00	20.00		kN/m^2

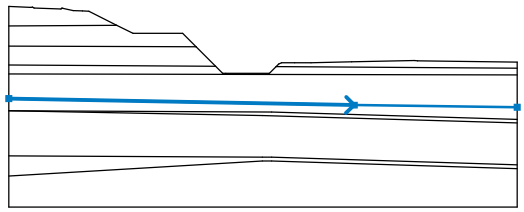
Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	TEMPORARY - SITE PLANT 20 kN/m^2

Water

Water type : GWT

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No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters							
Center :	x =	32.60	[m]	Angles :	α_1 =	-64.30	[°]
	z =	28.05	[m]		α_2 =	9.22	[°]
Radius :	R =	11.67	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 2479.53 kN/m
Sum of passive forces : F_p = 9572.73 kN/m

Sliding moment : M_a = 63525.49 kNm/m
Resisting moment : M_p = 245253.45 kNm/m
Utilization : 25.9 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : F_a = 389.59 kN/m
Sum of passive forces : F_p = 1494.92 kN/m

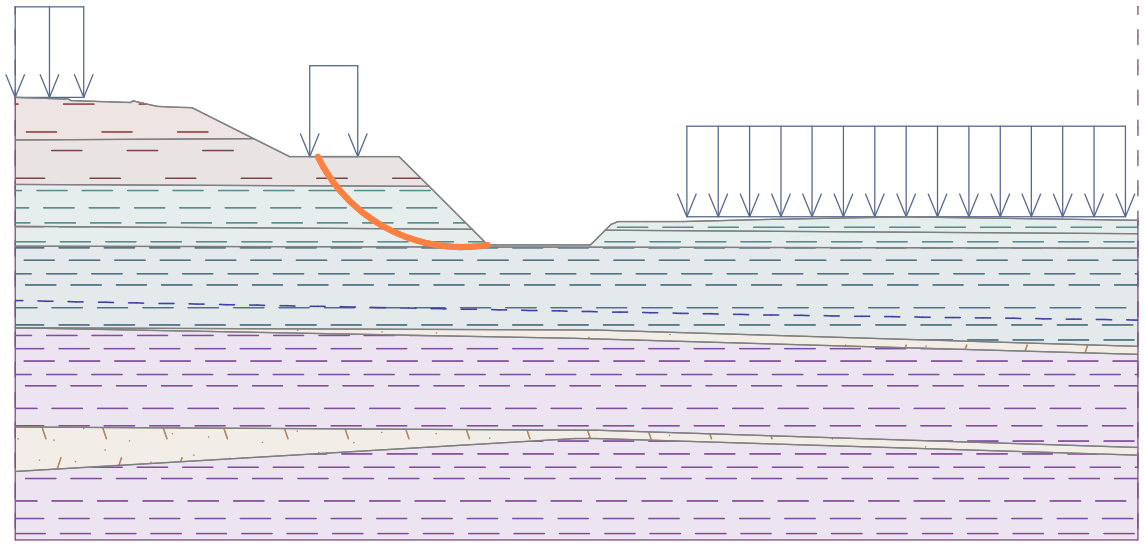
Sliding moment : M_a = 4546.49 kNm/m
Resisting moment : M_p = 17445.70 kNm/m
Utilization : 26.1 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

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Name : Analysis	Stage - analysis : 3 - 1



Analysis 2 (stage 3)

Polygonal slip surface

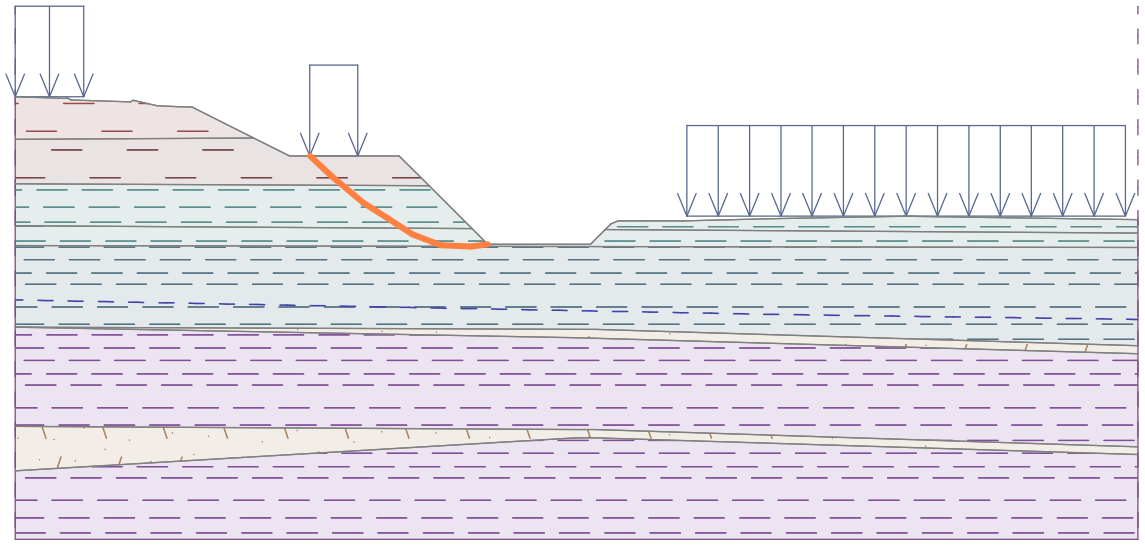
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
21.51	22.99	23.07	21.52	25.39	19.56	27.19	18.43	28.98	17.25
31.06	16.46	33.31	16.38	34.47	16.53				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 22.4 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 23.2 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

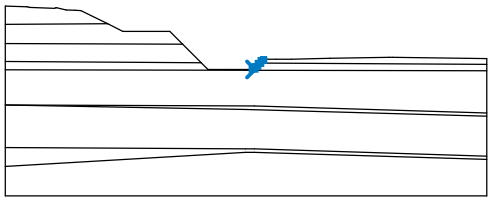
Name : Analysis	Stage - analysis : 3 - 2



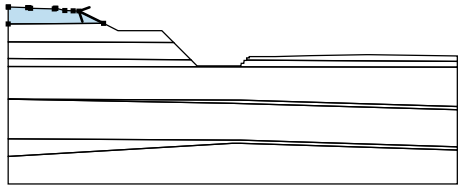
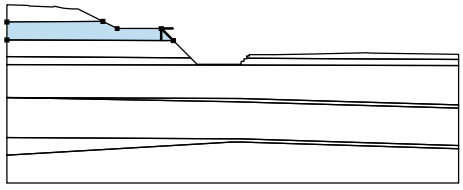
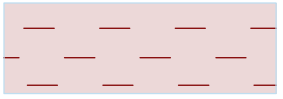
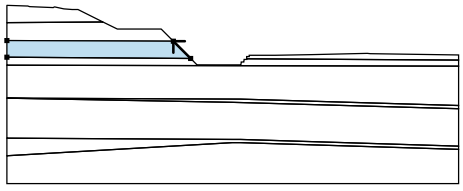
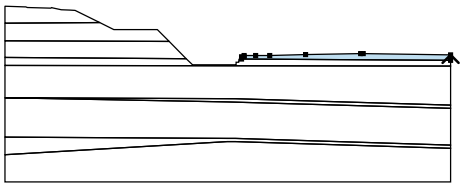
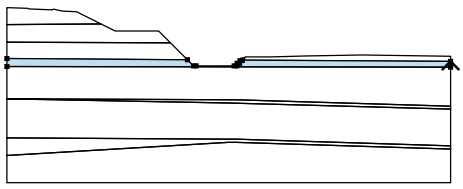
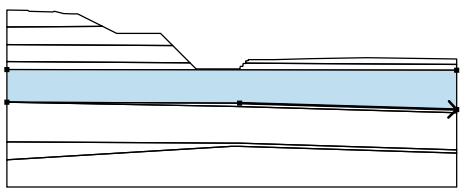
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Input data (Stage of construction 4)

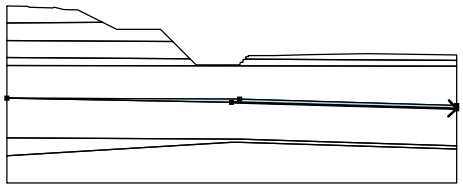
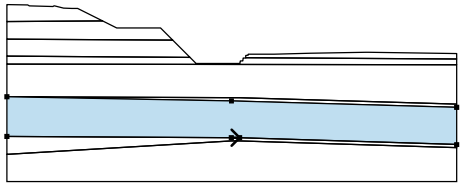
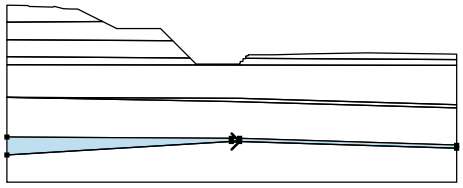
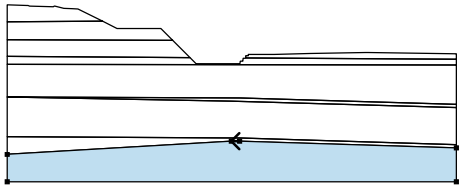
Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		41.97	16.53	42.47	16.53	42.51	17.03
		42.97	17.03	43.01	17.53	43.47	17.53
		43.51	18.02	43.97	18.03	43.97	18.23

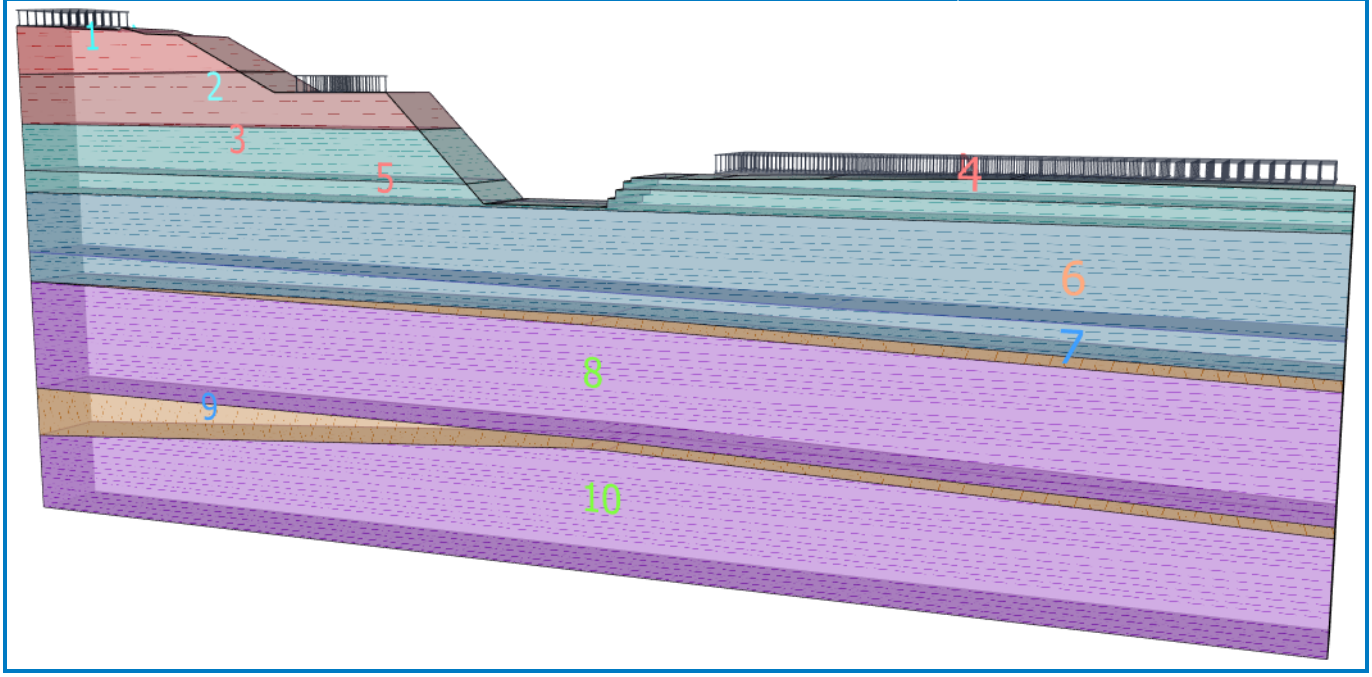
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
4		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
5		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.33	17.67	
		0.00	17.89	0.00	16.44	
6		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
8		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
9		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
10		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 4**



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Surcharge

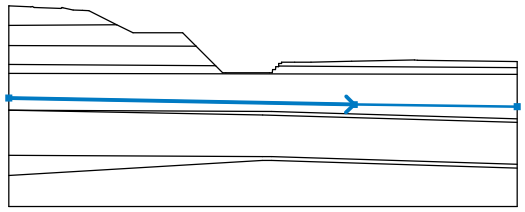
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2
3	No	No	strip	permanent	on terrain	x = 21.50	l = 3.50		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	TEMPORARY - SITE PLANT 20 kN/m^2

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 4)

Analysis 1 (stage 4)

Circular slip surface

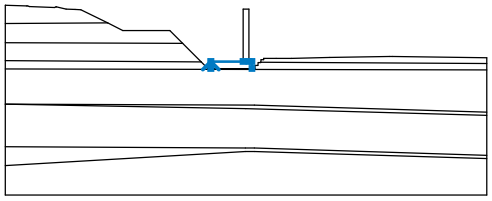
Slip surface is not specified

Slope stability verification (Bishop)

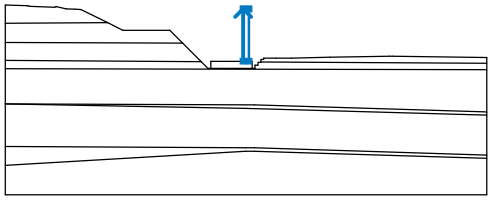
Analysis has not been performed.

Input data (Stage of construction 5)

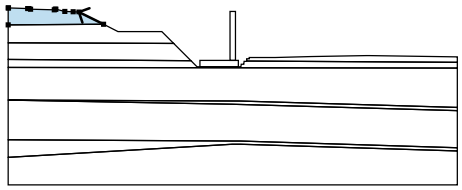
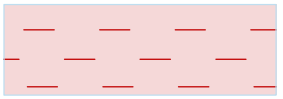
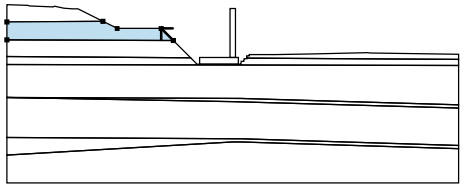
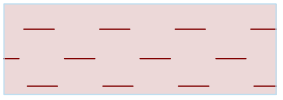
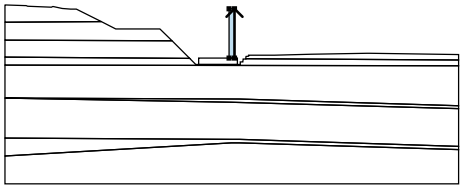
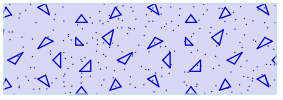
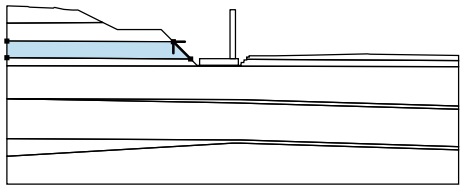
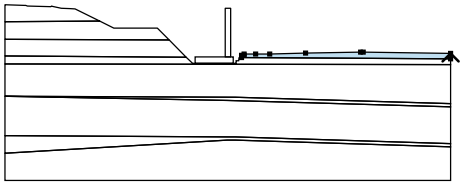
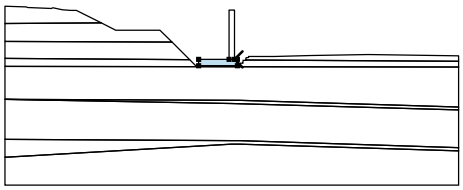
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		34.97	16.53	34.97	17.73	40.47	17.73
		41.47	17.73	41.97	17.73	41.97	16.53

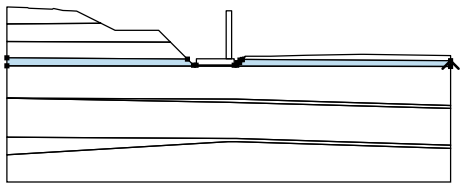
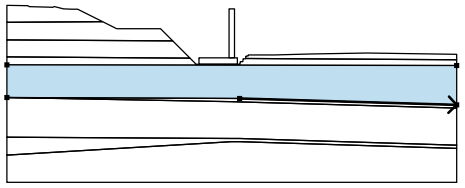
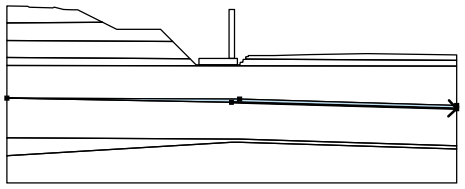
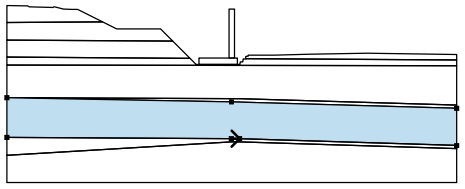
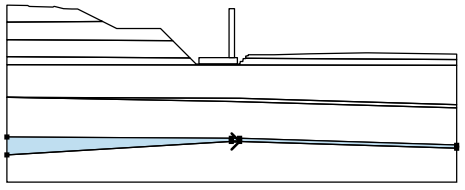
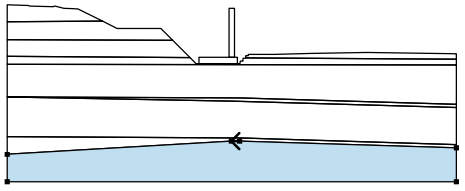
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No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		40.47	17.73	40.47	26.63	41.47	26.63
		41.47	17.73				

Assigning and surfaces

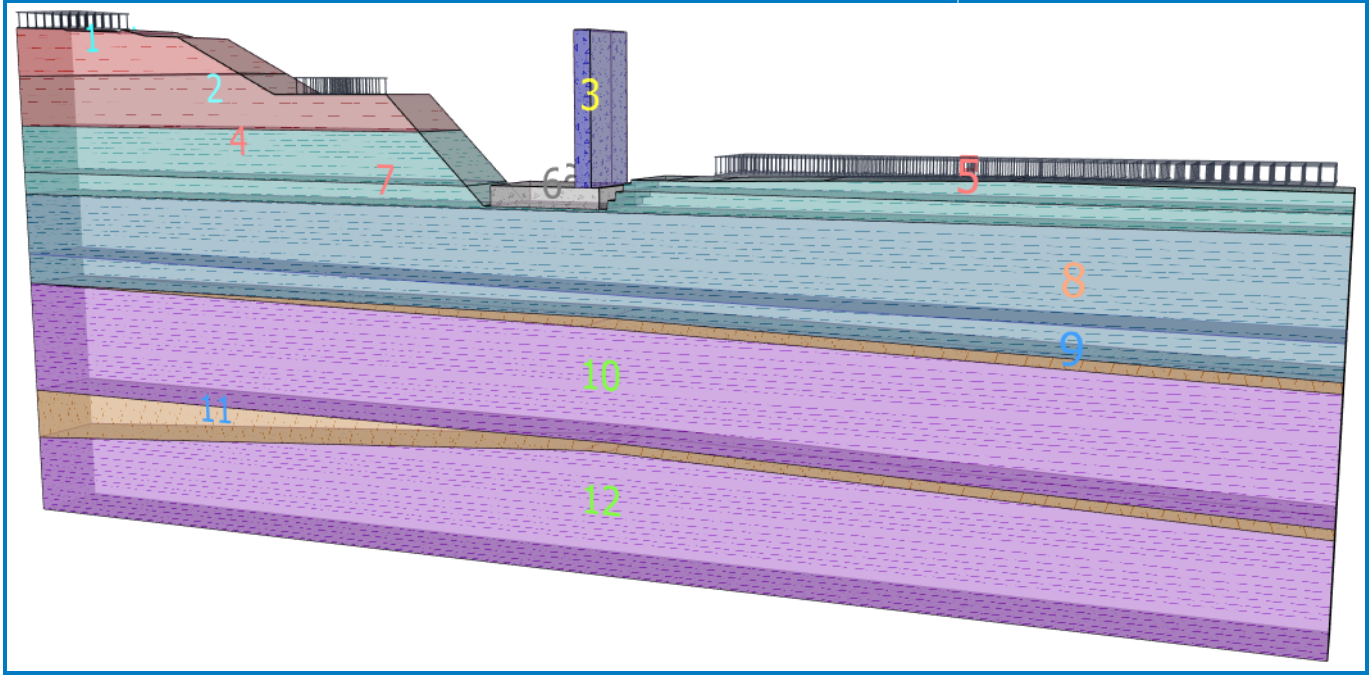
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		41.47	17.73	41.47	26.63	BRIDGE ABUTMENT
		40.47	26.63	40.47	17.73	
4		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
5		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
6		41.97	17.73	41.47	17.73	CONCRETE FOOTING
		40.47	17.73	34.97	17.73	
		34.97	16.53	41.97	16.53	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.33	17.67	
		0.00	17.89	0.00	16.44	
8		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
9		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
10		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
11		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
12		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

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Name : Soils and assignment | **Stage : 5**



Surcharge

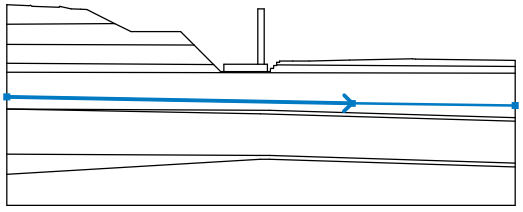
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2
3	No	No	strip	permanent	on terrain	x = 21.50	l = 3.50		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	TEMPORARY - SITE PLANT 20 kN/m^2

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

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Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 5)

Analysis 1 (stage 5)

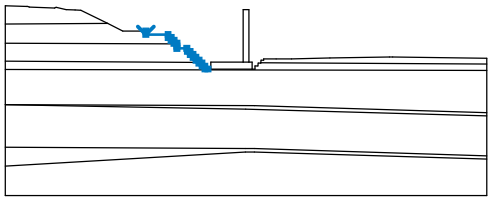
Circular slip surface

Slip surface is not specified

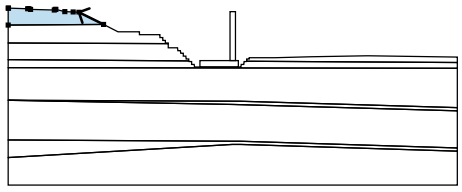
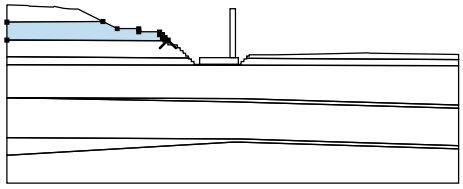
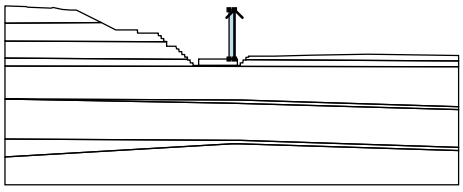
Slope stability verification (Bishop)
Analysis has not been performed.

Input data (Stage of construction 6)

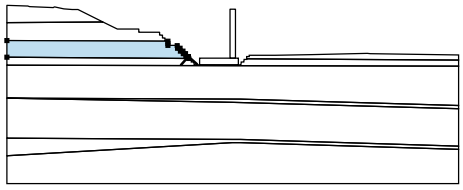
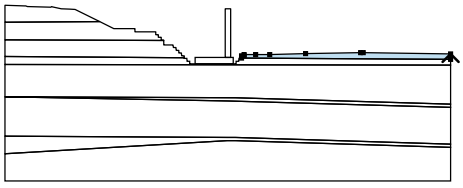
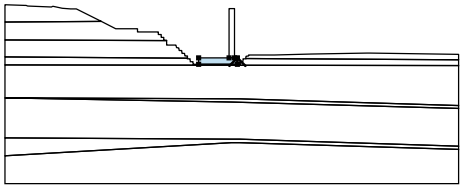
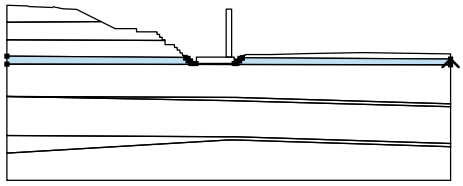
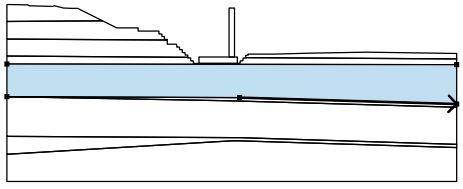
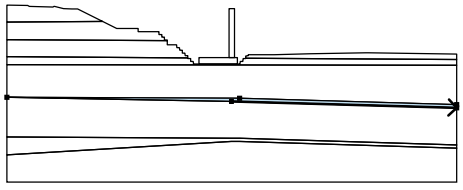
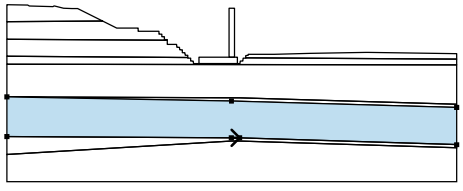
Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		23.92	22.99	23.92	22.41	27.70	22.41
		27.70	21.91	28.20	21.91	28.20	21.41
		28.70	21.41	28.70	20.91	29.20	20.91
		29.20	20.41	29.20	20.03	30.90	20.03
		30.97	19.53	31.42	19.52	31.47	19.03
		31.93	19.03	31.97	18.53	32.42	18.53
		32.47	18.03	32.94	18.03	32.97	17.53
		33.44	17.53	33.47	17.03	33.93	17.03
		33.97	16.53	34.47	16.53		

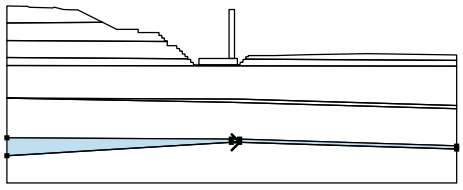
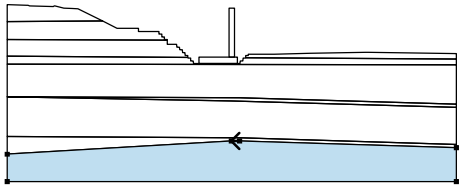
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		41.47	17.73	41.47	26.63	BRIDGE ABUTMENT
		40.47	26.63	40.47	17.73	

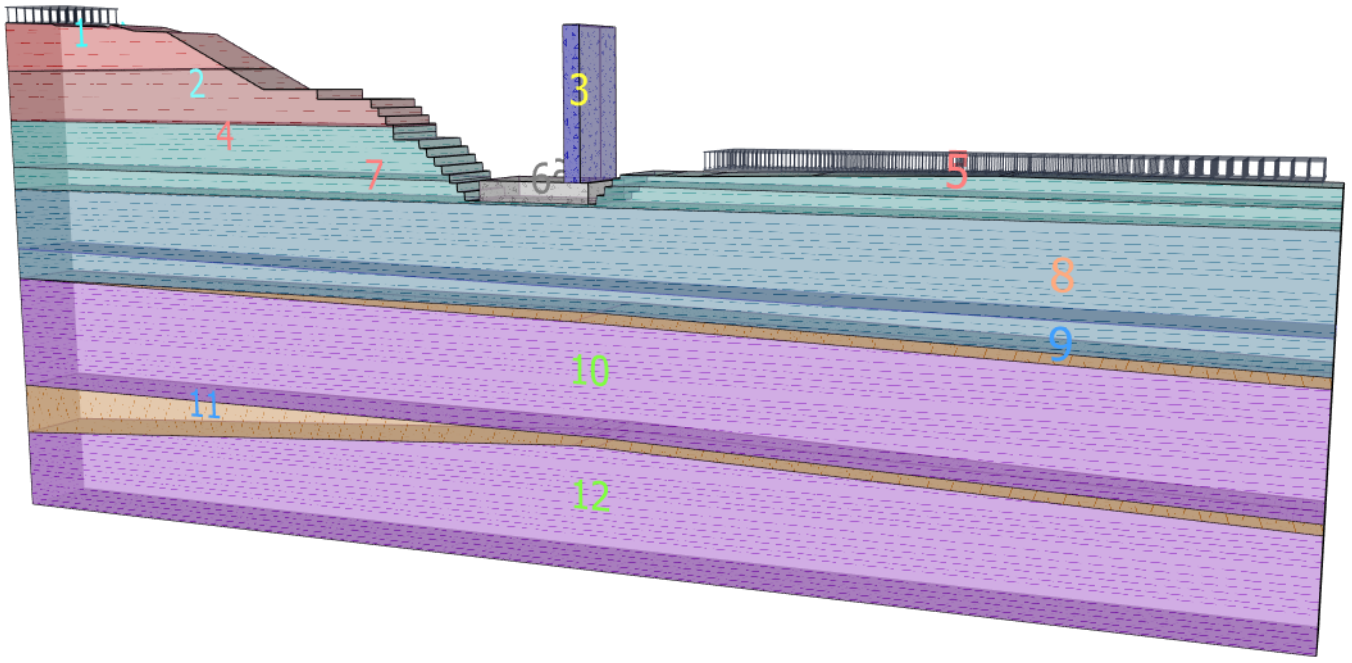
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
5		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
6		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
7		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
8		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
9		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
10		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
11		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
12		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 6**



Surcharge

No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

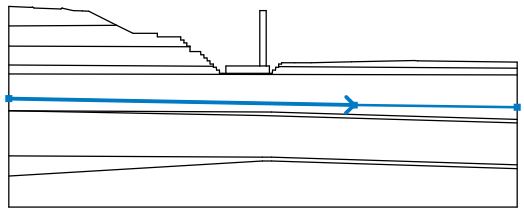
Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

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No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 6)

Analysis 1 (stage 6)

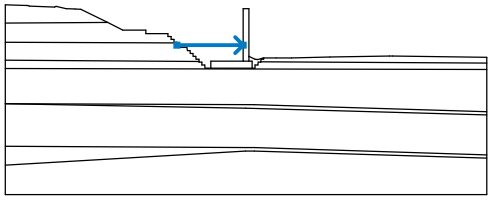
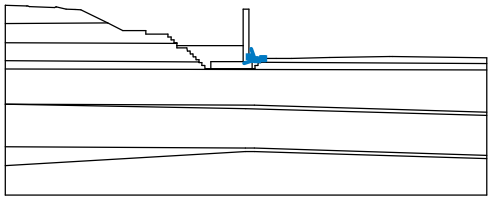
Circular slip surface

Slip surface is not specified

Slope stability verification (Bishop)
Analysis has not been performed.

Input data (Stage of construction 7)

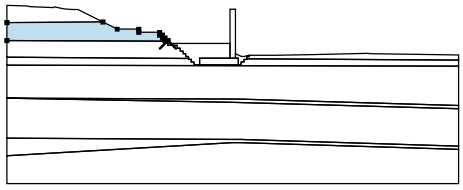
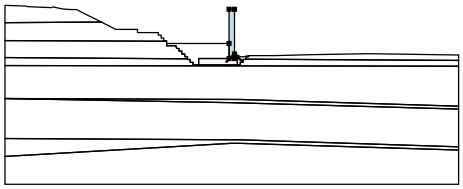
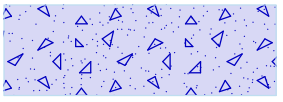
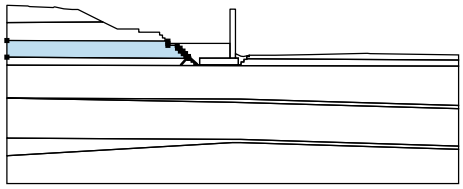
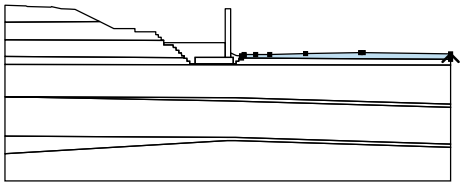
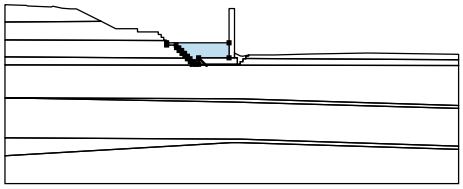
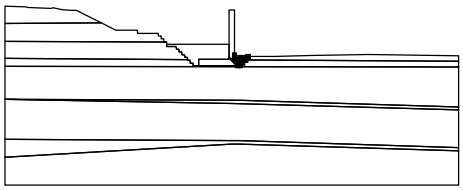
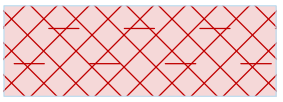
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.20	20.41	40.47	20.41		
2		41.47	18.55	42.47	18.06	42.93	18.00
		43.76	18.19	43.97	18.23		

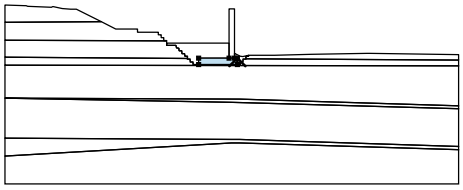
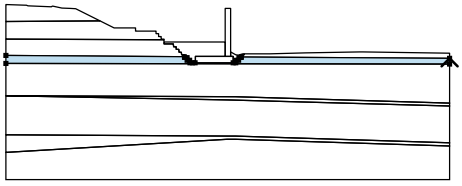
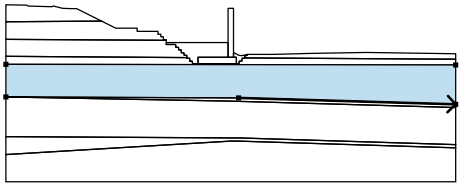
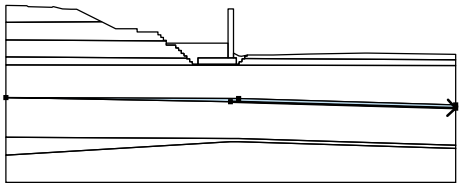
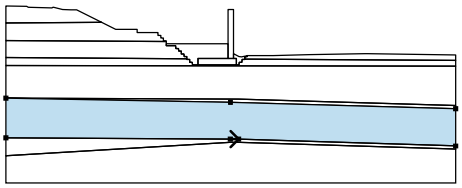
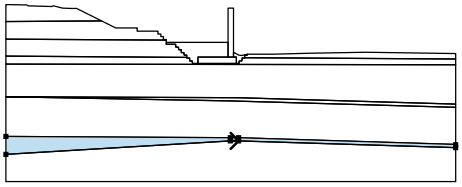
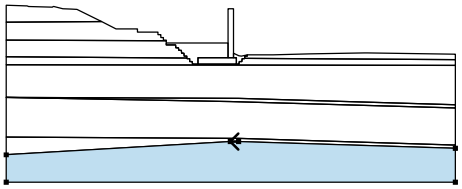
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			

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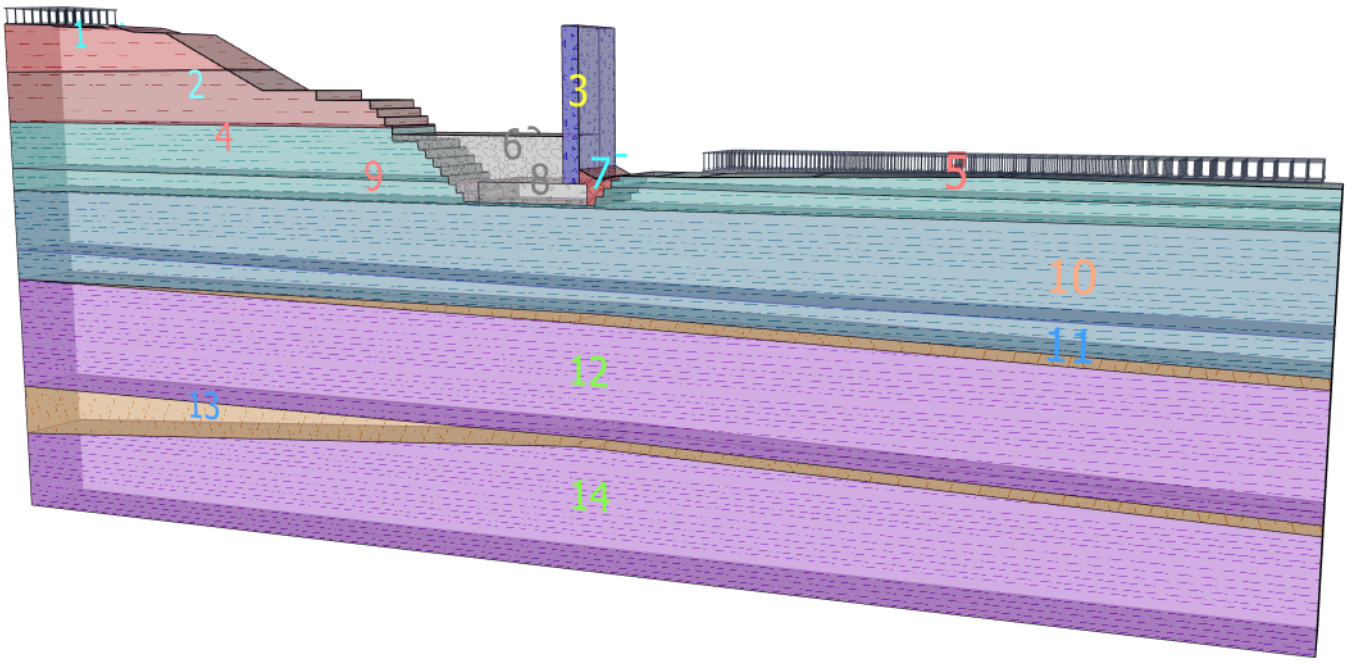
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	20.41	40.47	17.73	
4		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
5		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
6		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
7		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
9		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
10		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
11		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
12		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
13		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
14		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

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Name : Soils and assignment | **Stage : 7**



Surcharge

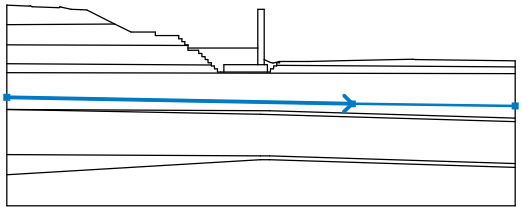
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

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Results (Stage of construction 7)

Analysis 1 (stage 7)

Circular slip surface

Slip surface parameters							
Center :	x =	20.43	[m]	Angles :	α_1 =	-56.60	[°]
	z =	40.60	[m]		α_2 =	33.42	[°]
Radius :	R =	24.19	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1
Sum of active forces : F_a = 1131.82 kN/m
Sum of passive forces : F_p = 4699.25 kN/m

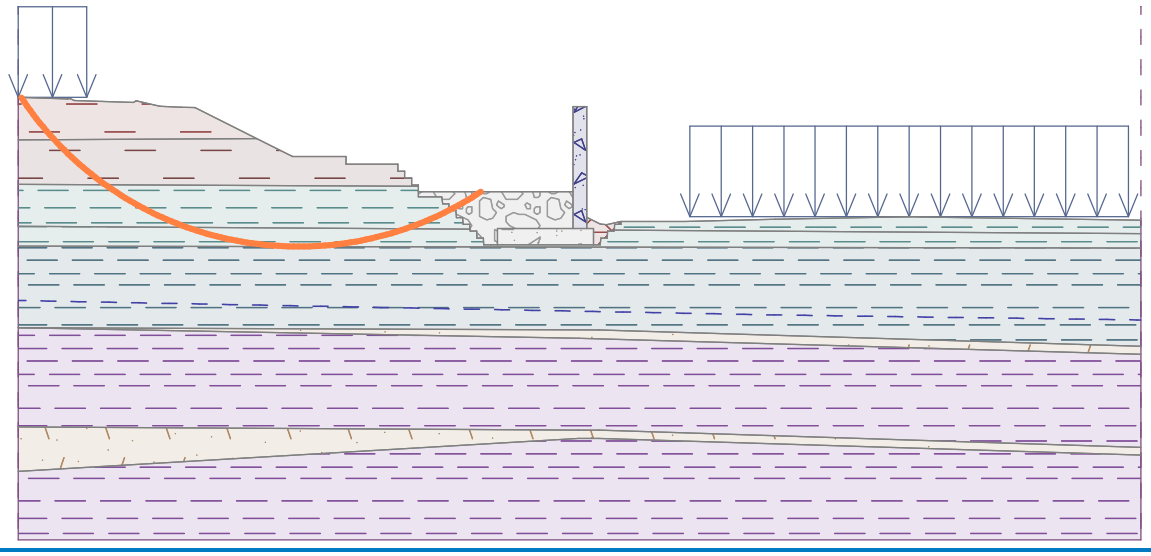
Sliding moment : M_a = 27378.77 kNm/m
Resisting moment : M_p = 113674.84 kNm/m
Utilization : 24.1 %

Slope stability ACCEPTABLE
Combination 2
Sum of active forces : F_a = 795.73 kN/m
Sum of passive forces : F_p = 3397.06 kN/m

Sliding moment : M_a = 20880.01 kNm/m
Resisting moment : M_p = 89138.79 kNm/m
Utilization : 23.4 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 1

Name : Analysis	Stage - analysis : 7 - 1



Analysis 2 (stage 7)

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
0.23	27.28	4.40	23.12	8.17	20.79	13.65	17.62	17.06	16.51
24.25	16.94	29.34	17.95	34.23	20.41				
The slip surface after optimization.									

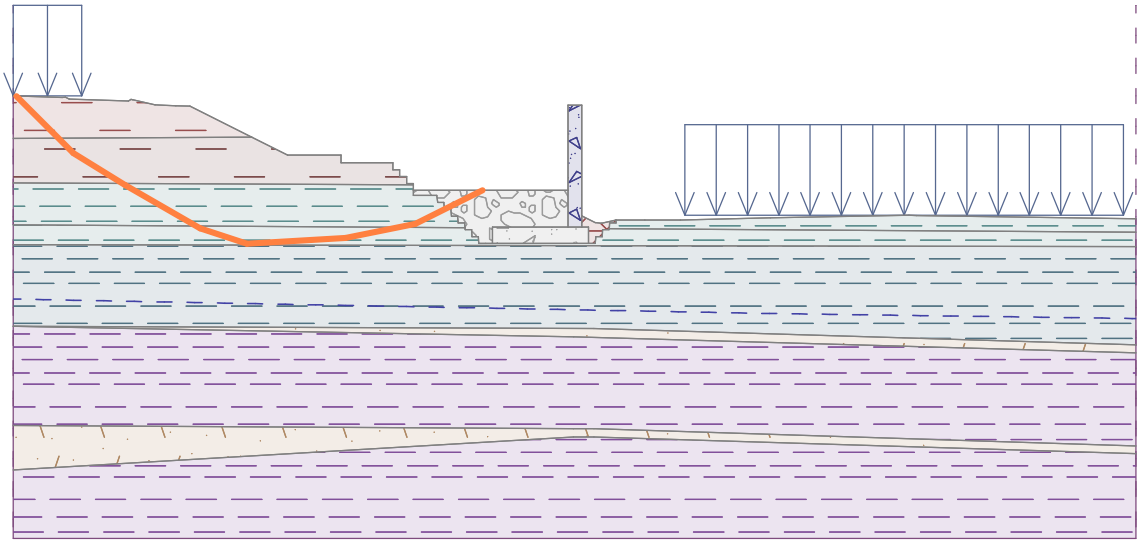
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Slope stability verification (Sarma)
Combination 1
Utilization : 22.6 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 22.1 %

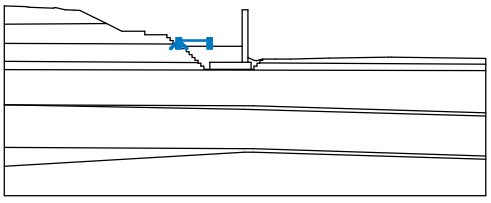
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 1

Name : Analysis	Stage - analysis : 7 - 2

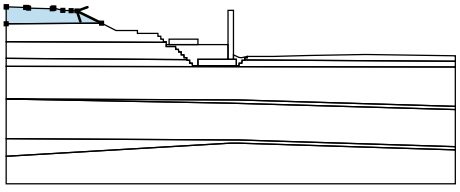


Input data (Stage of construction 8)

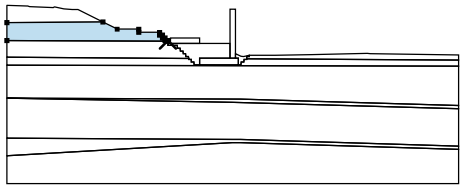
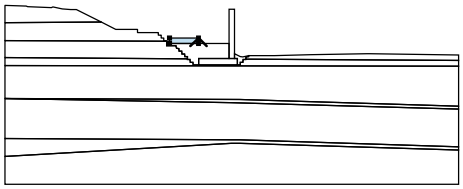
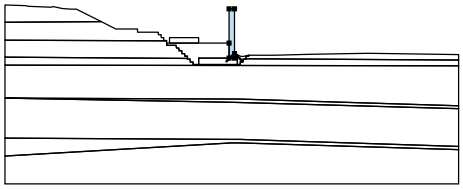
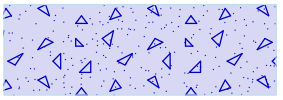
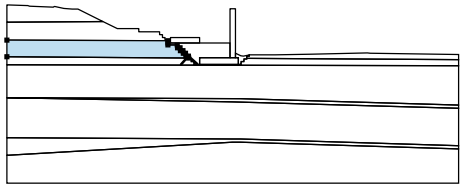
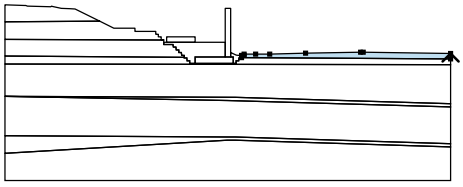
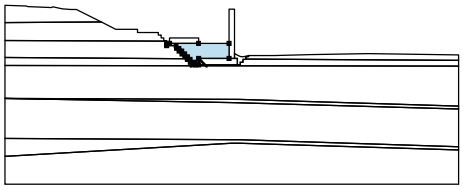
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.70	20.41	29.70	21.41	34.95	21.41
		34.95	20.41				

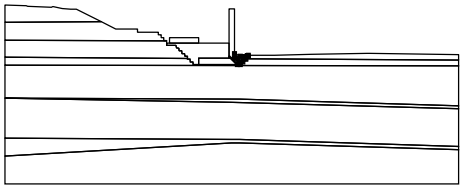
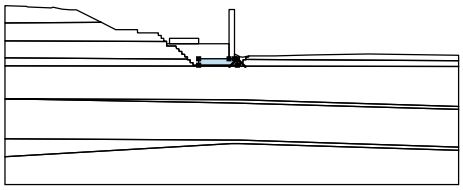
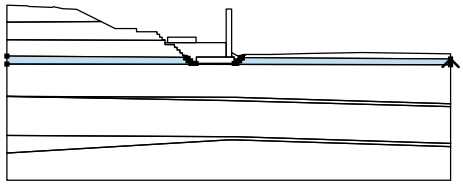
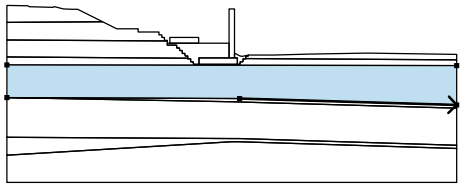
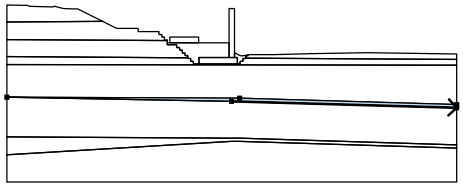
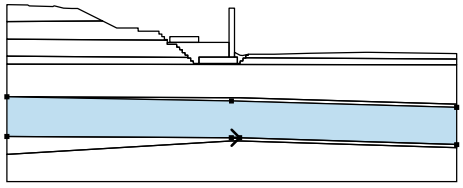
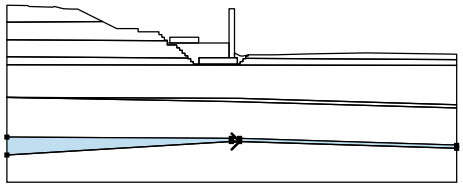
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			

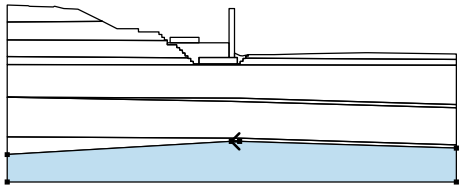
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
4		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	20.41	40.47	17.73	
5		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
6		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
7		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	

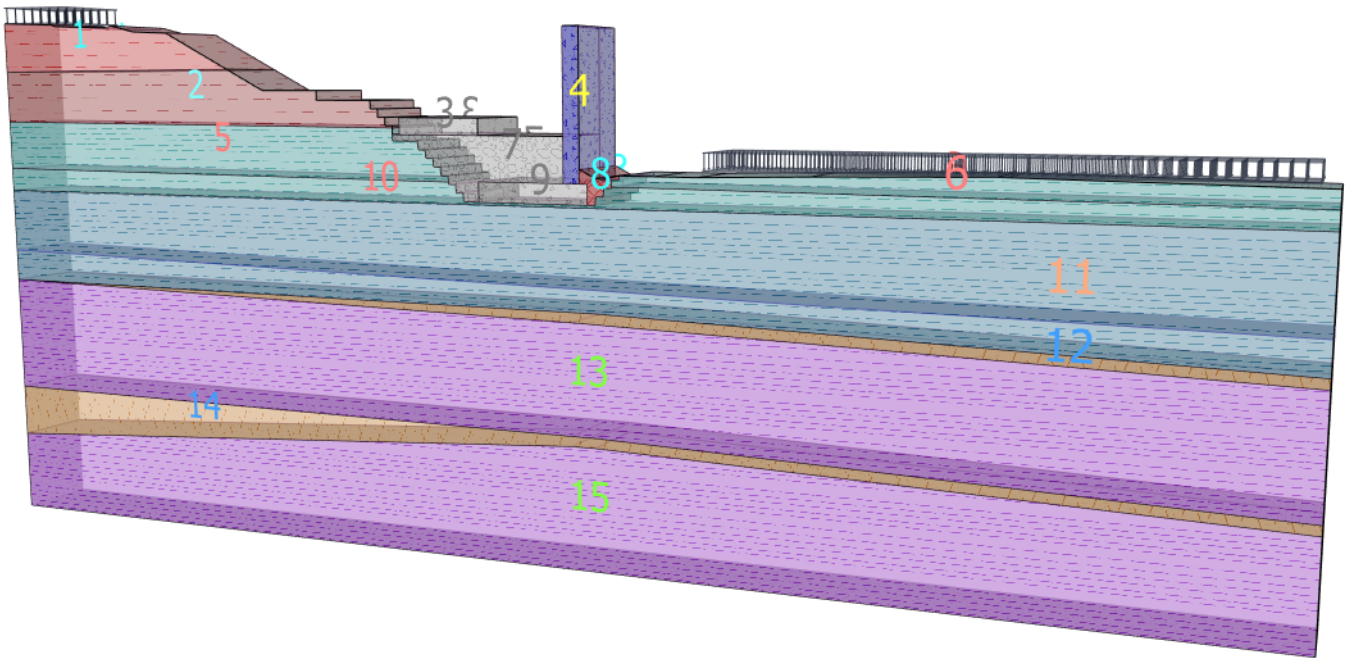
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
9		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
10		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
11		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
12		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
13		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
14		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
15		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 8**



Surcharge

No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

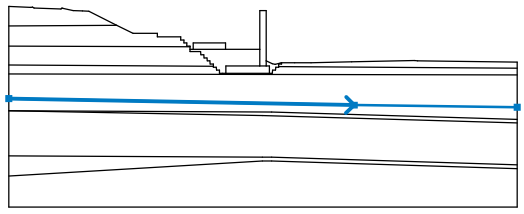
Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

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No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 8)

Analysis 1 (stage 8)

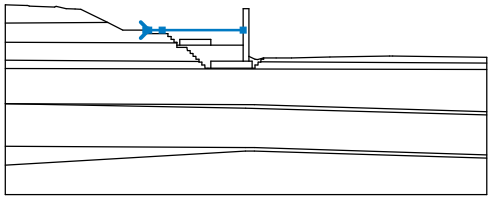
Circular slip surface

Slip surface is not specified

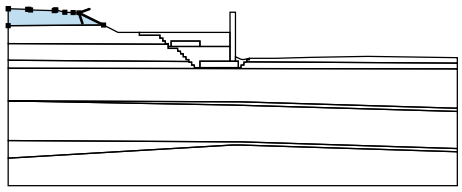
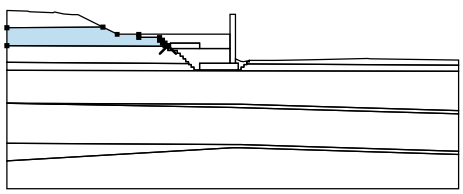
Slope stability verification (Bishop)
Analysis has not been performed.

Input data (Stage of construction 9)

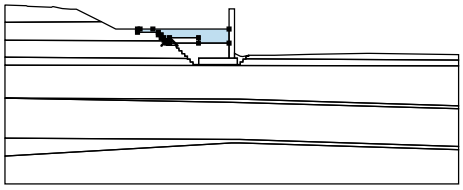
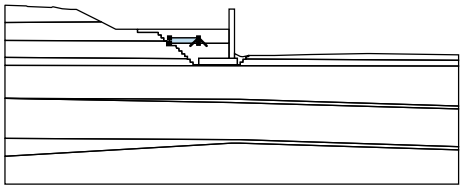
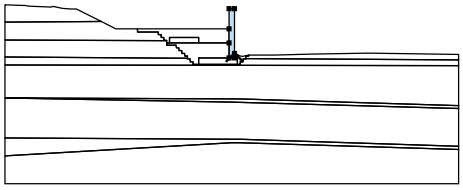
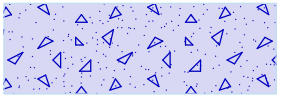
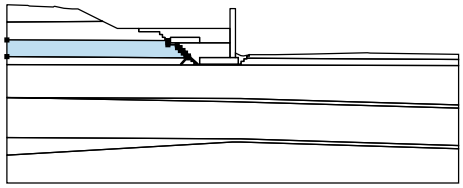
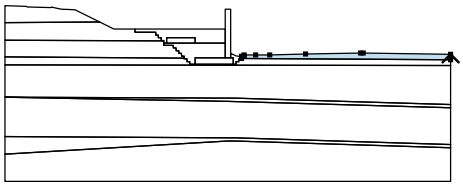
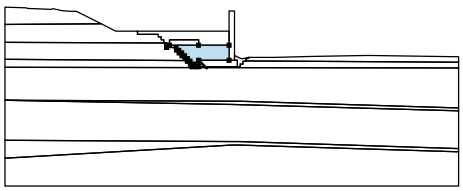
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		23.92	22.99	24.42	22.99	26.70	22.99
		40.47	22.99				

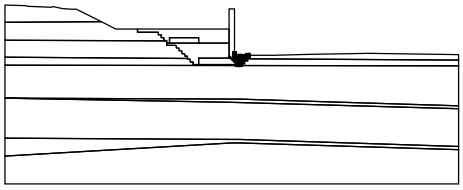
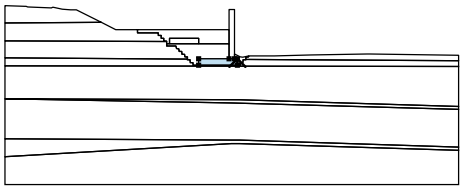
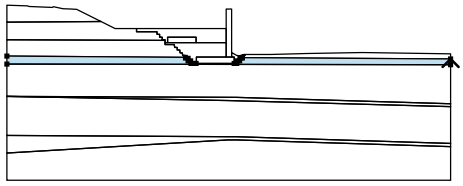
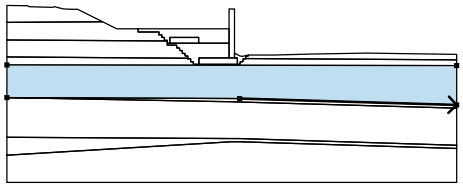
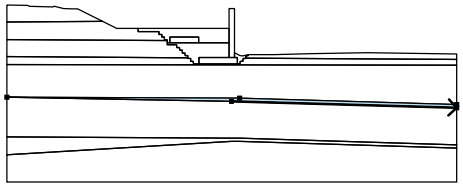
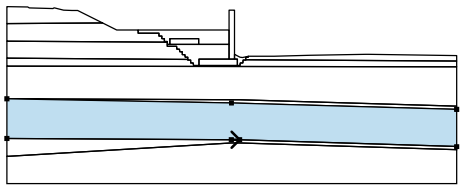
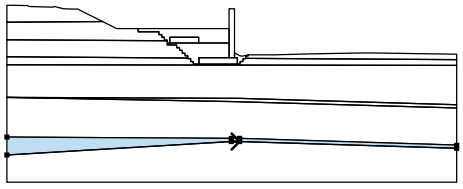
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	

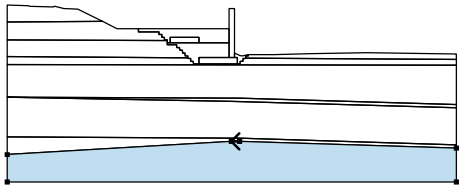
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
3		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		26.70	22.99	24.42	22.99	
		23.92	22.99	23.92	22.41	
		27.70	22.41	27.70	21.91	
		28.20	21.91	28.20	21.41	
		28.70	21.41	28.70	20.91	
		29.20	20.91	29.20	20.80	
		29.20	20.41			
4		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
						
5		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	22.99	40.47	20.41	
		40.47	17.73			
6		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
7		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
8		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	

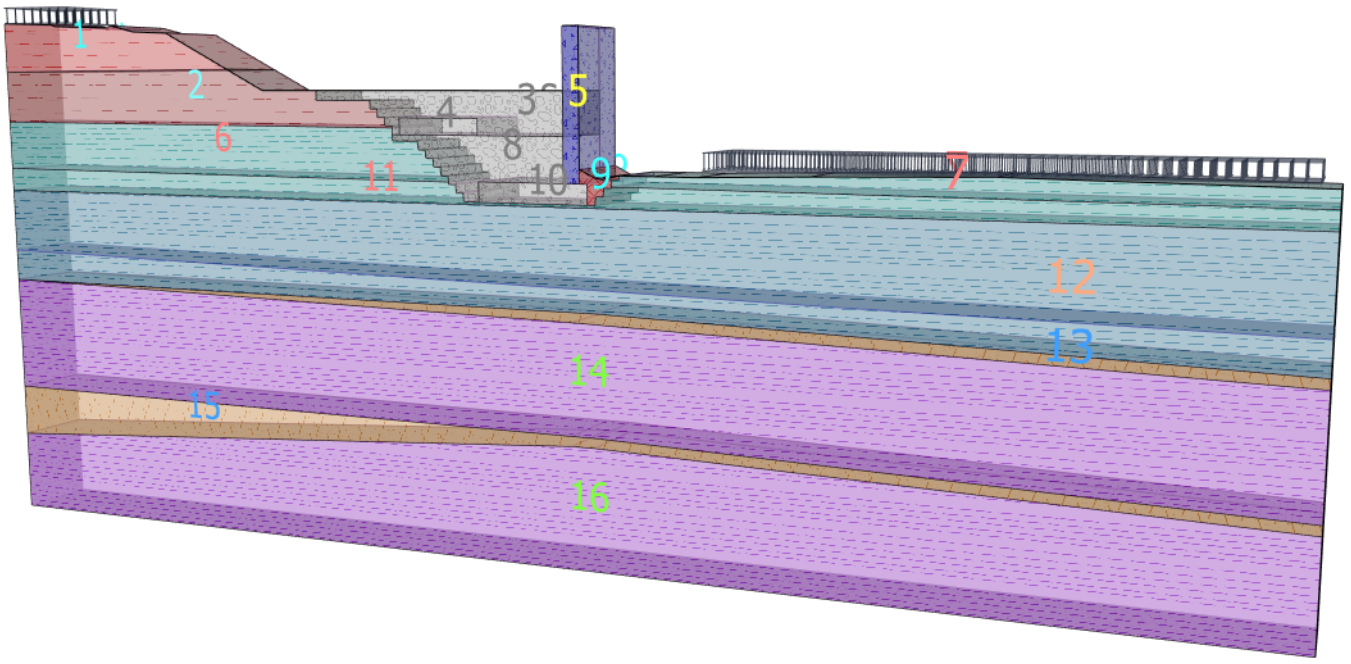
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
9		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
10		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
11		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
12		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
13		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
14		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
15		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
16		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 9**



Surcharge

No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

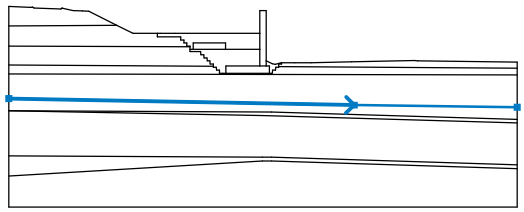
Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

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No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 9)

Analysis 1 (stage 9)

Circular slip surface

Slip surface parameters							
Center :	x =	13.32	[m]	Angles :	α_1 =	-52.11	[°]
	z =	37.50	[m]		α_2 =	29.25	[°]
Radius :	R =	16.63	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 2102.53 kN/m
Sum of passive forces : F_p = 11002.88 kN/m

Sliding moment : M_a = 66650.18 kNm/m
Resisting moment : M_p = 348791.21 kNm/m
Utilization : 19.1 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : F_a = 320.73 kN/m
Sum of passive forces : F_p = 1437.74 kN/m

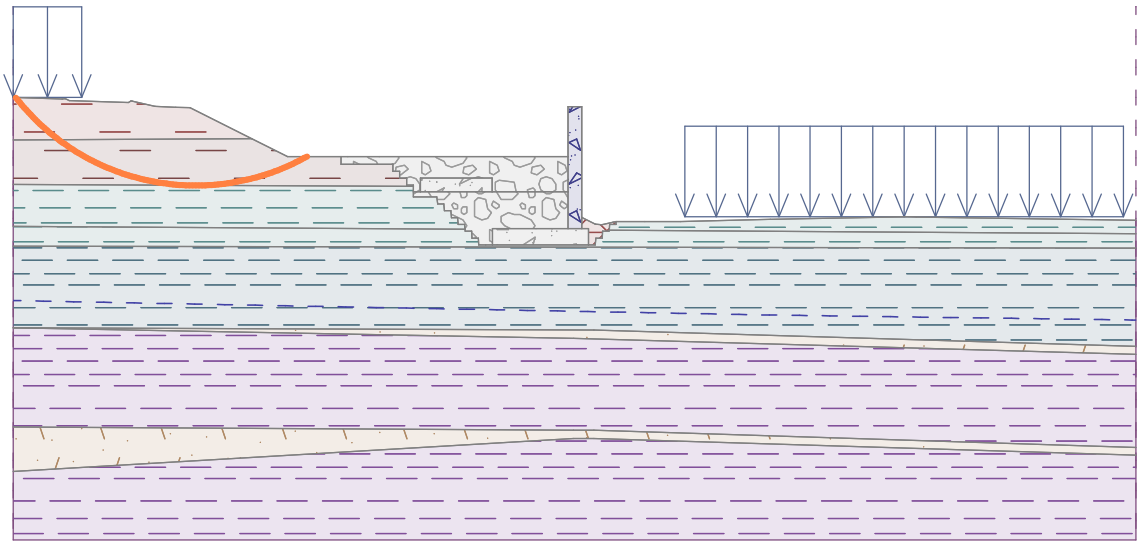
Sliding moment : M_a = 5333.78 kNm/m
Resisting moment : M_p = 23909.65 kNm/m
Utilization : 22.3 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

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Name : Analysis	Stage - analysis : 9 - 1



Analysis 2 (stage 9)

Polygonal slip surface

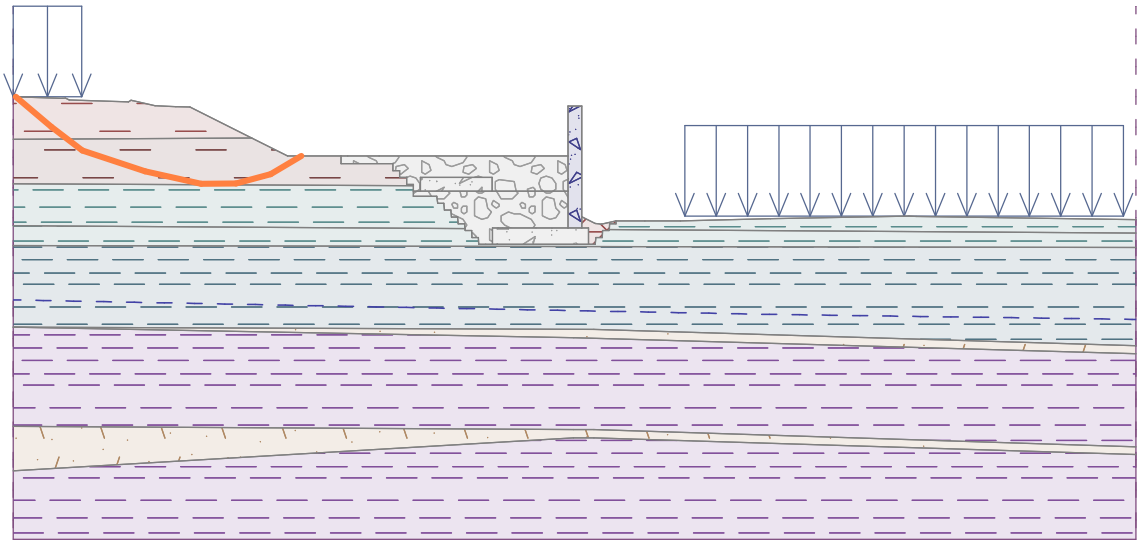
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
0.20	27.29	2.77	25.11	5.05	23.38	9.62	21.86	13.72	20.95
16.25	20.96	18.77	21.64	21.02	22.99				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 21.5 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 21.4 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 1

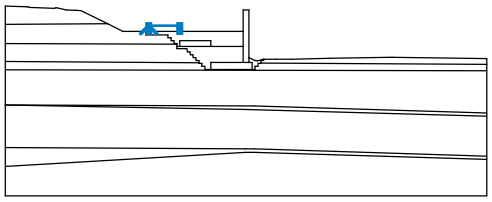
Name : Analysis	Stage - analysis : 9 - 2



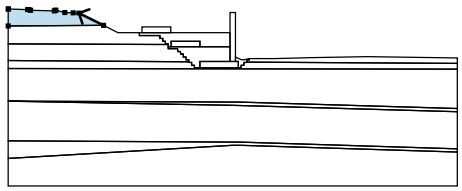
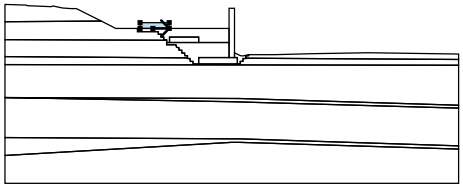
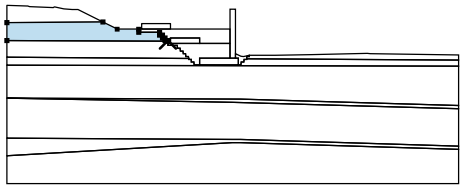
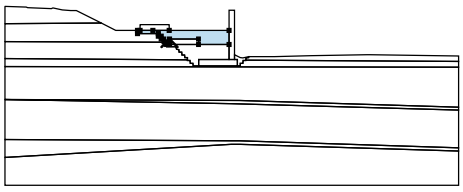
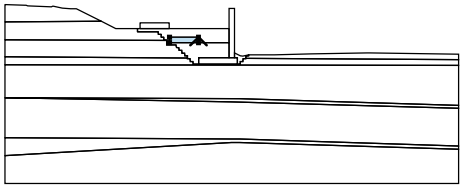
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Input data (Stage of construction 10)

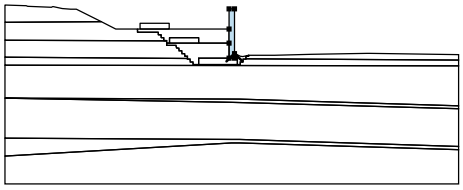
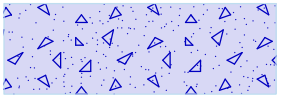
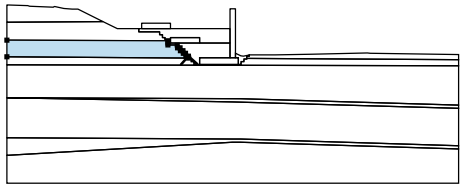
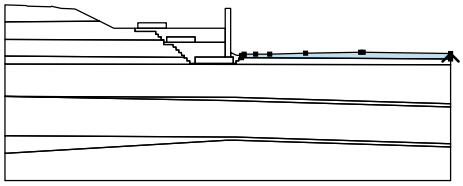
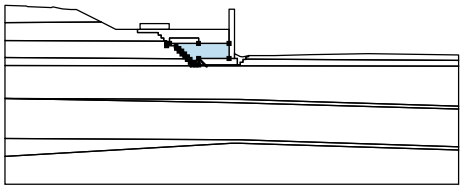
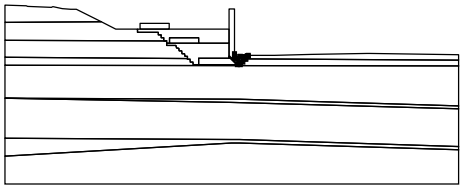
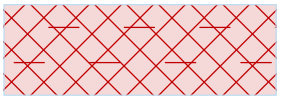
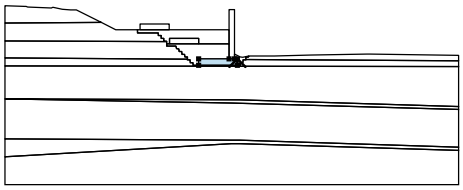
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		24.42	22.99	24.42	23.99	29.67	23.99
		29.68	22.99				

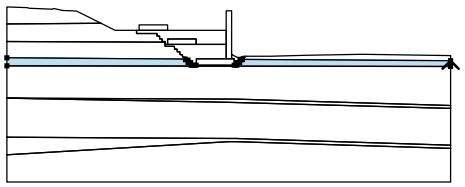
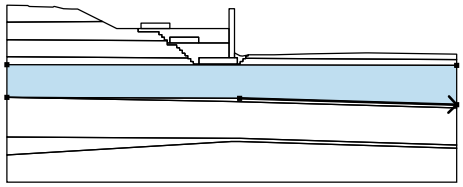
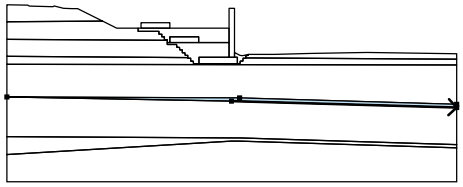
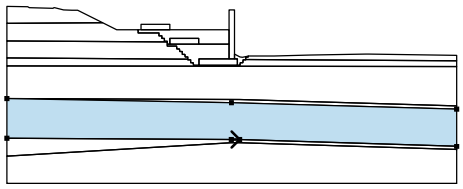
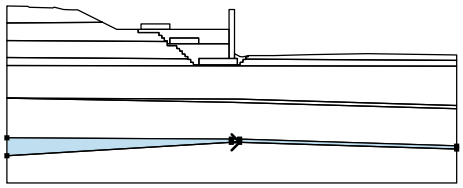
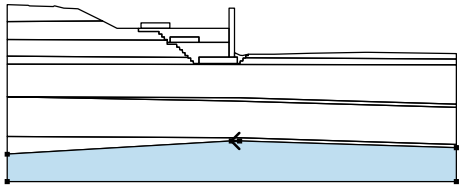
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
3		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
4		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
5		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	

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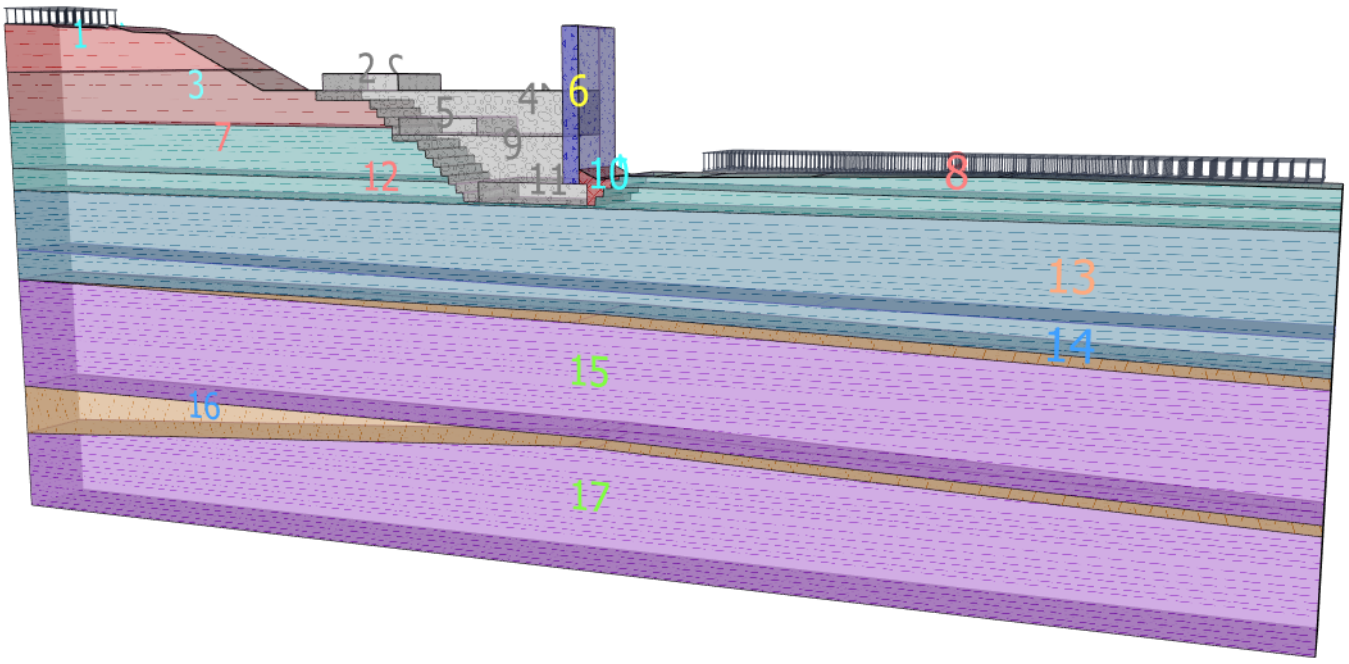
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	22.99	40.47	20.41	
		40.47	17.73			
7		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
8		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
9		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
10		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
11		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
12		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
13		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
14		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
15		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
16		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
17		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

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Name : Soils and assignment | **Stage : 10**



Surcharge

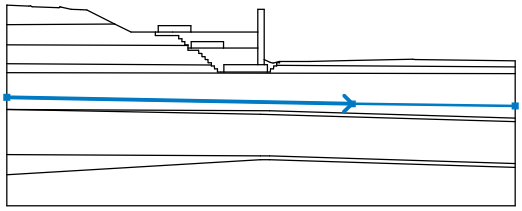
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

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Results (Stage of construction 10)

Analysis 1 (stage 10)

Circular slip surface

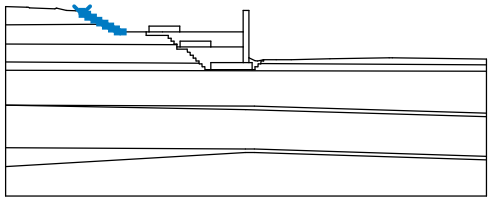
Slip surface is not specified

Slope stability verification (Bishop)

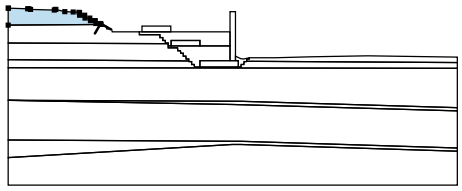
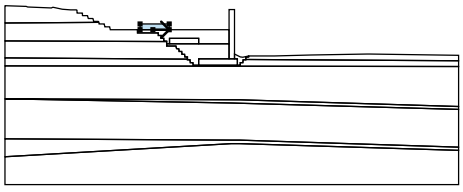
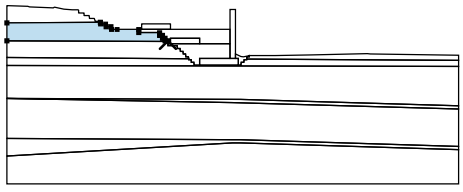
Analysis has not been performed.

Input data (Stage of construction 11)

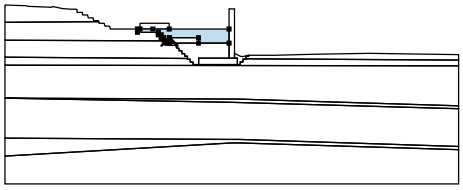
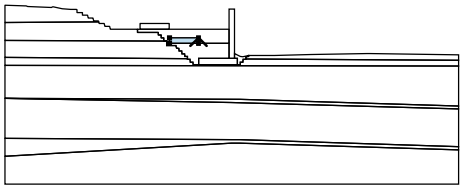
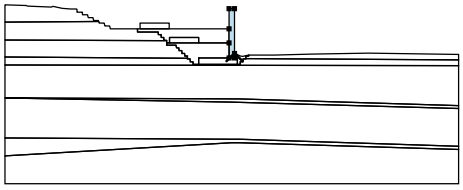
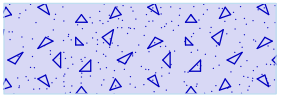
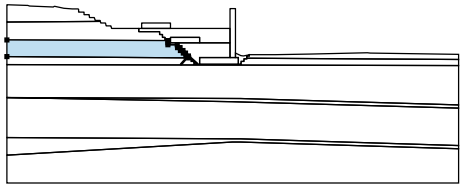
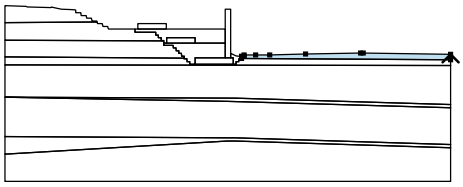
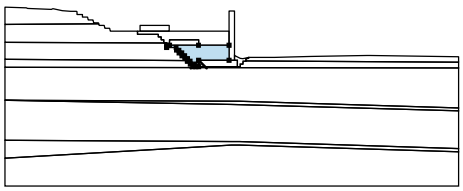
Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		13.01	26.49	13.01	25.99	13.97	25.99
		14.01	25.49	14.92	25.49	15.01	24.99
		15.88	24.99	16.01	24.49	16.89	24.48
		17.01	23.99	17.91	23.98	18.01	23.49
		18.88	23.49	19.01	22.99	20.01	22.99

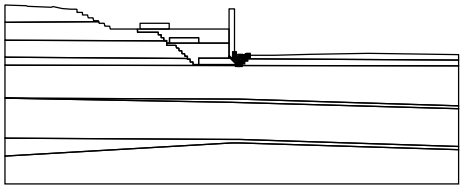
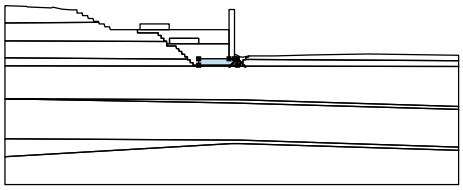
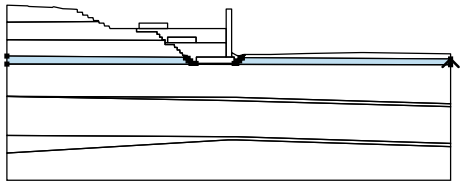
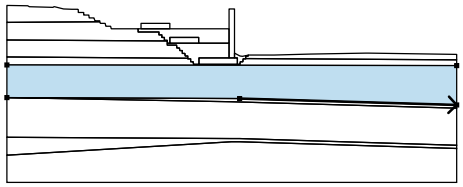
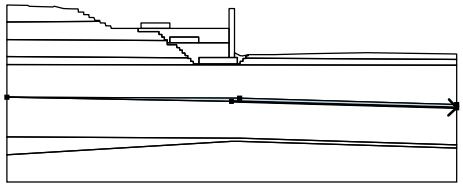
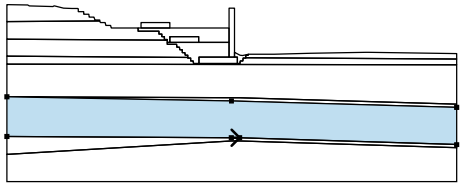
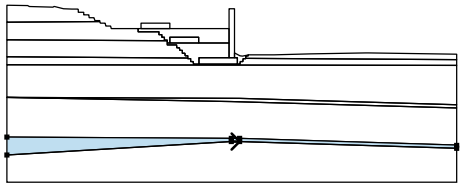
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.94	24.29	16.89	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		16.01	24.49	15.88	24.99	
		15.01	24.99	14.92	25.49	
		14.01	25.49	13.97	25.99	
		13.01	25.99	13.01	26.49	
		12.89	26.55	11.86	26.58	
		10.35	26.65	8.71	27.03	
		8.59	27.04	8.41	26.92	
		4.10	27.06	3.80	27.20	
		3.58	27.18	0.06	27.29	
		0.00	27.29	0.00	24.19	
2		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
3		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	19.01	22.99	
		18.88	23.49	18.01	23.49	
		17.91	23.98	17.01	23.99	
		16.94	24.29	0.00	24.19	
		0.00	20.94			

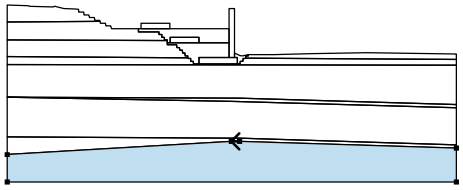
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
5		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
						
6		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	22.99	40.47	20.41	
		40.47	17.73			
7		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
8		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
9		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	

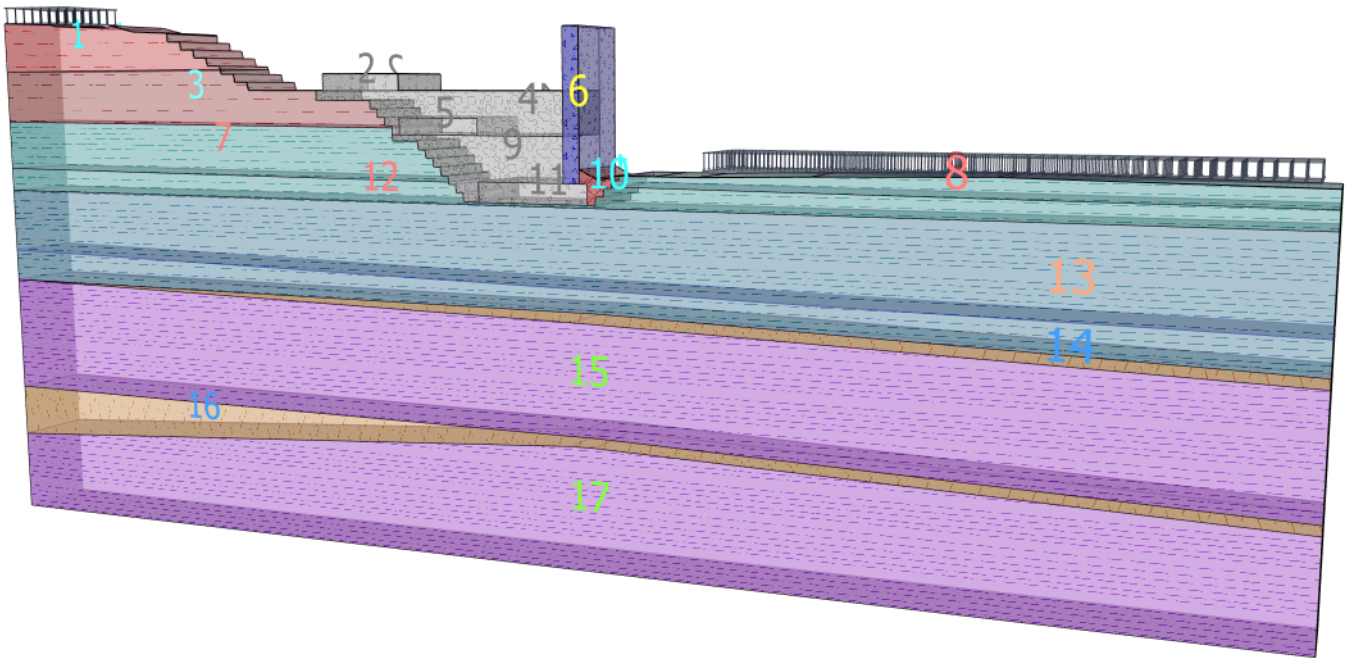
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
10		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
11		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
12		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
13		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
14		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
15		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
16		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
17		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 11**



Surcharge

No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

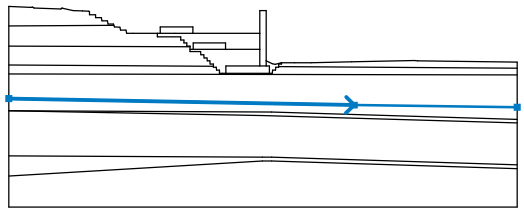
Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

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No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 11)

Analysis 1 (stage 11)

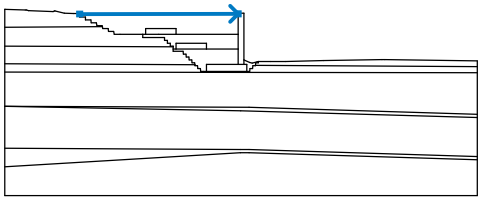
Circular slip surface

Slip surface is not specified

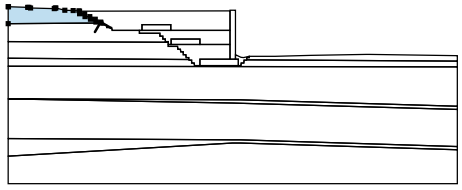
Slope stability verification (Bishop)
Analysis has not been performed.

Input data (Stage of construction 12)

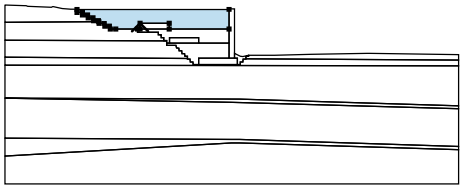
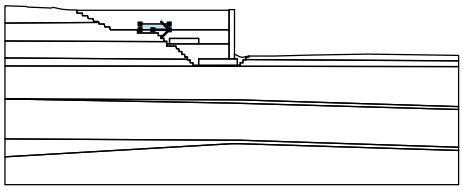
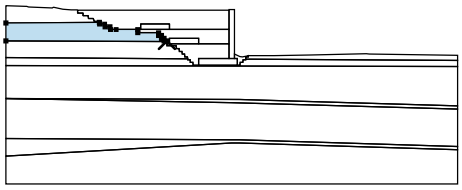
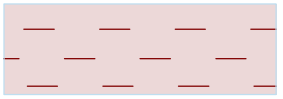
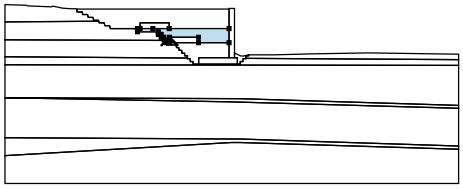
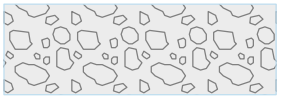
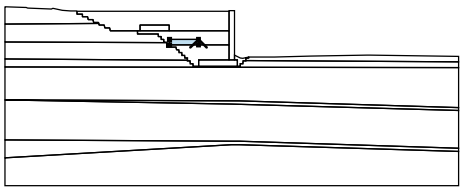
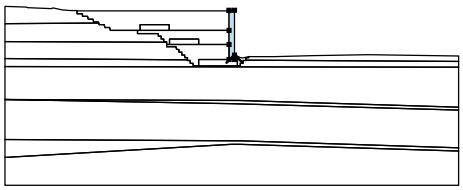
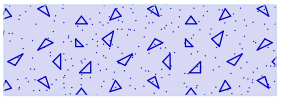
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		13.01	26.49	40.47	26.52		

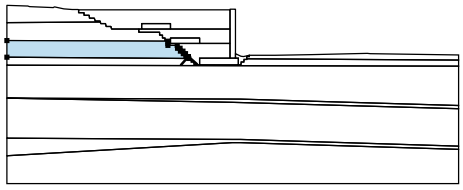
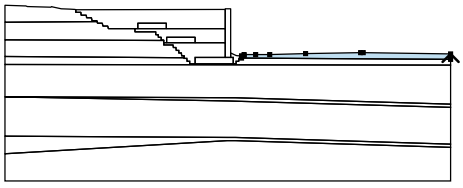
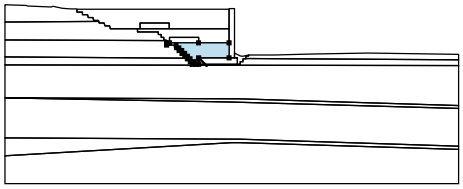
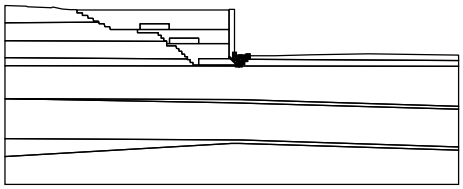
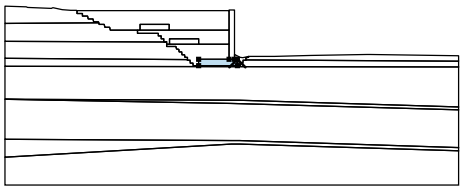
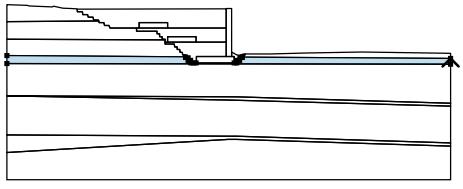
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.94	24.29	16.89	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		16.01	24.49	15.88	24.99	
		15.01	24.99	14.92	25.49	
		14.01	25.49	13.97	25.99	
		13.01	25.99	13.01	26.49	
		12.89	26.55	11.86	26.58	
		10.35	26.65	8.71	27.03	
		8.59	27.04	8.41	26.92	
		4.10	27.06	3.80	27.20	
		3.58	27.18	0.06	27.29	
		0.00	27.29	0.00	24.19	

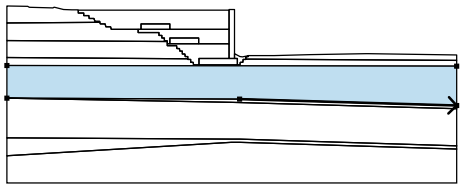
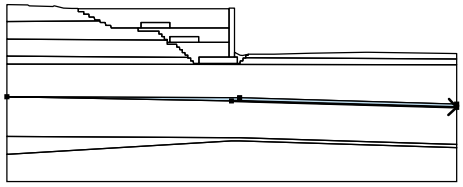
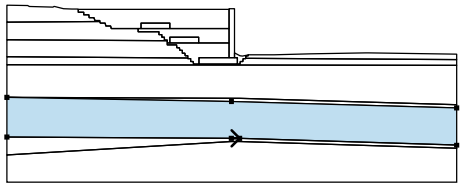
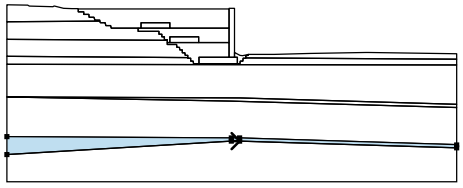
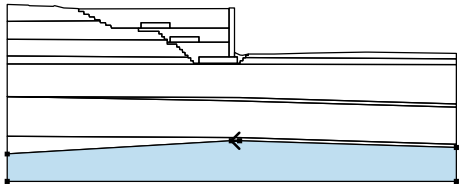
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		24.42	22.99	24.42	23.99	Class 6N Selected Backfill to Structures
		29.67	23.99	29.68	22.99	
		40.47	22.99	40.47	26.52	
		13.01	26.49	13.01	25.99	
		13.97	25.99	14.01	25.49	
		14.92	25.49	15.01	24.99	
		15.88	24.99	16.01	24.49	
		16.89	24.48	16.94	24.29	
		17.01	23.99	17.91	23.98	
		18.01	23.49	18.88	23.49	
		19.01	22.99	20.01	22.99	
		23.92	22.99			
3		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
4		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	19.01	22.99	
		18.88	23.49	18.01	23.49	
		17.91	23.98	17.01	23.99	
		16.94	24.29	0.00	24.19	
		0.00	20.94			
5		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
6		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
						
7		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	26.52	40.47	22.99	
		40.47	20.41	40.47	17.73	

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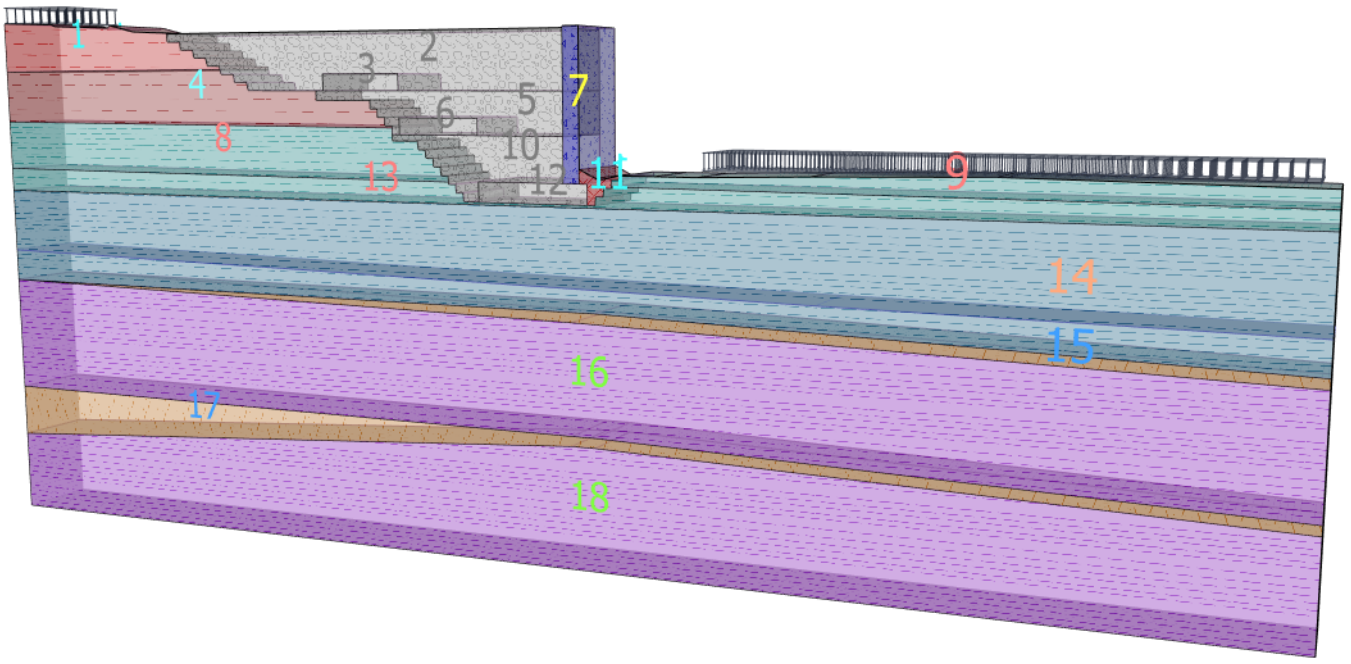
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
9		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
10		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
11		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
12		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
13		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
14		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
15		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
16		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
17		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
18		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

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Name : Soils and assignment | **Stage : 12**



Surcharge

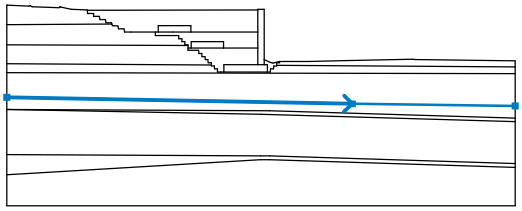
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

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Results (Stage of construction 12)

Analysis 1 (stage 12)

Circular slip surface

Slip surface parameters							
Center :	x =	38.40	[m]	Angles :	α_1 =	-65.48	[°]
	z =	33.83	[m]		α_2 =	27.95	[°]
Radius :	R =	17.66	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1
Sum of active forces : F_a = 1217.67 kN/m
Sum of passive forces : F_p = 4157.17 kN/m

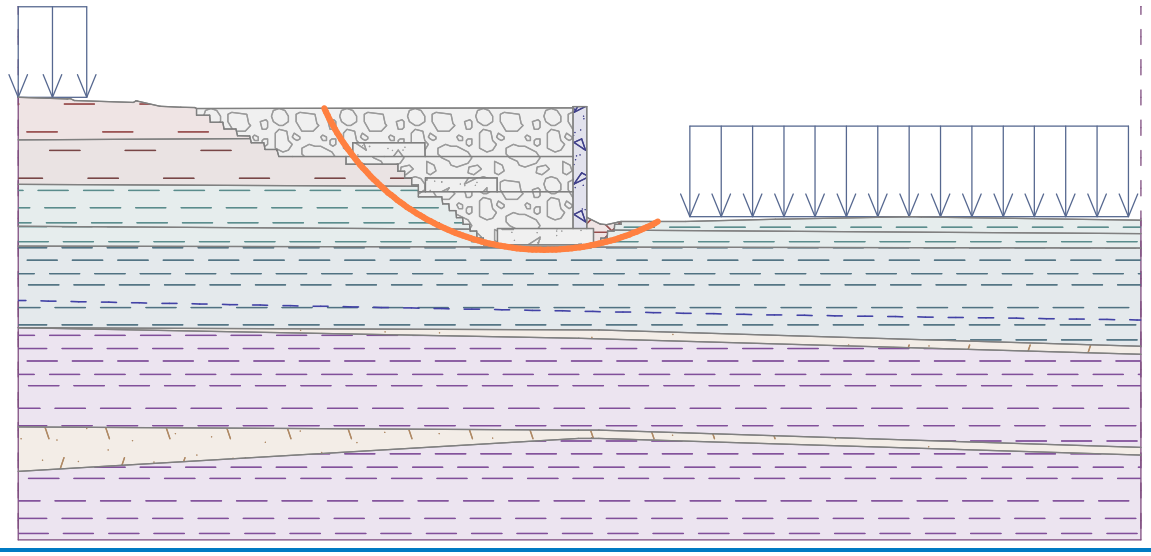
Sliding moment : M_a = 22356.36 kNm/m
Resisting moment : M_p = 76325.71 kNm/m
Utilization : 29.3 %

Slope stability ACCEPTABLE
Combination 2
Sum of active forces : F_a = 868.14 kN/m
Sum of passive forces : F_p = 2856.08 kN/m

Sliding moment : M_a = 15331.41 kNm/m
Resisting moment : M_p = 50438.40 kNm/m
Utilization : 30.4 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 12 - 1



Analysis 2 (stage 12)

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
22.33	26.50	24.46	22.99	27.34	20.06	30.81	17.88	34.70	16.56
37.98	16.17	42.85	16.07	45.86	18.23				
The slip surface after optimization.									

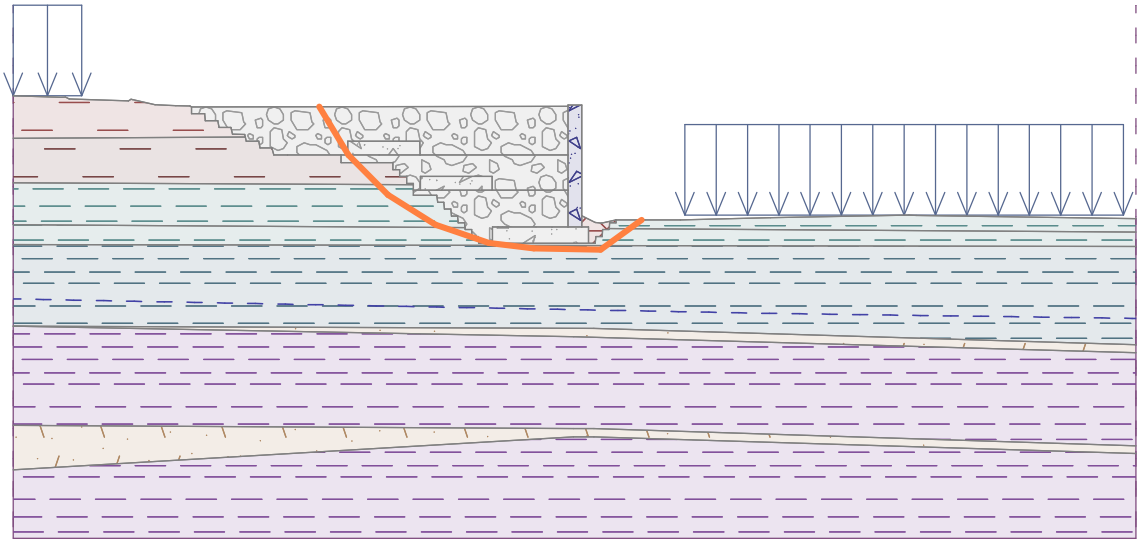
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Slope stability verification (Sarma)
Combination 1
Utilization : 32.9 %

Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.
Combination 2
Utilization : 35.0 %

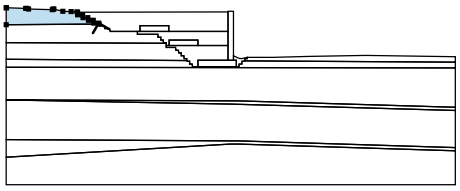
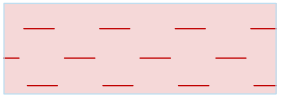
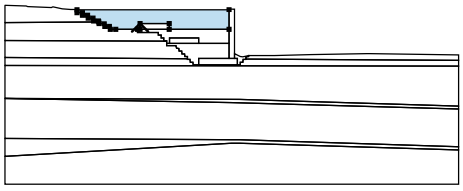
Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.Optimized slip surface for :
Combination 2

Name : Analysis	Stage - analysis : 12 - 2

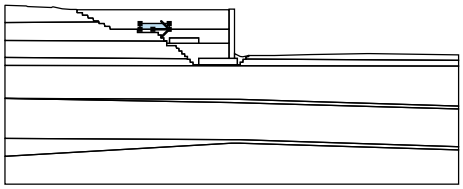
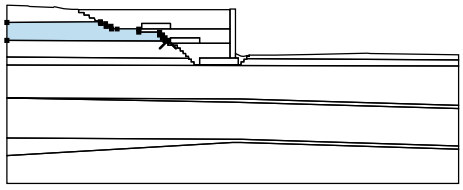
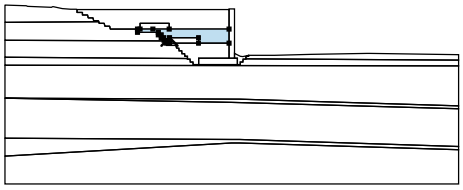
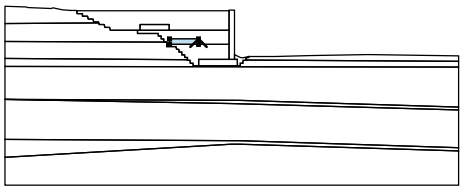
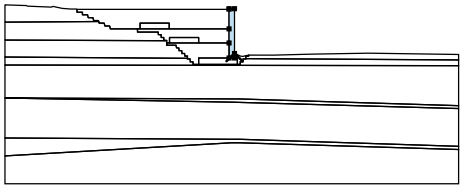
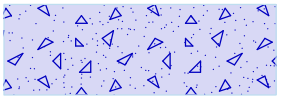
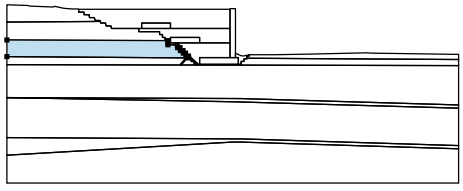


Input data (Stage of construction 13)

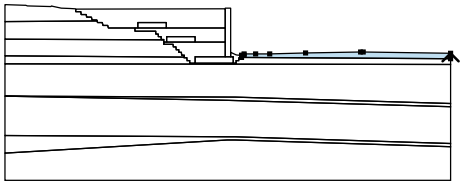
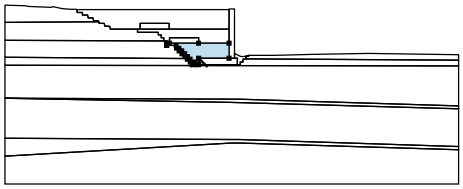
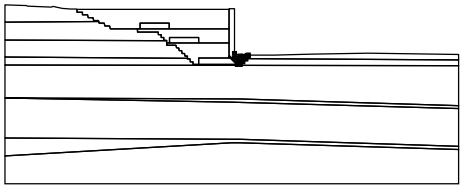
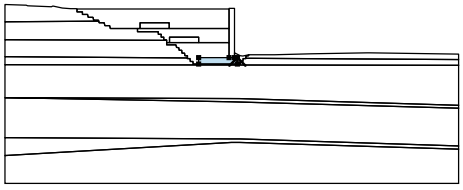
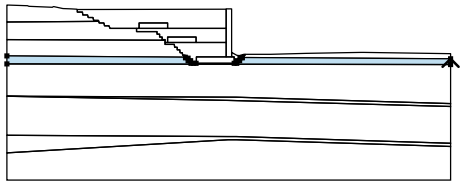
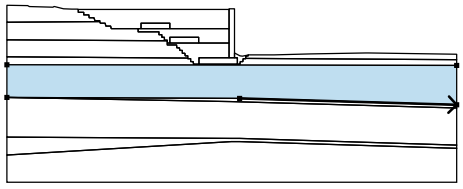
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.94	24.29	16.89	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		16.01	24.49	15.88	24.99	
		15.01	24.99	14.92	25.49	
		14.01	25.49	13.97	25.99	
		13.01	25.99	13.01	26.49	
		12.89	26.55	11.86	26.58	
		10.35	26.65	8.71	27.03	
		8.59	27.04	8.41	26.92	
		4.10	27.06	3.80	27.20	
		3.58	27.18	0.06	27.29	
		0.00	27.29	0.00	24.19	
2		24.42	22.99	24.42	23.99	Class 6N Selected Backfill to Structures
		29.67	23.99	29.68	22.99	
		40.47	22.99	40.47	26.52	
		13.01	26.49	13.01	25.99	
		13.97	25.99	14.01	25.49	
		14.92	25.49	15.01	24.99	
		15.88	24.99	16.01	24.49	
		16.89	24.48	16.94	24.29	
		17.01	23.99	17.91	23.98	

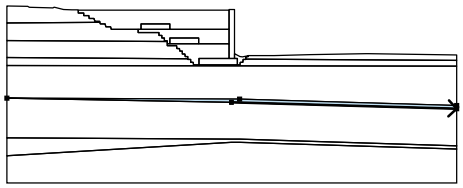
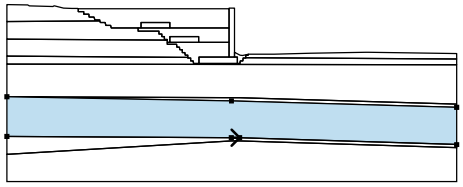
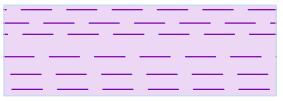
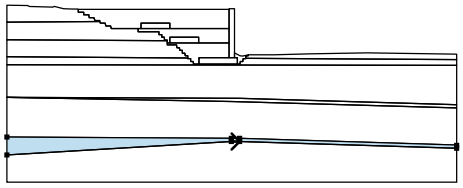
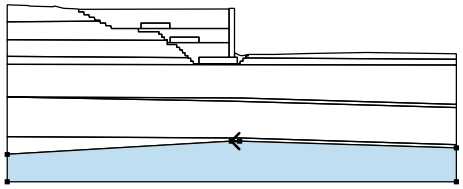
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
		18.01	23.49	18.88	23.49	
		19.01	22.99	20.01	22.99	
		23.92	22.99			
3		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
4		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	19.01	22.99	
		18.88	23.49	18.01	23.49	
		17.91	23.98	17.01	23.99	
		16.94	24.29	0.00	24.19	
		0.00	20.94			
5		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
6		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
7		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	26.52	40.47	22.99	
		40.47	20.41	40.47	17.73	
8		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			

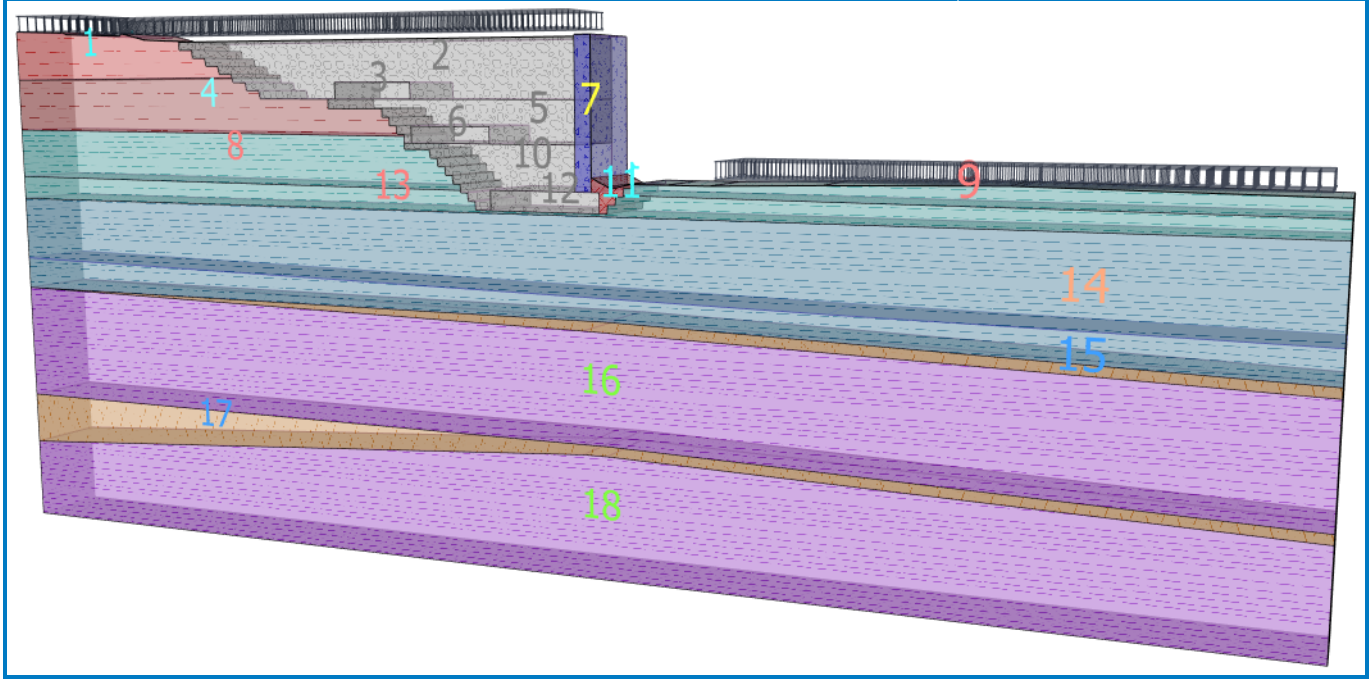
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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
9		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
10		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
11		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
12		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
13		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
14		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			

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No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
15		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
16		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
17		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
18		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment | **Stage : 13**



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Surcharge

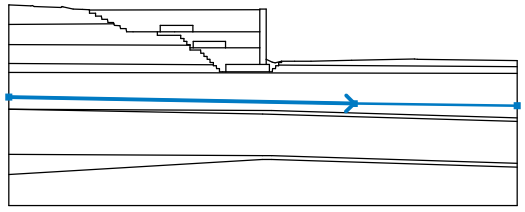
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m^2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m^2
3	No	No	strip	permanent	on terrain	x = 5.00	l = 35.00		0.00	20.00		kN/m^2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	A6 Bypass Traffic onto new M1 Overbridge

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 13)

Analysis 1 (stage 13)

Circular slip surface

Slip surface parameters							
Center :	x =	38.38	[m]	Angles :	α_1 =	-65.09	[°]
	z =	34.01	[m]		α_2 =	27.75	[°]
Radius :	R =	17.83	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 1408.16 kN/m
Sum of passive forces : F_p = 4178.97 kN/m

Sliding moment : M_a = 25403.23 kNm/m
Resisting moment : M_p = 75388.59 kNm/m
Utilization : 33.7 %

Slope stability ACCEPTABLE
Combination 2

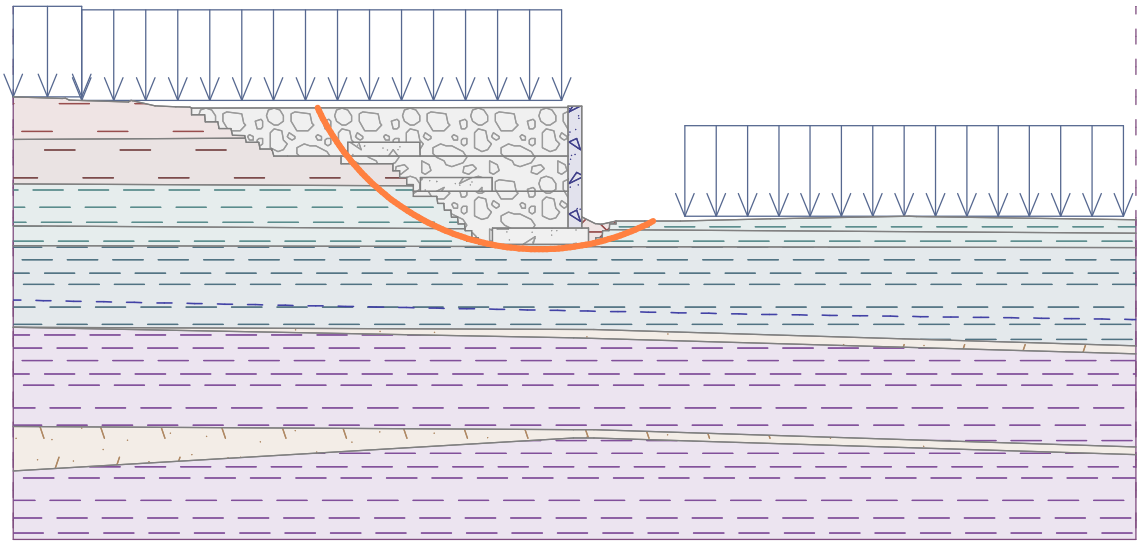
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Sum of active forces : F_a = 1015.57 kN/m
Sum of passive forces : F_p = 2919.79 kN/m

Sliding moment : M_a = 18107.63 kNm/m
Resisting moment : M_p = 52059.91 kNm/m
Utilization : 34.8 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 13 - 1



Analysis 2 (stage 13)

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
20.98	26.50	24.36	22.98	27.70	21.65	31.62	18.67	34.87	16.57
38.76	15.57	42.84	15.97	45.73	18.23				
The slip surface after optimization.									

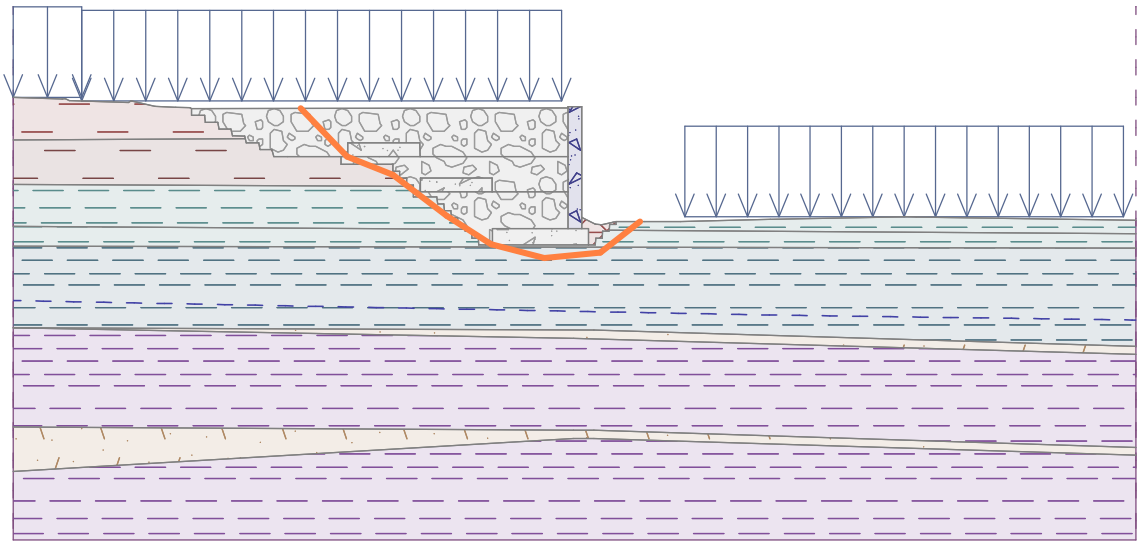
Slope stability verification (Sarma)
Combination 1
Utilization : 41.0 %

Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.
Combination 2
Utilization : 40.1 %

Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.Optimized slip surface for : Combination 1

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Name : Analysis | **Stage - analysis : 13 - 2**



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ANNEX B.5

EMG-HYD-C4-M1OB-CA-GE-0663

Cantilever wall analysis

Input data

Project

Task : EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part : M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description : M1 OVERBRIDGE RETAINING WALL ASSESSMENT
Customer : ROXHILL KEGWORTH LTD
Author : Ian Gardner
Date : 03/08/2017
Project ID : C14792
Project number : EMG-HYD-C4-M1OB-CA-GE-0663-S4-P3

Settings

United Kingdom - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Wall analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Base key : The base key is considered as inclined footing bottom
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)

Permanent design situation

		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on Poisson's ratio :	γ_v =	1.00	[–]	1.00	[–]

Partial factors for variable actions

Permanent design situation

Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

Material of structure

Unit weight γ = 23.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

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Concrete : C 20/25
Cylinder compressive strength f_{ck} = 20.00 MPa
Tensile strength f_{ctm} = 2.20 MPa

Longitudinal steel : B500
Yield strength f_{yk} = 500.00 MPa

Geometry of structure

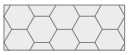
No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	5.00
3	4.00	5.00
4	4.00	6.00
5	-1.00	6.00
6	-1.00	5.00
7	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 10.00 m^2.

Basic soil parameters - (effective stress-state)

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00

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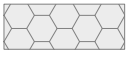
No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60
19	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
20	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
21	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
22	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
23	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
24	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
25	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
26	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
27	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
28	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
29	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
30	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
31	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
32	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
33	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
34	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
35	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
36	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50	12.50	14.00

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Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	γ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00
37	Redcued Level 60 - 59 m OD - MMG I		1097.00	116.00	23.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-

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No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-
19	Redcued Level 78 - 77 m OD - MMG IVB		cohesive	-	0.40	-	-
20	Redcued Level 77 - 76 m OD - MMG IVB		cohesive	-	0.40	-	-
21	Redcued Level 76 - 75 m OD - MMG IVB		cohesive	-	0.40	-	-
22	Redcued Level 75 - 74 m OD - MMG IVA		cohesive	-	0.40	-	-
23	Redcued Level 74 - 73 m OD - MMG IVA		cohesive	-	0.40	-	-
24	Redcued Level 73 - 72 m OD - MMG IVA		cohesive	-	0.40	-	-
25	Redcued Level 72 - 71 m OD - MMG IVA		cohesive	-	0.40	-	-
26	Redcued Level 71 - 70 m OD - MMG III		overconsolidated	-	-	2.00	-
27	Redcued Level 70 - 69 m OD - MMG III		overconsolidated	-	-	2.00	-
28	Redcued Level 69 - 68 m OD - MMG III		overconsolidated	-	-	2.00	-
29	Redcued Level 68 - 67 m OD - MMG III		overconsolidated	-	-	2.00	-
30	Redcued Level 67 - 66 m OD - MMG III		overconsolidated	-	-	2.00	-
31	Redcued Level 66 - 65 m OD - MMG III		overconsolidated	-	-	2.00	-
32	Redcued Level 65 - 64 m OD - MMG II		overconsolidated	-	-	2.00	-
33	Redcued Level 64 - 63 m OD - MMG II		overconsolidated	-	-	2.00	-
34	Redcued Level 63 - 62 m OD - MMG II		overconsolidated	-	-	2.00	-
35	Redcued Level 62 - 61 m OD - MMG II		overconsolidated	-	-	2.00	-
36	Redcued Level 61 - 60 m OD - MMG II		overconsolidated	-	-	2.00	-
37	Redcued Level 60 - 59 m OD - MMG I		overconsolidated	-	-	2.00	-

Soil parameters

Topsoil/Subsoil

Unit weight : γ = 16.50 kN/m^3

Stress-state : total

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Cohesion of soil :	c_u = 35.00 kPa
Adhesion struc.-soil :	a = 28.00 kPa
Soil :	cohesionless

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	γ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	δ = 7.50 °
Soil :	cohesive
Poisson's ratio :	ν = 0.40
Saturated unit weight :	γ_{sat} = 20.50 kN/m^3

Stiff red brown silty CLAY - MMG IVA

Unit weight :	γ = 20.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 4.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.40
Saturated unit weight :	γ_{sat} = 21.00 kN/m^3

Weathered Mudstone - MMG III

Unit weight :	γ = 22.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 10.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 2.00
Saturated unit weight :	γ_{sat} = 22.00 kN/m^3

Weathered Mudstone - MMG II

Unit weight :	γ = 22.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 42.00 °
Cohesion of soil :	c_{ef} = 16.00 kPa
Angle of friction struc.-soil :	δ = 14.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 3.00
Saturated unit weight :	γ_{sat} = 22.50 kN/m^3

Intact Mudstone - MMG I

Unit weight :	γ = 23.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 42.00 °
Cohesion of soil :	c_{ef} = 25.00 kPa
Angle of friction struc.-soil :	δ = 14.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 6.00
Saturated unit weight :	γ_{sat} = 23.00 kN/m^3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

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Unit weight :	γ	=	22.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	8.00 kPa
Angle of friction struc.-soil :	δ	=	12.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

Existing Highway General Fill

Unit weight :	γ	=	19.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Angle of friction struc.-soil :	δ	=	10.00 °
Soil :	cohesive		
Poisson's ratio :	ν	=	0.35
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Class 2 Fill (Site Won MMG IV)

Unit weight :	γ	=	19.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Angle of friction struc.-soil :	δ	=	10.00 °
Soil :	cohesive		
Poisson's ratio :	ν	=	0.35
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Class 6F Capping/Subbase/Surfacing

Unit weight :	γ	=	21.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	15.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	γ	=	20.00 kN/m^3
Stress-state :	total		
Cohesion of soil :	c_u	=	50.00 kPa
Adhesion struc.-soil :	a	=	20.00 kPa
Soil :	cohesive		
Poisson's ratio :	ν	=	0.40

Terrace Sands & Gravels

Unit weight :	γ	=	22.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	15.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Class 7A Selected Cohesive Fill

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Unit weight :	γ	=	20.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Angle of friction struc.-soil :	δ	=	12.00 °
Soil :	cohesive		
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Class 7C Selected Cohesive Fill

Unit weight :	γ	=	20.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Angle of friction struc.-soil :	δ	=	12.00 °
Soil :	cohesive		
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Pre-existing Made Ground

Unit weight :	γ	=	19.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	8.00 °
Soil :	cohesive		
Poisson's ratio :	ν	=	0.35
Saturated unit weight :	γ_{sat}	=	19.50 kN/m^3

Culvert

Unit weight :	γ	=	2.40 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	25.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	2.40 kN/m^3

Granular Backfill to Culvert

Unit weight :	γ	=	18.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	16.00 °
Soil :	cohesionless		
Saturated unit weight :	γ_{sat}	=	18.00 kN/m^3

Class 6N Selected Backfill to Structures

Unit weight :	γ	=	22.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Angle of friction struc.-soil :	δ	=	16.60 °
Soil :	cohesionless		

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Saturated unit weight : γ_{sat} = 23.00 kN/m3

Redcued Level 78 - 77 m OD - MMG IVB

Unit weight : γ = 19.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Angle of friction struc.-soil : δ = 8.30 °
Soil : cohesive
Poisson's ratio : ν = 0.40
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Redcued Level 77 - 76 m OD - MMG IVB

Unit weight : γ = 19.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Angle of friction struc.-soil : δ = 8.30 °
Soil : cohesive
Poisson's ratio : ν = 0.40
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Redcued Level 76 - 75 m OD - MMG IVB

Unit weight : γ = 19.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Angle of friction struc.-soil : δ = 8.30 °
Soil : cohesive
Poisson's ratio : ν = 0.40
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight : γ = 20.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 4.00 kPa
Angle of friction struc.-soil : δ = 10.70 °
Soil : cohesive
Poisson's ratio : ν = 0.40
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight : γ = 20.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 4.00 kPa
Angle of friction struc.-soil : δ = 10.70 °
Soil : cohesive
Poisson's ratio : ν = 0.40
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight : γ = 20.50 kN/m3
Stress-state : effective

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Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Angle of friction struc.-soil :	δ =	10.70 °
Soil :		cohesive
Poisson's ratio :	ν =	0.40
Saturated unit weight :	γ_{sat} =	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	γ =	20.50 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Angle of friction struc.-soil :	δ =	10.70 °
Soil :		cohesive
Poisson's ratio :	ν =	0.40
Saturated unit weight :	γ_{sat} =	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	γ =	22.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	δ =	10.70 °
Soil :		overconsolidated
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	γ =	22.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	δ =	10.70 °
Soil :		overconsolidated
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	γ =	22.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	δ =	10.70 °
Soil :		overconsolidated
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	γ =	22.00 kN/m^3
Stress-state :		effective
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	δ =	10.70 °
Soil :		overconsolidated
Overconsolidation ratio :	OCR =	2.00

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Saturated unit weight : γ_{sat} = 22.00 kN/m3

Redcued Level 67 - 66 m OD - MMG III

Unit weight : γ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Angle of friction struc.-soil : δ = 10.70 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.00 kN/m3

Redcued Level 66 - 65 m OD - MMG III

Unit weight : γ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Angle of friction struc.-soil : δ = 10.70 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.00 kN/m3

Redcued Level 65 - 64 m OD - MMG II

Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : δ = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Redcued Level 64 - 63 m OD - MMG II

Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : δ = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Redcued Level 63 - 62 m OD - MMG II

Unit weight : γ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : δ = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Redcued Level 62 - 61 m OD - MMG II

Unit weight : γ = 22.50 kN/m3
Stress-state : effective

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Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : δ = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II
Unit weight : γ = 22.50 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : δ = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : γ_{sat} = 22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I
Unit weight : γ = 23.00 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 1097.00 kPa
Adhesion struc.-soil : a = 116.00 kPa
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00

Backfill

Soil on front face of the structure - Class 6N Selected Backfill to Structures

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1.00	Redcued Level 77 - 76 m OD - MMG IVB	
2	1.00	Redcued Level 76 - 75 m OD - MMG IVB	
3	1.00	Redcued Level 75 - 74 m OD - MMG IVA	
4	1.00	Redcued Level 74 - 73 m OD - MMG IVA	
5	1.00	Redcued Level 73 - 72 m OD - MMG IVA	
6	1.00	Redcued Level 72 - 71 m OD - MMG IVA	
7	0.50	Class 6N Selected Backfill to Structures	
8	0.50	Redcued Level 71 - 70 m OD - MMG III	
9	1.00	Redcued Level 70 - 69 m OD - MMG III	
10	1.00	Redcued Level 69 - 68 m OD - MMG III	

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No.	Layer [m]	Assigned soil	Pattern
11	1.00	Redcued Level 68 - 67 m OD - MMG III	
12	1.00	Redcued Level 67 - 66 m OD - MMG III	
13	1.00	Redcued Level 66 - 65 m OD - MMG III	
14	1.00	Redcued Level 65 - 64 m OD - MMG II	
15	1.00	Redcued Level 64 - 63 m OD - MMG II	
16	1.00	Redcued Level 63 - 62 m OD - MMG II	
17	1.00	Redcued Level 62 - 61 m OD - MMG II	
18	1.00	Redcued Level 61 - 60 m OD - MMG II	
19	1.00	Redcued Level 60 - 59 m OD - MMG I	
20	-	Redcued Level 60 - 59 m OD - MMG I	

Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 11.00 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m2]	Mag.2 [kN/m2]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		permanent	20.00				on terrain

No.	Name
1	TYPICAL HIGHWAY UDL

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Class 6N Selected Backfill to Structures
Soil thickness in front of structure h = 1.00 m

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

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No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.00	230.00	1.50	1.000	1.000	1.350
FF resistance	-3.80	-0.33	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-3.17	323.31	2.51	1.000	1.000	1.350
Active pressure	79.32	-2.05	133.31	4.29	1.000	1.000	1.350
Water pressure	0.00	-6.00	0.00	2.75	1.000	1.000	1.000
TYPICAL HIGHWAY UDL	23.89	-3.05	46.11	3.90	1.350	1.000	1.350
TYPICAL HIGHWAY UDL	0.00	-6.00	34.95	1.87	1.000	1.000	1.350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 2036.42 kNm/m
Overturning moment M_{ovr} = 260.00 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 497.83 kN/m
Active horizontal force H_{act} = 99.41 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 228.81 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.00	230.00	1.50	1.000	1.000	1.000
FF resistance	-4.75	-0.33	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-3.17	323.31	2.51	1.000	1.000	1.000
Active pressure	104.39	-2.05	134.79	4.29	1.000	1.000	1.000
Water pressure	0.00	-6.00	0.00	2.75	1.000	1.000	1.000
TYPICAL HIGHWAY UDL	31.40	-3.04	46.49	3.90	1.000	1.000	1.000
TYPICAL HIGHWAY UDL	0.00	-6.00	34.95	1.87	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 1981.93 kNm/m
Overturning moment M_{ovr} = 308.08 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 398.61 kN/m
Active horizontal force H_{act} = 131.03 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 176.90 kPa

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Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	243.81	1036.38	135.53	0.047	228.81
2	183.16	783.83	99.41	0.047	172.93
3	250.02	769.54	131.03	0.065	176.90
4	250.02	769.54	131.03	0.065	176.90

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	180.27	767.69	99.41

Spread footing verification

Input data

Settings

United Kingdom - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

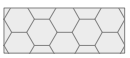
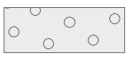
Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)							
Permanent design situation							
		Combination 1				Combination 2	
		Unfavourable		Favourable		Unfavourable	Favourable
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00 [–]	1.00 [–]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on unconfined strength :	γ_v =	1.00	[–]	1.40	[–]

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Basic soil parameters - (effective stress-state)

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60
19	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
20	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
21	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
22	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
23	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70

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No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
24	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
25	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
26	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
27	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
28	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
29	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
30	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
31	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
32	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
33	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
34	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
35	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
36	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50	12.50	14.00

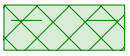
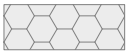
Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	γ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00
37	Redcued Level 60 - 59 m OD - MMG I		1097.00	116.00	23.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-

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No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-
19	Redcued Level 78 - 77 m OD - MMG IVB		cohesive	-	0.40	-	-
20	Redcued Level 77 - 76 m OD - MMG IVB		cohesive	-	0.40	-	-
21	Redcued Level 76 - 75 m OD - MMG IVB		cohesive	-	0.40	-	-
22	Redcued Level 75 - 74 m OD - MMG IVA		cohesive	-	0.40	-	-
23	Redcued Level 74 - 73 m OD - MMG IVA		cohesive	-	0.40	-	-
24	Redcued Level 73 - 72 m OD - MMG IVA		cohesive	-	0.40	-	-

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No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
25	Redcued Level 72 - 71 m OD - MMG IVA		cohesive	-	0.40	-	-
26	Redcued Level 71 - 70 m OD - MMG III		overconsolidated	-	-	2.00	-
27	Redcued Level 70 - 69 m OD - MMG III		overconsolidated	-	-	2.00	-
28	Redcued Level 69 - 68 m OD - MMG III		overconsolidated	-	-	2.00	-
29	Redcued Level 68 - 67 m OD - MMG III		overconsolidated	-	-	2.00	-
30	Redcued Level 67 - 66 m OD - MMG III		overconsolidated	-	-	2.00	-
31	Redcued Level 66 - 65 m OD - MMG III		overconsolidated	-	-	2.00	-
32	Redcued Level 65 - 64 m OD - MMG II		overconsolidated	-	-	2.00	-
33	Redcued Level 64 - 63 m OD - MMG II		overconsolidated	-	-	2.00	-
34	Redcued Level 63 - 62 m OD - MMG II		overconsolidated	-	-	2.00	-
35	Redcued Level 62 - 61 m OD - MMG II		overconsolidated	-	-	2.00	-
36	Redcued Level 61 - 60 m OD - MMG II		overconsolidated	-	-	2.00	-
37	Redcued Level 60 - 59 m OD - MMG I		overconsolidated	-	-	2.00	-

Soil parameters

Topsoil/Subsoil

Unit weight : $\gamma = 16.50$ kN/m^3
Angle of internal friction : $\varphi_{ef} = 24.50$ °
Cohesion of soil : $c_{ef} = 14.00$ kPa
Oedometric modulus : $E_{oed} = 2.50$ MPa
Saturated unit weight : $\gamma_{sat} = 18.50$ kN/m^3

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight : $\gamma = 19.50$ kN/m^3
Angle of internal friction : $\varphi_{ef} = 25.00$ °
Cohesion of soil : $c_{ef} = 2.00$ kPa
Oedometric modulus : $E_{oed} = 44.00$ MPa
Saturated unit weight : $\gamma_{sat} = 20.50$ kN/m^3

Stiff red brown silty CLAY - MMG IVA

Unit weight : $\gamma = 20.50$ kN/m^3
Angle of internal friction : $\varphi_{ef} = 32.00$ °
Cohesion of soil : $c_{ef} = 4.00$ kPa
Oedometric modulus : $E_{oed} = 68.00$ MPa

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Saturated unit weight : γ_{sat} = 21.00 kN/m3

Weathered Mudstone - MMG III

Unit weight : γ = 22.00 kN/m3
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Oedometric modulus : E_{oed} = 120.00 MPa
Saturated unit weight : γ_{sat} = 22.00 kN/m3

Weathered Mudstone - MMG II

Unit weight : γ = 22.50 kN/m3
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Oedometric modulus : E_{oed} = 200.00 MPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Intact Mudstone - MMG I

Unit weight : γ = 23.00 kN/m3
Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 25.00 kPa
Oedometric modulus : E_{oed} = 400.00 MPa
Saturated unit weight : γ_{sat} = 23.00 kN/m3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

Unit weight : γ = 22.50 kN/m3
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 8.00 kPa
Oedometric modulus : E_{oed} = 250.00 MPa
Saturated unit weight : γ_{sat} = 23.00 kN/m3

Existing Highway General Fill

Unit weight : γ = 19.50 kN/m3
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Oedometric modulus : E_{oed} = 17.50 MPa
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Class 2 Fill (Site Won MMG IV)

Unit weight : γ = 19.50 kN/m3
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Oedometric modulus : E_{oed} = 8.50 MPa
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Class 6F Capping/Subbase/Surfacing

Unit weight : γ = 21.00 kN/m3
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Oedometric modulus : E_{oed} = 478.00 MPa
Saturated unit weight : γ_{sat} = 21.50 kN/m3

Landscape Fill - Class 4

Unit weight : γ = 20.00 kN/m3

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Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	1.00 kPa
Oedometric modulus :	E_{oed}	=	8.50 MPa
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Terrace Sands & Gravels

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	35.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	65.00 MPa
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Class 7A Selected Cohesive Fill

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	20.00 MPa
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Class 7C Selected Cohesive Fill

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	20.00 MPa
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Pre-existing Made Ground

Unit weight :	γ	=	19.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	17.50 MPa
Saturated unit weight :	γ_{sat}	=	19.50 kN/m^3

Culvert

Unit weight :	γ	=	2.40 kN/m^3
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	2.40 kN/m^3

Granular Backfill to Culvert

Unit weight :	γ	=	18.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	18.00 kN/m^3

Class 6N Selected Backfill to Structures

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

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Redcued Level 78 - 77 m OD - MMG IVB

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	10.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Redcued Level 77 - 76 m OD - MMG IVB

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	20.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Redcued Level 76 - 75 m OD - MMG IVB

Unit weight :	γ	=	19.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	30.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	20.50 kN/m^3

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	40.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	50.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	60.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	γ	=	20.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa

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Deformation modulus :	E_{def}	=	70.00 MPa
Poisson's ratio :	ν	=	0.40
Saturated unit weight :	γ_{sat}	=	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	80.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	90.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	100.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	110.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 67 - 66 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	120.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 66 - 65 m OD - MMG III

Unit weight :	γ	=	22.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Deformation modulus :	E_{def}	=	130.00 MPa
Poisson's ratio :	ν	=	0.30
Saturated unit weight :	γ_{sat}	=	22.00 kN/m^3

Redcued Level 65 - 64 m OD - MMG II

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Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	151.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 64 - 63 m OD - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	184.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 63 - 62 m OD - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	217.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 62 - 61 m OD - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	250.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II

Unit weight :	γ	=	22.50 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	283.50 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I

Unit weight :	γ	=	23.00 kN/m^3
Angle of internal friction :	φ_{ef}	=	42.00 °
Cohesion of soil :	c_{ef}	=	25.00 kPa
Deformation modulus :	E_{def}	=	329.17 MPa
Poisson's ratio :	ν	=	0.25
Saturated unit weight :	γ_{sat}	=	23.00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	6.00 m
Depth of footing bottom	d	=	1.00 m
Foundation thickness	t	=	1.00 m
Incl. of finished grade	s_1	=	0.00 °

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Incl. of footing bottom s_2 = 0.00 °

Unit weight of soil above foundation = 20.50 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length = 5.25 m
Strip footing width (x) = 5.00 m
Column width in the direction of x = 0.10 m
Volume of strip footing = 5.00 m^3/m

Inserted loading is considered per unit length of continuous footing span.

Material of structure

Unit weight γ = 23.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength f_{ck} = 20.00 MPa
Tensile strength f_{ctm} = 2.20 MPa
Elasticity modulus E_{cm} = 30000.00 MPa

Longitudinal steel : B500

Yield strength f_{yk} = 500.00 MPa

Transverse steel: B500

Yield strength f_{yk} = 500.00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1.00	Redcued Level 77 - 76 m OD - MMG IVB	
2	1.00	Redcued Level 76 - 75 m OD - MMG IVB	
3	1.00	Redcued Level 75 - 74 m OD - MMG IVA	
4	1.00	Redcued Level 74 - 73 m OD - MMG IVA	
5	1.00	Redcued Level 73 - 72 m OD - MMG IVA	
6	1.00	Redcued Level 72 - 71 m OD - MMG IVA	
7	0.50	Class 6N Selected Backfill to Structures	
8	0.50	Redcued Level 71 - 70 m OD - MMG III	
9	1.00	Redcued Level 70 - 69 m OD - MMG III	
10	1.00	Redcued Level 69 - 68 m OD - MMG III	
11	1.00	Redcued Level 68 - 67 m OD - MMG III	

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No.	Layer [m]	Assigned soil	Pattern
12	1.00	Redcued Level 67 - 66 m OD - MMG III	
13	1.00	Redcued Level 66 - 65 m OD - MMG III	
14	1.00	Redcued Level 65 - 64 m OD - MMG II	
15	1.00	Redcued Level 64 - 63 m OD - MMG II	
16	1.00	Redcued Level 63 - 62 m OD - MMG II	
17	1.00	Redcued Level 62 - 61 m OD - MMG II	
18	1.00	Redcued Level 61 - 60 m OD - MMG II	
19	1.00	Redcued Level 60 - 59 m OD - MMG I	
20	-	Redcued Level 60 - 59 m OD - MMG I	

Load

No.	Load		Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
	new	change					
1	Yes		LC 1	Design	921.38	108.28	-135.53
2	Yes		LC 2	Design	668.83	83.75	-99.41
3	Yes		LC 3	Design	654.54	118.98	-131.03
4	Yes		LC 4	Design	654.54	118.98	-131.03
5	Yes		LC 5	Service	652.69	80.86	-99.41

Ground water table

The ground water table is at a depth of 11.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0.24	0.00	228.81	3430.76	6.67	Yes
LC 1	No	-0.24	0.00	228.81	3430.76	6.67	Yes
LC 2	Yes	-0.23	0.00	172.93	3479.88	4.97	Yes
LC 2	No	-0.23	0.00	172.93	3479.88	4.97	Yes
LC 3	Yes	-0.32	0.00	176.90	3109.75	5.69	Yes
LC 3	No	-0.32	0.00	176.90	3109.75	5.69	Yes

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Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 4	Yes	-0.32	0.00	176.90	3109.75	5.69	Yes
LC 4	No	-0.32	0.00	176.90	3109.75	5.69	Yes
LC 5	Yes	-0.23	0.00	169.46	1466.24	11.56	Yes
LC 5	No	-0.23	0.00	169.46	1466.24	11.56	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed self weight of strip foundation G = 115.00 kN/m
Computed weight of overburden Z = 0.00 kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 5. (LC 5)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 9.51 m
Length of slip surface l_{sp} = 31.29 m

Design bearing capacity of found.soil R_d = 1466.24 kPa
Extreme contact stress σ = 169.46 kPa

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.065<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.065<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 3. (LC 3)

Earth resistance: not considered

Horizontal bearing capacity R_{dh} = 680.83 kN
Extreme horizontal force H = 131.03 kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation G = 115.00 kN/m
Computed weight of overburden Z = 0.00 kN/m

Settlement of mid point of longitudinal edge = 1.8 mm
Settlement of mid point of transverse edge 1 = 2.1 mm
Settlement of mid point of transverse edge 2 = 1.5 mm

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(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 148.49 MPa
Foundation in the longitudinal direction is rigid (k=1.62)
Foundation in the direction of width is rigid (k=202.03)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.047<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.047<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 2.0 mm
Depth of influence zone = 5.85 m

Rotation in direction of width = 0.129 (tan*1000); (7.4E-03 °)

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ANNEX B.6

EMG-HYD-C4-M1OB-CA-GE-0664

Earth pressure on structure analysis

Input data

Project

Task : EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part : M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description : M1 OVERBRIDGE ABUTMENT ASSESSMENT
Customer : ROXHILL KEGWORTH LTD
Author : Ian Gardner
Date : 08/07/2017
Project ID : C14792
Project number : EMG-HYD-M1OB-GD-CA-GE-0664-S4-P2

Settings

United Kingdom - EN 1997

Pressure analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)

Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	γ_Q =	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	γ_w =	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)

Permanent design situation

		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on Poisson's ratio :	γ_v =	1.00	[–]	1.00	[–]

Partial factors for variable actions

Permanent design situation

Factor for combination value :	ψ_0 =	0.70	[–]
Factor for frequent value :	ψ_1 =	0.50	[–]
Factor for quasi-permanent value :	ψ_2 =	0.30	[–]

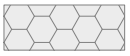
Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	10.50
3	0.00	0.00

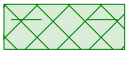
The origin [0,0] is located at the most upper point of the structure.

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Basic soil parameters - (effective stress-state)

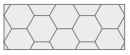
No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]	γ_{su} [kN/m^3]	δ [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60

Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	γ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00

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Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	φ_{ef} [°]	ν [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-

Soil parameters

Topsoil/Subsoil

Unit weight : γ = 16.50 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 35.00 kPa
Adhesion struc.-soil : a = 28.00 kPa
Soil : cohesionless

Firm to stiff red brown silty CLAY - MMG IVB

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Unit weight :	γ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	δ = 7.50 °
Soil :	cohesive
Poisson's ratio :	ν = 0.40
Saturated unit weight :	γ_{sat} = 20.50 kN/m^3

Stiff red brown silty CLAY - MMG IVA

Unit weight :	γ = 20.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 4.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.40
Saturated unit weight :	γ_{sat} = 21.00 kN/m^3

Weathered Mudstone - MMG III

Unit weight :	γ = 22.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 10.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 2.00
Saturated unit weight :	γ_{sat} = 22.00 kN/m^3

Weathered Mudstone - MMG II

Unit weight :	γ = 22.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 42.00 °
Cohesion of soil :	c_{ef} = 16.00 kPa
Angle of friction struc.-soil :	δ = 14.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 3.00
Saturated unit weight :	γ_{sat} = 22.50 kN/m^3

Intact Mudstone - MMG I

Unit weight :	γ = 23.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 42.00 °
Cohesion of soil :	c_{ef} = 25.00 kPa
Angle of friction struc.-soil :	δ = 14.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 6.00
Saturated unit weight :	γ_{sat} = 23.00 kN/m^3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	γ = 22.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 40.00 °
Cohesion of soil :	c_{ef} = 8.00 kPa
Angle of friction struc.-soil :	δ = 12.00 °

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Soil :	cohesionless
Saturated unit weight :	γ_{sat} = 23.00 kN/m^3

Existing Highway General Fill

Unit weight :	γ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.35
Saturated unit weight :	γ_{sat} = 20.50 kN/m^3

Class 2 Fill (Site Won MMG IV)

Unit weight :	γ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	δ = 10.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.35
Saturated unit weight :	γ_{sat} = 20.50 kN/m^3

Class 6F Capping/Subbase/Surfacing

Unit weight :	γ = 21.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 15.00 °
Soil :	cohesionless
Saturated unit weight :	γ_{sat} = 21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	γ = 20.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 50.00 kPa
Adhesion struc.-soil :	a = 20.00 kPa
Soil :	cohesive
Poisson's ratio :	ν = 0.40

Terrace Sands & Gravels

Unit weight :	γ = 22.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 15.00 °
Soil :	cohesionless
Saturated unit weight :	γ_{sat} = 22.50 kN/m^3

Class 7A Selected Cohesive Fill

Unit weight :	γ = 20.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	δ = 12.00 °

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Soil :	cohesive
Poisson's ratio :	ν = 0.40
Saturated unit weight :	γ_{sat} = 21.00 kN/m3

Class 7C Selected Cohesive Fill

Unit weight :	γ = 20.50 kN/m3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	δ = 12.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.40
Saturated unit weight :	γ_{sat} = 21.00 kN/m3

Pre-existing Made Ground

Unit weight :	γ = 19.00 kN/m3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 25.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 8.00 °
Soil :	cohesive
Poisson's ratio :	ν = 0.35
Saturated unit weight :	γ_{sat} = 19.50 kN/m3

Culvert

Unit weight :	γ = 2.40 kN/m3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 41.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 25.00 °
Soil :	cohesionless
Saturated unit weight :	γ_{sat} = 2.40 kN/m3

Granular Backfill to Culvert

Unit weight :	γ = 18.00 kN/m3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 41.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 16.00 °
Soil :	cohesionless
Saturated unit weight :	γ_{sat} = 18.00 kN/m3

Class 6N Selected Backfill to Structures

Unit weight :	γ = 22.50 kN/m3
Stress-state :	effective
Angle of internal friction :	φ_{ef} = 41.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	δ = 16.60 °
Soil :	cohesionless
Saturated unit weight :	γ_{sat} = 23.00 kN/m3

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Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	6.50	Class 6N Selected Backfill to Structures	
2	4.00	Class 6N Selected Backfill to Structures	
3	2.00	Weathered Mudstone - MMG II	
4	1.50	Weathered Mudstone - MMG II	
5	4.00	Intact Mudstone - MMG I	
6	-	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone	

Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 11.00 m

Input surface surcharges

No.	Surcharge		Action	Mag.1 [kN/m2]	Mag.2 [kN/m2]	Ord.x x [m]	Length l [m]	Depth z [m]
	new	change						
1	Yes		permanent	20.00				on terrain

No.	Name
1	TYPICAL HIGHWAY UDL

Settings of the stage of construction

Design situation : permanent

Analysis No. 1

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	4.86	1.45
2	1.00	10.32	3.08
3	6.50	40.36	12.03
4	10.50	62.21	18.55

Resultant forces

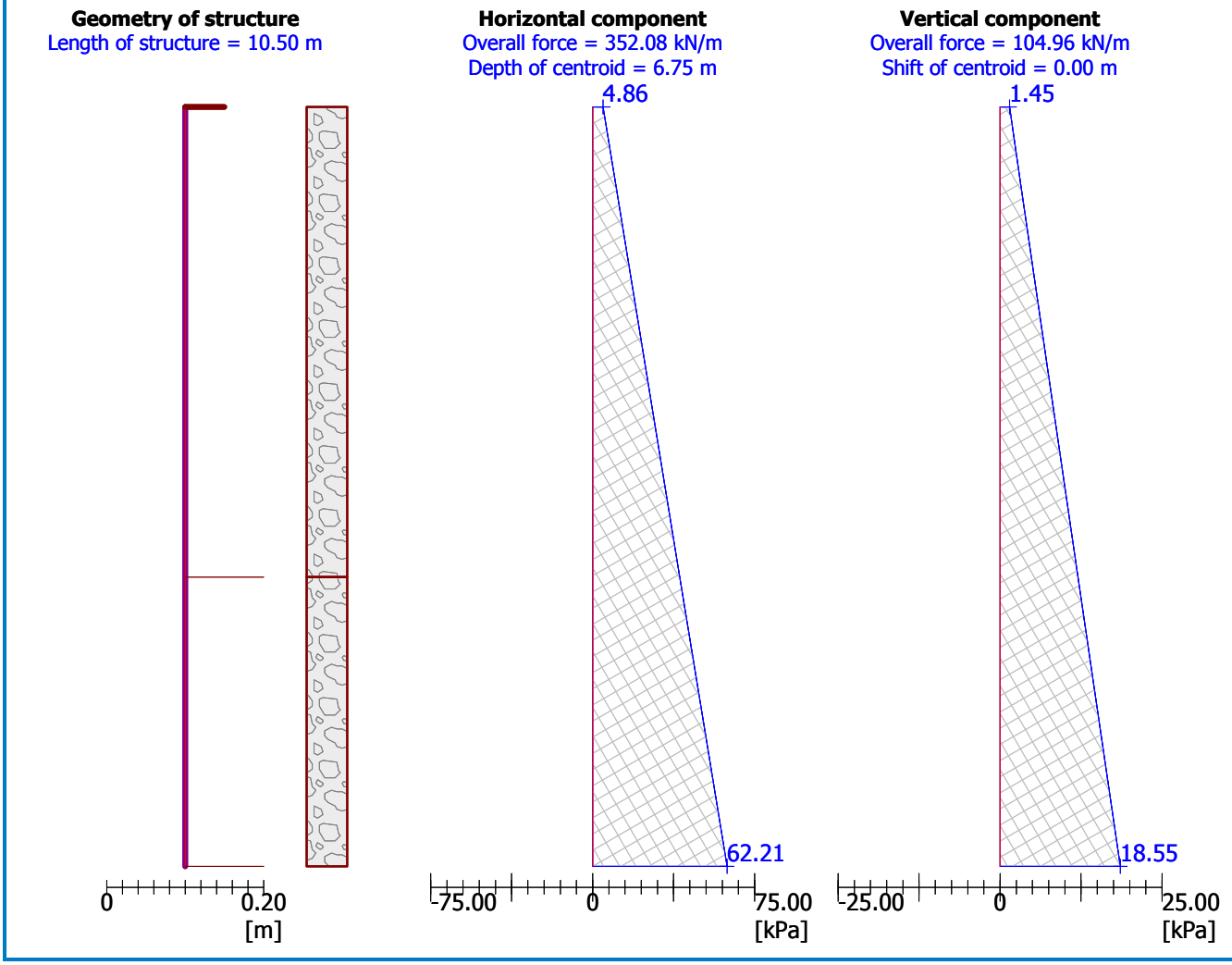
Cohesion of soils has not been subtracted from pressures caused by a surcharge.

Total horizontal pressure acting on construction = 352.08 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 104.96 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 1.

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Name : Analysis	Stage - analysis : 1 - 1



Analysis No. 2

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	4.76	1.20
2	1.00	10.12	2.55
3	6.50	39.59	9.96
4	10.50	61.03	15.35

Resultant forces

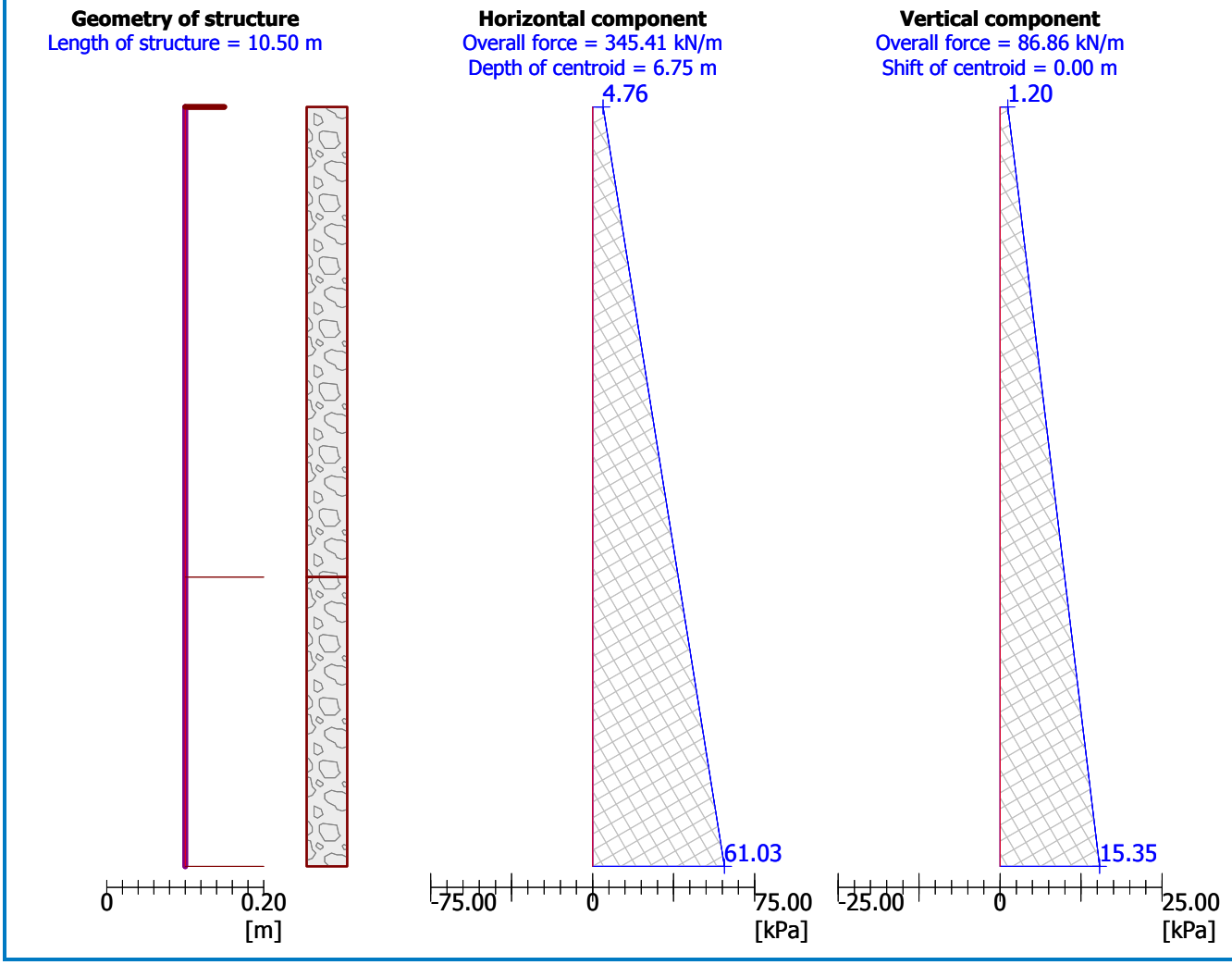
Cohesion of soils has not been subtracted from pressures caused by a surcharge.

Total horizontal pressure acting on construction = 345.41 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 86.86 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 2.

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Name : Analysis	Stage - analysis : 1 - 2



Analysis No. 3

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	9.11	0.00
2	1.00	19.36	0.00
3	6.50	75.72	0.00
4	10.50	116.71	0.00

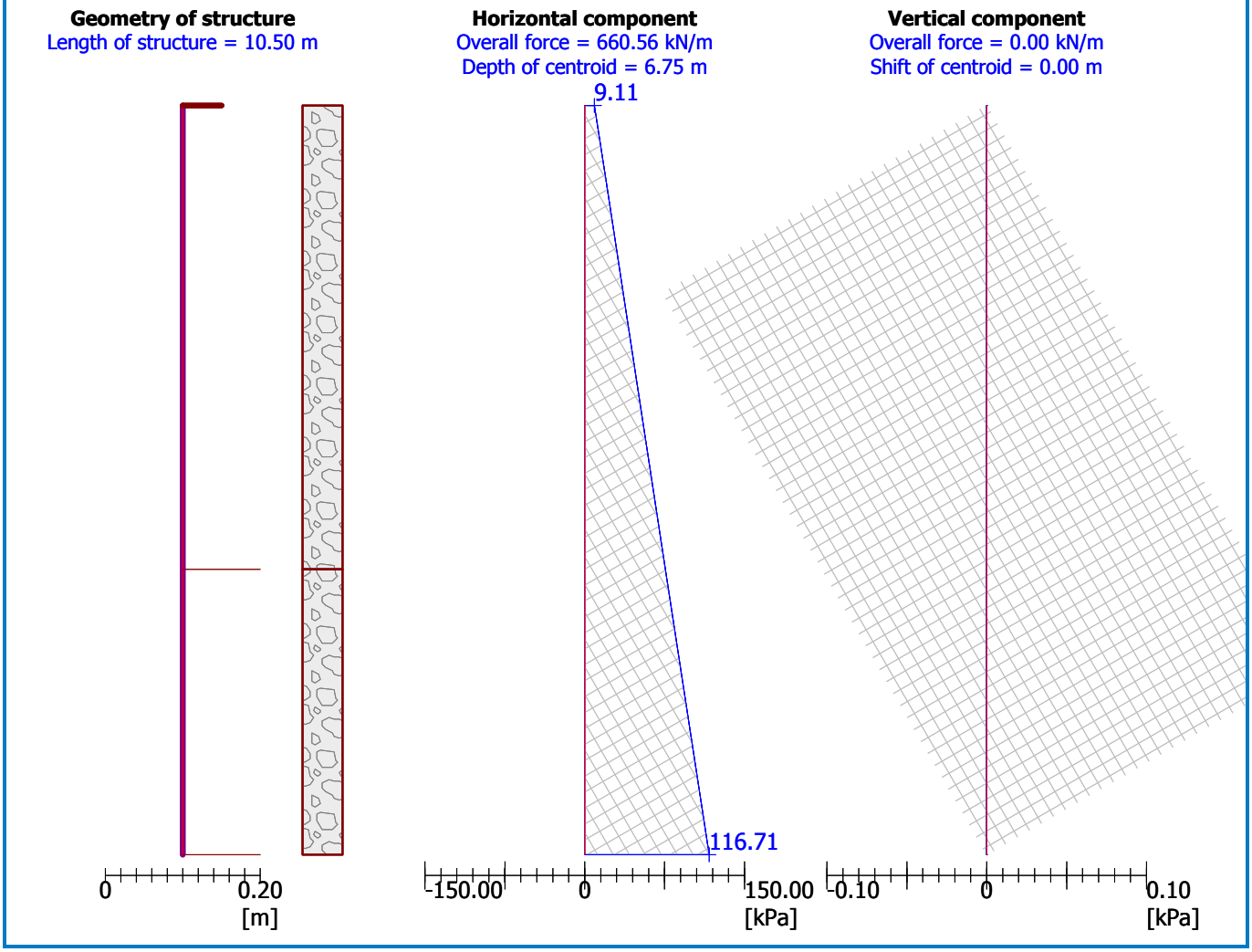
Resultant forces

Total horizontal pressure acting on construction = 660.56 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 0.00 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 1.

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Name : Analysis	Stage - analysis : 1 - 3



Analysis No. 4

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	8.45	0.00
2	1.00	17.95	0.00
3	6.50	70.20	0.00
4	10.50	108.21	0.00

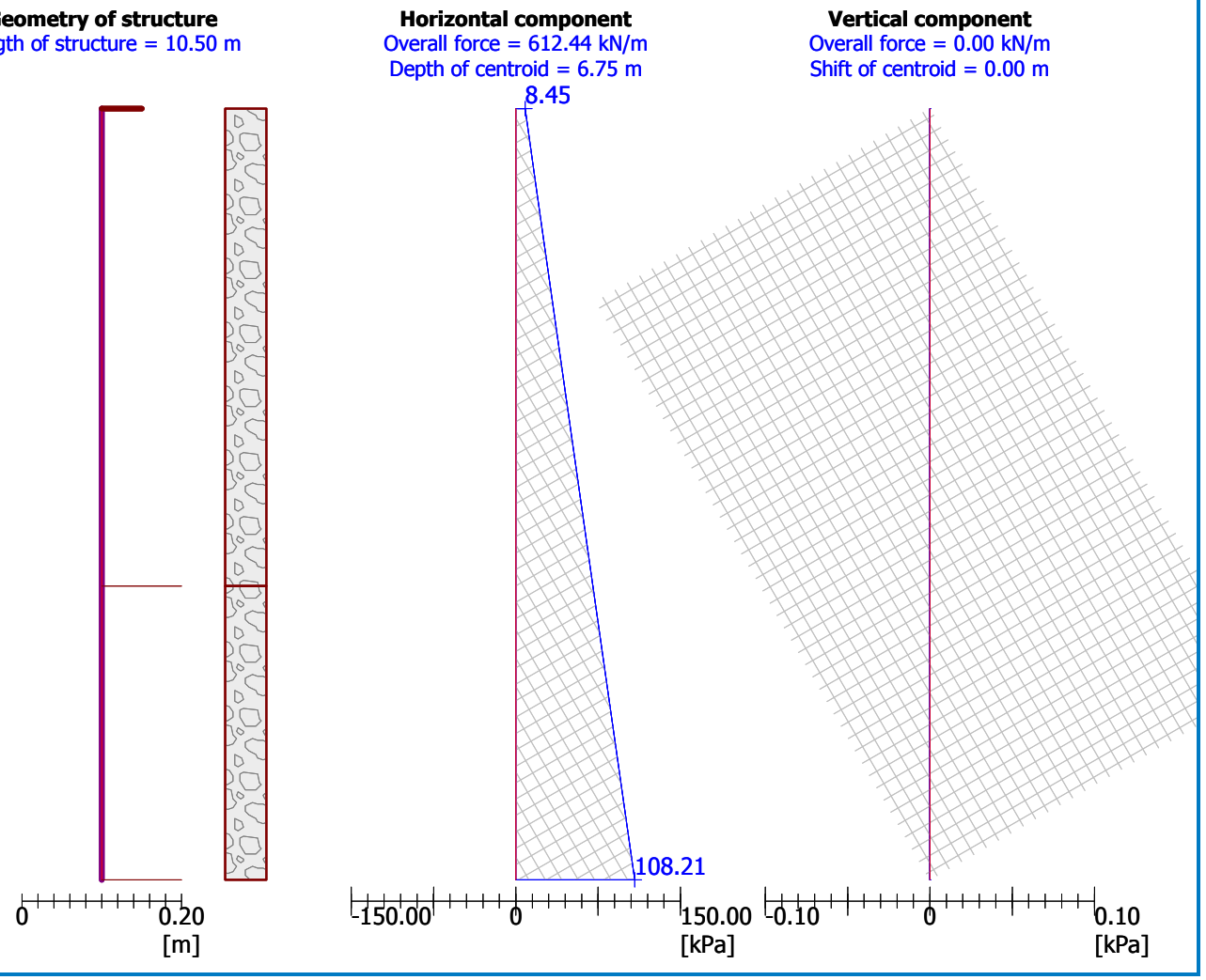
Resultant forces

Total horizontal pressure acting on construction = 612.44 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 0.00 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 2.

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Name : Analysis	Stage - analysis : 1 - 4



Analysis No. 5

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	206.27	-61.49
2	1.00	438.32	-130.67
3	6.50	1714.61	-511.15
4	10.50	2642.82	-787.86

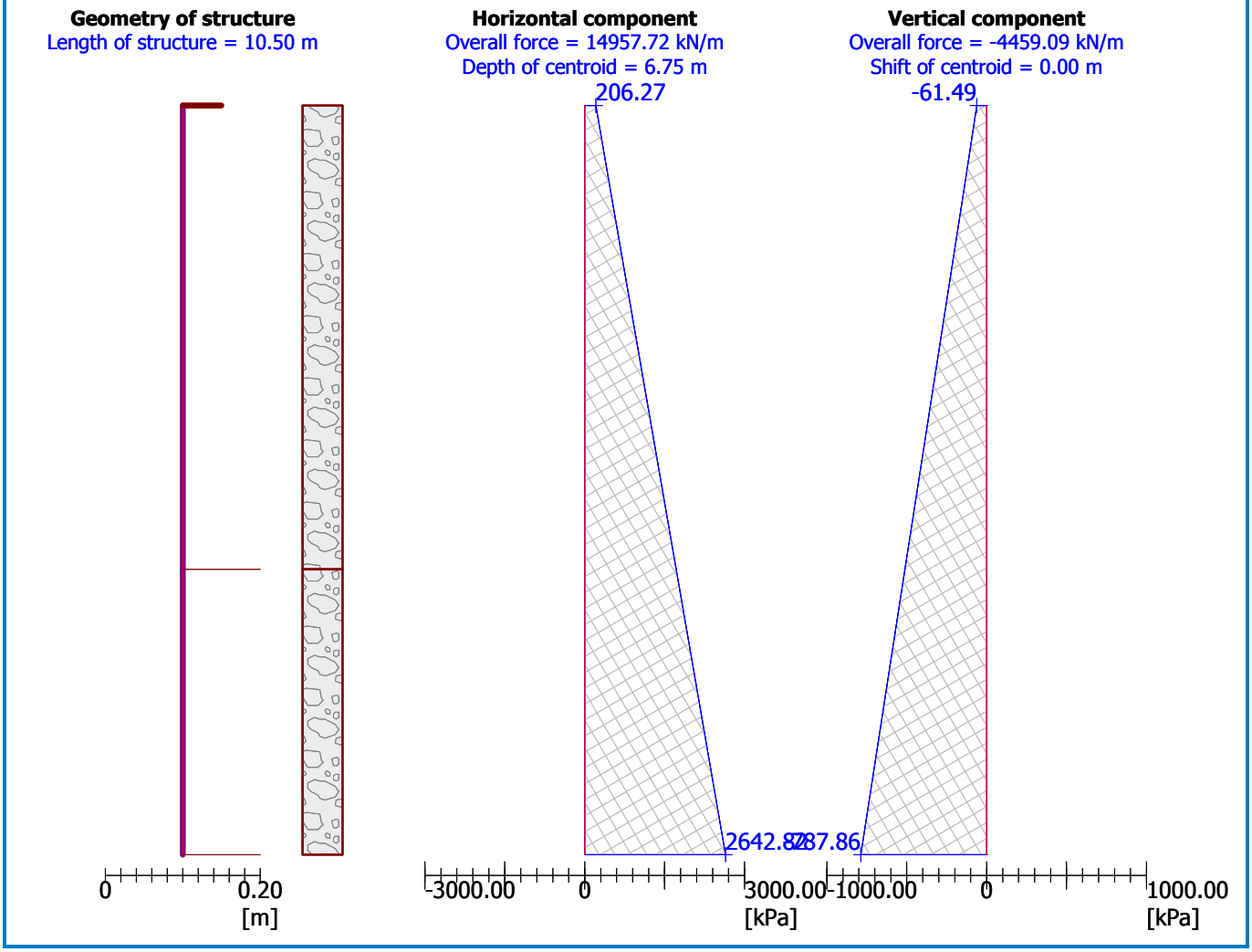
Resultant forces

Total horizontal pressure acting on construction = 14957.72 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = -4459.09 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 1.

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Name : Analysis	Stage - analysis : 1 - 5



Analysis No. 6

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	123.16	-30.97
2	1.00	261.72	-65.82
3	6.50	1023.80	-257.46
4	10.50	1578.03	-396.84

Resultant forces

Total horizontal pressure acting on construction = 8931.27 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = -2246.04 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 2.

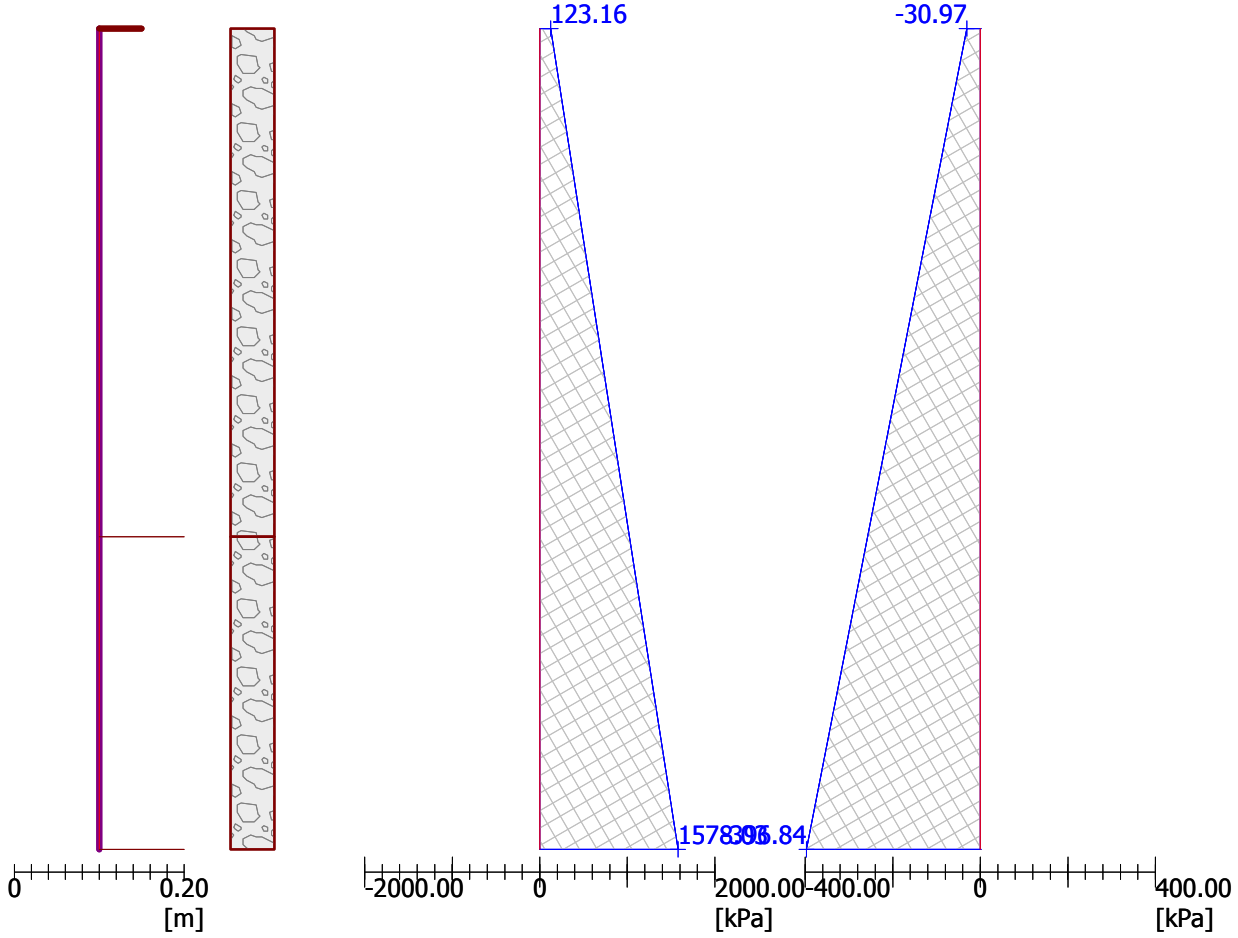
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Name : Analysis | **Stage - analysis : 1 - 6**

Geometry of structure
Length of structure = 10.50 m

Horizontal component
Overall force = 8931.27 kN/m
Depth of centroid = 6.75 m

Vertical component
Overall force = -2246.04 kN/m
Shift of centroid = 0.00 m



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ANNEX C

METHODS OF BEARING PRESSURE DISTRIBUTION AND SETTLEMENT ANALYSIS

Technical Description of Methodologies Used

The assessment of the settlement characteristics of the ground and the associated net increase in bearing pressure below a loaded area is discussed in detail within the following sections.

The ground is represented as a series of soil profiles, which have been determined using CPT soundings which will provide a continuous assessment of the cone resistance and sleeve friction. The use of the CPT equipment is able to provide a measurement of the corrected cone resistance q_t (Mpa), friction ratio R_f (%) and inclination (º) at intervals depth of 0.01m.

The results of the CPT soundings have been used as both direct and indirect assessment of the soil stiffness profile, using measured data, industry accepted correlations and experience of similar materials.

The loading conditions used in this assessment are based on Hydrock's current understanding of the proposed development; however once final loading conditions are known the assessment of settlement and displacement should be reviewed and revised accordingly.

Vertical displacements have been calculated using a combination of equations, based upon Bousinesq theory and modified as discussed within the following sections, The Bousinesq method of determining the stress distribution is correct for a uniform isotropic, elastic material having a constant Poisson's ratio. Vertical strains are derived from this stress distribution using elastic constants appropriate to that strain level for each soil layer and then summed to give displacements. Where the Bousinesq equations have been modified (Janbu *et al*, Osterberg etc) then this is stated within the following relevant sections.

The Bousinesq method allows the assessment of non-linear soil properties and the accuracy of this has been increased by treating each 0.01m measurement of q_t and R_f as a separate, individual layer.

Settlement assessed using Coefficient of Volume Compressibility

To calculate the settlement caused by consolidation, the modulus of volume compressibility (m_v) can be used once it has been determined. The use of this method to assess consolidation settlements is covered by BS EN 1997-2: 2004 Annex F.4, and typically the value of m_v is determined from one dimensional (oedometer) laboratory testing or it can be estimated from correlations with other tests such as SPT '*N*' values or CPT q_t values.

The general equation to calculate the oedometer settlement of a soil layer is given in many soil mechanics text books, including Tomlinson, and is shown below:

$\rho_{eod} = m_v \times \sigma_z \times H$

Where:

ρ_{eod} = Settlement due to consolidation

m_v = average coefficient of volume compressibility for the effective pressure increment for the soil layer under assessment;

σ_z = average effective vertical stress imposed on the soil layer under assessment; and

H = thickness of soil layer under consideration.

The results for various layers can be summed together in order to provide a comprehensive assessment of the total predicted settlement for a soil profile, however it is noted that the addition of settlements in the undrained and consolidation state can often lead to an overestimate of the total settlement. Therefore it has become common practice to use empirical corrections applied to the results to provide a more realistic estimate of settlement for the type of soil under assessment and to account for their 3 dimensional consolidation properties (typically referenced as μ and μ_g correction factors). This gives the following additional equation for the assessment of total settlement:

$\rho_c = \mu_g \times \rho_{eod}$

Where:

μ_g = a geological factor coefficient, which will depend on the type of clay and for which there are industry accepted values recorded in soil mechanics text books.

The assessment of consolidation settlement using this method does not provide a direct value for immediate or consolidation settlement for normally or over consolidated soils. However there are a number of references which can be used to assess the proportion of immediate, consolidation and total settlement as indicated below:

For stiff over consolidated clays;

Immediate	ρ_i	=0.5 to 0.6 ρ_{eod}
Consolidation	ρ_c	=0.5 to 0.4 ρ_{eod}
Total	ρ_{eod}	=1 x ρ_{eod}

For soft, normally consolidated clays;

Immediate	ρ_i	$=0.1\ \rho_{eod}$
Consolidation	ρ_c	$=1.0\ \rho_{eod}$
Total	ρ_{eod}	$=1.1 \times \rho_{eod}$

Therefore for the purposes of this assessment the reported total predicted settlement is based upon the calculated values of either ρ_{eod} for stiff consolidated soils, or $1.1 \times \rho_{eod}$ where the soils have been deemed to be soft, normally consolidated.

The options for the estimation and calculation of the average vertical stress for a particular soil layer under assessment are discussed in more detail within the following sections.

Assessment of Secondary Consolidation

Where ground improvement using surcharge is to be undertaken, then as part of the overall prediction of settlement it is necessary to undertake an assessment on the secondary settlement of the ground. In general, it is the aspiration of ground improvement using surcharge to instigate all the primary settlement and sufficient secondary settlement of the ground, so that the long-term settlement performance will be within acceptable levels. Without a clear understanding of the secondary settlement characteristics, it will be difficult to decide when sufficient settlement has occurred during the ground improvement phase to permit the removal of the surcharge load.

Secondary consolidation is the compression of soil that takes place after the primary consolidation phase. The shape of the secondary settlement curve differs from the primary consolidation in that it forms a slope which can be expressed as a logarithmic function, whereas the primary consolidation generally forms a polynomial curve. Even after the reduction of hydrostatic pressure some compression of soil takes place at slow rate and this is known as secondary consolidation.

Secondary consolidation is caused by creep, viscous behaviour of the clay-water system, compression of organic matter, and other processes. In sand, settlement caused by secondary compression is negligible, but in peat, it is very significant. The equations and methodology used in the assessment of the secondary consolidation of peat are detailed in the following sections, however for cohesive soils the following equation has been used in this assessment.

Secondary consolidation is given by either of the following formulas:

$$\rho_s = [c_\alpha / (1 + e_0)] \times H_o \log (t_2 / t_1)$$

or

$$\rho_s = c_{\alpha\varepsilon} / \times H_o \log (t_2 / t_1)$$

Where:

ρ_s	=	Total settlement
H_0	=	Thickness of compressible layer under consideration
e_0	=	the void ratio at the end of the primary consolidation

c_α = is the secondary compression index (where not determined from laboratory analysis an assessment is made on the basis that $c_\alpha \simeq 0.04 \times c_c$ unless otherwise stated)

$c_{\alpha\varepsilon}$ = modified secondary compression index or re-compression index (after Mesri 1973)

t_1 = time at end of the primary consolidation / ground improvement period

t_2 = time at end of design period for structure under consideration.

For the purposes of secondary settlement calculations, secondary settlement is assumed to start when primary settlement is substantially complete. Thus, if primary settlements were substantially complete in 12 years, the value t_1 would be 12. The value of t_2 depends upon the lifespan of the structure under consideration.

Values of c_α are obtained from the e vs. log ρ or Δh vs. log ρ plots. C_α is usually assumed to be related to C_c with values of c_α / C_c typically in the range of 0.025 to 0.006 for inorganic soils and 0.035 to 0.085 for organic soils. Some typical values are presented in Table C.1 and Figure C.1.

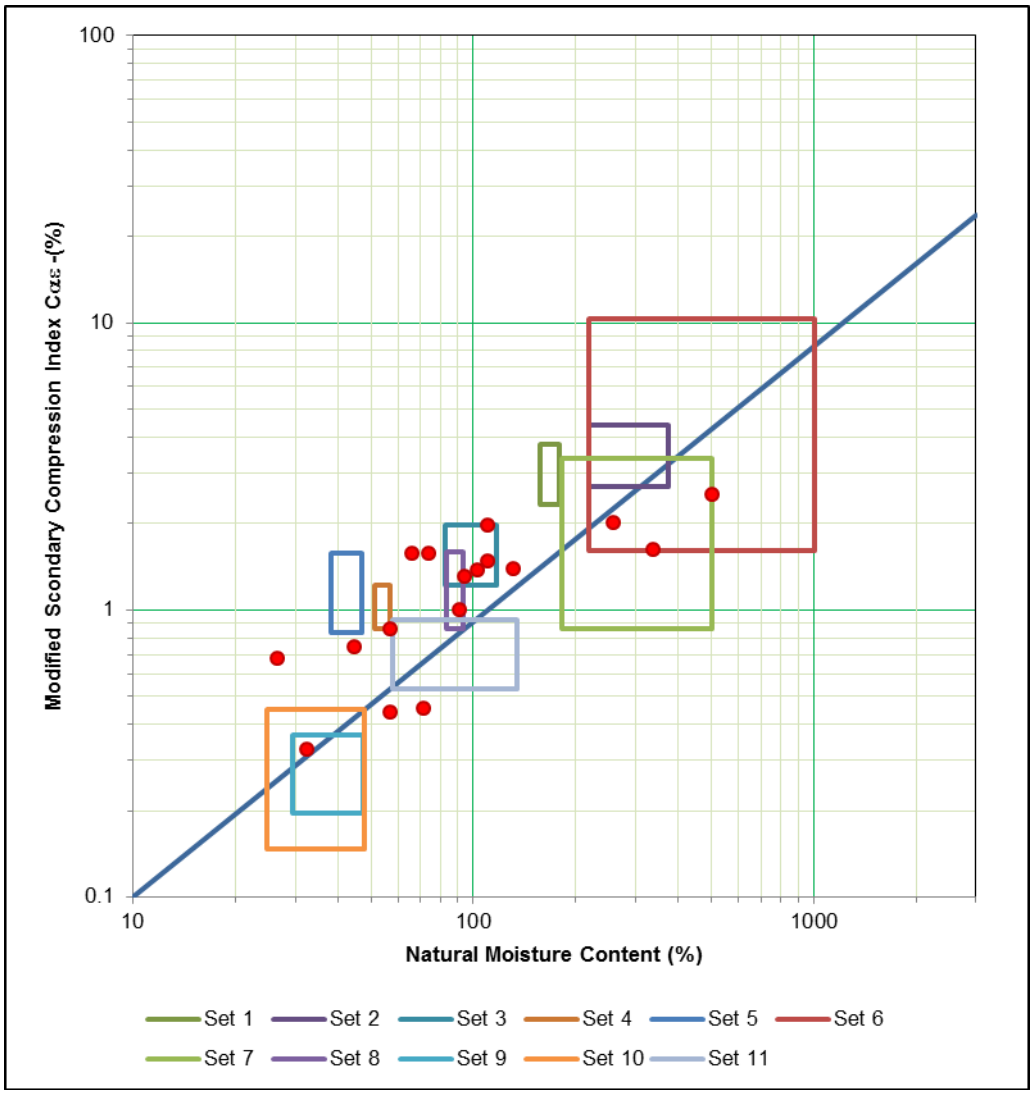
Table C.1: Typical Values of Compressibility Index and Secondary Compression (Carter *et al*)

Soil Type	**Compressibility Index** **Typical C_c**	**Compressibility to Secondary** **Typical C_α / C_c**	**Secondary Compression** **Expected C_α**
Normally consolidated medium sensitivity clays	0.20 to 0.50	0.025 to 0.055	0.005 to 0.025
Silty clay (CL)	0.15 to 0.30	0.030 to 0.060	0.004 to 0.018
Boston blue clay (CL)	0.30 to 0.50	0.030 to 0.060	0.009 to 0.030
Clay of high plasticity (CH)	0.50 to 0.60	0.050 to 0.070	0.025 to 0.042
Medium sensitivity clay (CL to CH)	1.0 to 3.0	0.050 to 0.070	0.050 to 0.210
Organic clays	Greater than 4	0.040 to 0.075	0.160 to 0.750
Peats	10 to 15	0.035 to 0.085	0.350 to 1.275
Organic silts	1.5 to 4.0	0.035 to 0.060	0.052 to 0.240
Alluvial silts and clays	0.40 to 1.2	0.040 to 0.060	0.016 to 0.072

As can be seen from Table C.1, there is a significant variation in the expected values of secondary compression and as such wherever possible the laboratory analysis will be used to determine an appropriate value.

Figure C.1 presents the correlation between the modified secondary compression index ($C_{\alpha\varepsilon}$) and the natural moisture content developed by Mesri.

Figure C.1: Correlation between Secondary Compression and Moisture Content



The relationship suggested by Mesri can be simplified to:

$C_{\alpha\varepsilon}$ = 0.0111 x (NMC $^{0.9572}$)

Where:

$C_{\alpha\varepsilon}$ = Modified secondary compression index

NMC = Natural Moisture Content

Settlement assessed using Static Cone Penetrometer Test (CPT)

For the assessment of the settlement of the cohesionless soil, Schmertmann *et al* have provided the following equation, using the results from static CPT results:

ρ = $C_1 \times C_2 \times \Delta_p \times \Sigma\ ^{2}{}_{0}{}^{B} (I_z/E_s) \times \Delta_z$

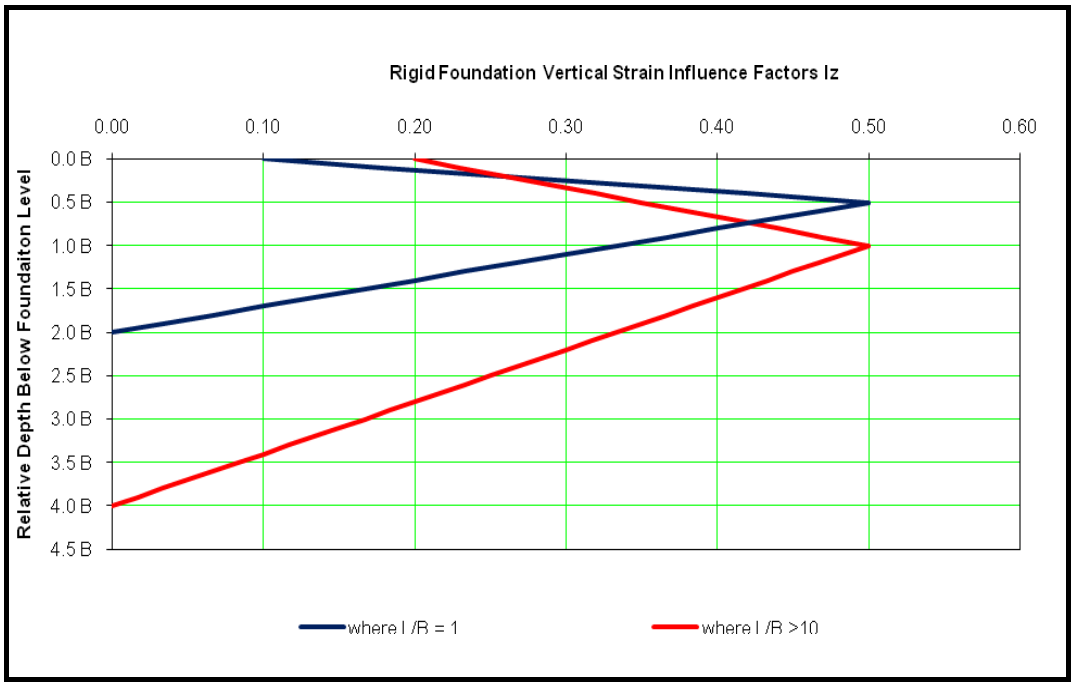
Where:

ρ	=	Total settlement		
C_1	=	Depth correction factor	=	$1 - 0.5\ (\sigma'_{vo} / \Delta_p)$
C_2	=	Creep factor	=	$1 + 0.2 \log_{10} (\text{time}_{\text{years}}/0.1)$
Δ_p	=	net increase of load on soil at foundation level		
B	=	Width of loaded area		
I_z	=	vertical strain influence factor	=	interpreted from Figure F.1
		and peak I_z	=	$0.5 + 0.1\ (\Delta_p / \sigma'_{vo})$
E_s	=	Deformation modulus	=	where L/B =1 $E_s = 2.5\ q_c$
				where L/B > 10 $E_s = 3.5\ q_c$
Δ_z	=	thickness of soil layer		
σ'_{vo}	=	effective overburden pressure at foundation level		

The values for assessing the deformation modulus for granular soils that are based upon the results of CPT investigations are in accordance with current national practice, however there are a number of different correlations relating E to q_c. Of particular note is the 2007 paper, entitled 'Settlements of shallow foundations on granular soil, an overview', by Braja M.das and Nagaratnam Sivakugan and published in the International Journal of Geotechnical Engineering. Reference has been made to these alternative methodologies and a sensitivity assessment completed within the spread sheet assessment of the CPT data.

However it should be noted that this method was developed for cohesionless soils and as such this method is not used where the soil type is considered to be cohesive.

Figure C.2 Vertical strain influence factor diagram (after Schmertmann et al) Tomlinson Fig 2.28



Settlement analysis using Compression Index

A similar process to assessing the consolidation settlement using the coefficient of volume compressibility value m_v is to use the compression index C_c, which can also be obtained from oedometer testing. The general equation to determine the consolidation settlement using the compression index is shown below:

ρ_{eod} = $[H / (1 + e_1)] \times C_c \text{ Log10} [(\sigma'_{vo} + \sigma_z) / \sigma'_{vo}]$

and

ρ_c = $\mu_g \times \rho_{eod}$

Where:

C_c = Compression index as determined from oedometer testing

e_1 = initial voids ratio

A similar process for assessing the combination of immediate and primary settlement to that used when considering consolidation settlement using mv has also been completed where the compression index method of calculation was employed.

Settlement analysis using Adjusted Elasticity Method

The total settlement of a foundation on cohesive or non-cohesive soil may be evaluated using the adjusted elasticity method as defined in BS EN 1997-1: Annex F.2 with the general equation shown below:

s = $p \times b \times (f / E_m)$

Where:

s = total settlement

E_m = the design value of the modulus of elasticity

p = bearing pressure linearly distributed on the base of the foundation

b = width of the foundation

f = factor which depends upon:

- the shape and dimensions of the foundation area;
- the variation of stiffness with depth;
- the thickness of the compressible formation;
- the Poisson's ratio ; and
- the point for which the settlement is calculated

As this is a relatively non-specific and general equation, with a significant number of variables encapsulated in the factor f, the above equation can be expanded as shown below:

ρ = $q_n \times B \times ((1- \upsilon^2)/E'_d) \times I_p$

Where:

ρ = the total settlement (immediate and consolidation)

q_n = net foundation pressure

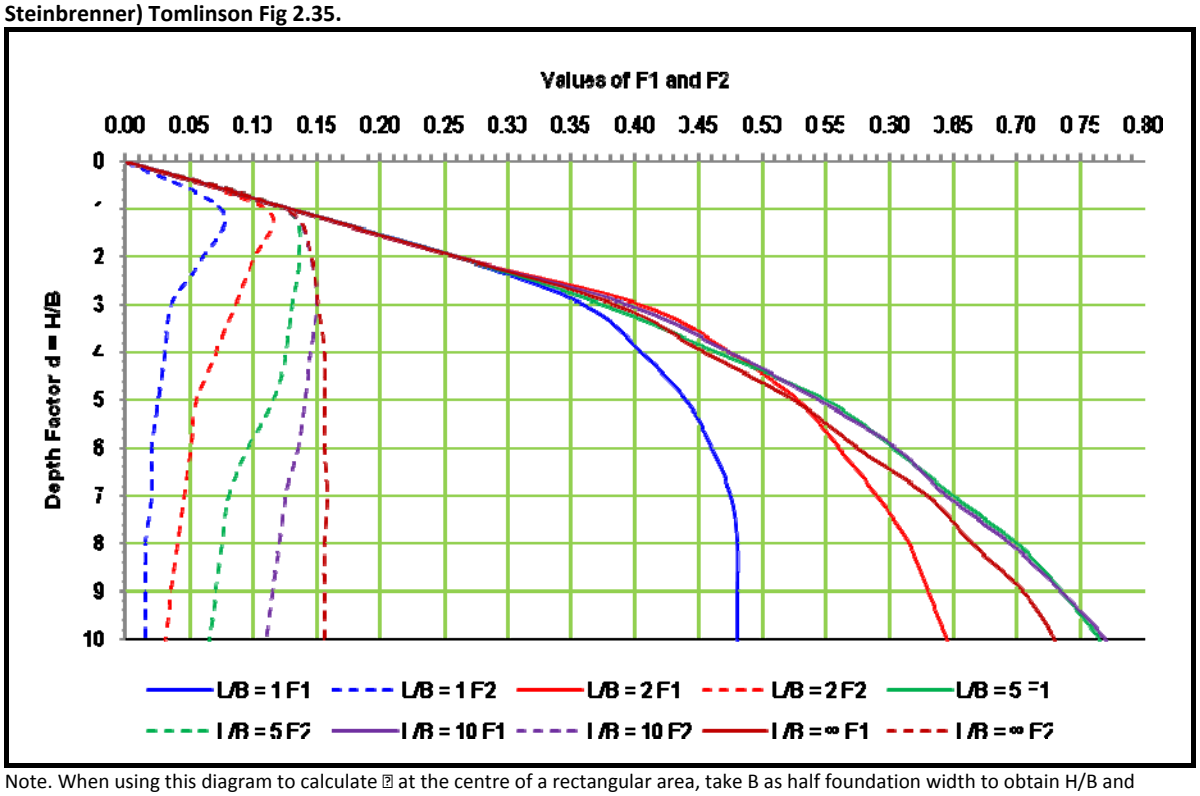
B = width of foundation

υ = Poisson's ratio

E'_d = deformation modulus for the soil in a drained condition

I_p = Influence factor, which is a function of the length to breadth ratio, the layer thickness and the Poisson's ratio which can be obtained from curves developed by Steinbrenner, reproduced as Figure C.3.

Figure C.3 Calculation of settlements due to flexible loaded area on the surface of an elastic layer (after Steinbrenner) Tomlinson Fig 2.35.



Note. When using this diagram to calculate □ at the centre of a rectangular area, take B as half foundation width to obtain H/B and L/B

When using Figure C.3, the assessment of the influence factor I_p is determined by using the following general equation:

For Poisson's ratio of 0.5: $I_p = F_1$; and

For Poisson's ratio of zero: $I_p = F_1 + F_2$.

Where the Poisson's ratio is between zero and 0.5, I_p is determined from interpreted values from Figure B.2.

In order to assess the drained modulus, and in the absence of drained triaxial tests, E'_d can be taken as the reciprocal of m_v, and in accordance with guidance provided by Tomlinson (and others) this allows for another method of assessment and interpretation of geotechnical test data. This approach

is supported by BS EN 1997-1: 2004 Annex F.2 note 3, where the designed drained modulus E_m may be estimated from the results of laboratory or in-situ tests

As noted in BS EN 1997-1 Annex F, this method should only be used if the stresses in the ground are such that no significant yielding occurs and the stress strain behaviour of the ground may be considered linear. In consideration of this, where the adjusted elasticity method has been used to assess the settlement of the ground, it has been completed on multiple thin layers as recorded by the CPT equipment so as to limit the effect of variations in stress strain behaviour between different soil layers.

Assessment of Primary and Secondary Settlement of Organic Soils

The accurate assessment of the settlement of these complex deposits is vital in the overall assessment of the ground conditions and will influence the geotechnical options for the redevelopment of a site.

Peat and other similar organic alluvial deposits are subject to settlement when loaded with additional weight or when groundwater levels are lowered. However, unlike other non-organic soils, the level of secondary settlement can be both significant and occur over a long period of time. For this reason it is important to assess both the primary and secondary settlements using separate equations.

As for other calculation methods, there are a number of different equations which can be used, however for the purposes of this assessment, the following methodologies have been adopted.

The general equation to calculate the primary settlement of Peat and organic alluvium is given by the following equation:

s_t = Expected Total Settlement

$s_t = s_i + s_c + s_s$

Where:

s_i = immediate settlement

s_c = primary consolidation

s_s = secondary compression.

The level of immediate settlement is only of concern with these types of soils during the initial loading of them as they will respond quickly to any change ion load, typically during the physical application. Therefore estimates of the level of immediate settlement are both differ cult to estimate and in the case of earthworks land raising difficult to quantify without having a datum placed below the earthworks fill level.

For estimation and assessment of the primary consolidation settlement, the following equation has been used:

s_c = $\{C_r \times [H /(1 + e_0)] \times \text{Log} (P'_p/P'_o)\} + \{C_c \times [H /(1 + e_0)] \times \text{Log} (P'_f/P'_p) \}$

Where:

C_r = recompression index

C_c = compression index

H = thickness of layer (peat or organic soil)

e_0 = initial voids ratio

P'_o = initial effective stress on layer

P'_p = maximum past pressure on the layer

P'_f = final effective stress on the layer

The secondary compression of these soils is a continuation of the volume change that starts during the primary consolidation, but occurs at a much slower rate. In this respect, the characteristics of this type of settlement for this ground do differ from the secondary and creep settlement of other non-organic soils, although they are still termed as secondary compression.

The general equation which has been used for the assessment for this site is as follows:

s_s = $C_\alpha \times [H /(1 + e_p)] \times [\Delta \text{Log} (t)]$

Where:

C_α = secondary compression index

e_p = void ratio at end of primary consolidation

t = time period being considered for design

In addition to the assessment of settlement for these soils, there are also a number of other characteristics which would need to be accounted for in the development of the overall ground improvement and foundation strategy. Of particular note for this project are the problems with the construction of roads over peat, and in consideration of this detailed reference has been made to the Roadex II project.

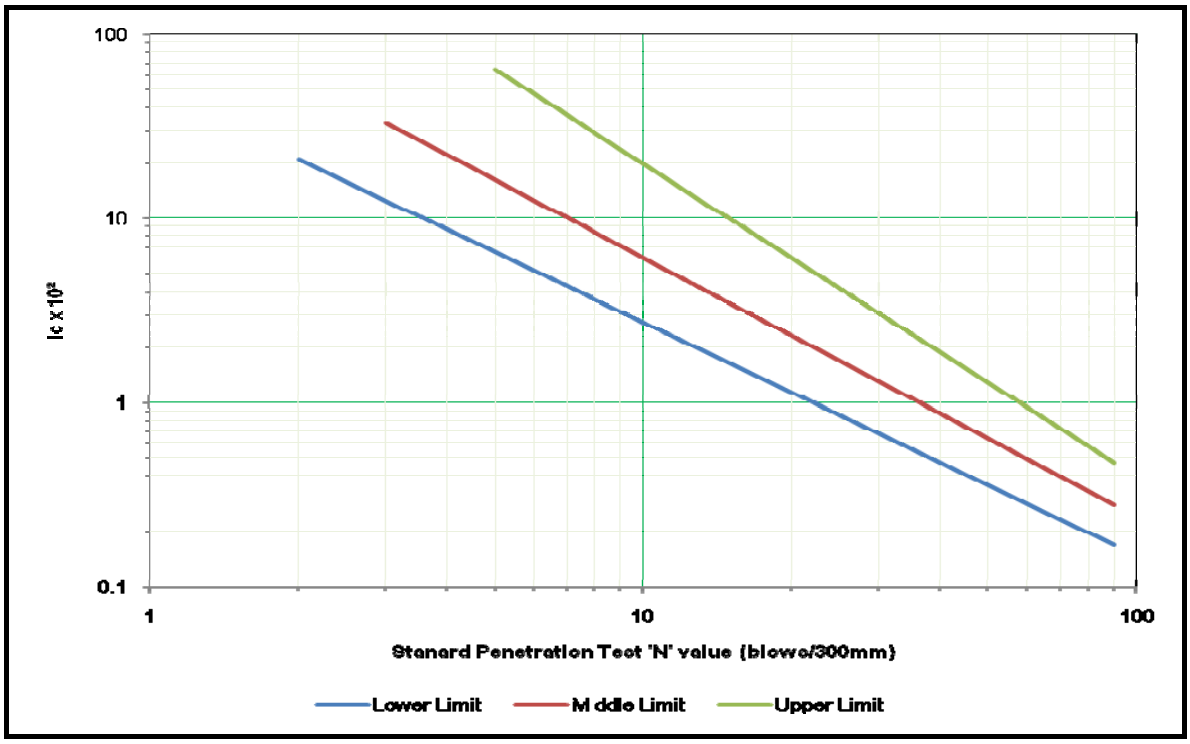
It is worth noting that any change in load will induce a new phase of settlement. Given the high level of settlement predicted for these types of soil, with relatively small increases in effective stress, the simple action of overlying a road on the peat soil with new surfacing without first removing material from the road construction will induce reflective settlement in the final profile after a very short period of time. Therefore, if re-surfacing of the roads are required in the future, then a corresponding depth of material should first be removed to prevent a supplementary phase of primary and secondary settlement.

Assessment of Settlement from Standard Penetration Tests 'N' Values SPT

There are a number of calculation techniques which can be used to assess the settlement directly from SPT 'N' results, with the most widely used of these being the methodology proposed by Burland and Burbidge. However, it should be noted that these methods are invariable used to assess the

settlements of sands and gravels and that the use of these equations is not suitable for cohesive soils (which make up the greater part of the near surface soils in the UK).

Figure C.4 Values of the compressibility index for sands and gravels (after Burland and Burbridge) Tomlinson Fig 2.26.



The general equation proposed by Burland and Burbidge for the assessment of settlement of sands and gravels from SPT 'N' values is as follows:

$\rho = f_s \times f_l \times f_t [(q'_n - {}^2/_3 \times p'_o) \times B^{0.7} \times I_c]$

Where:

ρ = the total settlement in mm

f_s = shape correction factor of the foundation, and

$f_s = [(1.25 \times L/B)/(L/B + 0.25)]^2$

f_l = depth correction factor of the sand or gravel layer, and

$f_l = \rho_t / \rho_i = H/z_i [2 - (H/z_i)]$

f_t = time correction factor, and

$f_t = [1 + R_3 + R \log(t/3)]$

R = creep ratio expressed as a proportion of the immediate settlement (ρ_i) that takes place per log cycle of time

R_3 = time-dependant settlement expressed as a proportion of the immediate settlement (ρ_i) that takes place during the first three years after construction

q'_n = average net applied pressure in KN/m²

p'_o = maximum previous effective overburden pressure in KN/m²

B = width of foundation in metres

L = length of foundation in metres

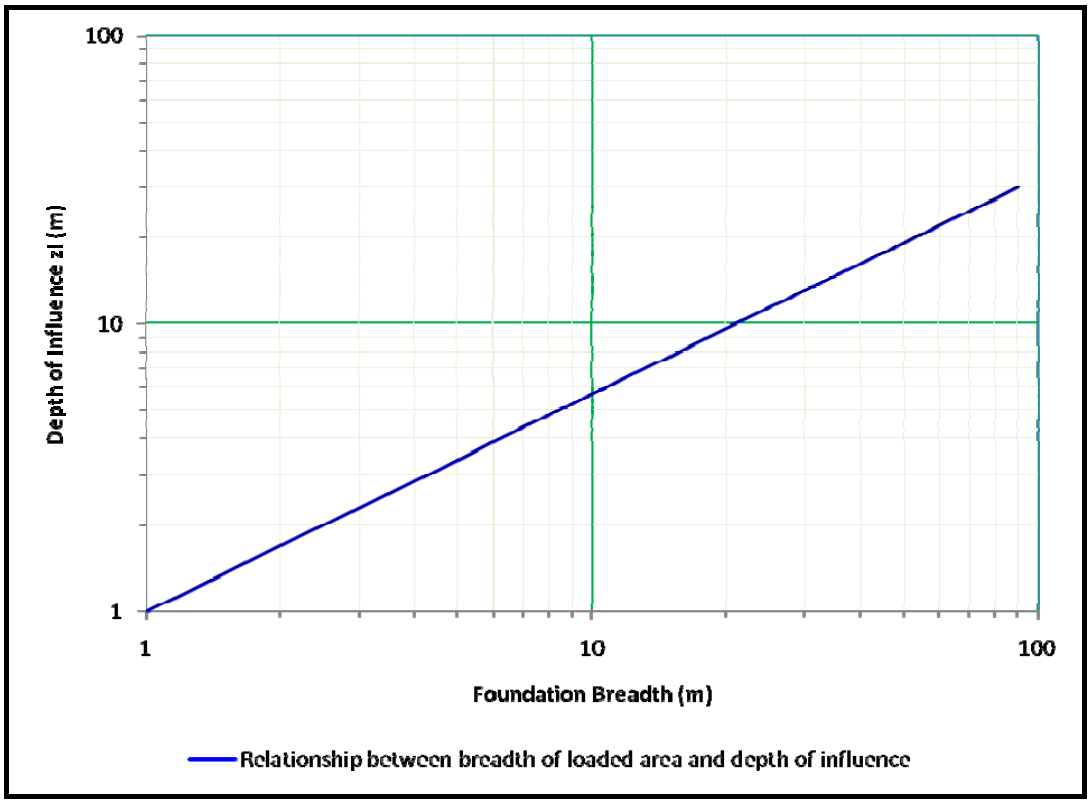
I_c = compressibility index, from Figure C.4

z_i = depth of influence for sands and gravels, from Figure C.5

The compressibility index I_c for sands and gravels, as determined by Burland and Burbidge, can be extrapolated from Figure C.4, which has been reproduced from Tomlinson.

The depth of influence z_i for sands and gravels, as determined by Burland and Burbidge, can be extrapolated from Figure C.5, which has been reproduced from Tomlinson.

Figure C.5 Relationship between the breadth of loaded area and the depth of influence z_i for sands and gravels (after Burland and Burbidge) Tomlinson Fig 2.27.



Assessment of Settlement using Propriety Software (Oasys Vdisp Version 17.8.4)

To supplement the modelling of the settlement characteristics using in-house spreadsheets, propriety software in the form of Oasys Vdsip. The modelling of the ground conditions and the determination of the resultant settlement characteristics follows the same methodology discussed above.

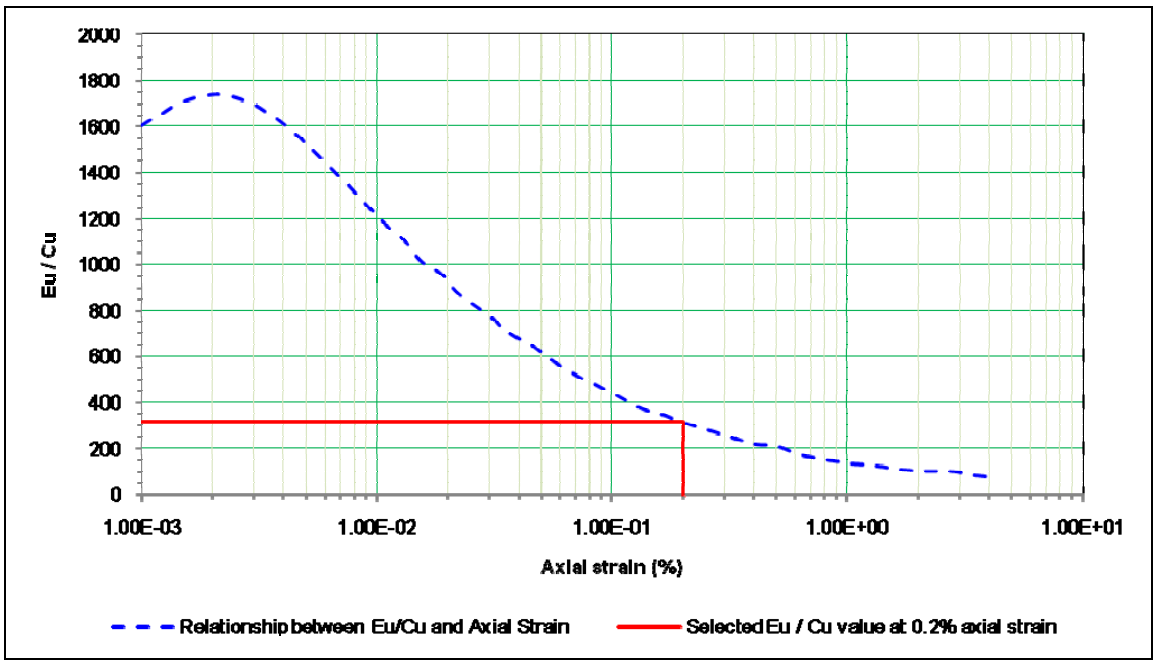
Where CPT soundings or effective stress parameters are not available for the correlation of the stiffness characteristics of the soil layers, then an additional series of industry recognise correlations are carried out.

For the purposes of the settlement assessment, the relationship between the undrained modulus (E_u) and the undrained shear strength (C_u) is used in conjunction with the axial strain (as reported by Tomlinson 2001) based upon the work by Jardine *et al* (1986).

Figure C.6 has been extracted from the paper by Jardine *et al* (1986), and this has been used in the assessment of the undrained modulus, once the undrained shear strength parameters have been determined by traditional methods. In order to complete the assessment of the undrained modulus, it is necessary to assess the axial strain which the soil will be subjected to. In accordance with the recommendations made by Tomlinson (2001), the strain applicable to normal foundations is in the range of 0.01 to 0.1%, confirming the relationship $E_u/C_u = 400$ which is frequently used for intact blue London Clay.

As the change in axial strain will directly influence the resultant stiffness of the soil, and in turn the stiffness will influence the strain exhibited, a range of axial strains are selected (typically in the range of 0.01% to 0.5%) so that a sensitivity analysis can be completed and an appropriate level of strain adopted.

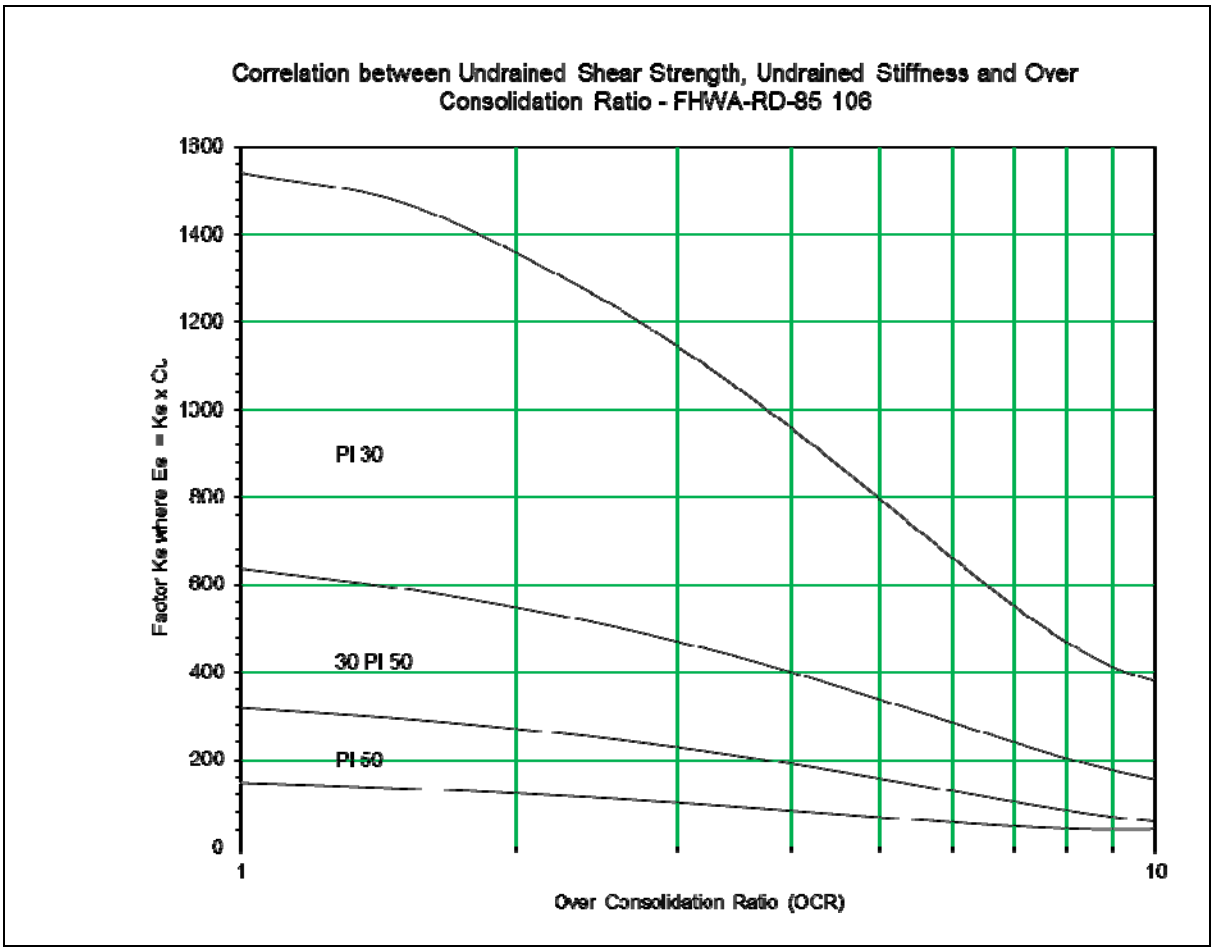
Figure C.6 Relationship between E_u/Cu and axial strain (after Jardine *et al*, 1986).



Once each soil layer and / or undrained shear strength (C_u) result has been converted to an equivalent undrained modulus (E_u), a further correlation is required in order to return a value for E'_d which can then be used for the determination of the settlement characteristics. Where the results of drained triaxial or equivalent effective stress parameters are not available to aid in the correlation between E_u and E'_d, the Tomlinson (2001) then the drained modulus may be obtained approximately from the relationship $E'_d = 0.6\ E_u$. Alternatively if m_v values are available from oedometer tests, then E'_d is the reciprocal of m_v.

Further to the general correlation based upon London Clay presented as Figure C.6, Figure C.7 presents the data for the comparison between the Over Consolidation Ratio (OCR), the undrained shear strength (Cu), the undrained stiffness (E_s) and the plasticity index (PI).

Figure C.7 Relationship between E_s/C_u and OCR (FHWA-RD-85- 106, "Behaviour of Piles and Pile Groups Under Lateral Load.").



The same principal relating the drained (E_d) to undrained stiffness (E_s) applies, with a value typically in the order of 60% adopted.

Assessment of Rate of Consolidation

In addition to the determination of how much settlement may be induced under a given load, it is also important to be able to assess the rate at which this settlement could occur. The settlement of a foundation in a cohesionless soil and the elastic settlement of a foundation in clay can be assumed to occur as soon as the load is applied (Smith 2006).

For cohesive soils, the rate of consolidation settlement is governed by the rate at which excess water can leave the soil, which in turn is a function of the soils permeability. The rate of consolidation of a cohesive soil is expressed as the coefficient of consolidation (c_v), typically expressed as m^2/year. This property can be determined from oedometer test results and from piezocone dissipation tests where these are undertaken as part of the CPT assessment.

For the estimation of the rate of settlement of a soil mass, the horizontal (c_h) and vertical (c_v) coefficients are used, however it can prove to be complex to assess the c_h from piezocone testing as often non-standard dissipation curves are derived from the in situ tests. The results from the dissipation testing are used to determine the time for 50%, identified as t_{50} and from this determine the c_h value to be used in the assessment of rate of settlement

Where piezocone dissipation tests have been completed, the empirical relationship proposed by Houlsby *et al* (1988 & 1991) and Chai *et al* (2004) is employed, where:

t_{50m} = $t_{50} / [1 + 18.5 \times (t_{umax} / t_{50})^{0.67} (I_r / 200)^{0.3}]$

Where

t_{50m} = corrected time for 50% excess pore pressure dissipation.

T_{umax} = time for measured excess pore pressure to reach its maximum value.

T_{50} = time difference between the maximum and 50% of the maximum excess pore pressure.

I_r = Rigidity Index, typically in the range of 50 to 500, with a value of 100 employed unless otherwise stated.

Using the corrected t_{50m} value, the horizontal coefficient of consolidation (c_h) is determined from the following equation:

c_h = $[c_p \times r_0^2 \times \sqrt{I_r}] / t_{50m}$

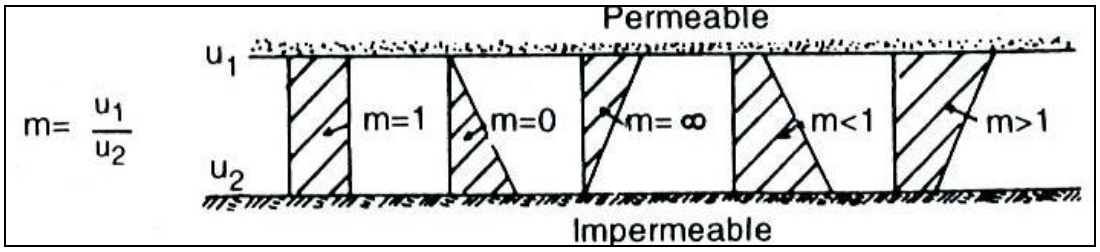
Where:

c_p = filter element correction factor, for a 10cm² cone with a shoulder element (as used in the dissipation testing unless otherwise stated) a value of 0.245 is adopted.

R_0^2 = radius of the cavity, the cone radius

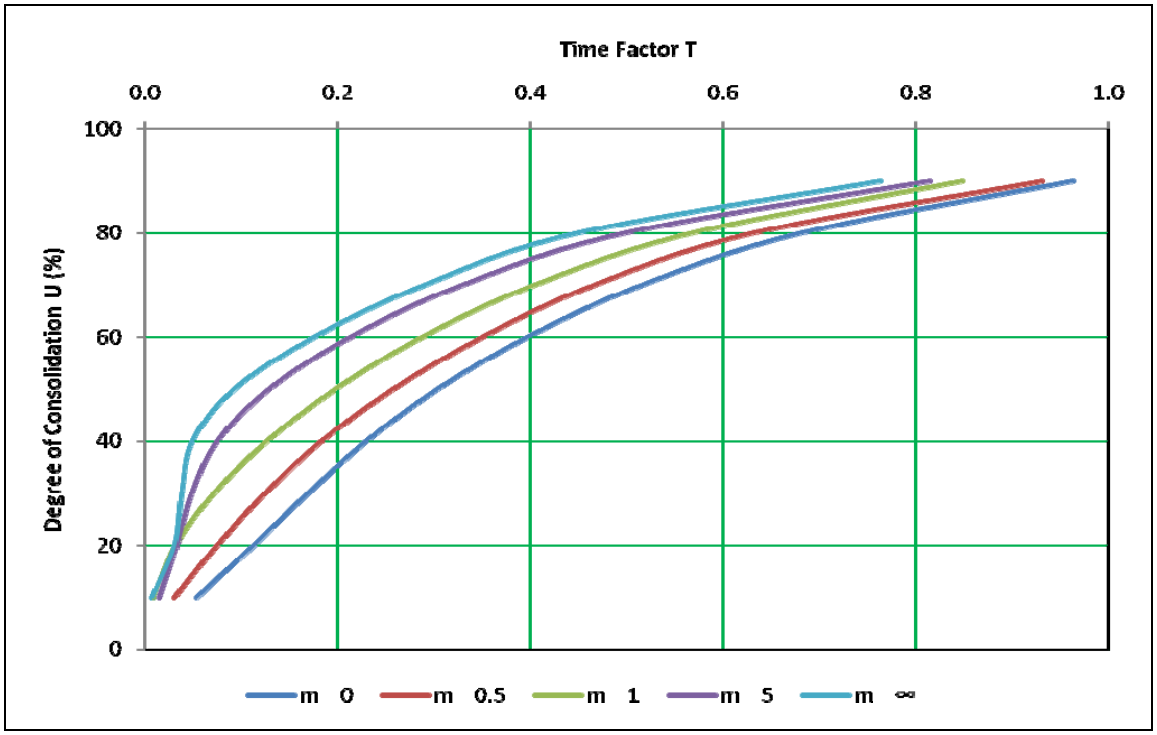
Using the values determined for c_v and c_h a series of soils profiles are constructed, with appropriate values allocated to each soil layer.

For each soil layer, the drainage path characteristics is also selected based upon the drainage characteristics of the surrounding material, and identified by the value m, where:



This is used in conjunction with a series of theoretical curves of consolidation, in order to determine the degree of consolidation at specific time intervals for each soil layer. Figure C.7 presents the theoretical curves derived for 'm' which are then used in the assessment of the degree of consolidation (U).

Figure C.7 Theoretical Consolidation Curves (Smith, 2006).



The average degree of consolidation is then can then be determined for each soil layer using the following equation:

$T = [(c_h \text{ or } c_v) \times t] / H^2$

Where

T = Time factor

t = Time period, in the same units as either c_h or c_v.

H = thickness of soil layer

Once the time factor (T) has been determined then a value for U is selected for each layer in the soil profile and the results summed to provide a value for the degree of consolidation at that time period. Therefore, for each soil profile assessed, and as each time interval, a comprehensive assessment of the degree of consolidation can be made.

In addition to using the theoretical consolidation curves listed in Figure B.6, it is possible to calculate U for general situations where m = 1 using the following equation:

$U\%/100 = [\sqrt{(4T/p)}] / \{[1 + (4T/p)^{2.8}]^{0.179}\}$

Where :

U% = Degree of consolidation as a percentage

T = Time factor

Conversely and by transposition of the above formula, the time factor T can be calculated using the following equation:

$T = [(\pi / 4)(U\%/100)]^2 / \{[1 - (U\%/100)^{5.6}]^{0.357}\}$

Where:

T = Time factor

U% = Degree of consolidation as a percentage

Using the general equations detailed above, it has been possible to derive a further relationship between the degree of consolidation and time using polynomial regression derived in the following form:

$$U\% = T \times \{a_0 + (a_1 * t) + (a_2 * t^2) + (a_3 * t^3) + (a_4 * t^4) + (a_5 * t^5) + (a_6 * t^6)\}$$

Where:

U% = Degree of consolidation as a percentage

t = duration in days

T = Time Factor, derived for each soil layer

a_0, a_1, a_2, a_3 & a_4 are factors derived from solving the polynomial regression equation where:

$$\begin{bmatrix} s_{c1} \\ s_{c2} \\ . \\ . \\ s_{cn} \end{bmatrix} = \begin{bmatrix} 1 & x_1 & x_1^2 & . & . & . & x_1^m \\ 1 & x_2 & x_2^2 & . & . & . & x_2^m \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 1 & x_n & x_n^2 & . & . & . & x_n^m \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ . \\ . \\ a_m \end{bmatrix}$$

Using the general equation for a soil corresponding to m = 1, T = 1 and achieving a U of 90% at 205 days the following factors have been derived.

A_0 = 0.000726047

a_1 = 0.011528752

a_2 = -6.28547×10^{-05}

a_3 = 1.95221×10^{-07}

a_4 = -3.48469×10^{-10}

a_5 = 3.30418×10^{-13}

a_6 = -1.28501×10^{-16}

The above equation can then be used to derive any curve of settlement by first determining the time to achieve 90% consolidation, and deriving a Time Factor T for each soil layer.

Additional assessment methods

In addition to the methods for assessing settlement discussed previously, there are a number of other techniques which can be used, but these have not been adopted as part of the current geotechnical assessment process.

The range of calculation techniques listed in this Appendix represent the range of methodologies which have been employed in the current settlement assessment. It is noted that not only are there

other general equations which can be used, but also there are a large number of additional correlations which can be employed to refine the settlement model. However, as stated above, the methodologies which have been used in this assessment are as detailed within this Appendix.

Assessment of Net Bearing Pressure

In addition to a range of methods for assessing the settlement of a soil layer, there are also a number of industry accepted methods for calculating the bearing pressure distribution below a foundation.

Bousinesq's original equation allows the calculation of the vertical stress (σ_z) at any point N below a loaded foundation, and is given by the following general equation:

$$\sigma_z = (3Q / 2\pi z^2) \times [1 / (\{ 1+ (r/z)^2\}^{5/2})]$$

Where:

σ_z = vertical stress at the point under consideration

Q = concentrated vertical load

z = vertical distance between N and the underside of the foundation

r = the horizontal distance from N to the line of action of the load.

The basic Bousinesq equation presented above is based on the assumption that the loaded material is elastic, homogenous and isotropic, which although not strictly true for soils in general, has been deemed to provide a suitably accurate method for the assessment of the pressure distribution below structures.

The original Bousinesq equations have been subsequently developed to allow for the calculation of stress below other types of foundation, including embankments and circular features. These expanded series of equations have been used in the assessment of pressure distribution below the proposed structures and embankments (using the Osterberg modified method).

For the purposes of this assessment, the following additional equations which expand upon the original Bousinesq equation have been used:

***For Strip Foundations (Bousinesq)**:*

$$\Delta\sigma_z = q / \pi \times [\alpha + \text{Sin}\alpha \, \text{Cos}(\alpha + 2\beta)]$$

Where:

$\Delta\sigma_z$ = change in vertical stress

q = contact pressure, applied load from foundation

α = $\text{Tan}^{-1} [(x + b) / z] - \beta$ (in radians)

β = $\text{Tan}^{-1} [(x - b) / z]$

B = Width of foundation

b = effective breadth of foundation = foundation width B/2

x = horizontal distance from centre of foundation to point under assessment

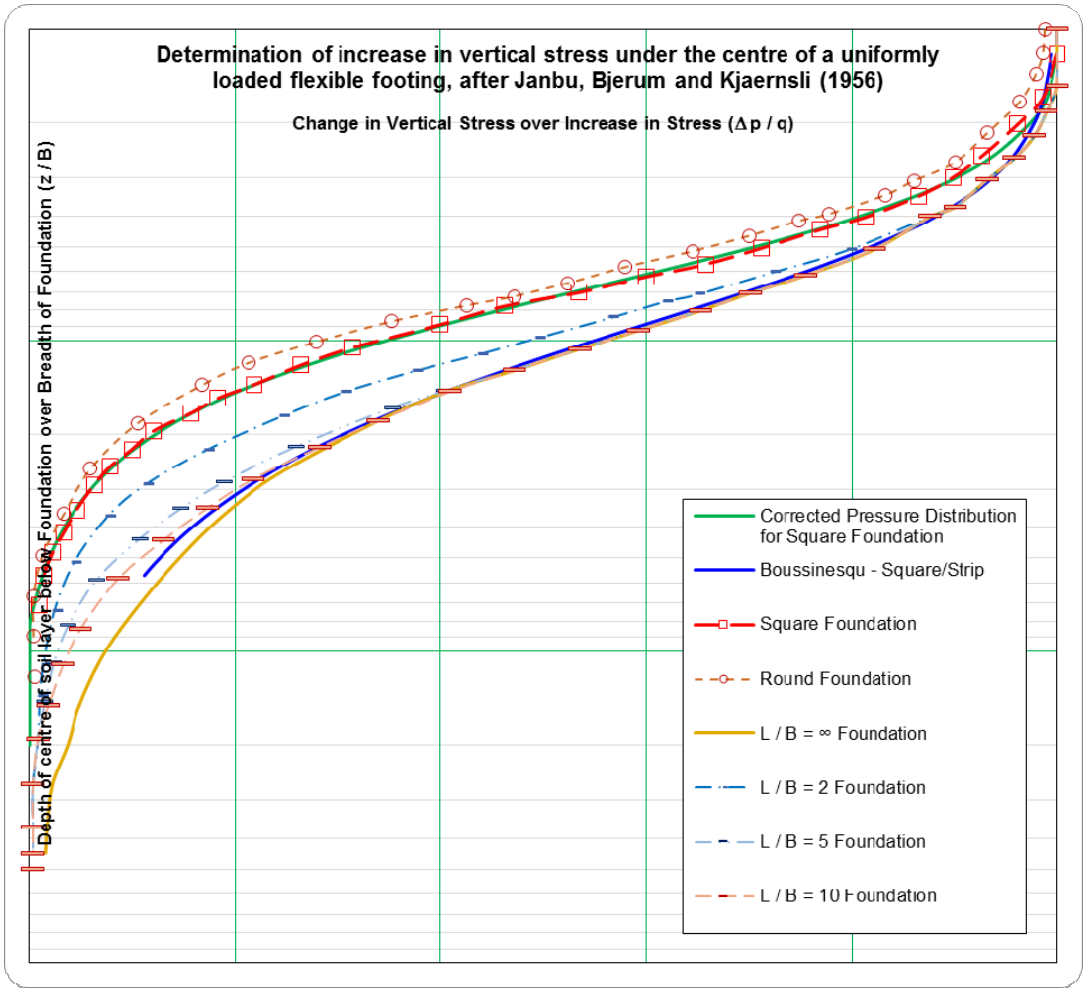
z = vertical distance from base of foundation to point under assessment.

For Strip Foundations (After Janbu, Bjerrum and Kjaernsli (1956))

The work completed by Janbu et al (1956) revised the general equation derived by Bousinesq for a range of foundations dimensions. Figure B5 presents the findings of the assessment completed by Janbu et al (1956) and includes the pressure distribution for a strip footing using the Bousinesq equation detailed previously.

Figure C.8 demonstrates that the assessment of vertical stress using the Bousinesq equation is directly comparable to the Janbu et al assessment for a rectangular footing of infinite length.

Figure C.8 Determination of increase in vertical stress under the center of a uniformly loaded flexible footing, after Janbu, Bjerum and Kjaernsli (1956).



Therefore, in order to correlate the relationship between the net increase in applied stress derived from the Bousinesq equation and that determined by Janbu et al, a polynomial relationship was determined for each foundation dimension.

The general equation used to derive the relationship between the Bousinesq and a strip footing is:

$\Delta\sigma_z = a_0 + (a_1 * x) + (a_2 * x^2) + (a_3 * x^3) + (a_4 * x^4)$

where

s_c = Primary Settlement/Consolidation

x = change in vertical stress determined using the Bousinesq equation for strip footings

a_0, a_1, a_2, a_3 & a_4 are factors derived from solving the polynomial linear equation where:

$$\begin{bmatrix} s_{c1} \\ s_{c2} \\ . \\ . \\ s_{cn} \end{bmatrix} = \begin{bmatrix} 1 & x_1 & x_1^2 & . & . & . & x_1^m \\ 1 & x_2 & x_2^2 & . & . & . & x_2^m \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 1 & x_n & x_n^2 & . & . & . & x_n^m \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ . \\ . \\ a_n \end{bmatrix}$$

The relationship determined for the correlation for a square foundation returned the following factors:

a_0 = -0.02278

a_1 = 0.22649

a_2 = 0.81125

a_3 = 0.00000

a_4 = 0.00000

A similar process is carried out where the foundation is not square, with the factors derived individually for the actual foundation dimensions under assessment.

The selection of the method of determining the pressure below a square or rectangular foundation is set as default to use the corrected pressure distribution equation corresponding to the Janbu et al methodology; however the user has the ability to switch between the Bousinesq, Newmark, Janbu and Steinbrenner as appropriate. Unless otherwise stated in the report, the Janbu et al methodology has been adopted for the assessment of vertical stress below a square or rectangular foundation.

For Area (point under centre of circular area):

$\Delta\sigma_z = qr^2 [(s^2 + 2z^2) / 2S^4]$

Where:

$\Delta\sigma_z$ = change in vertical stress

q = contact pressure, applied load from foundation

$S^2 = r^2 + z^2$

r = radius of foundation

z = vertical distance from centre of base of foundation to point under assessment.

The selection of the method of determining the pressure below a circular foundation is set as default to use the Bousinesq methodology as the resultant pressure distribution curve is identical to the

Janbu et al result; however the use has the ability to switch between the Bousinesq, Newmark, Janbu and Steinbrenner as appropriate. Unless otherwise stated in the report, the Janbu et al methodology has been adopted for the assessment of vertical stress below a circular foundation.

For Embankment Loads (Osterberg):

$\Delta\sigma_z$ = I q

Where

$\Delta\sigma_z$ = change in vertical stress

q = applied load from embankment above the point of assessment, and

q = γH

γ = unit weight of embankment material

H = height of embankment material

I = influence factor

Where:

I = $1/\pi$ x $[\{(a + b)/a\}\{\alpha_1 + \alpha_2\} - \{(b/a)/\alpha_2\}]$

a = the horizontal length of the slope portion of the trapezium (embankment) to the point of assessment

b = the horizontal length of the flat portion of the trapezium (embankment) to the point of the assessment

α_1 = $Tan^{-1}[(a + b)/z] - Tan^{-1}(a/z)$ (in radians)

α_2 = $Tan^{-1}(a/z)$ (in radians)

z = the depth to the point at which the stress is to be etermine.

The selection of the method of determining the pressure below a loaded area is set as default to use the Osterberg methodology.

For Floor Slabs (Hobbs):

In consideration of the stress distribution beneath a floor slab and similarly loaded areas, the following additional equation, proposed by Hobbs has also been employed in combination with those listed above:

P_z = $B \times L \times P_0 \times [1 / \{(B + 1.2z) \times (L + 1.2z)\}]$

Where:

P_z = stress at depth below the floor slab

P_0 = imposed load from foundation

B = width of slab area

L = length of slab area

z = depth below foundation

As for the previous assessment of pressure distribution, the settlement beneath the floor slab is only considered to a depth where the applied stress is greater than 20% of the previous overburden pressure, or where the ground is considered to be incompressible (BS EN 1997-1). The selection of the method of determining the pressure below a loaded area is set as default to use the Hobbs methodology.

Presentation of Assessment Data

Where the results of CPT soundings are used in the assessment of the settlement characteristics of the ground, the findings will be presented as a series of figures associated with each soil strength profile. The table below summarises the various mathematical equations that may be used in the electronic spreadsheet assessment of the settlement.

Table C.3: Assessment Method and Equations

Settlement Method	General Equation
Settlement based upon SPT	Total Settlement $\rho_t = f_s \times f_i \times f_t \times q'_n \times B^{\wedge 0.7} \times I_c$
Consolidation based on m_v	Consolidation Settlement per layer $\rho_{oed} = M_v \times \sigma_z \times H \times \mu_g$
Settlement inc. Creep based on CPT	Settlement from CPT $\rho = C_1 \times C_2 \times q_n \times (I_z/E_s) \times t$
Adjusted Elasticity Method E'd	Total Settlement $\rho = \sigma_z \times H \times ((1- \upsilon^2)/E'd)$
Consolidation based on Cc	Consolidation settlement from fill $\rho_c = Cc/ 1 + e_0 \times \log(p_2/p_1) \times H$
Primary Settlement of Peat	Primary settlement of Peat $s_c = [\{(Cr \times H)/ (1 + e_0)\} \times \{LOG(p'_p/p'_o)\}] + [\{(Cc \times H)/(1 + e_0)\} \times \{LOG(p'_f/p'_p)\}]$
Secondary Settlement of Peat	Secondary settlement of Peat $s_s = ((C_\alpha \times H)/(1 + e_p)) \times LOG(\text{Design Life of Structure})$

ANNEX D

GEOTECHNICAL RISK REGISTER

Introduction

A Geotechnical Risk Register has been complied in accordance with the general requirements of HD 22/08 to assist in the management of the risks and hazards. The following pages set out the identified geotechnical risks and hazards which associated with the proposed development and establish the approach which is to be taken to manage the risks including the geotechnical input and analysis.

The purpose of the Geotechnical Risk Register is to provide and outline a description of the hazards, identify the likely cause, describe the potential impact of the hazard and identify the design construction controls to be implemented in order to minimise the geotechnical risk.

The Geotechnical Risk Register will be actively used during the design and construction stage of the project as a guide to address geotechnical issues. The risk register will be up-dated, as necessary, to reflect additional information, data and experience as it is gained through the construction process.

Whilst the probability and impact of the hazard occurring can be reduced to a minimum by geotechnical design, the impact cannot be reduced below very low. The probability and impact of a hazard have been judged on a qualitative scale as set out in Table D.1

Table D.1: Qualitative Assessment of Hazards and Risks

P = Probability		
1	Very unlikely	(VU)
2	Unlikely	(U)
3	Plausible	(P)
4	Likely	(Lk)
5	Very Likely	(VLk)

I = Impact		
1	Very Low	(VLw)
2	Low	(Lw)
3	Medium	(M)
4	High	(H)
5	Very High	(VH)

R = Risk Rating (P x I)		
1 – 4	None / negligible	(N)
5 – 9	Minor	(Mn)
10 – 14	Moderate	(Md)
15 – 19	Substantial	(Sb)
20 – 25	Severe	(Sv)

Project Name:	East Midlands Gateway M1 Overbridge	Project Number:	C14792	Date:	08/07/2017

Hazard	Location	Who is at Risk	Consequence	Risk Before Mitigation			Mitigation Measures			Residual Risk		
				S	L	R	Preliminary Design	Detailed Design	Construction Team	S	L	R
Slope Stability – New highway embankments	Refer to BWB drawing series	Construction staff, vehicles and plant operators. Pavement construction and long-term durability of new carriageway	Embankment failure	4	3	12	Hydrock GDR reference R/14792/008 which includes the detailed slope stability assessment identifying acceptable slope profiles. Engineered fill requirements defined at outline design stage.	Minimum engineering performance defined in slope stability included in Earthworks Specification. Minimum testing frequencies in Appendix 1/5 required demonstrate compliance.	Earthworks testing in accordance with the Specification to comply with Appendix 6/1 and 6/3, at the frequencies defined in Appendix 1/5. Site records to be provided in accordance with Appendix 1/24	2	1	2
Slope Stability – Re-profiled embankments	Refer to BWB drawing series	Construction staff, vehicles and plant operators. Pavement construction and long-term durability of new carriageway	Embankment failure	4	3	12	Hydrock GDR reference R/14792/008 which includes the detailed slope stability assessment identifying acceptable slope profiles. Engineered fill requirements defined at outline design stage. Granular fill required to form re-profiled slope form.	Minimum engineering performance defined in slope stability included in Earthworks Specification. Minimum testing frequencies in Appendix 1/5 required demonstrate compliance. Contractor to source appropriate granular material which will meet the minimum requirements. All fill to be benched in to slope and include additional drainage.	Importation of an appropriate granular fill material. Earthworks testing in accordance with the Specification to comply with Appendix 6/1 and 6/3, at the frequencies defined in Appendix 1/5. Site records to be provided in accordance with Appendix 1/24. Benches to be formed by Contractor	2	1	2
Excessive settlement of foundations (poor stiffness of underlying soils and engineered fill)	Refer to BWB drawing series	Carriageway including roundabout	Service limit state failure highway	3	3	9	Determination of minimum stiffness of engineered fill to provide sufficient support to foundations and floor slab. Details provided in GDR, Hydrock reference R/14792/014	Determination of compliance values to be met by engineered fill to meet the long-term stiffness. Values added to Appendix 6/1.	Site inspection, careful selection of fill and testing at the frequency defined in Appendix 1/5, to demonstrate compliance with Appendix 6/1 and 6/3 with Contractor to provide records in	3	1	3

Hazard	Location	Who is at Risk	Consequence	Risk Before Mitigation			Mitigation Measures			Residual Risk		
				S	L	R	Preliminary Design	Detailed Design	Construction Team	S	L	R
									compliance with Appendix 1/24. Hydrock to undertake routine site inspections to ensure Contractor is in compliance with the Specification.			
Excavations	Site wide	Construction staff	Risk of collapse of excavation. Falling debris in excavation. Slips, trips and falls.	4	2	8	Temporary works design to be completed by appointed contractor.	Temporary works design to be completed by appointed contractor.	Contactor to determine safe method of work	4	1	4
Working adjacent to live traffic during earthworks operation	Refer to BWB drawing series	General Public Construction staff	Rick of obstruction, striking passing vehicles. Risk of construction site staff being struck by plant.	4	3	12	Design team to consider the construction sequence to mitigate risk.	Discussion with HE and LA regarding temporary works and their residual risks	Contractors safe method of working. Implementation of signing and traffic control measures in accordance with Chapter 8. Contractor to provide appropriate protection barriers. Workers to wear high visibility clothing.	4	1	4
Limited geotechnical data and SI coverage	M1 bridge abutment location	Unexpected ground conditions, long-term embankment stability	Service limit state failure highway	3	3	9	Conservative lower bound values used in design. Adoption of published values. Review of historical sources of data.	Additional boreholes to be drilled, once access given by HE	Sub-formation to be inspected and approved by Hydrock Contractor to inform Hydrock before filling commences to ensure sub-formation is acceptable. Allowance for removal of upper superficial soils.	3	1	3

Hazard	Location	Who is at Risk	Consequence	Risk Before Mitigation			Mitigation Measures			Residual Risk		
				S	L	R	Preliminary Design	Detailed Design	Construction Team	S	L	R
Structural assessment for whole life cycle of bridge, including demolition	M1 Overbridge	Inspectors and contractors including demolition contractors	Risk to workers, and members of the public	5	2	10	Included in geotechnical risk register	Confirmation from the bridge designer that this is included in their design and DRA.	Reference to the bridge designers DRA	5	1	5
General Public/Children trespassing on site during earthworks operation	Whole Site	General Public Children	Risk of public injury on site from trips, slips, falls, falling from height, falling into excavations, open water.	4	2	8	Consideration of Public Right of Way	Construction sequences assessed to minimize the duration of any obstruction/severance to the public right of way. Closure of Town Lane. Possible diversions identified and assessed for the safety of the public.	Ensure the site is properly secure and inform the surrounding public of site locations and boundaries. Identified diversions for public right of way established and clearly signed.	4	1	4

Prepared By:	Ian Gardner	Signature:	



Roxhill Developments Limited

East Midlands Gateway Strategic Rail Freight Interchange

Zone 3 Major Trunk Road Improvements

Factual Ground Investigation Report

312494-03 – 03 (00)

DECEMBER 2013

RSK GENERAL NOTES

Project No.: 312494/3 – 03 (00)

Title: East Midlands Gateway: Strategic Rail Freight Interchange
Zone 3 Major Trunk Road Improvements
Factual Ground Investigation Report

Client: Roxhill Developments Limited

Date: 2nd December 2013

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Signature		Signature	
Date:	5th December 2013	Date:	6th December 2013

RSK Environment Limited (RSK) has prepared this report for the sole use of the client, showing reasonable skill and care, for the intended purposes as stated in the agreement under which this work was completed. The report may not be relied upon by any other party without the express agreement of the client and RSK. No other warranty, expressed or implied, is made as to the professional advice included in this report.

Where any data supplied by the client or from other sources have been used, it has been assumed that the information is correct. No responsibility can be accepted by RSK for inaccuracies in the data supplied by any other party. The conclusions and recommendations in this report are based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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1 INTRODUCTION

1.1 Introduction

RSK Environment Limited (RSK) has been commissioned by Roxhill Developments Limited (the Client) to carry out a series of Factual Ground Investigation Reports for the site of the proposed East Midlands Gateway: Strategic Rail Freight Interchange (the Main Development Site).

This report is subject to the RSK service constraints given in Appendix A.

1.2 Terms of reference

This report comprises a factual report in general accordance with the requirements of;

- BS5930:1999+A2:2010 'Code of practice for site investigations'
- Environment Agency CLR 11 2004a 'Model Procedures for the Management of Land Contamination' (Contaminated Land Risk Assessment),
- Highways Agency HD22/08, 'Managing Geotechnical Risk' (Ground Investigation).
- BS EN 1997-2:2007. Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing.

1.3 Proposed development

It is understood that the site is being considered for development to provide a Strategic Rail Freight Interchange for the East Midlands regions. This includes a large distribution warehousing complex, major trunk road improvements to the A453, A50 and M1 Junctions 24 and 24a, a new bypass to the south of Kegworth including bridge over the M1, and a new rail freight terminal and associated branch line from the Castle Donington line.

For the purpose of discussion, and to facilitate reporting; the site has been divided into four Zones, on the basis of the four main elements of the proposals as follows. The extent of each of the four Zones is defined by the proposed general arrangement presented as Figure 2.

- Zone 1: Main Development Plateau and Rail Freight Terminal
- Zone 2: Rail Branch Line (Network Rail)
- Zone 3: Major Trunk Road Improvements

- Zone 4: Kegworth Bypass including bridge over the M1

This report presents the investigation relating to Zone 3; Major Trunk Road Improvements

1.4 Objective

The subject of this report is Zone 3, the proposed improvements to major trunk roads. In accordance with the Client's specific objectives, requirements and brief; the objective for the works was developed with the aim of providing sufficient preliminary data to:

- provide sufficient data to confirm the ground model
- obtain data to provide a chemical and geotechnical characterisation of each strata
- assist with master planning design
- provide data to support planning applications

In line with Eurocode 7, BS5930, BS10175 and CLR 11 further phases of targeted investigation (post Planning Approval) may be required to provide specific data and information for detailed design of individual elements of the scheme as the design evolves.

1.5 Scope

The project has been carried out to an agreed brief as set out in RSK's proposal (ref. East Midlands Gateway; Geotechnical and Geo-environmental Services - Master Planning and EIA Support, dated 13th August 2013).

The ground investigation fieldwork carried out on Zone 3 was undertaken in general accordance with the Site Investigation Steering Group's UK Specification for Ground Investigation 2nd edition (2012), BS 5930 and A2: 2010 'Code of practice for site investigations', BS EN ISO 14688-1:2002, BS EN ISO 14689 – 1:2003 and in general accordance with the recommendations made within BS10175:2011 'Investigation of Potentially Contaminated Sites – Code of Practice'.

2 SITE DETAILS

2.1 Site location

The Development Site covers a total area of approximately 374 hectares and currently comprises farmland with some areas of woodland, dissected by the M1 motorway. The village of Castle Donington is located approximately 600m to the west of the Development Site, and East Midlands Airport is located adjacent to the southern boundary. A location plan for the Development Site is presented as Figure 1.

Zone 3 consists of a parcel of land surrounding the M1 from just south of Junction 24 to Junction 24A and including major trunk roads in the proximity of the M1 including the A453 and the A50; as shown by the General Arrangement Plan presented as Figure 2. The footprint of Zone 3 covers an area of approximately 100Ha, the southernmost point is defined by the National Grid co-ordinates: 446804, 324710 and the northernmost point by the National Grid co-ordinates: 447021, 329335.

2.2 Local topography, geography and geomorphology

The site sits within a formerly glaciated area signified by undulating ground created by the harder geological formations and erosion of the glacial deposits.

Zone 3 generally slopes from the south adjacent to the East Midlands Airport boundary with a general ground level of approximately 80m AOD within the southern area of the site. The elevation of ground levels surrounding Junction 24 (i.e. not on the junction itself) range from approximately 40m AOD on the southwestern side of the junction to 34m AOD on the northeastern side.

Between Junction 24 and 24a on the eastern side of the M1 the ground is noted to slope very gradually from an elevation of 34m AOD adjacent to Junction 24a to 30.5m AOD about halfway between the two junctions. The ground elevation between this point and Junction 24a is noted to stay relatively flat at 30.5m AOD.

The surrounding topography generally falls towards the floodplain of the River Trent located approximately 2km to the north of the site.

The geological sequence is one of interbedded clays, mudstones, siltstones and sandstones deposited within sea conditions and eroded by periods of glaciation and later deposition and erosion from the River Trent which has cut through the geological strata depositing Alluvium and River Gravels along its course and flood plain.

2.3 Site description

A site walkover was undertaken on the 9th September 2013.

Zone 3 is primarily occupied by the M1 and its associated trunk roads the A453 and the A50. The area surrounding the road infrastructure is predominately used for arable farming with hedgerow field boundaries. There are several public footpaths which cross the site.

The East Midlands airport is present immediately adjacent to the sites southwestern boundary. A walkover of the airport could not be conducted. Evaluation of publically available aerial photos indicates that the fuel tanks are likely to be present around 1.4km west of the site.

The Molehill Farm lies immediately adjacent to the sites southeastern boundary. An inspection of the farm area has not been conducted. There is a possibility that the farm would contain a fuel tank.

The Derwent water main is noted to cross from east to west through the centre of the site.

The Lockington Quarry which extracts sand and gravel and in addition operates an inert waste landfill extends beyond the sites far northeastern boundary. Active sand and gravel extraction pits were noted to be present within the development area during the walkover. Any sand and gravel extraction pits are likely to be infilled in the future to become inert waste landfills.

A hotel is noted to lie between the M1 and the A50 just north of Junction 24, no obvious contamination sources were noted in relation to the hotel.

A number of lakes, ponds and disturbed ground are noted to be present to the immediate north of the site which is likely to be associated with the historic Hemington quarry and gravel pits. The walkover indicates that part of this area is likely to be an historic landfill.

2.4 Published geology and expected ground conditions

The British geological Survey (BGS) plans and maps obtained have been reviewed to determine the anticipated geology beneath Zone 3.

It is envisaged that the local geology beneath Zone 3 will be in line with the summary below detailed within Table 1 below.

Table 1: Expected geology

Geology	Comment
Surfacing and Buried Structures: (source: Envirocheck History Maps, Site Observation)	The archival Ordnance Survey (OS) maps do not indicate that buried structures should be present within Zone 3. However it should be noted that there are significant gaps in the historical plans especially during WWII and as such the presence of structures cannot be completely discounted.
Made Ground: (source: BGS Maps, Available Borehole Logs, Envirocheck Geology & History Maps, memoirs)	Deposits of made ground are likely to be encountered within areas of Zone 3 generally associated with the construction of the M1, its associated junctions and trunk roads. In addition the Envirocheck reports indicate the presence of significant deposits of made ground to the north of Zone 3 associated with the Hemington quarry/gravel pits.
Drift Deposits: (source: BGS Maps, Available Borehole Logs, Envirocheck Geology & History Maps, memoirs)	The superficial deposits that fall within Zone 3 are noted below: • Alluvium (Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel) • Head (comprises sand and gravel, locally with lenses of silt, clay or peat and organic material) • Egginton Common Sand and Gravel Member (poorly sorted sand and gravel, pebbles of quartzite, subangular flint, chert, sandstone etc) • Hemington Member (gravels, sands and loams Gravel. dominated by pebbles of quartz/quartzite with subordinate subangular flint, etc) • Holme Pierrepont Sand and Gravel Member (generally pinkish poorly sorted sand and gravel, gravel dominated by pebbles of quartz/quartzite plus flint) • Wanlip Member (sand and gravel with minor clay and silt lenses) Superficial deposits are noted to be absent from the southern area of the site.
Bedrock (source: BGS Maps, Available Borehole Logs, Envirocheck Geology & History Maps, memoirs)	The solid geology that falls within Zone 3 is noted below: • Edwalton Member (mudstone and siltstone, red-brown and greenish grey, with beds of siltstone and very fine-grained sandstone; finely disseminated gypsum common in upper half) • Arden Sandstone Formation (grey, green and purple mudstones interbedded with paler grey-green to buff coloured siltstones and fine- to medium-grained, varicoloured green, brown, buff, mauve sandstones) • Branscombe Mudstone Formation (mudstone and siltstone, red-brown with common grey-green reduction patches and spots. Gypsum/anhydrite is common throughout in nodules and veins)

Geology	Comment
	• Gunthorpe Member (mudstone, red-brown, with subordinate dolomitic siltstone and fine-grained sandstone, greenish grey, common gypsum veins and nodules) • Gunthorpe Member (siltstone) • Tarporley Siltstone Formation (interlaminated and interbedded siltstones, mudstones and sandstones in approximately equal proportions) • Diseworth Sandstone (pale greenish grey siltstone and fine-grained sandstone • Bromsgrove Sandstone Formation Sandstones (red, brown and grey sandstone, interbedded with red and brown siltstones and mudstones)
Soil Chemistry (source: Envirocheck / BGS)	Available soil chemistry data suggests that the natural soils anticipated to be present across the site do not have any elevated concentrations of contaminants that would be considered to represent a risk to Human Health for the elements tested for.
Mining (source: Coal Authority web viewer, BGS Maps, Envirocheck records, Geological and historical maps)	The Envirocheck Report states that the Site is not within an area affected by coal mining or mining instability. Furthermore, the Coal Authority's online search resource indicates that the Site does not lie within an area for which a Ground Stability Report is required.
Faults (source: BGS Maps, Available Borehole Logs, Envirocheck Geology Maps, memoirs)	Four faults are shown to cross Zone 3 though none appear to be present between Junction 24 and 24a whilst there are two faults which lay beneath the area where the road deviations, bridge and roundabout south of Junction 24 are planned.
Opencast Quarrying (source: Coal Authority web viewer, BGS Maps, Envirocheck History Maps)	With reference to the available data there is an operational quarry for sand and gravel deposits, parts of which have been infilled to be an inert landfill present within the northern area of the site. The quarry is known as the Lockington Quarry and is operated by Lafarge. Areas of the quarry both current and proposed are noted to lie within the area where modifications around Junction 24A are proposed.
Mineral Protection (source: Local Authority Plan)	The north eastern area of the site falls within a designated Mineral Protection area noted as the Lockington Grounds. The area is currently being quarried by Larfarge.
Groundwater Levels: (source: BGS)	BGS boreholes indicate that groundwater levels maybe relatively shallow within the River Terrace Deposits present within the northern site area from around 1 to 4m bgl. BGS boreholes within the area of Junction 24 and within the southern site area indicate that groundwater is likely to be likely at deeper levels at around 7 to 10m bgl. Due to the variable deposits anticipated to be present across Zone 3 and in particular the interbedded nature of the majority of the solid deposits it is expected that more permeable strata (sandstone and siltstone) beds confined between less permeable mudstones may yield local water tables.

Geology	Comment
	Given the rural location of the site, it is considered unlikely that the development will be affected by rising groundwater levels associated with diminished abstraction by industry.

The constraints to investigations undertaken in Zone 3 are summarised below in Table 2;

Table 2: Constraints to investigation

Issue	Comment
Landowners Permissions	Areas in close proximity to the highways are owned and operated by the highways agency or local highways authority. These areas were not accessed in this preliminary phase of investigation works as it was considered that this initial phase of work was required to confirm the surrounding ground model for outline designs. It is anticipated that at detailed design stage investigation on the highways, highways verges, embankments and cuttings may also be necessary. **North** The land adjacent to Junction 24A in the northern portion of the site is currently within the control of Lafarge Aggregates Limited and is being operated as a quarry and landfill. Access to this area was not required at this stage of the development cycle and indeed would be pointless as the site is in a constant state of change. However in order to aid detailed design at a later stage it is possible that some additional Ground Investigation may be required in the development areas following completion of Lafarge operations. Surrounding farm lands were under the control of Mr Coker and sufficient access was afforded to undertake sufficient extent of investigations. Access had to be arranged via Mr Coaker, Lafarge and via Highways Agency to access this area through their works on the widening of the A453 (via Laing O'Rourke contractor). As works in this area were in close proximity to the Severn Trent Water main (Derwent Valley Aqueduct) liaison was undertaken to ensure that the main position was known, set out and the easement observed. In addition checks were made as to the suitability of the plant to cross the main to undertake works on the eastern side before works were allowed to commence. **South** Lands to the west of the proposed bridge site are all under the control of the Highways Agency and their network managing agent A1+. The land at the crest of the cuttings on both sides of the M1 was heavily treed and inaccessible at this time. To the west and beyond slopes were present with the A453 and Ashby Road junction being present. Therefore due the restricted space, slopes, trees and major trunk roads borehole CP (R) 202 was placed on an area of wide verge alongside the A453 and Ashby Road junction. Permission was ought and gained from A1+ to undertake these works under a road space booking agreement. To the east of the M1 cutting the slope and immediate crest is heavily treed and fenced with an access track to Molehill farm beyond. It was not possible to block access and therefore borehole CP(R) 201 was placed

	in an adjacent field under the control of Mr Jarrom.
Utilities & Services	**Overhead power lines** are present within the northern part of the site crossing parts of Junction 24a east west. The Derwent Valley Aquaduct crosses beneath Junction 24a from the north west to south east where it crosses beneath the A453 immediately east of Junction 24.
Live Carriageway	No live carriageways were investigated as part of the works undertaken for Zone 3. However borehole CP (R) 202 was carried out on landscaped land controlled by the Highways Agency and road space booking permissions had to be gained before this work could be undertaken.
Airport	It was necessary to inform East Midlands Airport of the position (Coordinates and ground level) and height of all exploratory works to ensure that no breach regulated airspace would occur for all positions.

3 GROUND INVESTIGATION

3.1 Introduction

RSK prepared a site specific Stage 2 Preliminary Ground Investigation Specification in accordance with the Site Investigation Steering Group's UK Specification for Ground Investigation 2nd edition (2012) and BS 5930 and A2: 2010 'Code of practice for site investigations', BS EN ISO 14688-1:2002 and BS EN ISO 14689-1:2003. It was decided that the Mercia Mudstone Formation strata were to be logged for weathering grades in accordance with the guidelines in Chandler and Davis (1973): Further work on the engineering properties of Keuper Marl (CIRIA Report 47) so that the logs maybe readily compared to available historical exploratory hole data to facilitate interpretation.

The specification for the works was developed with the aim of providing sufficient preliminary data to assist with master planning design taking account of the anticipated ground conditions.

The site work for the investigation of the East Midlands Strategic Rail Freight Interchange across all four zones was undertaken between 24th September and 11th October 2013.

3.2 Investigation strategy and methodology

The techniques adopted for the intrusive investigation were appropriate to the expected geology and were also chosen to provide general preliminary non targeted arrangement covering both plan area and depth of strata sufficient to allow the ground model to be confirmed. In addition specific exploratory holes were targeted in order to provide data for specific critical design elements. Techniques were chosen. The investigation and sampling strategy was primarily focused on the assessment of the shallow soils and weathered bedrock.

The rationale for each planned exploratory hole location is detailed within the Stage 2 Preliminary Ground Investigation Specification and summarised within the Provisional Exploratory Hole Schedule included in Appendix B. This formed the basis for the works decision making as works progressed.

Following completion of fieldworks and upon preparation of exploratory hole logs a series of samples were scheduled for a selection of geotechnical and chemical laboratory testing to help characterise the strata properties. Groundwater samples were also taken and analysed where it was viable.

An initial programme of four weekly soil gas and groundwater level monitoring was undertaken to establish the groundwater and ground gas conditions beneath the site. The results of the monitoring are provided within Appendix J.

3.2.1 Health and safety

Services data was obtained and overlaid upon plans to aid in the safe positioning of exploratory holes.

RSK liaised with East Midlands Airport, Severn Trent Water, Lafarge, A1+ (Highways Agency), Laing O'Rourke and Landowners to agree suitable and safe exploratory hole locations and access routes and obtained all necessary permits and permissions.

RSK prepared site specific works H&S Plan, risk assessments and method statements for the undertaking of the works. These were reviewed by an independent CDMC appointed by Roxhill Developments Ltd. Risk Assessments and Method Statements were also provided to Severn Trent for approval prior to undertaking of works in the vicinity of the Derwent Valley Aquaduct.

A HSE Form F10, notification of construction project, was issued to the HSE to cover the works by the CDMC and was displayed on site throughout the works.

3.2.2 Location of exploratory hole positions and service clearance

RSK met with landowners and stakeholders to confirm suitable access routes and viable exploratory hole locations prior to finalising the ground investigation specification and commencing works.

Services data was obtained and overlaid upon plans to aid in the safe positioning of exploratory holes.

RSK SafeGround team used a number of techniques and equipment to check all exploratory hole positions and the surrounding areas were free of buried services and utilities. SafeGround used the following equipment:

- CAT & Genny (Radiodetection RD8000),
- Ground Penetrating Radar (GPR) - GSSI SIR-3000 console with the GSSI 400MHz antenna (standard frequency, used in high risk clearances) and the GSSI 200MHz antenna (low frequency, used in locating the high pressure water pipe)
- EM31 (Geonics)

Hand excavated service avoidance inspection pits were excavated to depths of 1.2mbgl prior to commencing all boreholes.

Investigative works in the area of the Derwent Valley Aquaduct (DVA) were coordinated with Severn Trent Water. No works were set out until the RSK SafeGround team had traced and set out the precise location of the DVA using all of the techniques available and detailed above. Once the alignment was set setting out and clearance of exploratory hole positions was conducted ensuring that positions were set out greater than 10m (easement) from the outer edge of the traced alignment of the DVA. Severn Trent attended site to check locations prior to works commencing and ground being broken.

Severn Trent Water are separately arranging to undertake hand excavated pits to confirm the exact position of the DVA using their own sub contractors approved to be able to work on the DVA. Roxhill developments Ltd are commissioning this directly through Severn Trent Water Ltd.

Upon completion of the works an as-built survey of the exploratory hole positions was commissioned and the coordinates and levels of each position were recorded using a Leica Viva GPS accurate to +/-5mm in horizontal positioning and +/-10mm in elevation. The coordinates and level data are recorded upon each exploratory hole log whilst the position of each exploratory hole is shown upon the exploratory hole location plan presented as Figure 4.

3.2.3 Investigation techniques

Trial pits

Machine excavated trial pits were utilised to provide coverage across the site and to provide data on the shallow near surface strata. Trial pits also allowed bulk disturbed samples to be taken for strata classification and earthworks testing.

Specific trial pits were undertaken at defined locations to facilitate soakaway testing to provide infiltration data to aid drainage design.

The trial pit logs and photographs are presented in Appendix C.

Cable percussion boring

150mm diameter cable percussion boreholes were utilised to penetrate shallow near surface drift strata to full depth and to prove the top of rock head. This technique was also used to provide in-situ strength and density testing (SPT), representative disturbed and undisturbed samples for laboratory testing and to facilitate installation of monitoring instrumentation within the shallow near surface deposits to facilitate long term soil gas and groundwater monitoring.

The cable percussion borehole logs are presented in Appendix D.

Rotary coring boreholes

92mm diameter ('P' size) rotary core drilling techniques were used to core solid strata at locations adjacent to selected cable percussion boreholes. This allowed representative rock core to be obtained for accurate logging and sub sampled for testing within the laboratory. The boreholes were installed with deep standpipes and standpipe piezometers to allow long term monitoring of groundwater and ground gas.

The rotary borehole logs and photographs are presented in Appendix E.

3.2.4 Zone 3 investigation

The investigation undertaken at Zone 3 comprised the following:

- Setting out and service Clearance (RSK SafeGround).
- Excavation of five trial pits using an operated wheeled excavator to provisional depths of between 1.60m and 4.2m bgl.
- Carry out one soakaway test in a selected trial pit to BRE 365.
- Sinking of eight boreholes to provisional depths of between 3.70m and 10.20m bgl using a standard cable percussive drilling rig.
- Sinking of four rotary cored boreholes (air /mist) open holed to rock head and cored (P size) to a depth of 25.00m bgl.
- Installation of eleven combined groundwater/gas monitoring wells and one piezometer to varying depths including provision of flush lockable covers and 1.5m high wooden marker stakes (in fields).
- Four initial return visits to monitor groundwater levels/ground gas concentrations.
- Surveying in of as built exploratory hole positions using GPS surveying equipment.
- Associated sampling and on site testing.
- Soil and rock sample geotechnical laboratory testing.
- Soil sample chemical and contamination laboratory testing.
- Groundwater sample chemical and contamination laboratory testing.

3.2.5 Soil sampling, in-situ testing and laboratory analysis

Details of the soil samples obtained during the intrusive investigation are recorded on the exploratory hole logs presented within Appendices C, D and E.

In-situ SPTs were undertaken within the cable percussion boreholes and are presented on the borehole logs included within Appendix D.

In-situ soakaway testing was undertaken in one trial pit (TP342) as denoted upon the exploratory hole plan presented as Figure 4. Preliminary soakaway tests were

undertaken in unsupported shallow trial pits and were attempted in general accordance with the recommendation of BRE 365. The in-situ soakaway test result is presented in Appendix F and summarised below.

Table 3: Summary of soakaway test results

Hole	Test Zone (Depth m bgl)	Calculated Infiltration Rate m/s	Strata
TPS342	0.90 – 1.60	$4.89x10^{-6}$	Wanlip Member

A programme of laboratory testing was scheduled by RSK to be carried out on selected suitable samples, in order to provide characteristic geotechnical strata properties.

The programme of geotechnical testing undertaken is summarised below within Table 4.

Table 4: Summary of geotechnical testing programme undertaken

Stratum	Analysis Undertaken	Number
Made Ground	Classification tests (natural moisture content)	1
Holme Pierrepont Sand and Gravel	Classification tests (natural moisture content)	2
	Sieve analysis	1
	Sedimentation analysis	1
Hemington Member	Classification tests (natural moisture content)	10
Wanlip Member	Sulphate Characterisation (BRE SD1)	1
	Classification tests (natural moisture content)	2
	Classification tests (Atterberg Limits)	1
	Sieve analysis	3
	Sedimentation analysis	3
Gunthorpe Member	Sulphate Characterisation (BRE SD1)	1
Tarporley Siltstone Formation	Sulphate Characterisation (BRE SD1)	10
	Classification tests (natural moisture content)	6
	Classification tests (Atterberg Limits)	4
	Undrained shear strength measured by laboratory shear vane testing (kN/m^2)	1

Stratum	Analysis Undertaken	Number
	Unconfined compressive strength (MPa)	2
	Coefficient of consolidation c_v (m^2/year)	3
	Undrained shear strength measured by triaxial testing (kN/m^2)	1
	Point load testing (Axial /Diametral)	2
Edwalton Member	Sulphate Characterisation (BRE SD1)	1
	Classification tests (natural moisture content)	2
	Undrained shear strength measured by triaxial testing (kN/m^2)	1
Branscombe Mudstone Formation	Classification tests (natural moisture content)	5
	Classification tests (Atterberg Limits)	1
	Coefficient of consolidation c_v (m^2/year)	2
	Undrained shear strength measured by triaxial testing (kN/m^2)	3
	Point load testing (Axial /Diametral)	2
	Sulphate Characterisation (BRE SD1)	5
	Unconfined compressive strength (MPa)	6

The results of the geotechnical laboratory testing are presented in full within Appendix G.

In addition a programme of non targeted analytical chemical and contamination suites of tests were scheduled upon selected soil and groundwater samples obtained to confirm characteristic soil and groundwater chemistry and contamination potential.

The programme of analytical chemical and contamination suites of tests undertaken on soil samples is summarised below within

Table 5.

Table 5: Summary of analytical chemical and contamination testing programme undertaken on soil samples

Stratum	Analysis Undertaken	Number
Subsoil	pH, arsenic, cadmium, copper, chromium, chromium (hexavalent), lead, mercury, nickel, selenium and zinc	2
	Total Organic Carbon (TOC)	1
	Pesticides	1
	Polycyclic Aromatic Hydrocarbons (PAHs)	2
	Triazine Herbicides	1
	Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG) + BTEX and MTBE	2
Wanlip Member	pH, arsenic, cadmium, copper, chromium, chromium (hexavalent), lead, mercury, nickel, selenium, zinc	1
	Pesticides	1
	Polycyclic Aromatic Hydrocarbons (PAHs)	1
	Triazine Herbicides	1
	Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG) + BTEX and MTBE	1

The results of the analytical chemical and contamination suites of tests are presented in full within Appendix H.

The programme of analytical chemical and contamination suites of tests undertaken on groundwater samples is summarised below within Table 6.

Table 6: Summary of analytical chemical and contamination testing programme undertaken on groundwater samples

Sample	Analysis Undertaken	Number

Sample	Analysis Undertaken	Number
Groundwater	pH, redox potential, electrical conductivity, dissolved oxygen, hardness, ammoniacal nitrogen, phenols, arsenic, cadmium, copper, chromium, chromium (hexavalent), lead, mercury, nickel, selenium and zinc	3
	Polycyclic Aromatic Hydrocarbons (PAHs)	3
	Semi-Volatile Organic Compounds (SVOCs)	3
	Volatile Organic Compounds (VOCs)	3
	Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG) + BTEX and MTBE	3

The results of the analytical chemical and contamination suites of tests for the groundwater samples are presented in full within Appendix I.

3.2.6 Instrumentation and monitoring

Long term monitoring of gas and groundwater levels was made possible by the installation of standpipes and standpipe piezometers as shown within Table 7.

Table 7: Monitoring well installation details

Hole	Standpipe Response Zone / Piezometer Response Zone (m)	Standpipe Slotted zone/Piezometer Tip Depth (m)	Strata
CP201	1.00 – 5.10	1.00 – 5.00	Tarporley Siltstone Formation
CP202	1.00 – 6.59	1.00 – 6.50	Made Ground and Tarporley Siltstone Formation
CP209	1.00 – 4.40	1.00 – 4.40	Hemington Member Sand and Gravel
CP226	1.00 – 3.70	1.00 – 3.70	Holme Pierrepont Sand and Gravel Member
CP227	7.80 – 10.20	7.80 – 9.80	Edwalton Formation
CP229	1.00 – 4.30	1.00 – 4.30	Hemington Member Sand and

Hole	Standpipe Response Zone / Piezometer Response Zone (m)	Standpipe Slotted zone/Piezometer Tip Depth (m)	Strata
			Gravel
CP230	1.00 – 7.74	1.00 – 7.60	Wanlip Member & Branscombe Mudstone Formation
CP231	1.00 – 5.50	1.00 – 5.50	Hemington Member Sand and Gravel
CP(R)201	16.00 – 25.00	16.00 – 25.00	Tarporley Siltstone Formation
CP(R)202	8.00 – 25.00	8.00 – 25.00	Tarporley Siltstone Formation
CP(R)209	12.00 – 25.00	12.00 – 25.00	Branscombe Mudstone Formation
CP(R)2229	16.00 – 19.00 (S)	17.50 (P)	Branscombe Mudstone Formation

Instrumentation installed within the boreholes has been monitored by trained technicians from RSK.

Initial Gas and Groundwater Monitoring was undertaken on 4 separate occasions over a five week period as follows;

- 16th and 17th October 2013
- 22nd and 23rd October 2013
- 30th and 31st October 2013
- 11th November 2013

Groundwater sampling was undertaken from Borehole CP202, CP209 and CPR229 on the 22nd October 2013. Groundwater sampling was undertaken in accordance with RSK Procedure No; SHEQ MS TP210 Groundwater and Surface Water – sampling and routine in-situ testing. This has been formulated in accordance with current published guidance. Samples obtained were sent to Envirolab for testing and the results are presented within Appendix I. Details of the in-situ water quality results are presented within Appendix J.

Gas and groundwater level monitoring was undertaken in accordance with RSK Group SHEQMS Technical Procedure TP211 Ground Gas (Permanent gases) Monitoring and Sampling. This has been formulated in accordance with current published guidance. Groundwater levels were established using a hand held dipmeter with levels recorded

with reference to depth below ground level. Gas monitoring was carried out using a Geotechnical Instruments GA2000+ Infra red gas analyser and Gas Data GFM610 flow pod. Monitoring was carried out to check for Methane, Carbon Monoxide, Carbon dioxide, Hydrogen Sulphide, Oxygen, Barometric pressure and Flow rate. In addition a Mini RAE 3000 Photo Ionisation Detector (PID) was used to confirm if volatile organic compounds were also present. The detailed results of the gas and groundwater level monitoring are presented within Appendix J.

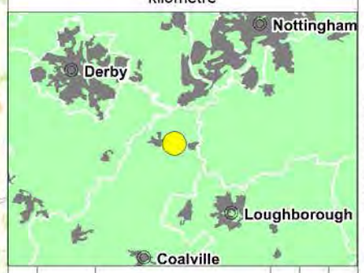
FIGURES

Boundary

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East Midlands Gateway

RSK

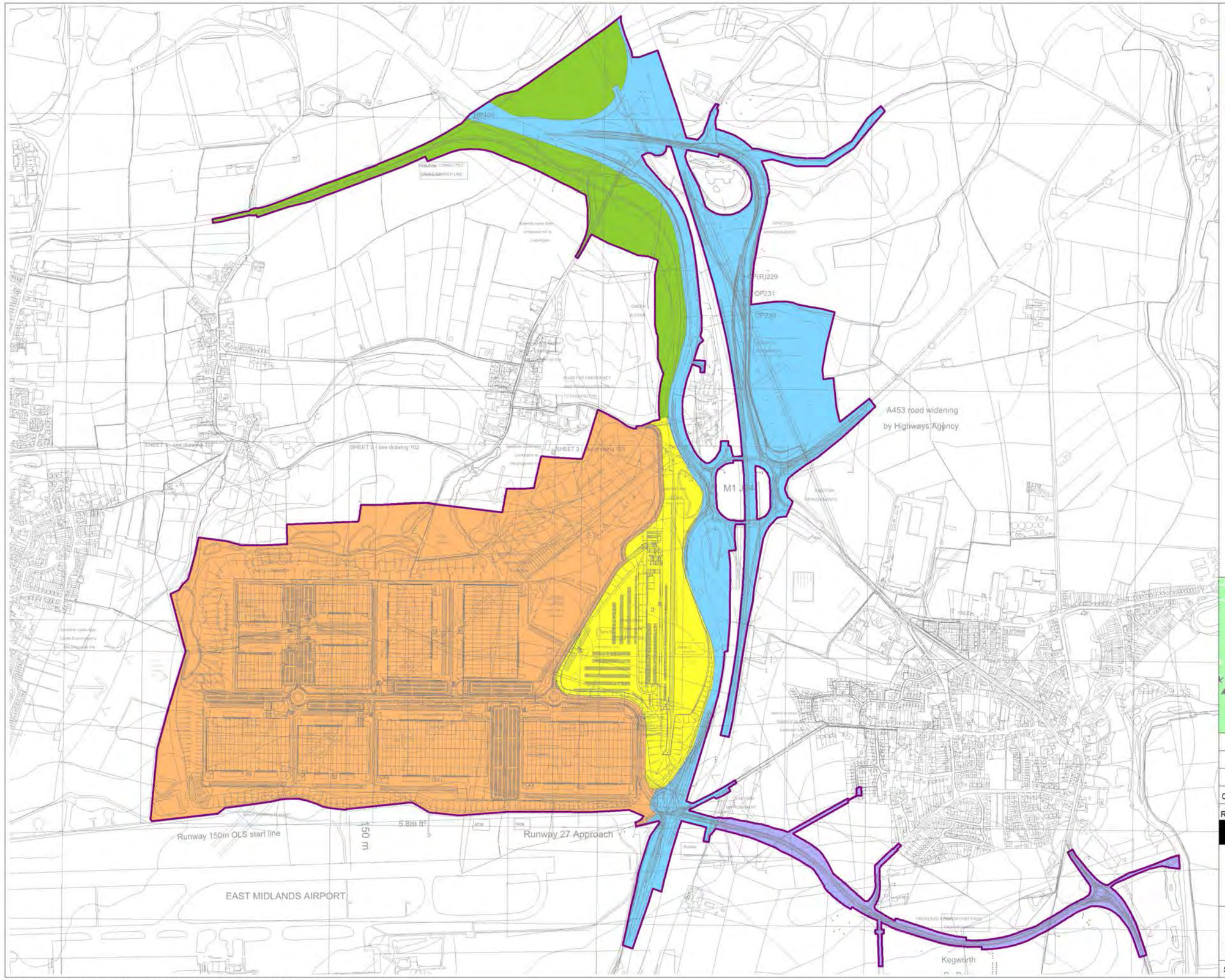
Figure 1

Site Location Plan

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Contains Ordnance Survey data © Crown copyright and database right 2013
Site boundary extracted from pHp Architects drawing RK 006 MASTERPLAN. Received 30.10.13.



Boundary

Zone 1A - Main Development Plateau - Distribution

Zone 1B - Main Development Plateau - Rail Freight Terminal

Zone 2 - New Rail Branch Line

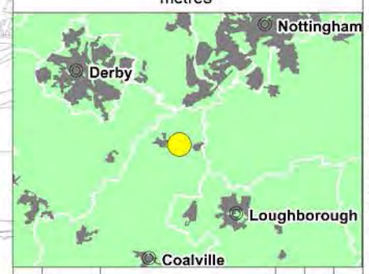
Zone 3 - Major Trunk Road Improvements (Highways Agency)

Zone 4 - Kegworth Bypass (Local Authority Highways)

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metres



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East Midlands Gateway

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Figure 2

Proposed Development Plan and Zones For Reporting

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Proposed Development Layout extracted from pHp Architects drawing RK 006 MASTERPLAN. Received 30.10.13.
Road Layout provided by BWB Consulting Limited drawing NTH209 Base Master. Received 27.08.13.

Zone 3 Boundary

A453 road widening
by Highways Agency

M1 J24

Runway 150m OLS start line

150 m

5.8m ft²

Runway 27 Approach

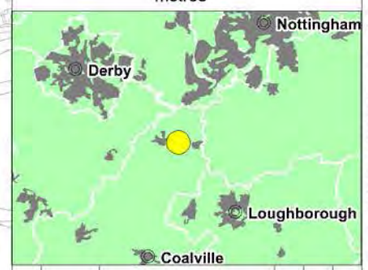
EAST MIDLANDS AIRPORT

Kegworth
By-Pass

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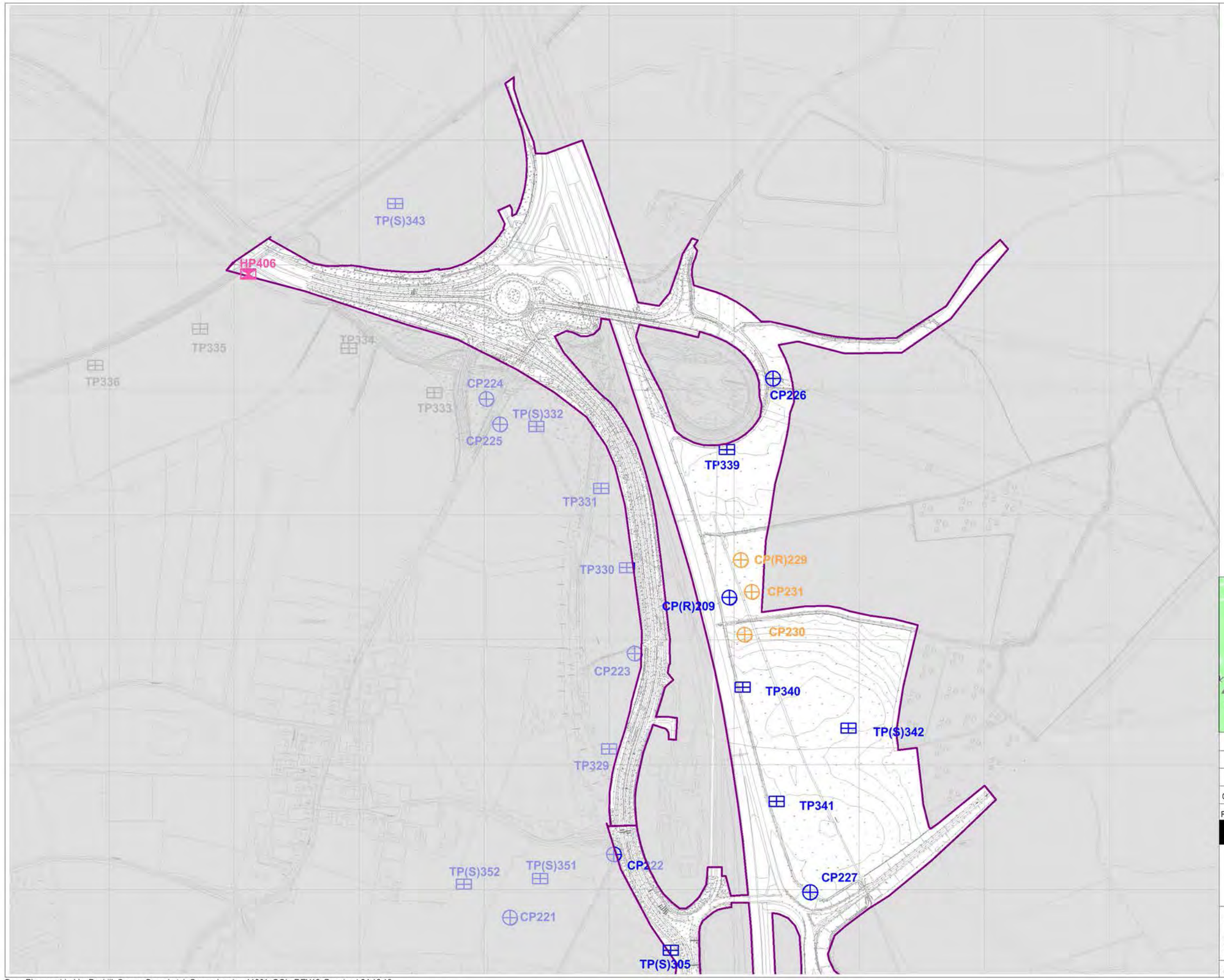
Figure 3

Zone 3 Plan

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Proposed Development Layout extracted from pHp Architects drawing RK 006 MASTERPLAN. Received 30.10.13.
Road Layout provided by BWB Consulting Limited drawing NTH209 Base Master. Received 27.08.13.



Zone 3 Boundary

Symbols Key

- CP — Cable Percussion Borehole
- CP(R) — Cable Percussion with Rotary follow on Borehole
- TP — Trial Pit
- TP(S) — Trial Pit (S) Soakaway
- HP — Hand Excavated Trial Trench

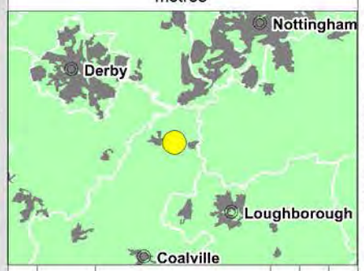
Colour Key

- Phase 2 Inverstigation (Autumn 2013)
- Requested by BWB to identify location and level of DVA pipes
- Requested by BWB to identify bridge foundations level and form

N W E S

0 250

metres



Rev	Date	Description	Drn	Chk	App
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East Midlands Gateway

RSK

Figure 4

Zone 3 Exploratory Hole Location Plan
Map 1 of 2

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Base Plan provided by Roxhill. Source Greenhatch Group drawing 11361_OGL_REV10. Received 24.10.13.
LiDAR data provided by BWB Consulting Limited drawing EA_LiDAR_2m_DTM_3D_Contours Keg Bypass. Received 04.11.13.



Zone 3 Boundary

Symbols Key

- CP — Cable Percussion Borehole
- CP(R) — Cable Percussion with Rotary follow on Borehole
- TP — Trial Pit
- TP(S) — Trial Pit (S) Soakaway
- HP — Hand Excavated Trial Trench

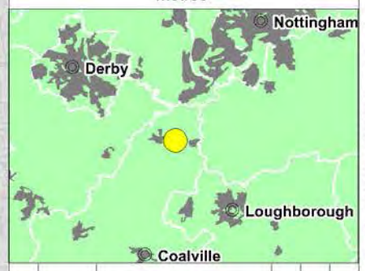
Colour Key

- Phase 2 Inverstigation (Autumn 2013)
- Requested by BWB to identify location and level of DVA pipes
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metres



Rev	Date	Description	Drn	Chk	App
00	29.11.13	Geo	RG	SP	DB

East Midlands Gateway

RSK

Figure 4

Zone 3 Exploratory Hole Location Plan
Map 2 of 2

SCALE: 1:7,500 @ A3 | REV 00

Base Plan provided by Roxhill. Source Greenhatch Group drawing 11361_OGL_REV10. Received 24.10.13.
LiDAR data provided by BWB Consulting Limited drawing EA_LiDAR_2m_DTM_3D_Contours Keg Bypass. Received 04.11.13.

FILE NAME: X:\Cov Ground and Environment\Enquiries\Focal Point Enquiries\312400 - 312499\East Midlands Gateway\GIS

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Roxhill Developments Limited in accordance with the terms of a contract between RSK and the "client", dated 3rd September 2013. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be** well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date hereof, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

APPENDIX B
PROVISIONAL EXPLORATORY HOLE SCHEDULE

312494 East Midlands Gateway
SRFI

Exploratory Hole Schedule - Zone 3

Hole	Hole Type	Provisional Depth m bgl	Anticipated CP depth mbgl	Anticipated Coring length m	Provisional Instrumentation	Current Use/surfacing	Purposed end use	Special insitu testing / sampling /Likely Lab Testing Requirements	Position E	Position N	Estimated Ground Level mAOD	Estimated Design Ground Level mAOD	Diff in level m
Boreholes													
CPR 201	CP & RC	**25**	8	17	To Be confirmed by Engineer depending upon ground conditions and water strikes encountered. In general shallow combined gas and Groundwater monitoring stanpipes using 50mm HDPE pipe to be utilised in Cable Percussion boreeholes around main buildings and plateaus to allow sahhlwo gas and perched or shallow groundwater strikes to be monitored . Deeper Standpipes or stand pipe piezometers to be utilised and installed in sperate deep rotary boreholes to allow deeper sub artesian or artesian water levels to be monitored.	Farm Track and fields	M1 overbridge Foundation	SPT 1m c/c, U100 samples where possible in CP holes, std geotech and env samples. Water strikes to be carefully recorded with casing and			80	80	0
CPR 202	CP & RC	**25**	8	17		Wide Trucnk Road /side road Highway Verge					80	80	0
CPR 209	CP & RC	**25**	12	13		Fields/Quarry Beware Watermain	M1/A50 slip road Highway bridge structure				30	NK	0
CP 226	CP	**12**	12			Quarry/Fields BEWARE Watermain and Overheads	New highway slip road connection				30.5	33.5	-3
CP 227	CP	**12**	12			Cropped Fields Beware Watermains	Positioned at toe of exisitng embankment slope with gabions.				34.5	34.5	0
CP(R) 229	CP & RC	**25**	12	13		Fields/Quarry Beware Watermain					30	NK	0
CP 230	CP	**12**	12								30	NK	0
CP231	CP	**12**	12				M1/A50 slip road Highway bridge structure				30	NK	0
Trial Pits													0
TP 328	TP	**4.5**				Farm fields	New Roundabout layout and connection itn Zone 1	HV and Std geotech and Env Sampling			73	70	3
TP 339	TP	**4.5**				Quarry/Fields/ farm access track Beware Watermain	New motorway Slip road				30.4	32	-1.6
TP 340	TP	**4.5**				Cropped Fields Beware Watermains	A50/M1 slip links in fields				33.7	34	-0.3
TP 341	TP	**4.5**									34.1	35	-0.9
TP 342	TP & Soakaway	**2.5**									33.5	31.5	2

NK = Not Known **TBC= To Be Confirmed** **Note: Rotary Holes to be commenced 5m away from Cable Percussion holes and open holed to the depth acchieved by Cable Percussion prior to commencing coring.**

Access not yet available , Acces to these positions still to be confirmed by client and landowner. Do not undertake these investigation positions untill can confirm.

Safeground GPR required as high risk utilities in area

APPENDIX C
TRIAL PIT LOGS AND PHOTOGRAPHS

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF ABBREVIATIONS

SAMPLING

Sample type codes

B	=	Bulk disturbed sample.
C	=	Core sample.
CS	=	Core sample taken from rotary core for lab testing.
D	=	Small disturbed sample.
DSPT	=	Small disturbed sample originating from SPT test.
ES	=	Soil sample for environmental testing.
U	=	Undisturbed driven tube sample - Number of blows indicated. % recovery reported.

Undisturbed sample detail codes

$U_{(100)}$	=	100mm diameter undisturbed sample.

IN-SITU TESTING

$SPT_{(c)}$	=	Standard Penetration Test using a solid 60 degree cone.
SPT	=	Standard Penetration Test using split spoon sampler. ($SPT_{(NR)}$ indicates 'No Sample Recovery').
	=	* denotes extrapolated N value. NP denotes 'No Penetration'.
V	=	Field Vane Test. Peak value (c_u) & Residual value (c_r), given as shear strength in kPa.

ROTARY DRILLING INFORMATION

W	=	Water flush returns (%)
TCR	=	Total core recovery (%)
SCR	=	Solid core recovery (%)
RQD	=	Rock quality designations (%)
If	=	Fracture spacing (mm).

In the fracture column (i) denotes discontinuity is infilled (refer to Fracture Table for details).
Where variable the minimum - average - maximum spacing may be quoted.
'NI' denotes non-intact core. 'NA' denotes not applicable.

All lengths used to determine rock core mechanical properties taken along the centre line of the core.
Obvious induced fractures have been ignored.
The assessment of solid core is based on lengths that show a full diameter and not necessarily a full circumference.
AZCL = Assessed zone of core loss.

ADDITIONAL NOTES

1. All soil and rock descriptions and legends in general accordance with BS EN ISO 14688-1, 14688-2, 14689-1, and BS5930:1999 including Amendment 2 (2010).
2. Material types divided by a broken line (- - -) indicates an unclear boundary.
3. The data on any sheet within the report showing the AGS icon is available in the AGS format.

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RSK Environment Ltd, The Enterprise Centre, Coventry University Technology Park, Coventry, CV1 2TX. Tel: 02476 236816, Fax: 02476 236014, Web: www.rsk.co.uk.

Contract Reference: **312494**

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF GRAPHIC SYMBOLS

WATER COLUMN SYMBOLS



First water strike, second water strike etc.

Standing water level following first strike, standing water level following second strike etc.

Seepage.

Standing water level recorded at documented date.

MATERIAL GRAPHIC LEGENDS

	CLAY		Clayey gravelly SAND		Gravelly clayey SAND		Clayey gravelly SAND with COBBLES
	Clayey SAND		Clayey SAND with COBBLES		Clayey sandy GRAVEL		GRAVEL
	GRAVEL with COBBLES		Gravelly CLAY		Gravelly silty CLAY		Silty gravelly CLAY
	Silty gravelly CLAY with COBBLES		Gravelly SAND		Gravelly clayey SILT		Gravelly SILT
	MADE GROUND		Mudstone		SAND		SAND with COBBLES

INSTRUMENTATION SYMBOLS

	Backfill		Bentonite seal		Concrete		Gravel filter
	Sand filter		Stopcock cover				
	Piezometer tip		Plain pipe		Slotted pipe		

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RSK Environment Ltd, The Enterprise Centre, Coventry University Technology Park, Coventry, CV1 2TX. Tel: 02476 236816, Fax: 02476 236014, Web: www.rsk.co.uk.

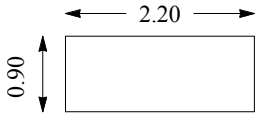
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
East Midlands Gateway	**Roxhill Developments Ltd**	**TP328**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**24.9.13**	**72.79**	**E:447242.7 N:326485.5**	**1** of **1**
	End: **24.9.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15-0.25	1	ES	Tx2+J+Vx2			Crop stubble over very stiff brown slightly gravelly silty sandy CLAY with frequent rootlets. Gravel is angular to subrounded fine to medium flint, quartzite and rare angular medium glass. (SUBSOIL)	(0.30) 0.30	
						Orange brown mottled brown slightly gravelly very sandy SILT with occasional rootlets. gravel is angular to rounded fine to medium quartzite and flint. (HEAD DEPOSITS)	(0.60) 0.90	
2.10-2.30	2	B				Very stiff fissured red brown occassionally bedded green grey slightly sandy very silty CLAY. Recovery includes occasional tabular and angular fine to coarse siltstone and fine sandstone fragments. (Weathering Grade IVb) (TARPORLEY SILTSTONE FORMATION)	(1.40) 2.30	
						Red brown bedded green grey extremely weak SILTSTONE and fine SANDSTONE recovered as tabular and angular fine to coarse gravel and occasional to some cobbles and rare boulders. (0.30m) (Weathering Grade III) (TARPORLEY SILTSTONE FORMATION)	2.40	
						Trial pit terminated at 2.4m depth.		

Plan (Not to Scale)



General Remarks

1. Location scanned with a CAT and Signal Generator prior to breaking ground. No services encountered.
2. Trial pit remained stable during excavation.
3. Groundwater not encountered.
4. Trial pit backfilled and compacted with arisings upon completion.
5. Made ground associated with backfill from the land drain encountered.
6. Pit terminated as machine unable to make significant further progress.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**MHocking**	DMB

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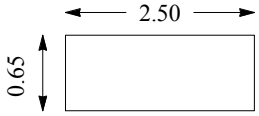
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
East Midlands Gateway	**Roxhill Developments Ltd**	**TP339**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**10.10.13**	**30.62**	**E:447486.2 N:328630.0**	**1** of **1**
	End: **10.10.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20-0.30	1	ES	Tx2+J+Vx2			Vegetation over very stiff slightly sandy silty gravelly to very gravelly CLAY with frequent rootlets. Gravel is angular to rounded fine to coarse quartzite and flint. (SUBSOIL)	(0.30)	
							0.30	
						Light orange grey slightly silty slightly gravelly very sandy CLAY. Gravel is subrounded to rounded fine to coarse quartzite. (HEMINGTON MEMBER)	0.50	
						Orange slightly clayey gravely fine to coarse SAND. Gravel is sub rounded to rounded fine to coarse quartzite. (HEMINGTON MEMBER)	(0.40)	
0.90-1.00	2	B					0.90	
						Brown occasionally mottled dark brown clayey very sandy angular to rounded and tabular fine to coarse quartzite, flint and occasional sandstone GRAVEL with occasional subrounded to rounded quartzite cobbles. (HOLME PIERREPONT SAND & GRAVEL MEMBER)		
2.20-2.40	3	B		1			(3.10)	
3.40-3.60	4	B				. . . below 3.30m bgl, brown clayey very sandy tabular and angular fine to medium mudstone GRAVEL with occasional medium to coarse gravel sized pockets of grey and red brown very stiff silt.		
							4.00	
						Trial pit terminated at 4.00m depth.		

Plan (Not to Scale)



General Remarks

1. Location scanned with a CAT and Signal Generator prior to breaking ground. No services encountered.
2. Trial pit remained stable during excavation.
3. Groundwater seepage/inflow encountered at 2.85m bgl.
4. Trial pit backfilled and compacted with arisings upon completion.
5. Trial pit terminated due to groundwater.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**MHocking**	DMB

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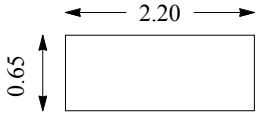
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
East Midlands Gateway	Roxhill Developments Ltd	TP340

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	10.10.13 End: 10.10.13	33.78	E:447517.2 N:328155.0	1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20-0.30	1	ES	Tx2+J+Vx2			Crop over brown gravelly very clayey very silty fine to medium SAND. Gravel is angular to rounded fine to coarse quartzite and flint. (SUBSOIL)	(0.30) 0.30	
0.50-0.70	2	B				Very stiff orange brown silty very sandy gravelly CLAY with occasional angular to rounded flint and quartzite cobbles. Gravel is angular to rounded fine to coarse flint and quartzite. (WANLIP MEMBER)	(0.40) 0.70	
1.20-1.40	3	B				Very stiff fissured red brown slightly silty slightly sandy slightly gravelly to gravelly CLAY. Gravel is angular to rounded fine to coarse quartzite and flint. (WANLIP MEMBER) . . . below 1.50m bgl, slightly silty slightly gravelly sand. . . . below 1.90m bgl, interlaminated with slightly clayey very gravelly fine to medium SAND, and rare quartzite boulders.	(1.60) 2.30	
2.60-2.80	4	B				Red brown very clayey very silty fine SAND. (WANLIP MEMBER)	(0.80) 3.10	
3.20-3.50	5	B				Red brown occasionally green grey very thinly laminated extremely weak SILTSTONE. (Weathering Grade IVb) (ARDEN SANDSTONE FORMATION) . . . below 3.45m bgl, green grey.	(0.70) 3.80	
3.80-4.00	6	B				Light grey slightly silty gravelly to very gravelly fine to medium occasional coarse SAND. Gravel is tabular and angular fine to coarse sandstone. (Weathering Grade IVb) (ARDEN SANDSTONE FORMATION) . . . below 3.90m bgl, frequent tabular sandstone cobbles. Trial pit terminated at 4.00m depth.	4.00	

Plan (Not to Scale)



General Remarks

1. Location scanned with a CAT and Signal Generator prior to breaking ground. No services encountered.
2. Trial pit remained stable during excavation.
3. Groundwater not encountered.
4. Trial pit backfilled and compacted with arisings upon completion.

All dimensions in metres | Scale: 1:25

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	JCB-3CX	MHocking	DMB

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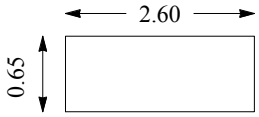
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
East Midlands Gateway	**Roxhill Developments Ltd**	**TP341**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**10.10.13** End: **10.10.13**	**34.18**	**E:447584.9 N:327926.0**	**1** of **1**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						Crop over brown gravelly very clayey very silty fine to medium SAND. Gravel is angular to rounded fine to coarse quartzite and flint. (SUBSOIL)	(0.30) 0.30	
0.35-0.45	1	ES	Tx2+J+Vx2			Very stiff orange brown slightly clayey gravelly to very gravelly fine to medium SAND with occasional coarse gravel sized clasts of orange and dark orange semi-lithified gravel fine to medium sand. Gravel is angular to rounded fine to coarse quartzite and flint. (WANLIP MEMBER)	(1.10)	
1.00-1.10	2	D				. . . between 1.00m and 1.10m bgl frequent cobble sized clasts of firm sandy clay. . . . below 1.10m bgl, dark orange brown slightly clayey very gravelly.	1.40	
1.40-1.60	3	B				Dark orange brown slightly clayey very gravelly SAND. Gravel fraction is angular fine to coarse quartzite and flint. (WANLIP MEMBER)		
						. . . below 2.30m bgl, sandy very clayey GRAVEL.	(2.00)	
2.60-2.80	4	B					3.40	
3.50-3.60	5	D				Stiff to very stiff red brown mottled light grey slightly sandy slightly gravelly very silty CLAY. Gravel fraction is tabular and angular fine to medium sandstone. (ARDEN SANDSTONE FORMATION) . . . between 3.40m and 3.50m bgl, light grey brown very silty very gravelly fine to medium SAND; Gravel is tabular and angular fine to coarse sandstone.	(0.70) 4.10	
						Light grey mottled red brown SANDSTONE recovered as silty sandy tabular and angular gravel and cobbles. (ARDEN SANDSTONE FORMATION)	4.20	
						Trial pit terminated at 4.20m depth.		

Plan (Not to Scale)



General Remarks

1. Location scanned with a CAT and Signal Generator prior to breaking ground. No services encountered.
2. Trial pit remained stable during excavation.
3. Groundwater not encountered.
4. Trial pit backfilled and compacted with arisings upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**MHocking**	DMB

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RSK Environment Ltd, The Enterprise Centre, Coventry University Technology Park, Coventry, CV1 2TX. Tel: 02476 236816, Fax: 02476 236014, Web: www.rsk.co.uk.

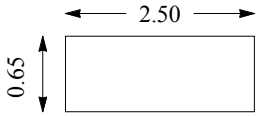
TRIAL PIT LOG

Contract:	Client:	Trial Pit:
East Midlands Gateway	**Roxhill Developments Ltd**	**TPS342**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**11.10.13**	**33.57**	**E:447728.6 N:328073.0**	**1** of **1**
	End: **11.10.13**			

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						Crop over very stiff brown slightly gravelly silty to very silty sandy to very sandy CLAY with frequent rootlets. Gravel is angular to rounded fine to coarse quartzite and sandstone. (SUBSOIL)	(0.30) 0.30	
0.35-0.45	1	ES	Tx2+J+Vx2			Dark orange brown very clayey very gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse quartzite and flint. (WANLIP MEMBER)	0.50	
0.70-0.90	2	B				Orange brown very clayey very sandy angular to rounded fine to coarse quartzite and flint GRAVEL and slightly sandy gravel to very gravelly CLAY, with occasional angular flint and quartzite cobbles. (WANLIP MEMBER)	(0.40) 0.90	
1.00-1.20	3	D				Very stiff fissured red brown to gravelly silty CLAY with occasional cobble sized pockets of slightly gravelly to gravelly sandy to very sandy clay. Gravel is angular to rounded fine to coarse flint and quartzite. (WANLIP MEMBER)	(0.50) 1.40	
						Very stiff fissured red brown slightly silty CLAY. Recovery includes occasional tabular and angular fine to medium gravel sized siltstone and fine grained sandstone fragments. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION)	1.60	
						Trial pit terminated at 1.60m depth.		

Plan (Not to Scale)



General Remarks

1. Location scanned with a CAT and Signal Generator prior to breaking ground. No services encountered.
2. Trial pit remained stable during excavation.
3. Groundwater not encountered.
4. Trial pit backfilled and compacted with arisings upon completion.
5. Soakaway test completed.
6. Pit terminated at anticipated maximum depth of soakaway/pond feature.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Logged By:	Checked By:
Machine dug	**JCB-3CX**	**MHocking**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log TRIAL PIT LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:07 | KF.
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PHOTOGRAPHIC LOG – Trial pits – Zone 3

Photo No.	**Date:**
1	24.09.13

Direction Photo Taken:

N/A

Description:

TP328



Photo No.	**Date:**
2	10.10.13

Direction Photo Taken:

N/A

Description:

TP339



Photo No.	Date:	
3	10.10.13	
Direction Photo Taken: N/A		
Description: TP340		

Photo No.	Date:	
4	10.10.13	
Direction Photo Taken: N/A		
Description: TP341		

Photo No.	Date:	
5	11.10.13	
Direction Photo Taken: N/A		
Description: TPS342 – soakaway test completed within trial pit		

APPENDIX D
CABLE PERCUSSION BOREHOLE LOGS

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF ABBREVIATIONS

SAMPLING

Sample type codes

B	=	Bulk disturbed sample.
C	=	Core sample.
CS	=	Core sample taken from rotary core for lab testing.
D	=	Small disturbed sample.
DSPT	=	Small disturbed sample originating from SPT test.
ES	=	Soil sample for environmental testing.
U	=	Undisturbed driven tube sample - Number of blows indicated. % recovery reported.

Undisturbed sample detail codes

$U_{(100)}$	=	100mm diameter undisturbed sample.

IN-SITU TESTING

$SPT_{(c)}$	=	Standard Penetration Test using a solid 60 degree cone.
SPT	=	Standard Penetration Test using split spoon sampler. ($SPT_{(NR)}$ indicates 'No Sample Recovery').
	=	* denotes extrapolated N value. NP denotes 'No Penetration'.
V	=	Field Vane Test. Peak value (c_u) & Residual value (c_r), given as shear strength in kPa.

ROTARY DRILLING INFORMATION

W	=	Water flush returns (%)
TCR	=	Total core recovery (%)
SCR	=	Solid core recovery (%)
RQD	=	Rock quality designations (%)
If	=	Fracture spacing (mm).

In the fracture column (i) denotes discontinuity is infilled (refer to Fracture Table for details).
Where variable the minimum - average - maximum spacing may be quoted.
'NI' denotes non-intact core. 'NA' denotes not applicable.

All lengths used to determine rock core mechanical properties taken along the centre line of the core.
Obvious induced fractures have been ignored.
The assessment of solid core is based on lengths that show a full diameter and not necessarily a full circumference.
AZCL = Assessed zone of core loss.

ADDITIONAL NOTES

1. All soil and rock descriptions and legends in general accordance with BS EN ISO 14688-1, 14688-2, 14689-1, and BS5930:1999 including Amendment 2 (2010).
2. Material types divided by a broken line (- - -) indicates an unclear boundary.
3. The data on any sheet within the report showing the AGS icon is available in the AGS format.

GINT_LIBRARY_V8_05.GLB'GrfcText G - LEGEND - 1 OF 2 | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 29/11/13 - 10:00 | KF.
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Contract Reference: **312494**

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF GRAPHIC SYMBOLS

WATER COLUMN SYMBOLS



First water strike, second water strike etc.

Standing water level following first strike, standing water level following second strike etc.

Seepage.

Standing water level recorded at documented date.

MATERIAL GRAPHIC LEGENDS

	CLAY		Clayey gravelly SAND		Gravelly clayey SAND		Clayey gravelly SAND with COBBLES
	Clayey SAND		Clayey SAND with COBBLES		Clayey sandy GRAVEL		GRAVEL
	GRAVEL with COBBLES		Gravelly CLAY		Gravelly silty CLAY		Silty gravelly CLAY
	Silty gravelly CLAY with COBBLES		Gravelly SAND		Gravelly clayey SILT		Gravelly SILT
	MADE GROUND		Mudstone		SAND		SAND with COBBLES

INSTRUMENTATION SYMBOLS

	Backfill		Bentonite seal		Concrete		Gravel filter
	Sand filter		Stopcock cover				
	Piezometer tip		Plain pipe		Slotted pipe		

GINT_LIBRARY_V8_05.GLB!Grf¢Text G - LEGEND - 2 OF 2 | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 29/11/13 - 10:00 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP201**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**1.10.13**	**75.26**	**E:447442.7 N:326387.9**	**1** of **2**
	End: **1.10.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						Grass over brown slightly gravelly fine to medium SAND. Gravel is subangular fine to coarse quartzite. (TOPSOIL)	(0.30)	
							0.30	
0.40	1	D				Firm red brown silty CLAY. Recovery includes occasional subangular fine to coarse sandstone skerries fragments. (Weathering Grade IVa) (TARPORLEY SILTSTONE FORMATION)		
0.50-1.00	2	B						
							(1.30)	
1.20	3	D						
1.20-1.65	4	$U_{(100)}$	36 blows 60% recovery					
							1.60	
1.70	5	D				Stiff red brown silty CLAY with occasional grey reduction spots. (Weathering Grade IVb) (TARPORLEY SILTSTONE FORMATION)		
2.00	6	D						
2.20-2.65	1	SPT	N=23					
2.20-2.70	7	B					(1.80)	
3.00	8	D						
3.00-3.45	9	$U_{(100)}$	87 blows 60% recovery					
							3.40	
3.50	10	D				Weak red brown SILTSTONE, occasional grey reduction spots. (Weathering Grade III) (TARPORLEY SILTSTONE FORMATION)		
4.00-4.30	2	SPT	N=100*					
4.00	11	D					(1.70)	
4.40	12	D						

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
01/10/13		5.10	3.00	150	Dry

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
4.00	4.50	01:00
4.50	5.00	01:00

General Remarks

1. Location scanned with GPR and a CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater not encountered.
4. Gas and groundwater monitoring well installed to 5.00m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:02 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP201**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**1.10.13**	**75.26**	**E:447442.7 N:326387.9**	**2** of **2**
	End: **1.10.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
4.50-4.69	3	SPT	N=176*			Weak red brown SILTSTONE, occasional grey reduction spots. (Weathering Grade III) (TARPORLEY SILTSTONE FORMATION) *(stratum copied from 3.40m from previous sheet)* . . . at 4.50m bgl, occasional clay bands.		
5.00	13	D					5.10	
5.10-5.20	4	SPT(c)	N=300*			Borehole terminated at 5.10m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:02 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP202**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**30.9.13**	**74.82**	**E:447336.8 N:326442.7**	**1** of **2**
	End: **30.9.13**			

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						Grass over brown slightly gravelly fine to medium SAND. Gravel is subangular fine to coarse quartzite. (TOPSOIL)	0.15	
0.25	1	D				Brown slightly gravelly slightly clayey fine SAND. Gravel is angular fine to coarse quartzite, sandstone and bituminous hardstanding. (MADE GROUND)	(0.95)	
0.30-0.80	2	B					1.10	
1.20-1.65	1	SPT(c)	N=23			Stiff brown slightly sandy gravelly CLAY. Gravel is angular fine to coarse concrete, sandstone and quartzite. (MADE GROUND)		
1.20	3	D						
1.20-1.65	4	B						
1.80	5	D					(1.60)	
2.00-2.20	6	B						
2.20-2.65	2	SPT(c)	N=20				2.70	
2.80	7	D				Stiff red brown silty CLAY. (Weathering Grade IVb) (TARPORLEY SILTSTONE FORMATION)		
3.00-3.45	8	$U_{(100)}$	42 blows 100% recovery				(0.70)	
							3.40	
3.50	9	D				Stiff red brown slightly clayey SILT. Recovery includes occasional angular fine to coarse siltstone skerries fragments. (Weathering Grade IVa) (TARPORLEY SILTSTONE FORMATION)	(0.50)	
							3.90	
3.90	10	D				Stiff red brown mottled grey silty CLAY. Recovery includes occasional fine to coarse gravel sized angular mudstone lithorelicts.. (Weathering Grade IVa) (TARPORLEY SILTSTONE FORMATION)		
4.00-4.45	3	SPT	N=18				(0.90)	
4.00-4.45	11	B						

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
30/09/13		6.59	3.00	150	Dry

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
5.50	6.00	01:00
6.00	6.50	01:00

General Remarks

1. Location scanned with GPR and a CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater not encountered.
4. Gas and groundwater monitoring well installed to 6.50m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:03 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP202**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**30.9.13** End: **30.9.13**	**74.82**	**E:447336.8 N:326442.7**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
							4.80	
4.90	12	D				Stiff red brown mottled grey slightly silty CLAY. Recovery includes occasional angular fine to coarse sandstone skerries fragments. (Weathering Grade IVb) (TARPORLEY SILTSTONE FORMATION)	(0.50)	
5.00-5.45	13	$U_{(100)}$	96 blows 60% recovery				5.30	
5.50-5.69	4	SPT	N=158*			Weak red brown SILTSTONE. (Weathering Grade III) (TARPORLEY SILTSTONE FORMATION)	(0.50)	
5.50	14	D					5.80	
5.80	15	D				Weak grey brown MUDSTONE and SILTSTONE. (Weathering Grade III) (TARPORLEY SILTSTONE FORMATION)	(0.70)	
6.00-6.19	5	SPT(c)	N=176*				6.50	
6.50-6.60	6	SPT(c)	N=300*			Moderately weak red brown MUDSTONE. (Weathering Grade III) (TARPORLEY SILTSTONE FORMATION)	6.59	
6.50	16	D				Borehole terminated at 6.59m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:03 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP209**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13**	**30.11**	**E:447486.8 N:328334.8**	**1** of **2**
	End: **9.10.13**			

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	D				Dark brown slightly gravelly slightly sandy CLAY. Gravel is angular to subrounded fine to coarse quartzite. (TOPSOIL)	(0.40)	
							0.40	
0.50	2	D				Grey brown sandy GRAVEL. Gravel is subrounded to rounded fine to coarse quartzite. (HEMINGTON MEMBER SAND AND GRAVEL)	0.65	
0.75	3	D				Loose orange brown mottled grey slightly clayey gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite and sandstone. (HEMINGTON MEMBER SAND AND GRAVEL)		
0.80-1.20	4	B						
1.20-1.65	1	SPT(c)	N=9				(1.15)	
							1.80	
1.90	5	D				Medium dense brown gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite and sandstone. (HEMINGTON MEMBER SAND AND GRAVEL)		
2.00-2.45	2	SPT(c)	N=19					
2.90	6	D					(2.40)	
3.00-3.45	3	SPT(c)	N=21					
3.60	7	D						
4.00-4.45	4	SPT(c)	N=16					
							4.20	
4.30	8	D				*Description on next sheet*		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
09/10/13	00:00	3.45	3.00	150	3.45
09/10/13	00:20	3.45	3.00	150	2.26
09/10/13	00:00	5.55	5.00	150	5.55
09/10/13	00:20	5.55	5.00	150	4.20
09/10/13		7.45	7.00	150	3.90

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
6.80	7.20	01:00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater encountered at 3.45m and 5.50m bgl.
4. Gas and groundwater monitoring well installed to 4.40m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:03 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP209**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13**	**30.11**	**E:447486.8 N:328334.8**	**2** of **2**
	End: **9.10.13**			

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						Stiff becoming very stiff red brown sandy CLAY. (Weathering Grade IVa) (BRANSCOMBE MUDSTONE FORMATION) *(stratum copied from 4.20m from previous sheet)*	(1.30)	
5.00	9	D						
5.10-5.55	5	SPT(c)	N=34					
				▼1			5.50	
						Very stiff red brown mottled grey slightly clayey sandy SILT with occasional grey reduction spots. (Weathering Grade IVa) (BRANSCOMBE MUDSTONE FORMATION)	(0.90)	
5.90	10	D						
6.20-6.62	6	SPT(c)	N=57*				6.40	
						Very dense red brown slightly clayey silty fine SAND with occasional grey sandstone skerries. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION)	(0.40)	
							6.80	
6.90	11	D				Weak brown medium grained SANDSTONE. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)	(0.65)	
7.20-7.45	7	SPT(c)	N=150*					
							7.45	
						Borehole terminated at 7.45m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:03 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP226**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**4.10.13**	**29.99**	**E:447578.0 N:328772.3**	**1** of **2**
	End: **4.10.13**			

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						Brown slightly gravelly CLAY. Gravel is angular fine to medium quartzite, with occasional rootlets. (MADE GROUND)	(0.40)	
0.20	1	D					0.40	
						Orange brown mottled grey slightly gravelly sandy CLAY. Gravel is angular to subrounded quartzite and clinker. (MADE GROUND)	(0.30)	
0.50	2	D					0.70	
						Medium dense grey gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (HOLME PIERREPONT SAND AND GRAVEL MEMBER)		
0.80	3	D						
1.20-1.65	1	SPT(c)	N=27				(1.10)	
							1.80	
1.80	4	D				Dense brown sandy GRAVEL. Gravel is subrounded to rounded fine to coarse quartzite. (HOLME PIERREPONT SAND AND GRAVEL MEMBER)		
2.00-2.45	2	SPT(c)	N=47	1				
							(1.90)	
3.00-3.35	3	SPT(c)	N=75*			. . . at 3.00m bgl, becoming very dense.		
3.00	5	D		1				
							3.70	
3.80	6	D				Dense red brown slightly gravelly clayey fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (HOLME PIERREPONT SAND AND GRAVEL MEMBER)	(0.50)	
4.00-4.45	4	SPT	N=30					
4.00-4.50	7	B					4.20	
						Description on next sheet		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
04/10/13	00:00	3.35	3.00	150	3.35
04/10/13	00:00	3.35	3.00	150	2.42
04/10/13	00:00	7.50	6.50	150	7.50
04/10/13	00:20	7.50	6.50	150	4.25
04/10/13		7.52	6.50	150	Dry

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
6.80	7.20	01:00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater encountered at 3.35m bgl and 7.50m bgl.
4. Gas and groundwater monitoring well installed to 3.70m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:03 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP226**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**4.10.13**	**29.99**	**E:447578.0 N:328772.3**	**2** of **2**
	End: **4.10.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
				2		Stiff red brown CLAY. Recovery includes occasional to some angular fine to coarse mudstone lithorelicts with grey reduction spots. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION) *(stratum copied from 4.20m from previous sheet)*		
4.90	8	D						
5.00-5.45	9	$U_{(100)}$	37 blows 80% recovery				(2.30)	
5.50	10	D						
6.00	11	D						
6.20-6.62	5	SPT	N=57*			. . . at 6.20m bgl, becoming very stiff.	6.50	
						Very weak red brown MUDSTONE, with occasional grey reduction spots. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)	(1.02)	
7.10	12	D						
7.20-7.52	6	SPT	N=88*	2			7.52	
						Borehole terminated at 7.52m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP227**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**7.10.13** End: **7.10.13**	**34.63**	**E:447652.7 N:327745.3**	**1** of **3**

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	D				Brown slightly gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (TOPSOIL)	(0.40)	
							0.40	
0.50	2	D				Loose orange brown slightly gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (WANLIP MEMBER)		
0.80-1.20	3	B					(0.80)	
1.00-1.45	1	SPT(c)	N=8					
							1.20	
1.90	4	D				Loose orange brown slightly gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (WANLIP MEMBER)		
2.00-2.45	2	SPT(c)	N=10			. . . at 2.00m bgl, becoming loose to medium dense.		
							(2.60)	
2.80	5	D						
3.00-3.45	3	SPT(c)	N=14			. . . at 3.00m blg, becoming medium dense.		
							3.80	
3.90	6	D				Medium dense orange brown slightly gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (WANLIP MEMBER)		
4.00-4.45	7	$U_{(100)}$	48 blows 90% recovery				(0.50)	
							4.30	
						Description on next sheet		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
07/10/13	00:00	4.50	4.00	150	4.50
07/10/13	00:20	4.50	4.00	150	4.10
07/10/13	00:00	8.60	8.00	150	8.60
07/10/13	00:20	8.60	8.00	150	6.85
07/10/13		10.20	9.50	150	5.90

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
8.60	9.00	01:00
9.30	9.80	01:00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater encountered at 4.50m and 8.60m bgl.
4. Gas and groundwater monitoring well installed to 9.80m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP227**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**7.10.13**	**34.63**	**E:447652.7 N:327745.3**	**2** of **3**
	End: **7.10.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
4.50	8	D				Soft red brown slightly silty sandy CLAY, with occasional grey reduction spots. (Weathering Grade IVa) (EDWALTON MEMBER) *(stratum copied from 4.30m from previous sheet)*	(1.10)	
4.80	9	D						
5.00-5.45	4	SPT	N=7				5.40	
						Firm red brown slightly silty CLAY. Recovery includes occasional angular fine to medium mudstone lithorelicts. (Weathering Grade IVa) (EDWALTON MEMBER)	(0.90)	
5.90	10	D						
6.00-6.45	11	$U_{(100)}$	54 blows 90% recovery				6.30	
						Grey SANDSTONE recovered as slightly gravelly slightly clayey fine to medium SAND. Gravel is angular fine to medium sandstone. (Weathering Grade IVb) (EDWALTON MEMBER)	(0.60)	
6.50	12	D					6.90	
						Very stiff to very weak red brown MUDSTONE, with occasional grey reduction spots. (Weathering Grade III) (EDWALTON MEMBER)		
7.20-7.65	5	SPT	N=37					
7.20-7.70	13	B						
8.00	14	D						
8.30-8.69	6	SPT	N=64*	2		. . . at 8.30m bgl, becomes very weak.	(3.30)	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP227**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**7.10.13** End: **7.10.13**	**34.63**	**E:447652.7 N:327745.3**	**3** of **3**

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
9.00-9.34	7	SPT	N=81*			Very stiff to very weak red brown MUDSTONE, with occasional grey reduction spots. (Weathering Grade III) (EDWALTON MEMBER) *(stratum copied from 6.90m from previous sheet)*		
9.80-10.20 9.80	8 15	SPT D	N=60*				10.20	
						Borehole terminated at 10.20m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP229**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13** End: **10.10.13**	**30.31**	**E:447514.4 N:328412.9**	**1** of **2**

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						Brown slightly gravelly CLAY. Gravel is angular to subangular fine to coarse quartzite and sandstone, with occasional rootlets. (TOPSOIL)	(0.30)	
0.20	1	D					0.30	
						Brown slightly gravelly sandy CLAY. Gravel is subangular fine to coarse quartzite and sandstone. (HEMINGTON MEMBER)	(0.45)	
0.60	2	D					0.75	
0.85	3	D				Medium dense orange brown slightly gravelly fine to medium SAND. Gravel is subangular to subrounded fine to medium quartzite and sandstone, with occasional pockets of clay. (HEMINGTON MEMBER)		
0.90-1.20	4	B						
1.20-1.65	1	SPT(c)	N=12				(0.95)	
1.20-1.65	5	B						
							1.70	
1.80	5	D				Medium dense grey gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite and sandstone. (HEMINGTON MEMBER)		
2.00-2.45	2	SPT(c)	N=15					
2.00-2.45	6	B						
				1				
							(2.60)	
3.00	7	D						
3.10-3.55	3	SPT(c)	N=23					
3.10-3.55	8	B						
				1				
3.90	7	D						
4.00-4.45	4	SPT(c)	N=17					
4.00-4.45	9	B					4.30	
						Description on next sheet		
4.40	10	D						

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
09/10/13		2.50	2.00	150	Dry
10/10/13	00:00	3.50	3.40	150	3.50
10/10/13	00:20	3.50	3.40	150	2.70
10/10/13		7.34	5.00	150	

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
6.70	7.00	01:00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater encountered at 3.50m bgl.
4. Gas and groundwater monitoring well installed to 4.30m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP229**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13** End: **10.10.13**	**30.31**	**E:447514.4 N:328412.9**	**2** of **2**

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						Stiff brown slightly gravely sandy CLAY. Gravel is subrounded to rounded fine to coarse quartzite and sandstone. (REWORKED BRANSCOMBE MUDSTONE FORMATION) *(stratum copied from 4.30m from previous sheet)*	(0.60) 4.90	
5.00 5.00-5.45	11 12	D $U_{(100)}$	48 blows 80% recovery			Stiff red brown sandy CLAY. Recovery includes occasional angular fine to medium mudstone and sandstone fragments, with occasional grey reduction spots. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION)		
5.50	13	D					(1.70)	
6.20 6.30-6.73	14 5	D SPT	N=55*			. . . at 6.30m bgl, becomes very stiff.	6.60	
						Very weak red brown interbedded fine grained SANDSTONE and MUDSTONE, with occasional grey reduction spots. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)	(0.74)	
7.00-7.35 7.00	6 15	SPT D	N=77*				7.34	
						Borehole terminated at 7.34m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP230**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**31.73**	**E:447520.7 N:328260.6**	**1** of **2**
	End: **8.10.13**			

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
						Dark brown slightly silty slightly gravelly fine SAND. Gravel is subrounded to rounded fine to coarse quartzite. (TOPSOIL)	(0.30)	
0.20	1	D					0.30	
						Medium dense brown gravelly fine SAND. Gravel is subrounded to rounded fine to coarse quartzite. (WANLIP MEMBER)		
0.70	2	D						
0.80-1.20	3	B					(1.10)	
1.20-1.65	1	SPT(c)	N=15					
							1.40	
1.50	4	D				Firm to stiff brown slightly gravelly sandy CLAY. Gravel is subrounded to rounded fine to coarse quartzite. (WANLIP MEMBER)		
2.00-2.45	2	SPT(c)	N=15				(0.90)	
2.00-2.45	5	B						
							2.30	
						Firm to stiff red brown slightly sandy clayey SILT, with occasional grey reduction spots. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION)		
2.90	6	D						
3.00-3.45	7	$U_{(100)}$	84 blows 90% recovery				(1.40)	
3.50	8	D						
							3.70	
3.80	9	D				Firm red brown highly weathered thinly bedded interbedded MUDSTONE and SANDSTONE recovered as sandy clay. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION)		
4.10-4.55	3	SPT	N=12					
4.10-4.60	10	B						
							(1.60)	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
08/10/13	00:00	5.45	4.50	150	5.45
08/10/13	00:20	5.45	4.50	150	4.75
08/10/13		7.74	7.00	150	6.60

Chiselling / Slow Progress

From	To	Duration (hh:mm)
7.20	7.60	01:00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater encountered at 5.45m bgl.
4. Gas and groundwater monitoring well installed to 7.60m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP230**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**31.73**	**E:447520.7 N:328260.6**	**2** of **2**
	End: **8.10.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
				1		Firm red brown highly weathered thinly bedded interbedded MUDSTONE and SANDSTONE recovered as sandy clay. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION) *(stratum copied from 3.70m from previous sheet)*		
4.90	11	D						
5.00-5.45	12	$U_{(100)}$	29 blows 100% recovery				5.30	
				1		Very stiff to very weak red brown clayey MUDSTONE, with occasional sandstone skerries, and grey reduction spots. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)		
5.50	13	D						
6.00	14	D					(1.50)	
6.20-6.65	4	SPT	N=38					
							6.80	
6.90	15	D				Very weak red brown clayey fine to medium grained SANDSTONE. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)	(0.40)	
7.00-7.40	5	SPT	N=61*					
							7.20	
						Weak to moderately weak red brown and grey interbedded SANDSTONE and MUDSTONE. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)	(0.54)	
7.60-7.75	6	SPT	N=333*					
7.60	16	D					7.74	
						Borehole terminated at 7.74m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP231**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**30.12**	**E:447535.5 N:328346.1**	**1** of **2**
	End: **8.10.13**			

Samples and In-situ Tests				Water	Backfill & Instru-mentation	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	D				Brown slightly gravelly CLAY. Gravel is subrounded to rounded fine to medium quartzite. (TOPSOIL)	(0.40) 0.40	
0.50	2	D				Firm to stiff grey mottled orange CLAY. (HEMINGTON MEMBER SAND AND GRAVEL)		
0.80	3	B						
1.20-1.65	1	SPT	N=15				(1.80)	
1.80	4	D						
2.00-2.45	2	SPT(c)	N=27				2.20	
						Medium dense grey brown slightly clayey gravelly fine to medium SAND. Gravel is subrounded to rounded fine to coarse quartzite. (HEMINGTON MEMBER SAND AND GRAVEL)	(0.60) 2.80	
2.90	5	D				Medium dense brown gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to coarse quartzite. (HEMINGTON MEMBER SAND AND GRAVEL)		
3.00-3.45	3	SPT(c)	N=21					
3.90	6	D						
4.00-4.45	4	SPT(c)	N=28				(2.50)	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
08/10/13	00:00	3.45	3.00	150	3.45
08/10/13	00:20	3.45	3.00	150	1.80
08/10/13		7.47	7.30	150	6.90

Chiselling / Slow Progress		
From	To	Duration (hh:mm)
7.10	7.40	01:00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. No services encountered.
2. Hand dug inspection pit excavated to 1.20m bgl
3. Groundwater encountered at 3.45m bgl.
4. Gas and groundwater monitoring well installed to 5.40m bgl upon completion.

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	TMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP231**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**30.12**	**E:447535.5 N:328346.1**	**2** of **2**
	End: **8.10.13**			

Samples and In-situ Tests				Water	Backfill & Instrumentation	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
4.90	7	D				Medium dense brown gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to coarse quartzite. (HEMINGTON MEMBER SAND AND GRAVEL) *(stratum copied from 2.80m from previous sheet)*		
5.00-5.45	5	SPT(c)	N=18				5.30	
5.40	8	D				Stiff red brown sandy CLAY. Recovery includes occasional angular to rounded fine to medium mudstone and quartzite, with occasional grey reduction spots. (Weathering Grade IVb) (BRANSCOMBE MUDSTONE FORMATION)	(1.00)	
6.00	9	D						
6.00-6.45	10	$U_{(100)}$	64 blows 95% recovery				6.30	
6.50	11	D				Moderately weak red brown and grey interbedded SANDSTONE and SILTSTONE. (Weathering Grade III) (REWORKED BRANSCOMBE MUDSTONE FORMATION)	(1.17)	
7.00	12	D						
7.10-7.21	6	SPT(c)	N=250*					
7.30	13	D						
7.40-7.48	7	SPT(c)	N=429*				7.47	
7.40	14	D				Borehole terminated at 7.47m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

Chiselling / Slow Progress		
From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:25**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Pilcon Wayfarer 1500**	**GH**	**GShaw**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log CABLE PERCUSSION LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:05 | KF.
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APPENDIX E
ROTARY CORED BOREHOLE LOGS AND PHOTOGRAPHS

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF ABBREVIATIONS

SAMPLING

Sample type codes

B	=	Bulk disturbed sample.
C	=	Core sample.
CS	=	Core sample taken from rotary core for lab testing.
D	=	Small disturbed sample.
DSPT	=	Small disturbed sample originating from SPT test.
ES	=	Soil sample for environmental testing.
U	=	Undisturbed driven tube sample - Number of blows indicated. % recovery reported.

Undisturbed sample detail codes

$U_{(100)}$	=	100mm diameter undisturbed sample.

IN-SITU TESTING

$SPT_{(c)}$	=	Standard Penetration Test using a solid 60 degree cone.
SPT	=	Standard Penetration Test using split spoon sampler. ($SPT_{(NR)}$ indicates 'No Sample Recovery').
	=	* denotes extrapolated N value. NP denotes 'No Penetration'.
V	=	Field Vane Test. Peak value (c_u) & Residual value (c_r), given as shear strength in kPa.

ROTARY DRILLING INFORMATION

W	=	Water flush returns (%)
TCR	=	Total core recovery (%)
SCR	=	Solid core recovery (%)
RQD	=	Rock quality designations (%)
If	=	Fracture spacing (mm).

In the fracture column (i) denotes discontinuity is infilled (refer to Fracture Table for details).
Where variable the minimum - average - maximum spacing may be quoted.
'NI' denotes non-intact core. 'NA' denotes not applicable.

All lengths used to determine rock core mechanical properties taken along the centre line of the core.
Obvious induced fractures have been ignored.
The assessment of solid core is based on lengths that show a full diameter and not necessarily a full circumference.
AZCL = Assessed zone of core loss.

ADDITIONAL NOTES

1. All soil and rock descriptions and legends in general accordance with BS EN ISO 14688-1, 14688-2, 14689-1, and BS5930:1999 including Amendment 2 (2010).
2. Material types divided by a broken line (- - -) indicates an unclear boundary.
3. The data on any sheet within the report showing the AGS icon is available in the AGS format.

GINT_LIBRARY_V8_05.GLB'GrfcText G - LEGEND - 1 OF 2 | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 29/11/13 - 10:00 | KF.
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Contract Reference: **312494**

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF GRAPHIC SYMBOLS

WATER COLUMN SYMBOLS



First water strike, second water strike etc.

Standing water level following first strike, standing water level following second strike etc.

Seepage.

Standing water level recorded at documented date.

MATERIAL GRAPHIC LEGENDS

	CLAY		Clayey gravelly SAND		Gravelly clayey SAND		Clayey gravelly SAND with COBBLES
	Clayey SAND		Clayey SAND with COBBLES		Clayey sandy GRAVEL		GRAVEL
	GRAVEL with COBBLES		Gravelly CLAY		Gravelly silty CLAY		Silty gravelly CLAY
	Silty gravelly CLAY with COBBLES		Gravelly SAND		Gravelly clayey SILT		Gravelly SILT
	MADE GROUND		Mudstone		SAND		SAND with COBBLES

INSTRUMENTATION SYMBOLS

	Backfill		Bentonite seal		Concrete		Gravel filter
	Sand filter		Stopcock cover				
	Piezometer tip		Plain pipe		Slotted pipe		

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)201**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**2.10.13**	**75.26**	**E:447442.6 N:326389.4**	**1** of **4**
	End: **2.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Drillers descriptions - Firm to stiff red brown CLAY.	(4.46)	
4.00-5.50				68	49	33				. . . between 4.00m and 4.46m bgl, zone of core loss.	4.46	
										Firm to stiff indistinctly thickly laminated red brown silty CLAY. Recovery includes subangular medium to coarse mudstone lithorelicts. (Weathering Grade II) (TARPORLEY SILTSTONE FORMATION)	4.65	
5.50-7.00				100	77	52				Very weak to medium strong thickly laminated to thickly bedded red brown MUDSTONE with occasional thin interbeds of light grey siltstone. Discontinuities are subhorizontal very closely to medium spaced (23/1100/400) planar rough or undulating rough tight to open with some dark grey staining, occasional black speckling and occasional thin clay smearing. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION)		
6.57-6.75	1	CS								. . . between 5.02m and 5.16m bgl, planar subvertical fracture.		
7.00-8.50				100	93	80						

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
02/10/13	08:00	4.00	4.00	121	-
02/10/13	17:00	25.00	7.00	121	-

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. Hand dug service pit to 1.20m bgl. No services encountered.
2. Rotary open holed to 4.00m bgl.
3. Borehole advanced to 25.00m bgl using coring techniques.
4. Gas and groundwater monitoring well installed to 25.00m bgl upon completion.
5. No groundwater strikes noted.

All dimensions in metres | Scale: **1:42**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)201**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**2.10.13**	**75.26**	**E:447442.6 N:326389.4**	**2** of **4**
	End: **2.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
				100	93	80				Very weak to medium strong thickly laminated to thickly bedded red brown MUDSTONE with occasional thin interbeds of light grey siltstone. Discontinuities are subhorizontal very closely to medium spaced (23/1100/400) planar rough or undulating rough tight to open with some dark grey staining, occasional black speckling and occasional thin clay smearing. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION) *(stratum copied from 4.65m from previous sheet)*	(7.60)	
8.50-10.00				100	69	31						
10.00-11.50										. . . between 10.00m and 10.10m bgl, zone of core loss.		
10.86-11.06	2	CS		93	72	37						
11.50-13.00											12.25	
				100	93	33				Weak to medium strong thinly interlaminated to thinly interbedded red brown MUDSTONE and light green grey siltstone. Discontinuities are subhorizontal very closely to medium spaced planner rough or undulating partly open to open weak dark grey staining, occasional black speckling and thin clay smearing. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION) . . . between 13.00m and 13.38m bgl, zone of core loss.		
13.00-14.50				75	62	10					(3.55)	
14.50-16.00				100	67	13						

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:42**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:08 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)201**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**2.10.13**	**75.26**	**E:447442.6 N:326389.4**	**3** of **4**
	End: **2.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
				100	67	13				. . . between 15.13m and 15.41m bgl, weak. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION)	15.80	
16.00-17.50 / 16.10-16.20	4	CS		90	65	13				Medium strong to strong thinly to thickly bedded light brown grey and red brown fine to medium grained micaceous SANDSTONE. Discontinuities are subhorizontal very closely to closely spaced (42/80/120) planar rough open with occasional thin clay smearing, with some fine gravel sized open clean vugs throughout. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION) . . . between 16.00m and 16.15m bgl, zone of core loss.	(0.70) / 16.50	
17.50-19.00 / 18.22-18.40	3	CS		97	42	13				Medium strong to strong very thinly interlaminated to thinly interbedded red brown and light grey MUDSTONE, SILTSTONE and fine grained micaceous sandstone. Discontinuities are subhorizontal planar rough undulating rough very closely to medium spaced (20/60/190) partly open to open with dark grey staining and occasionally micaceous. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION) . . . between 16.61m and 16.75m bgl, recovered as firm grained clay. . . . between 17.50m and 17.55m bgl, zone of core loss. . . . between 17.70m and 17.80m bgl, subvertical fracture with calcite infill. . . . between 18.93m and 19.04m bgl, light brown grey fine to grained sandstone band.	(2.54) / 19.04	
19.00-20.50				87	60	12				Weak to medium strong very thinly interlaminated to very thinly bedded red brown and light grey MUDSTONE and SILTSTONE, with occasional medium to coarse gravel sized vugs with partial calcite infill. Discontinuities are subhorizontal planar rough or undulating rough very closely to medium spaced (18/80/250) partly open to open with occasional grey and orange brown staining and black speckling and occasionally micaceous. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION) . . . between 20.30m and 20.50m bgl, zone of core loss. . . . between 20.77m and 20.82m bgl, planar subvertical fracture.	(2.96)	
20.50-22.00 / 21.70-21.90	5	CS		100	52	13				. . . between 21.79 and 21.82m bgl, honeycombed band of medium to coarse gravel sized vugs with partial calcite infill.	22.00	
22.00-23.50 / 22.26-22.38	6	CS		93	69	19				*Description on next sheet*	(0.86)	

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:42**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)201**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**2.10.13**	**75.26**	**E:447442.6 N:326389.4**	**4** of **4**
	End: **2.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Medium strong to strong thinly interlaminated to thickly interbedded light brown grey fine grained SANDSTONE and red brown MUDSTONE. Discontinuities are subhorizontal very closely to closely spaced (27/80/100) planar rough undulating rough tight to open with occasional thin clay smearing. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION)	22.86	
23.50-25.00				93	69	19						
23.55-23.83	7	CS								. . . between 22.00m and 22.10m bgl, zone of core loss. *(stratum copied from 22.00m from previous sheet)*	(2.14)	
				100	81	39				Strong thinly interlaminated to thinly interbedded red brown and light grey MUDSTONE, SILTSTONE and fine grained SANDSTONE. Discontinuities are subhorizontal extremely closely to medium spaced (16/90/250) planar rough or undulating tight to open with some dark grey and occasional orange brown staining and occasional thin clay smearing. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION)	25.00	
										Rotary probehole terminated at 25.00m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:42**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)202**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**1.10.13**	**74.82**	**E:447336.8 N:326442.7**	**1** of **3**
	End: **1.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instru-mentation	Water	Description of Strata	Depth (Thick ness)	Material Graphic Legend
										Drillers description - Stiff red and brown CLAY with gravels.	(1.00) 1.00	
										Drillers description - Firm to stiff red and brown CLAY.	(6.20)	
7.00-8.50				87	22	0				. . . between 7.00m and 7.20m bgl, zone of core loss. *Description on next sheet*	7.20	AZCL
8.50-10.00				97	33	0				. . . between 8.08m and 8.21m bgl, undulating rough subvertical fracture with grey staining and thin clay smearing. . . . between 8.50m and 8.55m bgl, zone of core loss.		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
01/10/13	08:00	7.00	7.00	121	-
01/10/13	17:00	25.00	7.00	121	-

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. Hand dug service pit to 1.20m bgl. No services encountered.
2. Rotary open holed to 7.00m bgl.
3. Borehole advanced to 25.00m bgl using coring techniques.
4. Gas and groundwater monitoring well installed to 25.00m bgl upon completion.
5. No groundwater strikes noted.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)202**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**1.10.13**	**74.82**	**E:447336.8 N:326442.7**	**2** of **3**
	End: **1.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instru-mentation	Water	Description of Strata	Depth (Thick ness)	Material Graphic Legend
				97	33	0				. . . between 8.77m and 8.00m bgl, and 8.89m and 9.02m bgl, and 9.17m and 9.19m bgl, all recovered as red brown clayey gravel. Weak to very strong thinly interlaminated to very thinly interbedded and rarely ripple laminated red brown and light grey SILTSTONE and mudstone, with occasional thickly interlaminated to very thinly interbedded red brown and light grey brown fine grained sandstone. Discontinuities are subhorizontal undulating rough and planar rough extremely closely to medium spaced (8/90/280) tight to open with thin to thick clay smearing, occasional orange brown staining, black speckling and occasionally micaceous. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION)		
10.00-11.50				47	3	0						AZCL
11.50-13.00				93	45	13				. . . between 7.20m and 7.24m, and 7.34m and 7.40ml and 7.51m and 7.61m bgl, all recovered as red brown clayey gravel.*(stratum copied from* 7.20m from previous sheet) . . . between 9.20m and 9.25m bgl, planar smooth clean subvertical fracture possible drilling induced. . . . between 9.68m and 9.75m bgl, recovered as red brown clayey gravel. . . . between 9.87m and 9.389m bgl, string of interconnecting vugs with partial calcite infill. . . . between 10.00m and 10.80m bgl, zone of core loss. . . . between 11.50m and 11.60m bgl, zone of core loss. . . . between 11.85m and 11.95m, and 12.05m and 12.10m, and 12.14m and 12.16m, 12.27m and 12.31m bgl, all recovered as red brown clayey gravel.		
13.00-14.50				99	63	24						
13.95-14.13	1	CS									(14.50)	
14.50-16.00				100	76	19				. . . at 12.33m bgl, 35mm clean vug. . . . between 12.41m and 12.44m bgl, recovered as red brown clayey gravel. . . . between 12.50m and 12.67m bgl, subvertical stepped rough fracture. . . . between 12.70m and 12.74m bgl, honeycombed appearance. . . . between 13.00m and 13.02m bgl, zone of core loss. . . . between 13.10m and 13.53m bgl, with occasional medium to coarse gravel sized vugs, some with partial calcite infill. . . . between 14.50m and 15.20m bgl, light grey brown and red brown fine to medium grained sandstone with honeycombed appearance. . . . between 15.59m and 15.62m bgl, clayey gravel. . . . between 16.00m and 16.20m bgl, zone of core loss. . . . at 16.57m bgl, 23mm vug with partial calcite infill. . . . between 16.60m and 16.84m bgl, light grey brown and red brown fine to medium grained		
16.00-17.50				87	51	20						
17.50-19.00				97	71	20						

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)202**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**1.10.13** End: **1.10.13**	**74.82**	**E:447336.8 N:326442.7**	**3** of **3**

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
				97	71	20				sandstone with honeycombed appearance. . . . between 17.50m and 17.55m bgl, zone of core loss. . . . between 17.80m and 18.17m bgl, light grey brown and red brown fine to medium grained sandstone with honeycombed appearance.		
19.00-20.50				97	62	35				Weak to very strong thinly interlaminated to very thinly interbedded and rarely ripple laminated red brown and light grey SILTSTONE and mudstone, with occasional thickly interlaminated to very thinly interbedded red brown and light grey brown fine grained sandstone. Discontinuities are subhorizontal undulating rough and planar rough extremely closely to medium spaced (8/90/280) tight to open with thin to thick clay smearing, occasional orange brown staining, black speckling and occasionally micaceous. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION)		
20.50-22.00				93	88	21				. . . between 7.20m and 7.24m, and 7.34m and 7.40ml and 7.51m and 7.61m bgl, all recovered as red brown clayey gravel.*(stratum copied from* 7.20m from previous sheet)	21.70	
21.82-22.00	2	CS								. . . between 19.00m and 19.05m bgl, zone of core loss. . . . between 19.60 and 19.62m bgl, clayey gravel. . . . between 19.75m and 20.65m bgl, light grey brown and red brown fine to medium grained sandstone. . . . between 20.12m and 20.26m bgl, with occasional medium to coarse gravel sized vugs, some with partial calcite infill. . . . between 20.50m and 20.60m bgl, zone of core loss. . . . at 21.12m bgl, vug with partial calcite infill. . . . between 21.12m bgl and 21.14m bgl, clayey gravel.	(3.30)	
22.00-23.50				100	85	51						
23.50-25.00												
23.95-24.13	3	CS		100	88	61				Medium strong to strong very thinly to thinly bedded red brown and light grey brown fine to medium grained SANDSTONE, with occasional honeycombed appearance and with occasional thinly interlaminated to very thinly interbedded mudstone and siltstone. Discontinuities are subhorizontal undulating rough and planar rough very closely to medium spaced (34/120/230) partly open to open with thin clay smearing. (Weathering Grade I) (TARPORLEY SILTSTONE FORMATION) . . . between 23.04m and 23.07m bgl, clayey gravel. . . . at 23.28m bgl, 25mm vug with partial calcite infill. . . . between 24.38m and 24.39m bgl, clayey gravel.	25.00	
										Rotary probehole terminated at 25.00m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)209**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**30.07**	**E:447486.8 N:328334.8**	**1** of **4**
	End: **8.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Drillers descriptions - Stiff grey brown clayey TOPSOIL.	(0.50) 0.50	
										Drillers descriptions - Firm grey brown CLAY.	(0.50) 1.00	
									2	Drillers descriptions - Dense brown SAND and GRAVEL.	(5.50) 6.50	
										Drillers descriptions - Firm to stiff red brown CLAY.	(2.50) 9.00	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
08/10/13	08:00	0.00	None	121	-
08/10/13	09:00	4.00	None	121	4.00
08/10/13	09:20	4.00	None	121	2.00
08/10/13	14:00	18.00	10.00	121	18.00
08/10/13	14:20	18.00	10.00	121	4.80
08/10/13	17:00	25.00	10.00	121	1.00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. Hand dug service pit 10 1.20m bgl. No services encountered.
2. Rotary open holed to 10.00m bgl.
3. Borehole advanced to 25.00m bgl using coring techniques.
4. Gas and groundwater monitoring well installed to 25.00m bgl.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:08 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)209**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**30.07**	**E:447486.8 N:328334.8**	**2** of **4**
	End: **8.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Drillers descriptions - Very weak red brown weathered MUDSTONE.	(1.00)	
											10.00	
10.00-11.50										Very strong very thinly to thinly bedded light grey fine grained SANDSTONE. Discontinuities are subhorizontal undulating rough and planar rough very closely to medium spaced (40/160/210) partly open to open clean, rarely with thin gypsum coating. (Weathering Grade I) (BRANSCOMBE MUDSTONE FORMATION)	(1.40)	
10.27-10.49	1	CS		93	84	53						
											11.40	
11.50-13.00				100	97	85				. . . between 10.93m and 11.40m bgl, with rare very thin interbeds of red brown mudstone and with some subhorizontal and occasional subvertical gypsum veins. . . . at 11.00m bgl, 10mm subhorizontal gypsum vein. Weak to medium strong thickly interlaminated to thinly interbedded red brown and light grey MUDSTONE and siltstone with many subhorizontal and occasional subvertical gypsum veins and with rare reduction spots. Discontinuities are subhorizontal undulating rough or planar rough very closely to medium spaced (29/100/320) tight to open with thin clay smearing and occasionally with thin gypsum coating. (Weathering Grade I) (BRANSCOMBE MUDSTONE FORMATION)		
13.00-14.50				97	85	37				. . . at 12.30m bgl, 20mm subhorizontal gypsum vein. . . . between 13.00m and 13.05m bgl, zone of core loss. . . . at 13.26m bgl, 20mm subhorizontal undulating/nodular gypsum vein. . . . between 14.70m and 14.73m bgl, subhorizontal gypsum vein.		
14.50-16.00				100	93	59				. . . between 15.05m and 15.45m bgl, with some medium to coarse gravel sized gypsum nodules.		
15.30-15.52	2	CS										
16.00-17.50				97	75	42				. . . between 16.20m and 16.24m bgl, subhorizontal gypsum vein. . . . between 16.30m and 16.50m bgl, with some cross-cutting and subvertical gypsum veins. . . . between 16.45m and 16.46m bgl, subhorizontal gypsum vein. . . . between 16.48m and 17.05m bgl, with many medium to coarse gravel sized gypsum nodules.		
17.50-19.00				100	86	29				. . . between 16.85m and 16.87m bgl, subhorizontal gypsum vein. *Description on next sheet*		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)209**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13**	**30.07**	**E:447486.8 N:328334.8**	**3** of **4**
	End: **8.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										. . . between 17.50m and 17.72m bgl, with cross-cutting and subvertical gypsum veins. Weak to medium strong thickly interlaminated to thinly interbedded red brown and light grey MUDSTONE and siltstone with many subhorizontal and occasional subvertical gypsum veins and with rare reduction spots. Discontinuities are subhorizontal undulating rough or planar rough very closely to medium spaced (29/100/320) tight to open with thin clay smearing and occasionally with thin gypsum coating. (Weathering Grade I) (BRANSCOMBE MUDSTONE FORMATION)	(13.60)	
19.00-20.50				100	86	29						
20.00-20.16	3	CS		100	87	47				*(stratum copied from 11.40m from previous sheet)* . . . between 18.52m and 18.64m bgl, 4mm-8mm subvertical gypsum vein. . . . between 19.00m and 19.14m bgl, with some cross-cutting and subvertical gypsum veins. . . . between 19.14m and 19.40m bgl, with occasional medium to coarse gravel sized gypsum nodules. . . . between 19.36m and 19.40m bgl, soft gravelly clay. . . . between 19.64m and 19.68m bgl, subhorizontal gypsum vein. . . . between 19.70m and 20.00m bgl, with many subvertical gypsum veins. . . . between 20.30m and 20.32m bgl, subhorizontal gypsum vein. . . . between 20.43m and 20.47m bgl, subhorizontal gypsum vein. . . . between 20.81m and 20.84m bgl, subhorizontal gypsum vein. . . . between 20.92m and 20.94m bgl, subhorizontal gypsum vein. . . . between 20.94m and 21.87m bgl, with occasional medium to coarse gravel sized gypsum nodules. . . . between 20.97m and 20.98m bgl, subhorizontal gypsum vein. . . . between 21.24m and 21.25 bgl, subhorizontal gypsum vein. . . . between 21.27m and 21.32m bgl, subhorizontal gypsum vein.		
20.50-22.00				100	95	75						
22.00-23.50				100	75	49						
23.50-25.00				100	49	30						
24.30-24.50	4	CS									25.00	
										. . . between 21.31m and 21.32m bgl, subhorizontal gypsum vein. . . . between 21.87m and 21.91m bgl, subhorizontal gypsum vein. . . . between 22.00m and 25.00m bgl, red brown with rare reduction spots/bands. . . . between 23.30m and 23.31m bgl, subhorizontal gypsum vein. . . . between 23.37m and 23.39m bgl, subhorizontal gypsum vein. . . . between 23.50m and 24.30m bgl, several drilling induced fractures and non-intact. . . . between 23.50 and 25.00m bgl, with some		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)209**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**8.10.13** End: **8.10.13**	**30.07**	**E:447486.8 N:328334.8**	**4** of **4**

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										subhorizontal and rare subvertical gypsum veins. Rotary probehole terminated at 25.00m depth.		

Boring Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)229**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13**	**30.29**	**E:447510.6 N:328408.0**	**1** of **4**
	End: **9.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Drillers descriptions - Stiff grey brown clayey TOPSOIL.	0.20	
										Drillers descriptions - Firm grey brown CLAY.	(1.10)	
									1		1.30	
									1	Drillers descriptions - Dense grey brown SAND and GRAVEL.	(4.70)	
											6.00	
										Drillers descriptions - Firm to stiff red brown CLAY.	(3.00)	
											9.00	

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth
08/10/13	08:00	2.00	None	121	-
08/10/13	08:20	2.00	None	121	1.50
08/10/13	14:00	18.50	10.00	121	18.50
08/10/13	14:20	18.50	10.00	121	12.80
08/10/13	17:00	25.00	10.00	121	1.00

General Remarks

1. Location scanned with GPR and CAT and signal generator prior to breaking ground. Hand dug service pit 10 1.20m bgl. No services encountered.
2. Rotary open holed to 10.00m bgl.
3. Borehole advanced to 25.00m bgl using coring techniques.
4. Piezometer installed at 17.50m bgl.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs 0002 | Log COMPOSITE LOG | 312494 - EAST MIDLANDS GATEWAY.GPJ - v8_05 | 10/12/13 - 11:09 | KF.
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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)229**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13**	**30.29**	**E:447510.6 N:328408.0**	**2** of **4**
	End: **9.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
										Drillers descriptions - Very weak red brown weathered MUDSTONE.	(1.00)	
											10.00	
10.00-11.50				100	84	35				Soft to firm red brown and light grey silty CLAY. Recovery includes subangular to subrounded fine to coarse mudstone lithorelicts. (Weathering Grade III) (BRANSCOMBE MUDSTONE FORMATION)	10.20	
										Red brown and light grey MUDSTONE recovered as clayey angular to subrounded fine to coarse gravel of mudstone. (Weathering Grade II) (BRANSCOMBE MUDSTONE FORMATION)	10.25	
11.50-13.00				100	95	68				Medium strong to strong very thinly to thinly bedded light grey fine to medium grained SANDSTONE with occasional very thinly to thinly interbedded mudstone and siltstone. Discontinuities are subhorizontal undulating rough and planar rough very closely to medium spaced (45/140/230) partly open to open with thin clay smearing and occasional thin gypsum coating.	(2.65)	
12.76-12.98	1	CS									12.90	
13.00-14.50				93	83	61				(Weathering Grade I) (BRANSCOMBE MUDSTONE FORMATION) . . . between 10.70m and 11.80m bgl, with frequent thin gypsum veins. . . . at 10.77m bgl, 10mm subhorizontal gypsum vein. . . . at 11.22m bgl, medium strong red brown and light grey mudstone and siltstone. . . . at 11.45m bgl, 10mm subhorizontal gypsum vein. . . . between 11.58m and 11.60m bgl, subhorizontal gypsum vein. . . . at 12.76m bgl, 10mm subhorizontal gypsum vein.		
14.50-16.00				100	91	13				Weak to very strong thickly interlaminated to very thinly interbedded MUDSTONE and siltstone with frequent thin gypsum veins and with rare reduction spots. Discontinuities are subhorizontal undulating rough and planar rough extremely closely to medium spaced (18/120/270) tight to open with thin clay smearing, occasional thin gypsum coating and occasional black speckling. . . . between 13.34m and 13.44m bgl, 11mm subhorizontal gypsum vein. . . . at 13.50m bgl, 16mm subhorizontal gypsum vein. . . . at 15.65m bgl, clayey gravel. . . . between 16.00m and 16.54m bgl, zone of core loss. . . . at 16.90m bgl, 10mm subhorizontal gypsum vein.		
16.00-17.50				64	58	41						
17.33-17.50	2	CS										
17.50-19.00				93	83	49						

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)229**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13**	**30.29**	**E:447510.6 N:328408.0**	**3** of **4**
	End: **9.10.13**			

Depth (m)	Samples & Testing: No	Type	Results	Mechanical Log: TCR (%)	SCR (%)	RQD (%)	If (mm)	Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
				93	83	49			2	. . . between 16.92m and 16.94m bgl, clayey gravel. . . . between 16.94m and 16.95m bgl, subhorizontal gypsum vein. . . . between 17.50m and 17.60m bgl, zone of core loss.	(12.10)	
19.00-20.50				87	68	0				. . . between 17.60m and 18.30m bgl, with rare medium to coarse gravel sized gypsum nodules. Weak to very strong thickly interlaminated to very thinly interbedded MUDSTONE and siltstone with frequent thin gypsum veins and with rare reduction spots. Discontinuities are subhorizontal undulating rough and planar rough extremely closely to medium spaced (18/120/270) tight to open with thin clay smearing, occasional thin gypsum coating and occasional black speckling. *(stratum copied from 12.90m from previous sheet)* . . . at 18.57m bgl, upto 12mm subhorizontal gypsum vein.		
20.50-22.00				100	83	51				. . . between 18.74m and 18.77m bgl, subhorizontal gypsum vein. . . . between 19.00m and 19.20m bgl, zone of core loss.		
21.60-21.80	3	CS								. . . at 19.22m bgl, 10mm subhorizontal gypsum vein.		
22.00-23.50				97	94	69				. . . at 19.72m bgl, 13mm subhorizontal gypsum vein. . . . at 20.16m bgl, 10mm subhorizontal gypsum vein. . . . at 20.31m bgl, 10mm subhorizontal gypsum vein. . . . at 20.33m bgl, 15mm subhorizontal gypsum vein. . . . between 21.10m bgl and 22.70m bgl, with occasional medium to coarse gravel sized gypsum nodules.		
23.50-25.00				100	70	21				. . . between 21.53m and 21.57m bgl, subhorizontal gypsum vein. . . . between 21.72m and 21.80m bgl, 10mm subvertical gypsum vein. . . . between 22.00m and 22.05m bgl, zone of core loss. . . . between 23.00m and 23.04m bgl, subhorizontal gypsum vein. . . . at 23.24m bgl, 12mm subhorizontal gypsum vein. . . . between 23.60m and 24.30m bgl, with occasional thin gypsum veins. . . . at 24.40m bgl, 10mm subhorizontal gypsum vein. . . . between 24.41m and 24.43m bgl, subhorizontal gypsum vein. . . . between 24.67m and 24.71m bgl, subhorizontal gypsum vein. . . . between 24.90m and 24.96m bgl, subhorizontal gypsum vein.	25.00	
										Rotary probehole terminated at 25.00m depth.		

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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BOREHOLE LOG

Contract:	Client:	Borehole:
East Midlands Gateway	**Roxhill Developments Ltd**	**CP(R)229**

Contract Ref:	Start:	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
312494	**9.10.13**	**30.29**	**E:447510.6 N:328408.0**	**4** of **4**
	End: **9.10.13**			

Depth (m)	Samples & Testing			Mechanical Log				Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
	No	Type	Results	TCR (%)	SCR (%)	RQD (%)	If (mm)					

Boring Progress and Water Observations

Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary open hole + Rotary Cored	**Comacchio MC450-P1**	**SC/JO**	**LAlderman**	DMB

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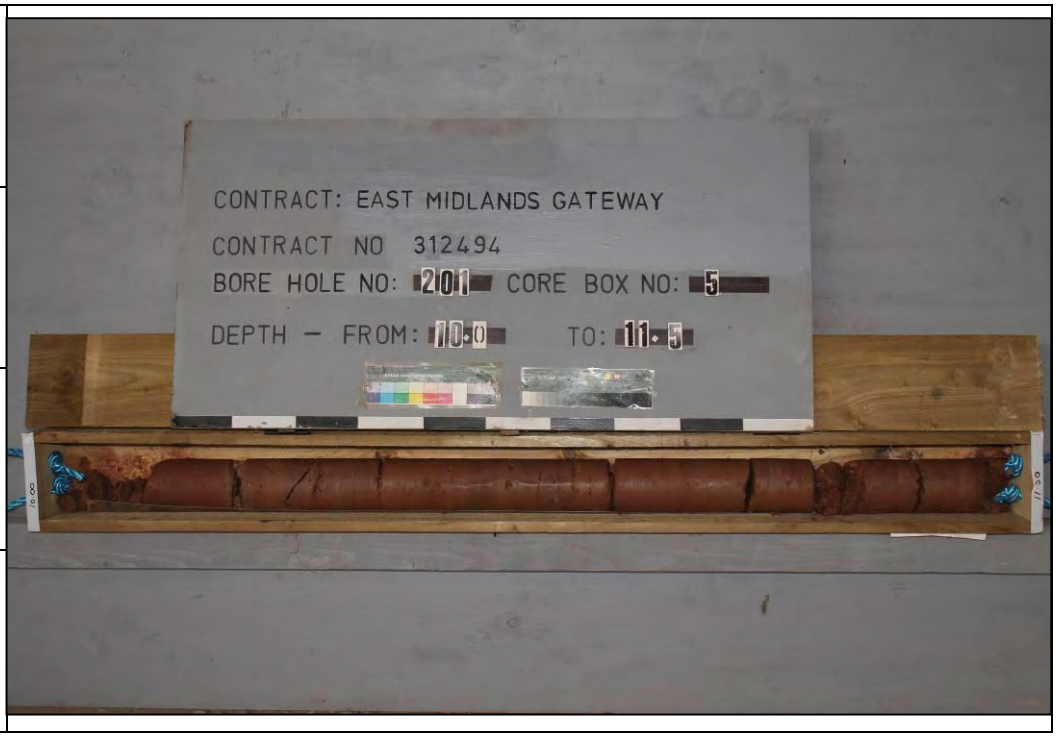
APPENDIX E
ROTARY CORED BOREHOLE PHOTOGRAPHS

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 4.00 – 5.50m	

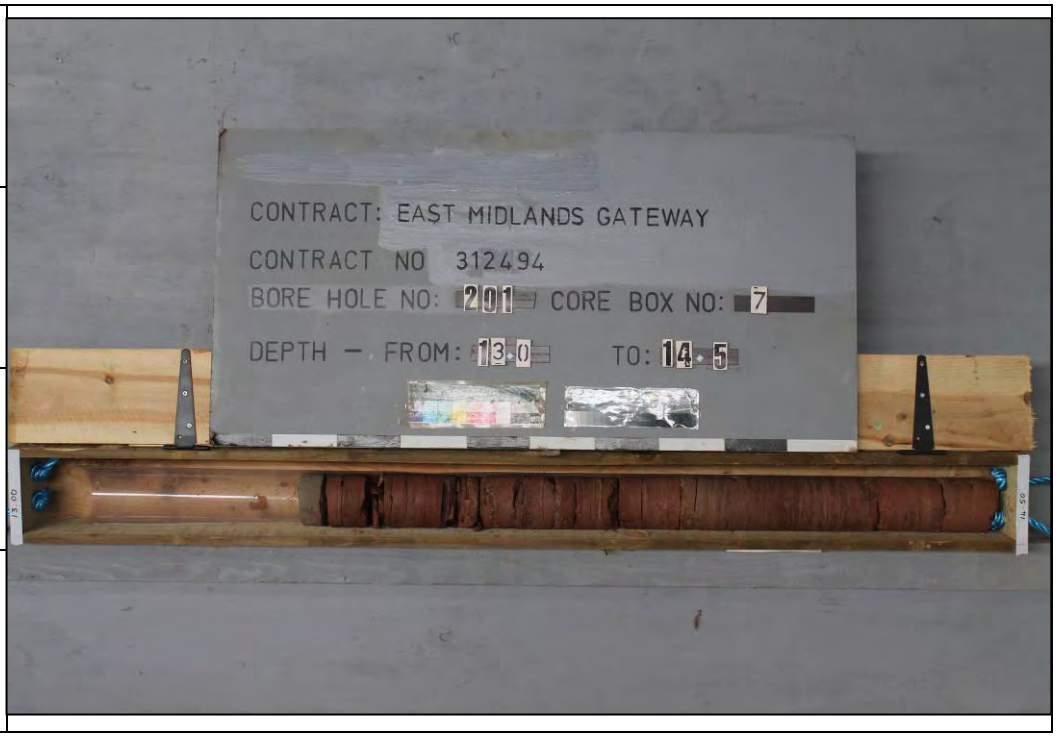
Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 5.50 – 7.00m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 7.00 – 8.50m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 8.50 – 10.00m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 10.00 – 11.50m	

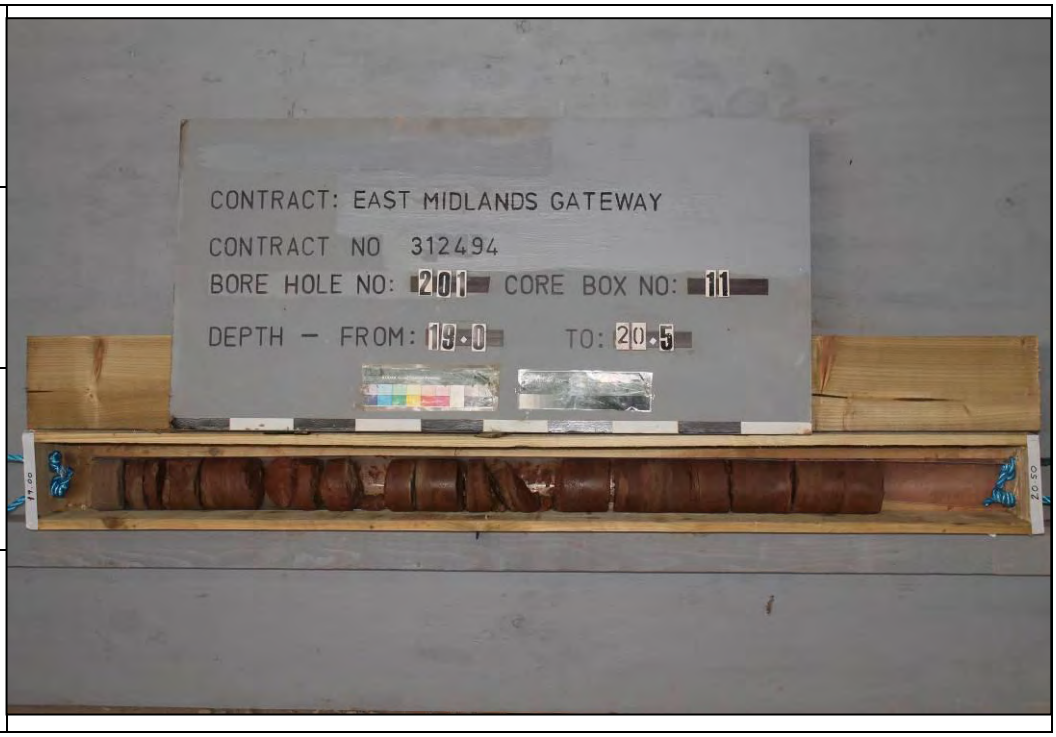
Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 11.50 – 13.00m	

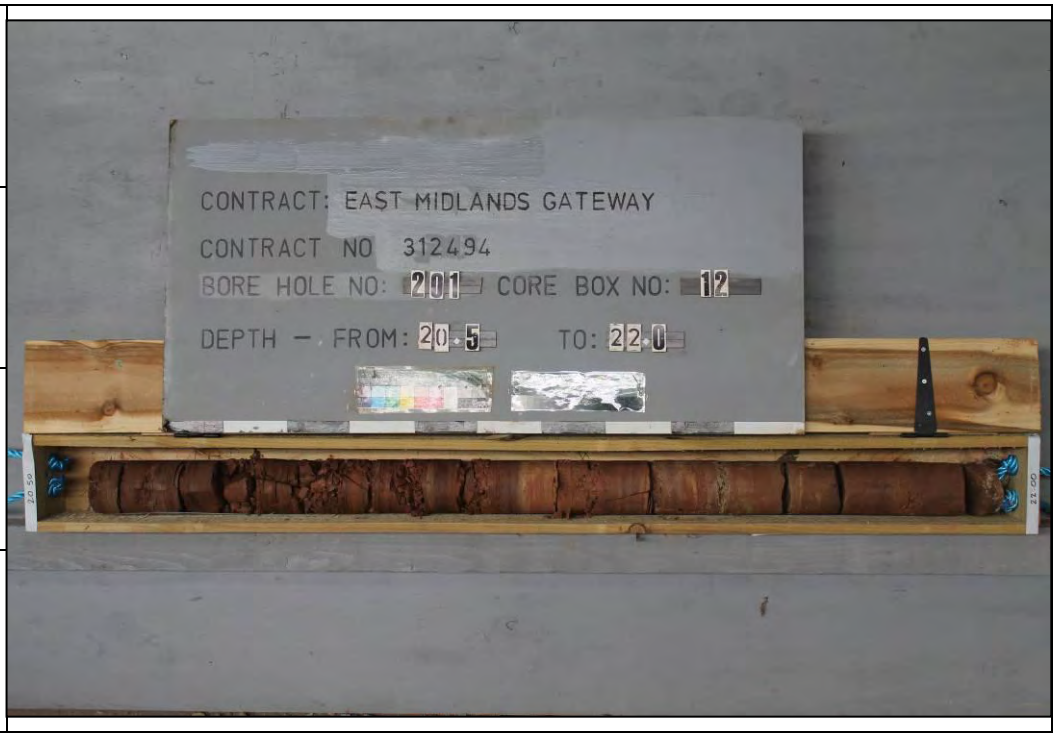
Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 13.00 – 14.50m	

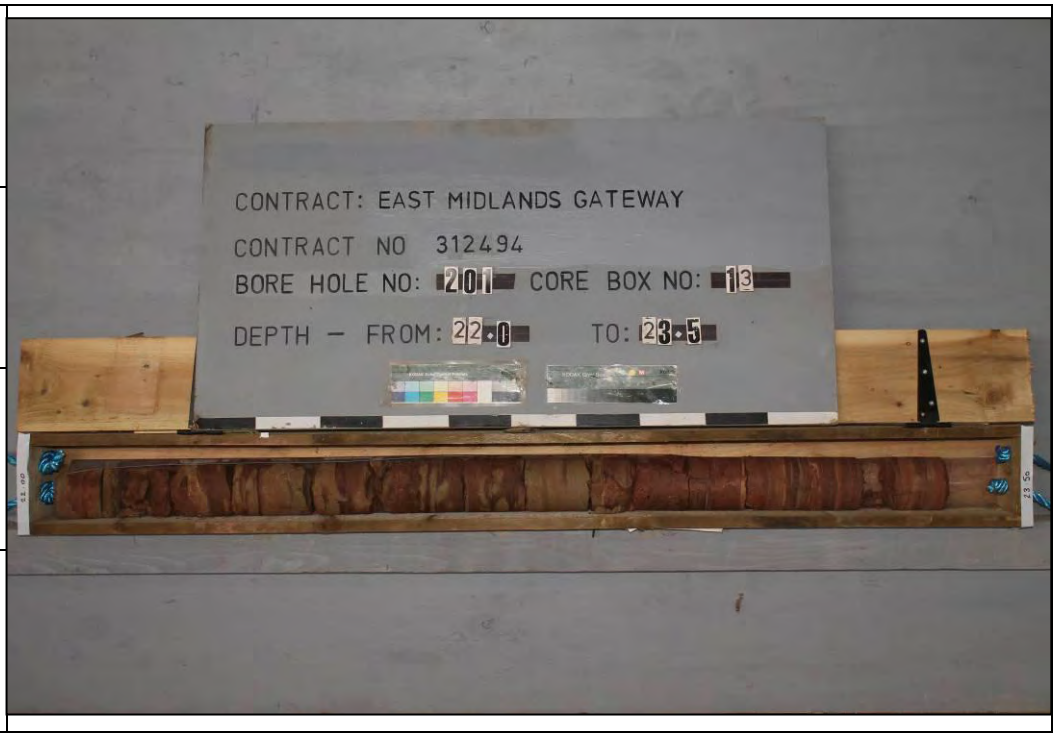
Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 14.50 – 16.00m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 16.00 – 17.50m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 17.50 – 19.00m	

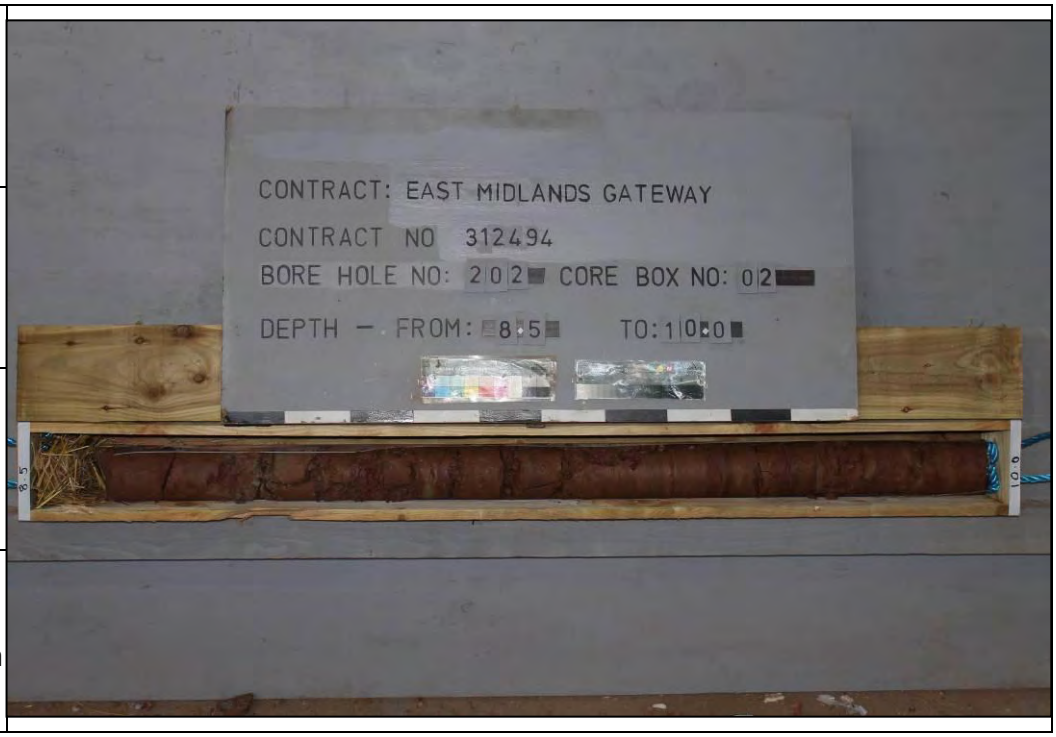
Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 19.00 – 20.50m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 20.50 – 22.00m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 22.00 – 23.50m	

Zone: 3	
Borehole number: CP(R)201	
Date drilled: 02/10/13	
Depth range: 23.50 – 25.00m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 7.00 – 8.50m	

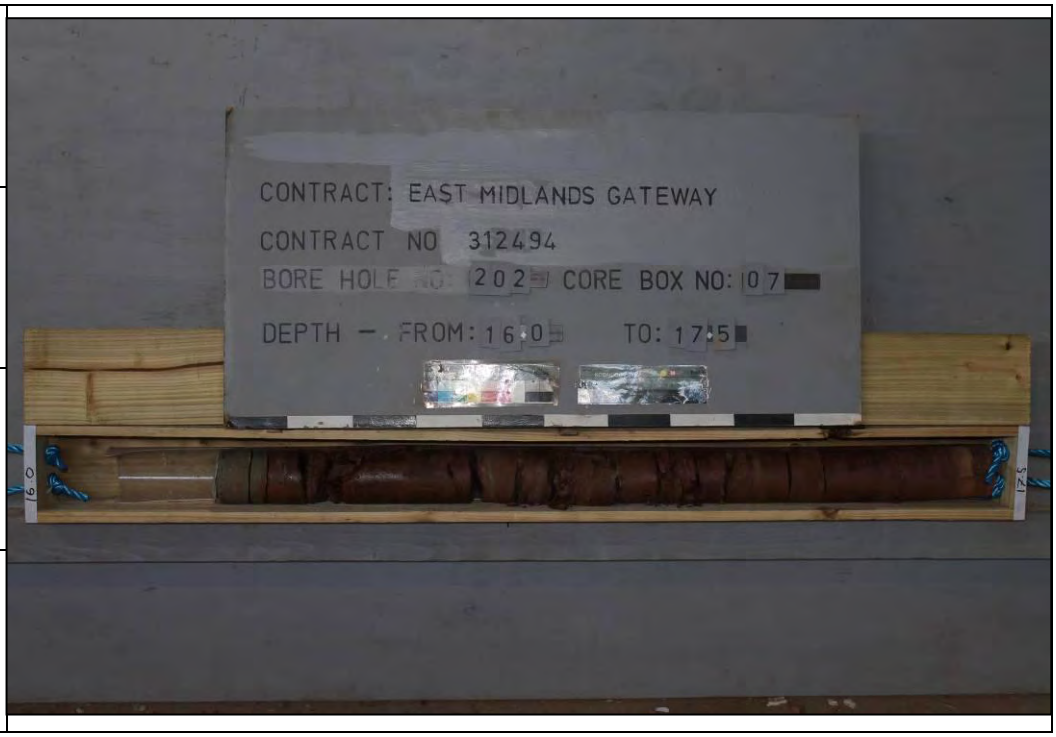
Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 8.50 – 10.00m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 10.00 – 11.50m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 11.50 – 13.00m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 13.00 – 14.50m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 14.50 – 16.00m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 16.00 – 17.50m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 17.50 – 19.00m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 19.00 – 20.50m	

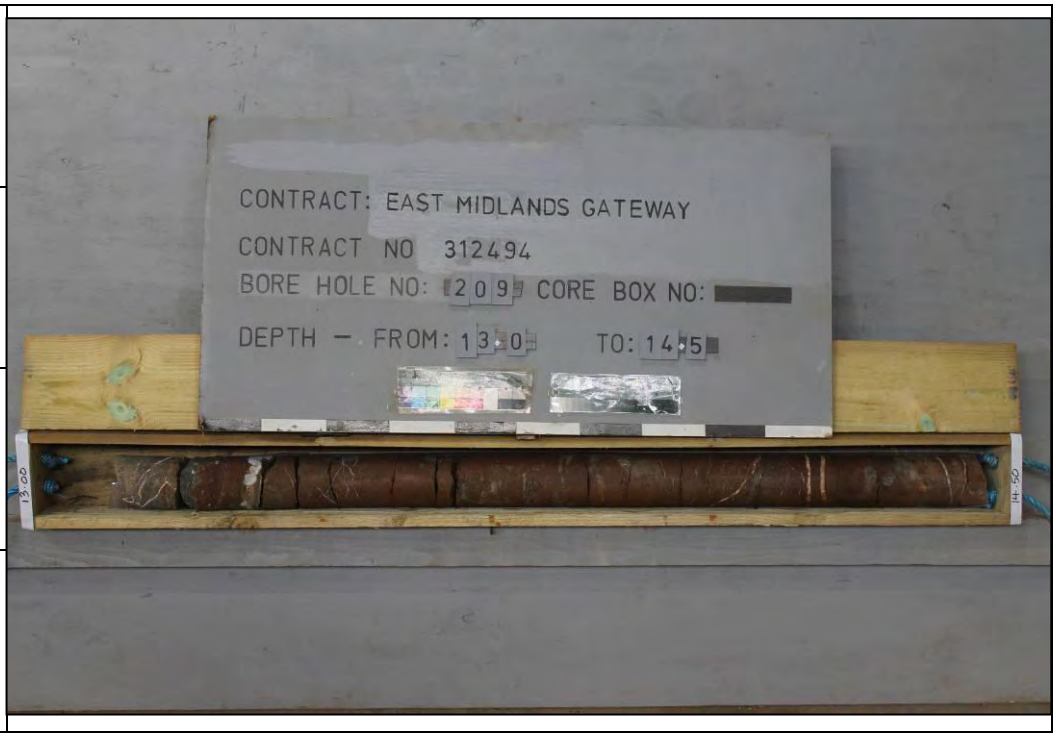
Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 20.50 – 22.00m	

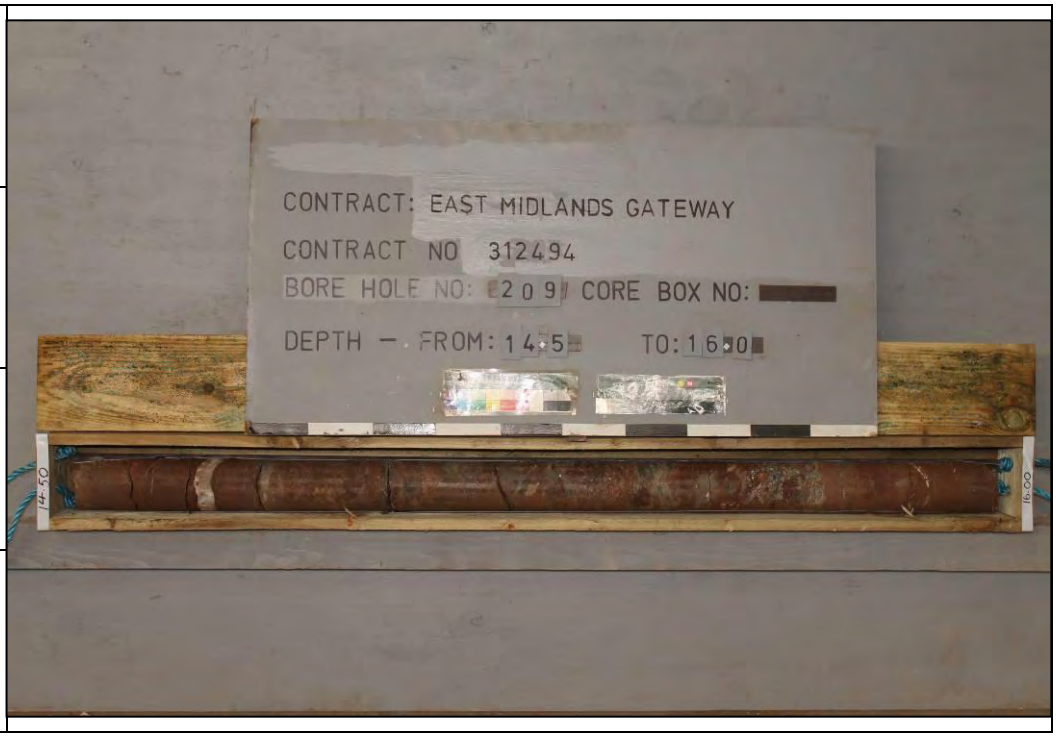
Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 22.00 – 23.50m	

Zone: 3	
Borehole number: CP(R)202	
Date drilled: 01/10/13	
Depth range: 23.50 – 25.00m	

Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 10.00 – 11.50m	

Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 11.50 – 13.00m	

Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 13.00 – 14.50m	

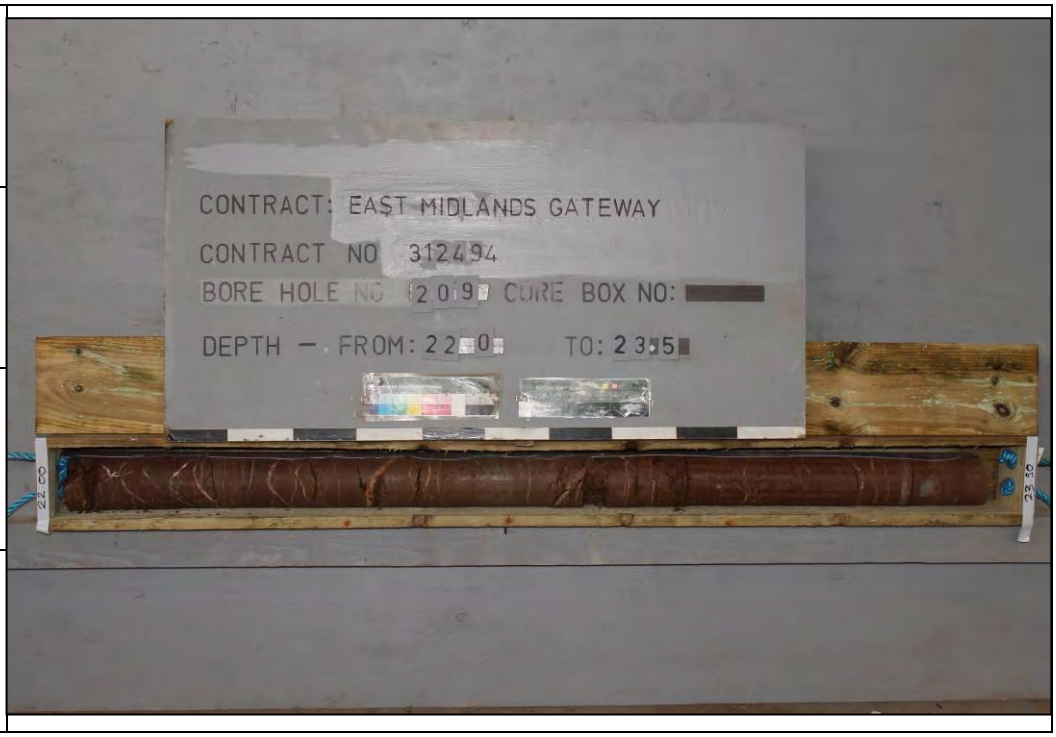
Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 14.50 – 16.00m	

Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 16.00 – 17.50m	

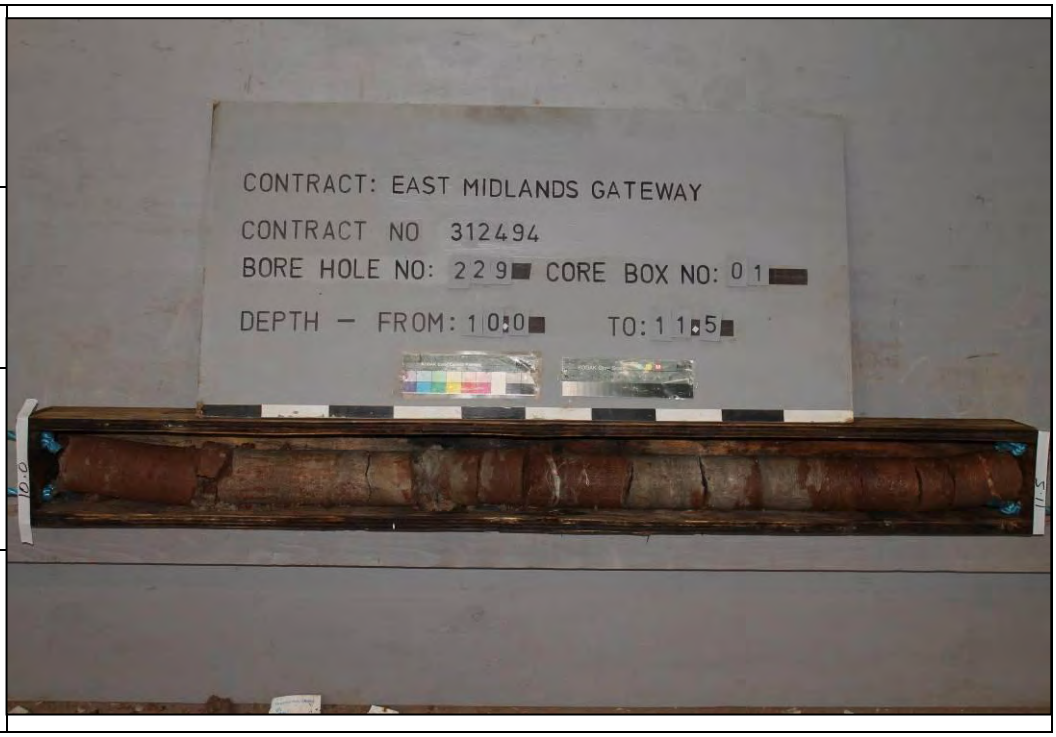
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Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 17.50 – 19.00m	

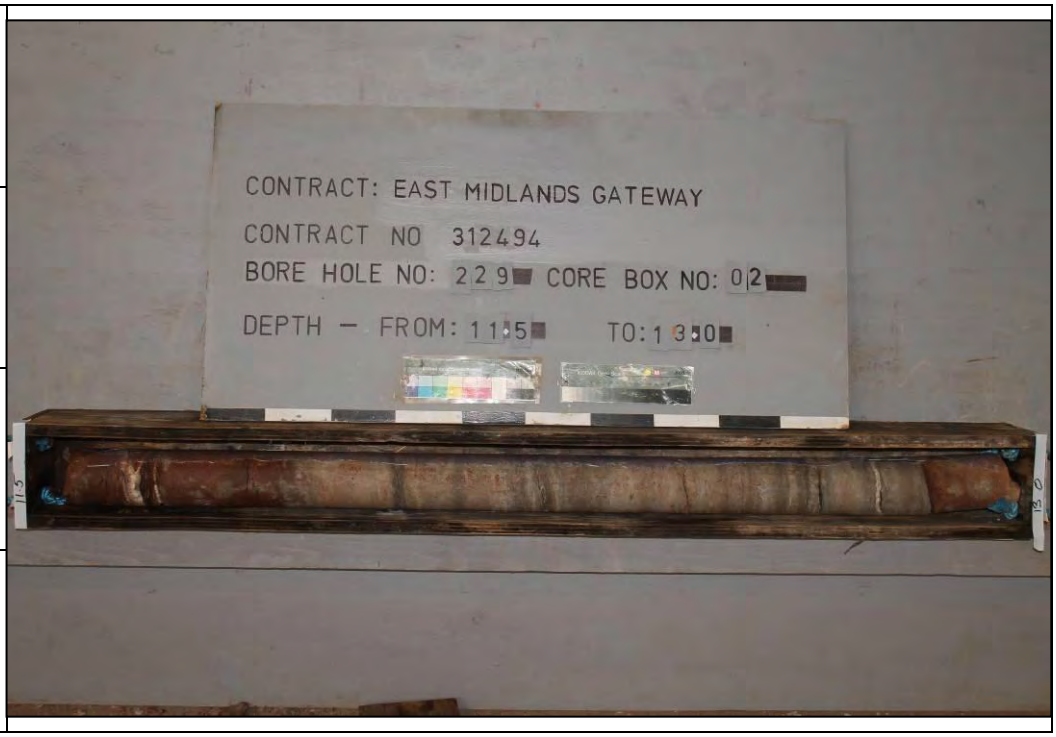
Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 19.00 – 20.50m	

Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 20.50 – 22.00m	

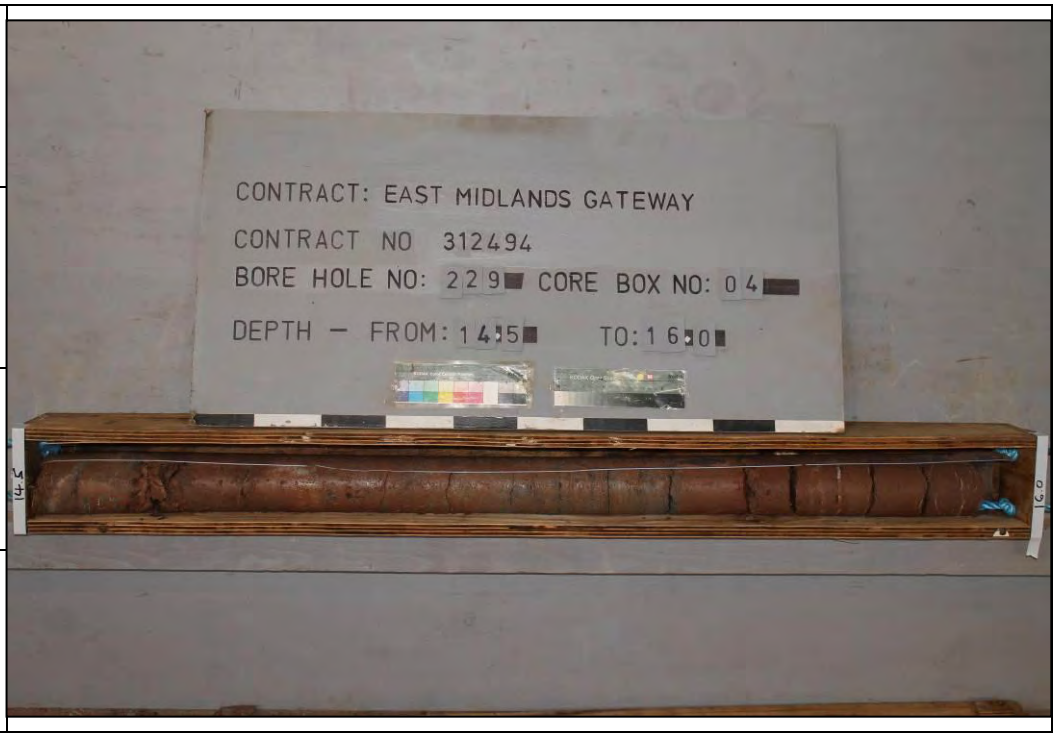
Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 22.00 – 23.50m	

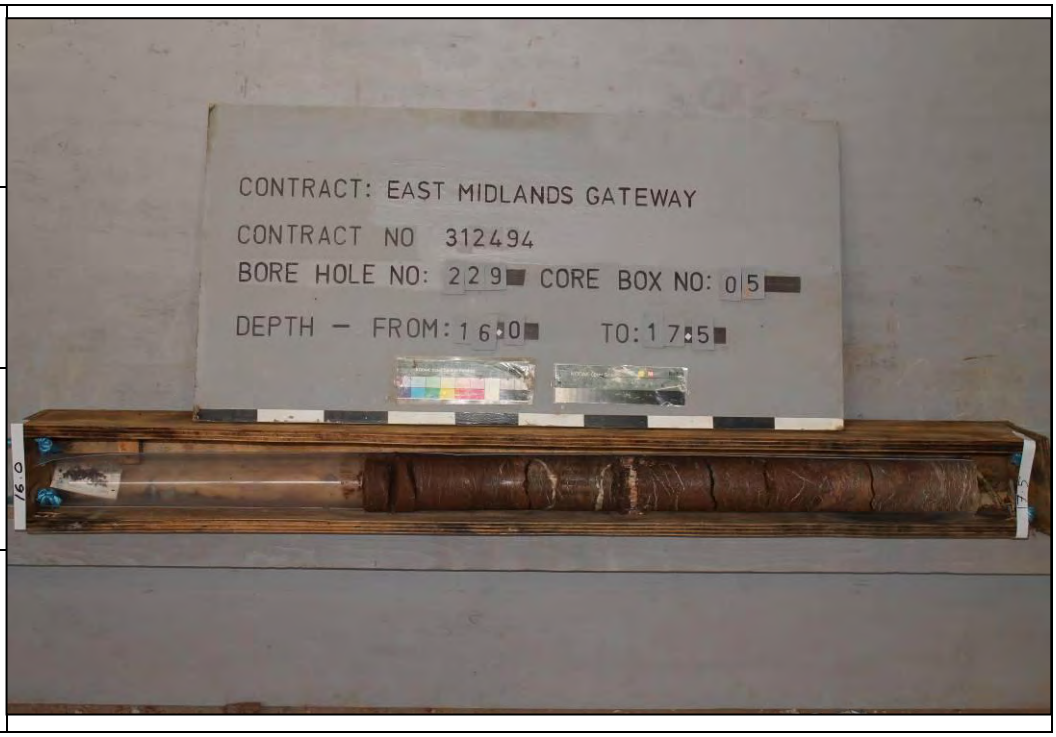
Zone: 3	
Borehole number: CP(R)209	
Date drilled: 08/10/13	
Depth range: 23.50 – 25.00m	

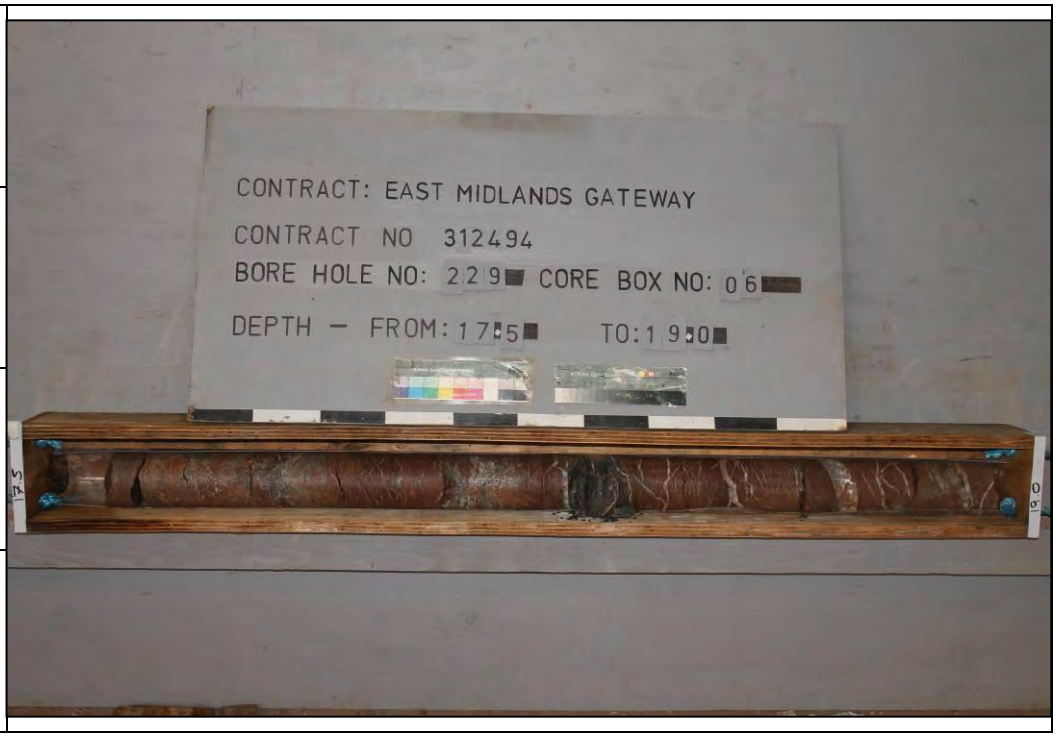
Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 10.00 – 11.50m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 11.50 – 13.00m	

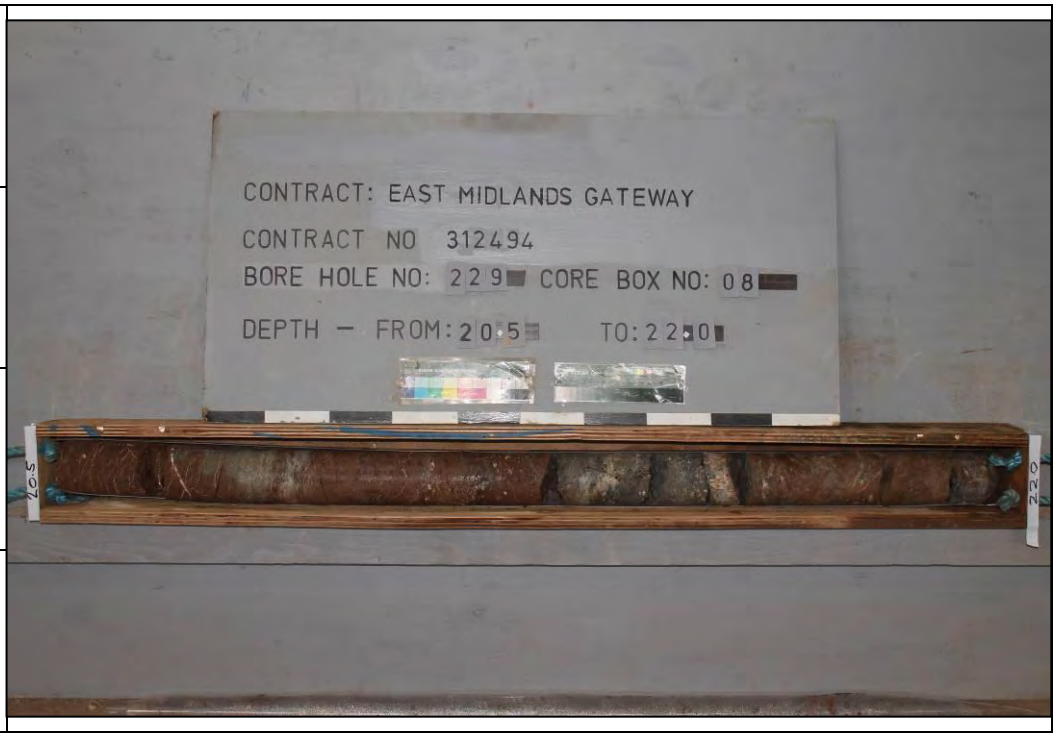
Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 13.00 – 14.50m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 14.50 – 16.00m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 16.00 – 17.50m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 17.50 – 19.00m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 19.00 – 20.50m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 20.50 – 22.00m	

Zone: 3	
Borehole number: CP(R)229	
Date drilled: 09/10/13	
Depth range: 22.00 – 25.00m	

APPENDIX F
IN-SITU SOAKAWAY TEST RESULTS

STRUCTURAL SOILS LTD

INSITU TESTING REPORT

Report No. 744139R.01(04)

Date	27-November-2013	Contract	Field Farm, Lockington (Zone 3)

Client RSK Environment Ltd
Address Abbey Park
Humber Road
Coventry
CV3 4AQ

For the Attention of Gareth Shaw

Order received	18-September-2013	Client Reference	None
Testing Started	01-October-2013	Client Order No.	P0235653
Testing Completed	11-October-2013	Instruction Type	Written

Test(s) undertaken (Not UKAS Accredited)

1no. Insitu soakaway tests carried out at locations specified by client.

Testing undertaken in the Laboratory

Environmental conditions (if relevant)

The results represent the ground conditions at the specified locations and depths at the time of testing.

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of .
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

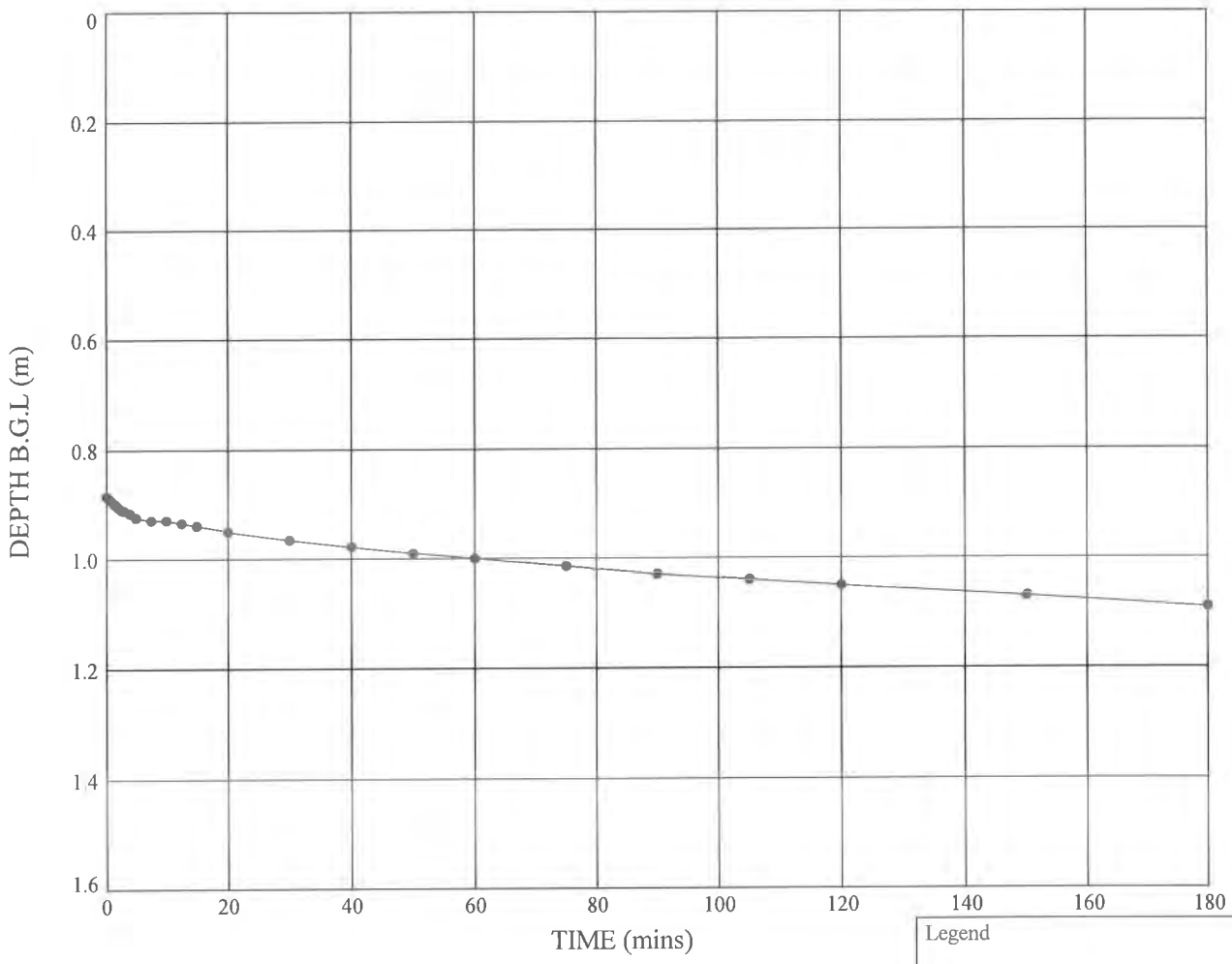
Structural Soils Ltd 1a Princess Street Bedminster Bristol BS3 4AG Tel.0117 9471000 Fax.0117 9471004 e-mail david.trowbridge@soils.co.uk

FULL SCALE SOAKAWAY TEST

Non standard test

Soakaway Test - Position ID : **TP342**

PLOT OF DEPTH OF WATER BELOW GROUND LEVEL AGAINST TIME



Test 1

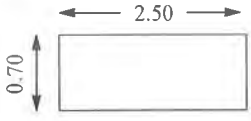
Legend

● Test 1 (11.10.13)

Pit start depth:	=	**1.60**	m
Pit final depth:	=	**1.58**	m
Effective depth, De	=	**0.70**	m
Effective storage volume, V_{p75-25}	=	**0.6081**	m^3
Surface area, a_{p50}	=	**3.9740**	m^2
Time, t_{p75-25}	=	**31274**	secs
Infiltration rate, f	=	**4.89×10^{-6}**	m/s

Notes: Plot was extrapolated to calculate infiltration rate.

Plan (Not to scale)



No Bearing Taken

Approved Signatories: D. TROWBRIDGE A. FROST F. HAMILTON M. STOKES

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By	Date	Checked By	Date
M. Stokes	21/10/13	S. Frost	21/10/13

Contract:	Contract Ref:
Field Farm, Lockington	**744139**

GINT LIBRARY V8_05 GLB LibVersion: v8_05 - Lib0003 PrjVersion: v8_05 - Core+In Situ Testing - 0002 | Graph 1 - TP SOAKAWAYS - 2 - FINAL REPORT | 744139.GPJ - v8_05 | 21/10/13 - 14:14 | MS

APPENDIX G
GEOTECHNICAL LABORATORY TESTING RESULTS

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/05397
Issue Number: 2b **Date:** 20 November, 2013

Client:
Structural Soils Castleford Lab
The Potteries
Pottery Street
Castleford
West Yorkshire
UK
WF10 1NJ

Project Manager: Mark Athorne
Project Name: East Midlands Gateway - Zone 1
Project Ref: 781044
Order No: Not specified
Date Samples Received: 12/11/13
Date Instructions Received: 13/11/13
Date Analysis Completed: 20/11/13

Prepared by:
Melanie Marshall
Laboratory Coordinator

Approved by:
Liz Oliver
Client Service Manager

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME
UKAS TESTING 1247

Envirolab Job Number: 13/05397

Client Project Name: East Midlands Gateway - Zone 1

Client Project Ref: 781044

Lab Sample ID	13/05397/7	13/05397/8	13/05397/9	13/05397/10	13/05397/11	13/05397/12			Units	Method ref
Client Sample No										
Client Sample ID	CP(R)201	CP(R)202	CP(R)202	CP(R)209	CP(R)209	CP(R)229				
Depth to Top	10.86	13.95	21.82	10.27	24.30	17.33				
Depth To Bottom	11.06		22.00	10.49	24.50					
Date Sampled										
Sample Type	Soil	Solid	Solid	Solid	Solid	Soil				
Sample Matrix Code	5	7	7	7	7	5				
% Stones >10mm$_A^{\#}$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			% w/w	A-T-044
pH BRE$_D^{M\#}$	9.11	9.02	9.19	8.82	8.82	8.59			pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	<10	21	<10	1450	2070	1720			mg/l	A-T-026s
Sulphate BRE (acid sol)$_D^{M\#}$	<0.02	0.05	<0.02	13.9	9.34	8.43			% w/w	A-T-028
Sulphur BRE (total)$_D$	<0.01	0.02	<0.01	4.59	3.23	3.23			% w/w	A-T-024

REPORT NOTES

Notes - Soil chemical analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
All analysis is performed on the sample as received for soil samples from outside the European Union and this supercedes any "D" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if present as discrete fibres/fragments. Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified a being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

MATtest Limited
materials testing & consultancy

Edinburgh Road
Springhill
Shotts
ML7 5DT

Tel: 01501 822 244
Fax 01501 825 044

email: info@mattest.org
Website: www.mattest.org

LABORATORY TEST CERTIFICATE
MATERIALS LABORATORY

Certificate No **13/889 - 01A**

To : **Mr Mark Athorne**

Client : **Structural Soils Limited**
The Potteries
Pottery Street
Castleford
WF10 1NJ

Dear Sirs,

LABORATORY TESTING OF ROCK

Introduction

We refer to samples taken from East Midlands Gateway, Zone 3 and delivered to our laboratory on the 18th November 2013.

Material & Source

Sampled By	:	Client
Test Reference	:	See Report Plates
Description	:	N/A
Date Sampled	:	Not Supplied
Date Tested	:	18th November 2013 Onwards
Source	:	East Midlands Gateway - Zone 3

Test Results;

As Detailed On Page 2 to Page 5 inclusive.

Comments;

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks;

Approved for Issue

Date 29/11/2013

C Ferrie
Laboratory Manager

UKAS TESTING
2643

MATtest Limited
materials testing & consultancy

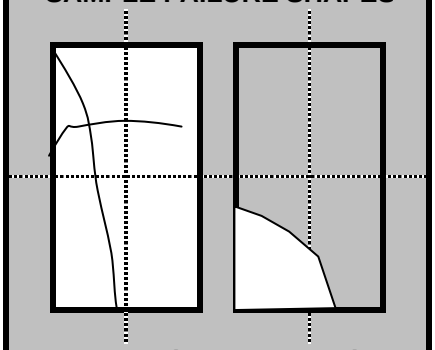
BOREHOLE	SAMPLE	DEPTH (m)	MOISTURE CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
CP(R)201	-	21.70	7.9	2.39	2.22
CP(R)202	-	23.95	8.0	2.32	2.15
CP(R)209	-	10.27	3.0	2.46	2.39
CP(R)209	-	15.30	12.4	2.23	1.98
CP(R)209	-	24.30	10.1	2.38	2.16
CP(R)229	-	12.76	6.8	2.46	2.30
CP(R)229	-	17.33	12.3	2.17	1.93
CP(R)229	-	21.60	6.8	2.29	2.14

Tested in accordance with "ISRM Suggested Methods"

SUMMARY OF MOISTURE CONTENT AND DENSITY TEST RESULTS

BOREHOLE		CP(R)201
CORE RUN		-
DEPTH		21.70
SAMPLE DIAMETER	mm	86.44
SAMPLE HEIGHT	mm	133.40
WATER CONTENT	%	7.9
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.1
TEST DURATION	min.sec	4.17
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		50kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	34.5
UNCONFINED COMPRESSIVE STRENGTH	MPa	5.9

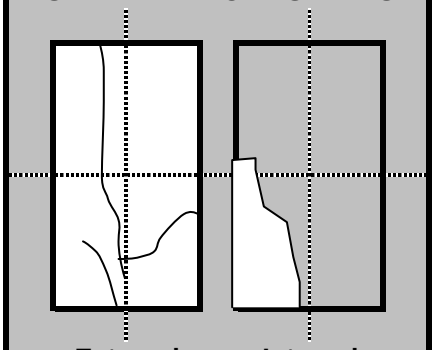
SAMPLE FAILURE SHAPES



Test specimen does not meet specified length / diameter ratio requirements

BOREHOLE		CP(R)202
CORE RUN		-
DEPTH		23.95
SAMPLE DIAMETER	mm	86.97
SAMPLE HEIGHT	mm	144.24
WATER CONTENT	%	8.0
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.1
TEST DURATION	min.sec	4.03
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		50kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	21.4
UNCONFINED COMPRESSIVE STRENGTH	MPa	3.6

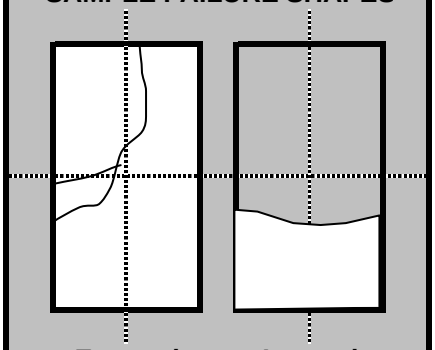
SAMPLE FAILURE SHAPES



Test specimen does not meet specified length / diameter ratio requirements

BOREHOLE		CP(R)209
CORE RUN		-
DEPTH		10.27
SAMPLE DIAMETER	mm	87.03
SAMPLE HEIGHT	mm	176.14
WATER CONTENT	%	3.0
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.3
TEST DURATION	min.sec	6.32
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	112.1
UNCONFINED COMPRESSIVE STRENGTH	MPa	18.8

SAMPLE FAILURE SHAPES

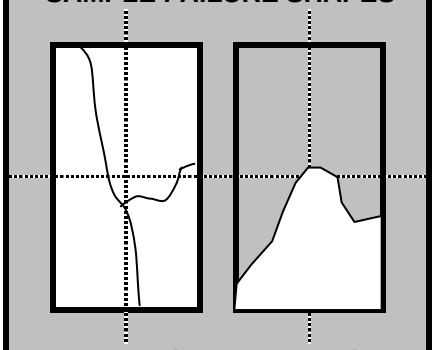


Tested in accordance with ASTM D7012 - 10

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

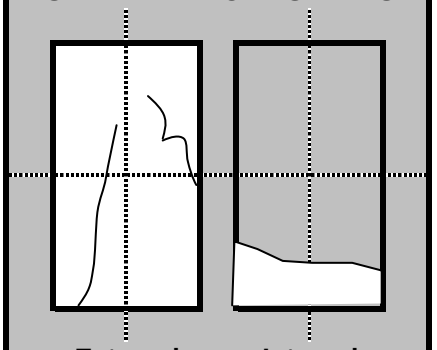
BOREHOLE		CP(R)209
CORE RUN		-
DEPTH		15.30
SAMPLE DIAMETER	mm	86.86
SAMPLE HEIGHT	mm	177.40
WATER CONTENT	%	12.4
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.1
TEST DURATION	min.sec	4.31
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		50kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	23.1
UNCONFINED COMPRESSIVE STRENGTH	MPa	3.9

SAMPLE FAILURE SHAPES



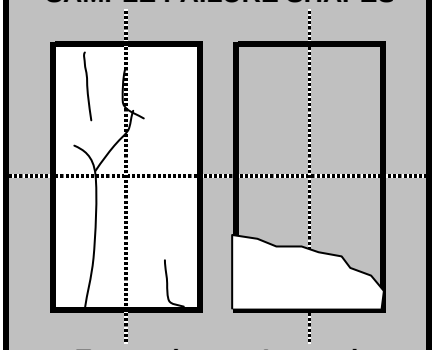
BOREHOLE		CP(R)209
CORE RUN		-
DEPTH		24.30
SAMPLE DIAMETER	mm	86.91
SAMPLE HEIGHT	mm	170.75
WATER CONTENT	%	10.1
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.2
TEST DURATION	min.sec	5.48
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	65.5
UNCONFINED COMPRESSIVE STRENGTH	MPa	11.0

SAMPLE FAILURE SHAPES



BOREHOLE		CP(R)229
CORE RUN		-
DEPTH		12.76
SAMPLE DIAMETER	mm	86.96
SAMPLE HEIGHT	mm	203.37
WATER CONTENT	%	6.8
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.3
TEST DURATION	min.sec	4.03
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	70.1
UNCONFINED COMPRESSIVE STRENGTH	MPa	11.8

SAMPLE FAILURE SHAPES

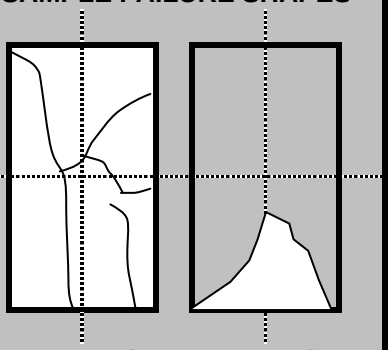


Tested in accordance with ASTM D7012 - 10

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		CP(R)229
CORE RUN		-
DEPTH		17.33
SAMPLE DIAMETER	mm	86.84
SAMPLE HEIGHT	mm	142.00
WATER CONTENT	%	12.3
TEST CONDITION		As received
RATE OF LOADING	kN/s	50kN
TEST DURATION	min.sec	4.02
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		0.10
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	12.6
UNCONFINED COMPRESSIVE STRENGTH	MPa	2.1

SAMPLE FAILURE SHAPES

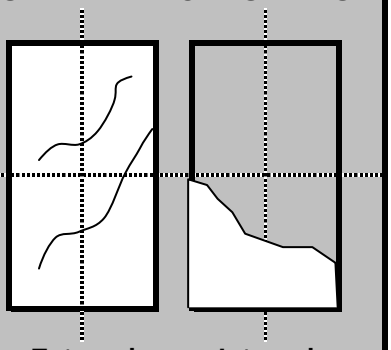


External Internal

Test specimen does not meet specified length / diameter ratio requirements

BOREHOLE		CP(R)229
CORE RUN		-
DEPTH		21.60
SAMPLE DIAMETER	mm	86.86
SAMPLE HEIGHT	mm	161.82
WATER CONTENT	%	6.8
TEST CONDITION		As received
RATE OF LOADING	kN/s	0.2
TEST DURATION	min.sec	6.09
DATE OF TESTING		20-Nov-13
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Perpendicular
FAILURE LOAD	kN	58.1
UNCONFINED COMPRESSIVE STRENGTH	MPa	9.8

SAMPLE FAILURE SHAPES

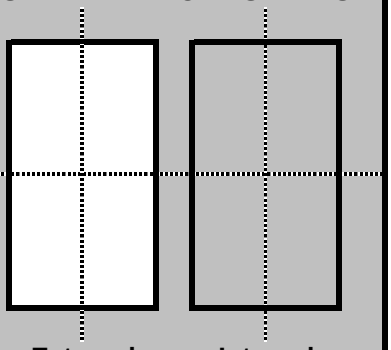


External Internal

Test specimen does not meet specified length / diameter ratio requirements

BOREHOLE		
CORE RUN		
DEPTH		
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
WATER CONTENT	%	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	

SAMPLE FAILURE SHAPES



External Internal

Tested in accordance with ASTM D7012 - 10

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 744186R.03(00) 1774

Date 20-November-2013 Contract East Midlands Gateway - Zone 3

Client RSK Environment
Address Abbey Park
Humber Road
Coventry
CV3 4AQ

For the Attention of Darren Bench

Samples submitted by client	16-October-2013	Client Reference	312494
Testing Started	18-October-2013	Client Order No.	None
Testing Completed	14-November-2013	Instruction Type	Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests

1.01	Moisture Content (oven drying method) BS1377:Part 2:1990:clause 3.2
1.03	Liquid Limit (one point method) & Plastic Limit BS1377:Part 2:1990,clause 4.4/5.3
1.08	Density linear measurement method BS1377:Part 2:1990, clause 7.2
1.10	Particle Size Distribution wet sieve method BS1377:Part 2:1990,clause 9.2
5.04	Undrained shear strength triaxial compression without pore pressure measurement (definitive method) 100mm diameter specimens BS1377:Part 7:1990,clause 8.4
5.05	Undrained shear strength triaxial compression without pore pressure measurement (multistage loading) BS1377:Part 7:1990,clause 9.4

Not UKAS Acredited Tests

1.13	Particle Size Distribution sedimentation hydrometer method BS1377:Part 2: 1990,clause 9.5
4.01	One-dimensional consolidation BS1377:Part 5:1990,clause 3.5
	Hand Vane

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of .
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd 1a Princess Street Bedminster Bristol BS3 4AG Tel.0117 9471000 Fax.0117 9471004 e-mail david.trowbridge@soils.co.uk

TESTING VERIFICATION CERTIFICATE

1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with Structural Soils Ltd Laboratory Quality Assurance Manual, Issue 6, January 2010 all results sheets and summaries of results issued by the laboratory are checked by an approved signatory. This check will also involve checking of at least 10% of calculations for each test type to ensure that data has been correctly entered into the computer and calculated. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Assurance Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **16/11/2013 09:01:43**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory
Justin Barrett (Laboratory Manager)

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Contract: **East Midlands Gateway - Zone 3**

Job No: **744186**

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0002 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | GrfcText L - LAB VERIFICATION REPORT | 744186.GPJ - v8_05 | 16/11/13 - 09:03 | JB.
Structural Soils Ltd, Branch Office - Bristol Lab: 1a Princess Street, Bedminster, Bristol, BS3 4AG. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email: ask@soils.co.uk.

SUMMARY OF MOISTURE CONTENT TESTS

In accordance with clause 3.2 of BS1377:Part 2

Exploratory Position ID	Sample Ref	Depth (m)	Sample Type	Moisture Content (%)
CP201	**7**	**2.20**	**DSPT**	**15**
CP201	**12**	**4.00**	**D**	**16**
CP201	**14**	**4.40**	**D**	**10**
CP202	**3**	**1.20**	**D**	**7.6**
CP202	**11**	**4.00**	**DSPT**	**15**
CP202	**15**	**5.50**	**D**	**12**
CP202	**19**	**6.50**	**D**	**11**
CP209	**5**	**1.20**	**B**	**13**
CP209	**7**	**2.00**	**B**	**7.1**
CP209	**9**	**3.00**	**B**	**21**
CP209	**16**	**6.20**	**DSPT**	**20**
CP226	**6**	**2.20**	**B**	**1.4**
CP226	**10**	**3.90**	**DSPT**	**16**
CP226	**16**	**6.20**	**DSPT**	**17**
CP227	**8**	**3.00**	**B**	**12**
CP227	**13**	**5.00**	**DSPT**	**39**
CP227	**18**	**7.20**	**DSPT**	**25**
CP229	**5**	**1.20**	**B**	**12**
CP229	**7**	**2.00**	**B**	**6.7**
CP229	**9**	**3.10**	**B**	**4.1**
CP229	**17**	**6.30**	**DSPT**	**19**
CP230	**5**	**1.50**	**D**	**14**
CP230	**11**	**4.10**	**DSPT**	**31**
CP230	**17**	**6.20**	**DSPT**	**28**
CP231	**4**	**1.20**	**DSPT**	**29**
CP231	**6**	**2.00**	**B**	**7.7**
CP231	**8**	**3.00**	**B**	**11**
CP231	**10**	**4.00**	**B**	**9.7**

Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

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1a Princess Street
Bedminster
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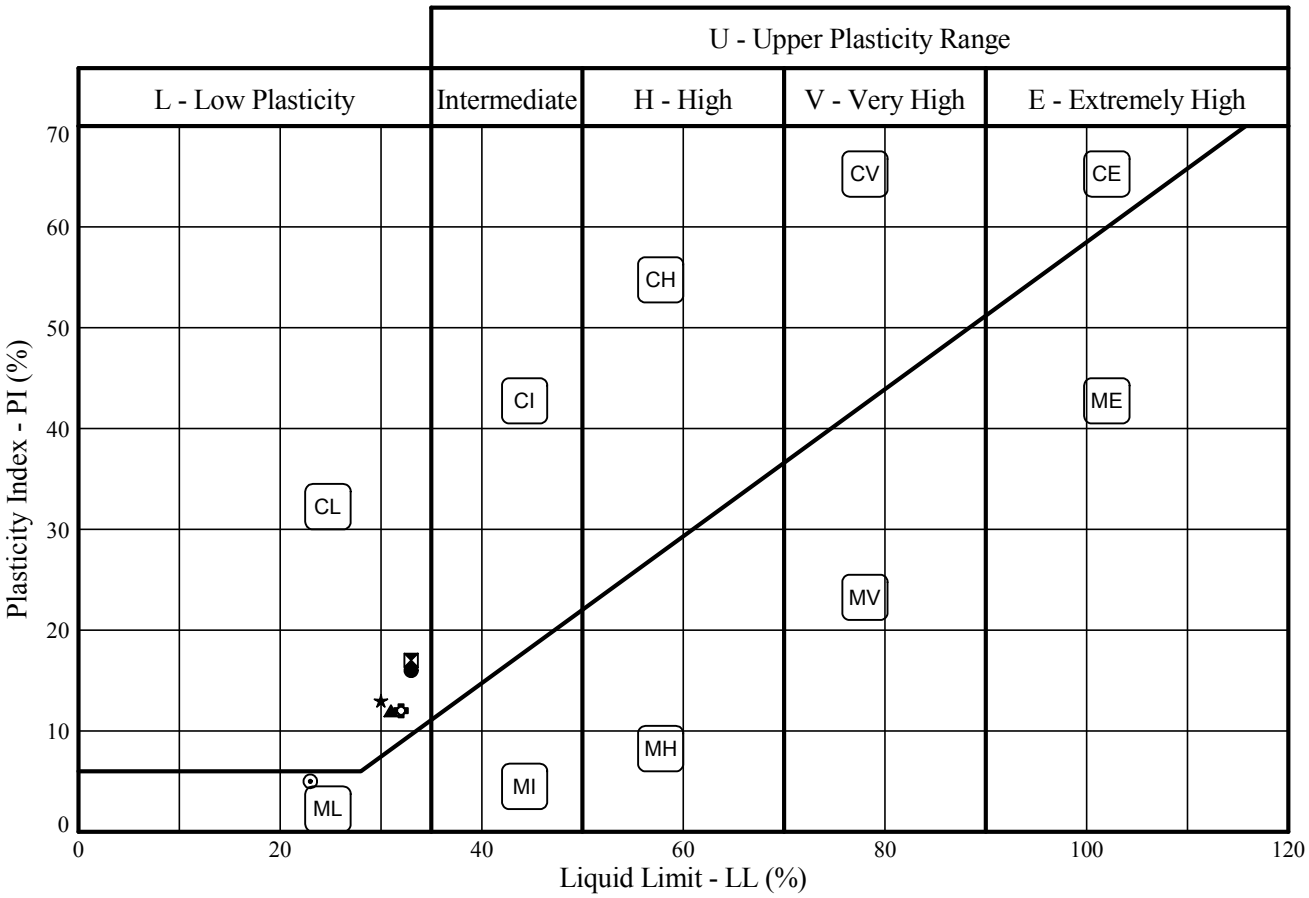
Compiled By		Date
A.D. Frost	**ALAN FROST**	**15/11/13**

Contract:	Contract Ref:
East Midlands Gateway - Zone 3	**744186**

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | GrfcTblL - SUMMARY OF STANDALONE MC - A4P | 744186.GPJ - v8_05 | 15/11/13 - 07:24 | AF.
Structural Soils Ltd, Branch Office - Bristol Lab: 1a Princess Street, Bedminster, Bristol, BS3 4AG. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email: ask@soils.co.uk.

PLASTICITY CHART - PI Vs LL

In accordance with clause 42.3 of BS5930:1999
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %	
	Exploratory Position ID	Sample	Depth (m)								
●	CP201	4U	1.20	3.2/4.4/5.3/5.4	4.2.3	17	33	17	16	84	
⊠	CP201	10U	3.22	3.2/4.4/5.3/5.4	4.2.3	14	33	16	17	84	
▲	CP202	8U	3.35	3.2/4.4/5.3/5.4	4.2.3	21	31	19	12	100	
★	CP202	14U	5.00	3.2/4.4/5.3/5.4	4.2.3	11	30	17	13	65	
⊙	CP209	14DSPT	5.10	3.2/4.4/5.3/5.4	4.2.3	17	23	18	5	97	
✿	TP342	B	0.70	3.2/4.4/5.3/5.4	4.2.4	9.4	32	20	12	18	

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non standard test, NP = Non plastic.

Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

STRUCTURAL SOILS
1a Princess Street
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Compiled By		Date
A.D.Frost	**ALAN FROST**	**15/11/13**

Contract	Contract Ref:
East Midlands Gateway - Zone 3	**744186**

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GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | Graph L - ALINE STANDARD - EC7 | 744186.GPJ - v8_05 | 15/11/13 - 07:25 | AF.
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SUMMARY OF DENSITY TESTS

In accordance with clause 7.2 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Depth (m)	Sample Type	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)
CP202	**14**	**5.00**	**U**	**11**	**2.06**	**1.85**

Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

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Compiled By		Date
A.D. Frost	**ALAN FROST**	**15/11/13**

Contract:	Contract Ref:
East Midlands Gateway - Zone 3	**744186**

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | GrfcTbl L - SUMMARY OF DENSITY - A4P | 744186.GPJ - v8_05 | 15/11/13 - 07:30 | AF.
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SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
CP201	4	U	1.20	17			33	17	16	84	Reddish brown mottled grey slightly gravelly slightly sandy CLAY
CP201	7	DSPT	2.20	15							Reddish brown CLAY
CP201	10	U	3.22	14			33	16	17	84	Brown slightly sandy slightly gravelly CLAY
CP201	12	D	4.00	16							Reddish brown CLAY
CP201	14	D	4.40	10							Brown slightly sandy CLAY
CP202	3	D	1.20	7.6							Brown CLAY
CP202	8	U	3.35	21			31	19	12	100	Reddish brown slightly sandy CLAY
CP202	11	DSPT	4.00	15							Reddish brown mottled greenish grey CLAY

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
CP202	14	U	5.00	11	2.06	1.85	30	17	13	65	Brown slightly sandy slightly gravelly CLAY
CP202	15	D	5.50	12							Reddish brown CLAY
CP202	19	D	6.50	11							Reddish brown mottled greenidh grey slightly gravelly CLAY
CP209	5	B	1.20	13							Orangish brown slightly gravelly slightly sandy CLAY
CP209	7	B	2.00	7.1							Brown slightly silty sandy GRAVEL
CP209	9	B	3.00	21							Brown silty SAND
CP209	14	DSPT	5.10	17			23	18	5	97	Reddish brown mottled grey slightly gravelly SILT
CP209	16	DSPT	6.20	20							Reddish brown slightly sandy CLAY

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
CP226	6	B	2.20	1.4							Brown slightly silty sandy GRAVEL
CP226	10	DSPT	3.90	16							Brown sandy CLAY
CP226	16	DSPT	6.20	17							Reddish brown slightly sandy CLAY
CP227	8	B	3.00	12							Reddish brown silty sandy GRAVEL
CP227	13	DSPT	5.00	39							Reddish brown mottled greenish grey CLAY
CP227	18	DSPT	7.20	25							Reddish brown CLAY
CP229	5	B	1.20	12							Brown slightly gravelly sandy CLAY
CP229	7	B	2.00	6.7							Dark grey slightly silty sandy GRAVEL

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
CP229	9	B	3.10	4.1							Dark grey slightly silty sandy GRAVEL
CP229	17	DSPT	6.30	19							Reddish brown slightly sandy CLAY
CP230	5	D	1.50	14							Reddish brown slightly gravelly slightly sandy CLAY
CP230	11	DSPT	4.10	31							Reddish brown slightly sandy CLAY
CP230	17	DSPT	6.20	28							Reddish brown mottled greenish grey slightly sandy CLAY
CP231	4	DSPT	1.20	29							Dark greenish grey slightly gravelly CLAY
CP231	6	B	2.00	7.7							Dark grey slightly silty sandy GRAVEL
CP231	8	B	3.00	11							Brown silty gravelly SAND

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
CP231	10	B	4.00	9.7							Dark grey silty sandy GRAVEL
TP342		B	0.70	9.4			32	20	12	18	Brown slightly clayey very sandy GRAVEL with high cobble content

STRUCTURAL SOILS LTD

Contract: **East Midlands Gateway - Zone 3**

Contract Ref: **744186**

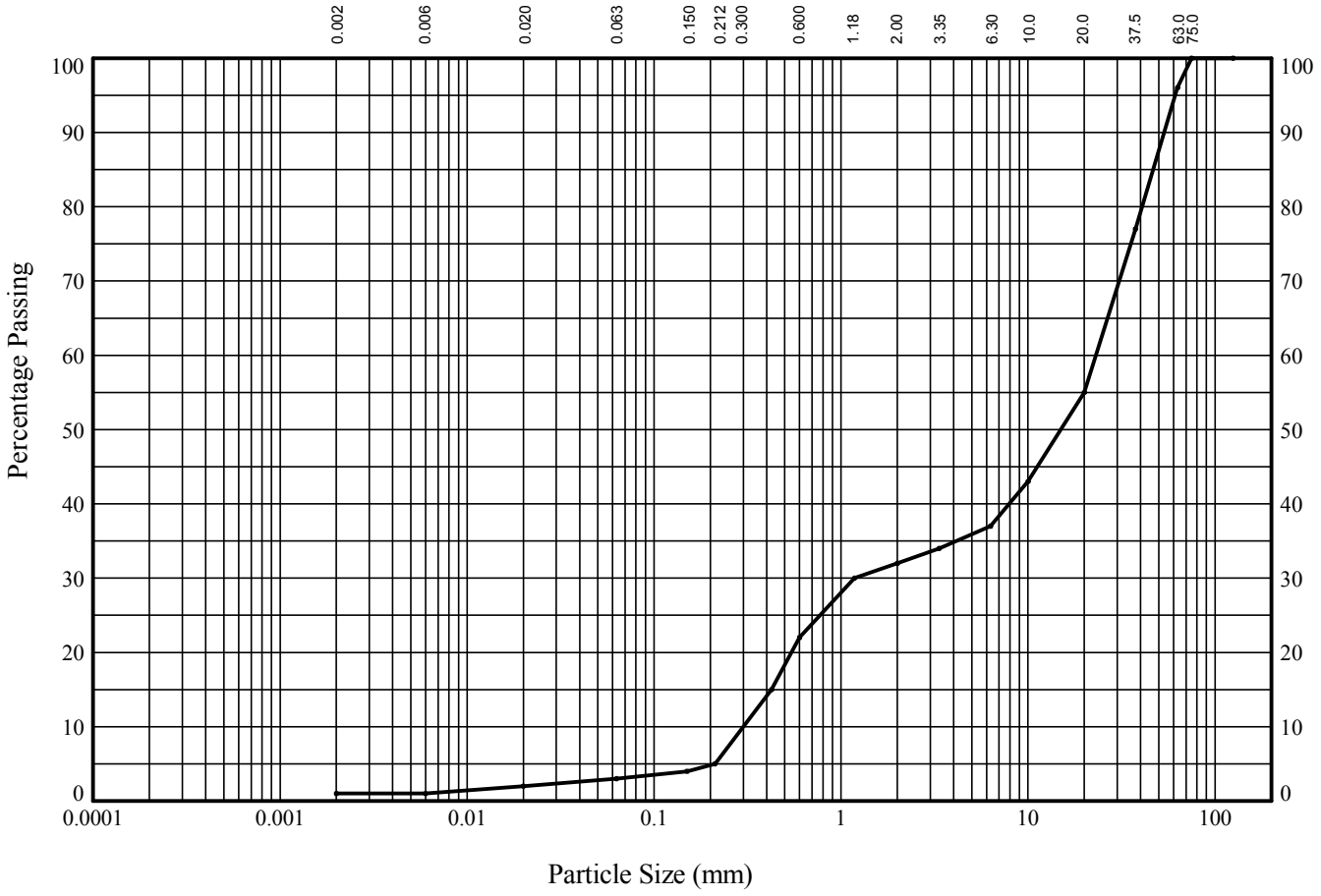
AGS

PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

NON STANDARD TEST

Trial Pit : **TP339** Sample Ref: Sample Type: **B** Depth (m): **2.20**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	96
37.5	77
20.0	55
10.0	43
6.30	37
3.35	34
2.00	32
1.18	30
0.600	22
0.425	15
0.212	5
0.150	4
0.063	3

Particle Diameter	Percentage Passing
0.02	**2**
0.006	**1**
0.002	**1**

Soil Fraction	Sieve Percentage
COBBLES	**4**
GRAVEL	**64**
SAND	**29**
SILT	**2**
CLAY	**1**

Soil Description:

Brown slightly silty very sandy GRAVEL with low cobble content

Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
M. Stokes	**MATT STOKES**	**15/11/13**

Contract: **East Midlands Gateway - Zone 3**

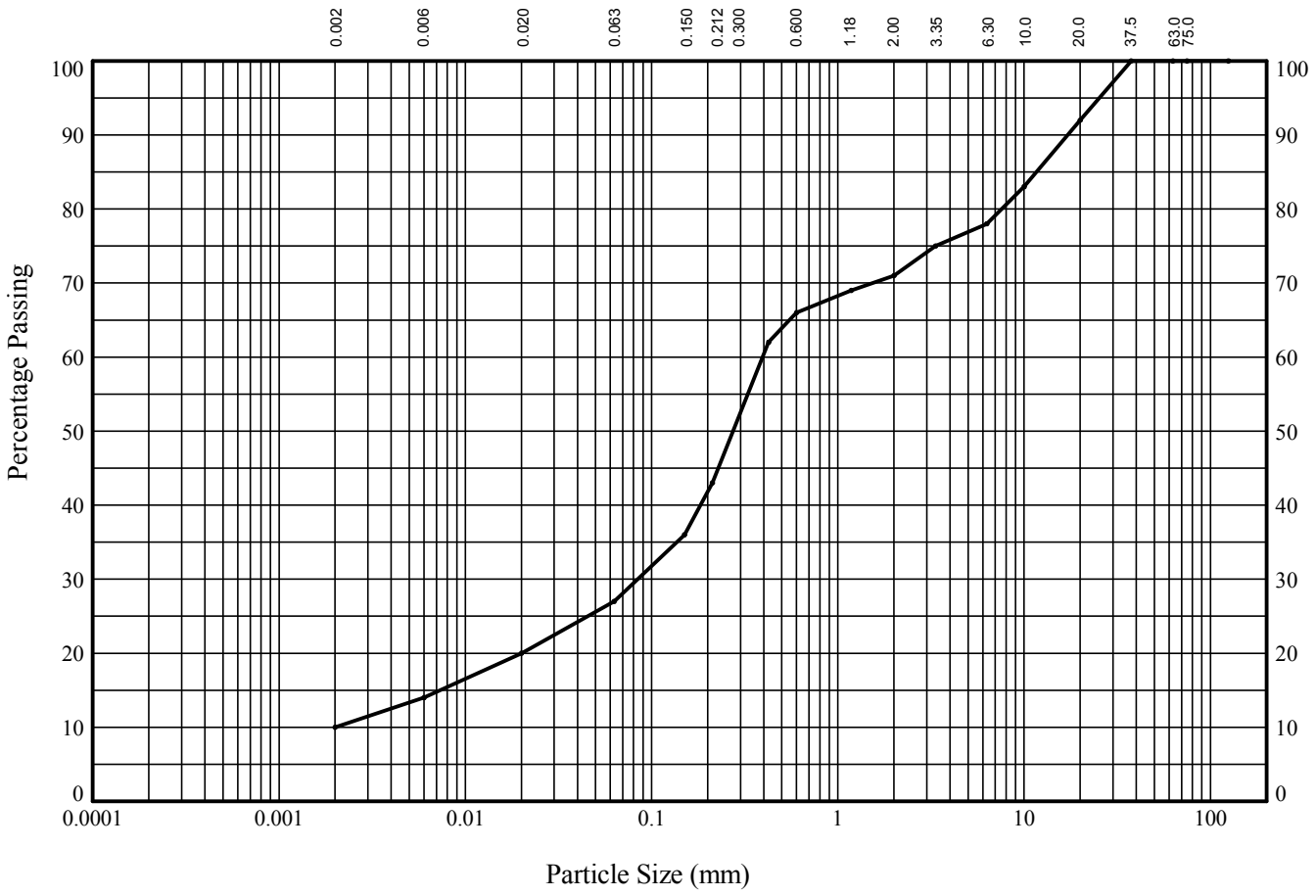
Contract Ref: **744186**

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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Trial Pit : **TP340** Sample Ref: Sample Type: **B** Depth (m): **0.50**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	100
20.0	92
10.0	83
6.30	78
3.35	75
2.00	71
1.18	69
0.600	66
0.425	62
0.212	43
0.150	36
0.063	27

Particle Diameter	Percentage Passing
0.02	**20**
0.006	**14**
0.002	**10**

Soil Fraction	Sieve Percentage
GRAVEL	**29**
SAND	**44**
SILT	**17**
CLAY	**10**

Soil Description:
Brown clayey very gravelly SAND

Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

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1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
M. Stokes	**MATT STOKES**	**15/11/13**

Contract	Contract Ref:
East Midlands Gateway - Zone 3	**744186**

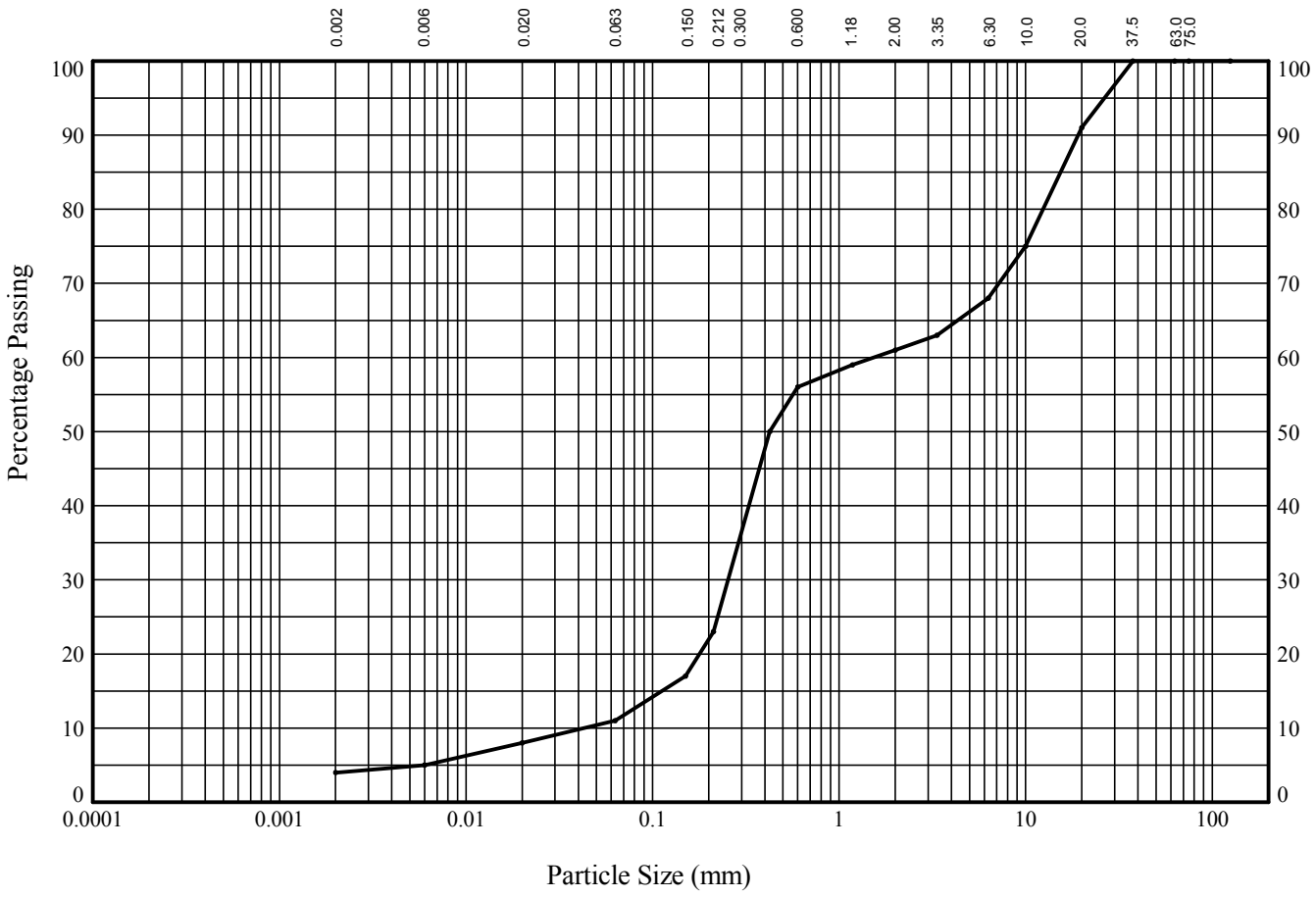
AGS

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | Graph L - PSD - EC7 | 744186.GPJ - v8_05 | 15/11/13 - 07:34 | AF.
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

Trial Pit : **TP341** Sample Ref: Sample Type: **B** Depth (m): **1.40**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	100
63.0	100
37.5	100
20.0	91
10.0	75
6.30	68
3.35	63
2.00	61
1.18	59
0.600	56
0.425	50
0.212	23
0.150	17
0.063	11

Particle Diameter	Percentage Passing
0.02	**8**
0.006	**5**
0.002	**4**

Soil Fraction	Sieve Percentage
GRAVEL	**39**
SAND	**50**
SILT	**7**
CLAY	**4**

Soil Description:
Brown silty very gravelly SAND

Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

STRUCTURAL SOILS
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Bedminster
Bristol
BS3 4AG

Compiled By		Date
M. Stokes	**MATT STOKES**	**15/11/13**

Contract	Contract Ref:
East Midlands Gateway - Zone 3	**744186**

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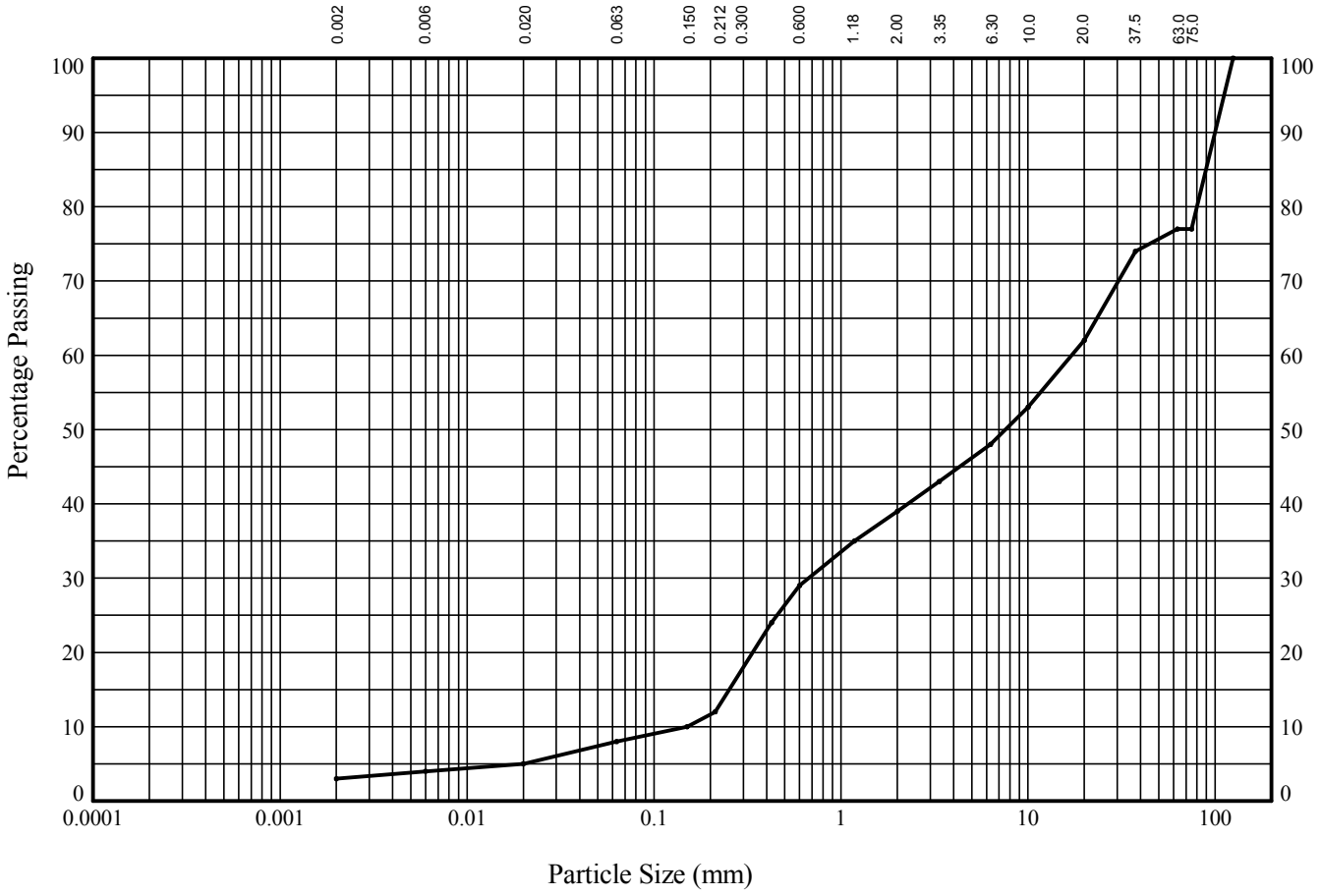
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PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

NON STANDARD TEST

Trial Pit : **TP342** Sample Ref: Sample Type: **B** Depth (m): **0.70**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	77
63.0	77
37.5	74
20.0	62
10.0	53
6.30	48
3.35	43
2.00	39
1.18	35
0.600	29
0.425	24
0.212	12
0.150	10
0.063	8

Particle Diameter	Percentage Passing
0.02	**5**
0.006	**4**
0.002	**3**

Soil Fraction	Sieve Percentage
COBBLES	**23**
GRAVEL	**38**
SAND	**31**
SILT	**5**
CLAY	**3**

Soil Description:
Brown slightly clayey very sandy GRAVEL with high cobble content

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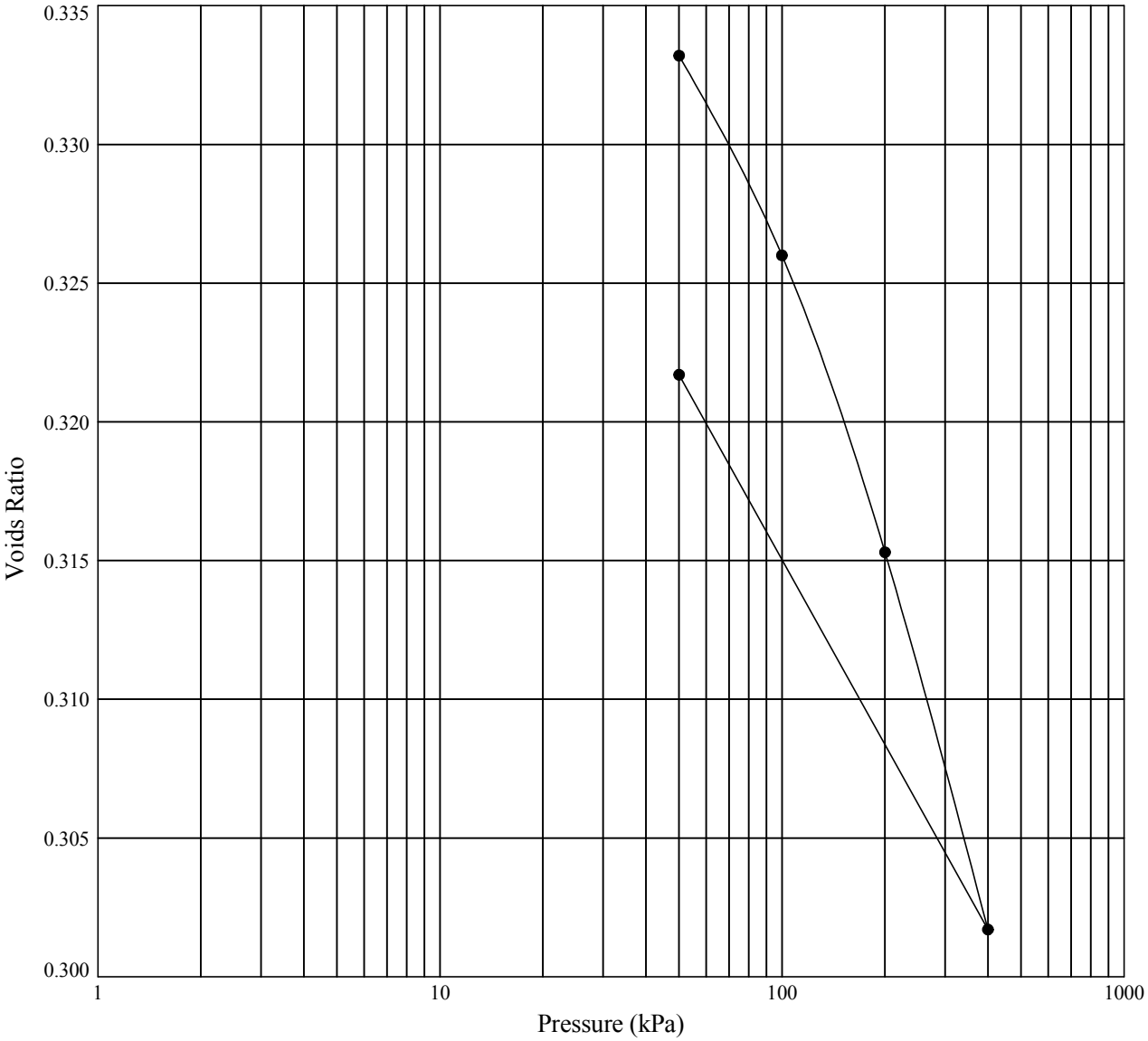
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ONE DIMENSIONAL CONSOLIDATION TEST

In accordance with BS1377:Part 5:1990

Position ID : **CP201** Sample Ref: **10** Sample Type: **U** Depth (m): **3.20**



Initial Specimen Condition			Final Specimen Condition		
Moisture Content (%)	:	**14**	Moisture Content (%)	:	**14**
Bulk Density (Mg/m^3)	:	**2.24**	Bulk Density (Mg/m^3)	:	**2.28**
Dry Density (Mg/m^3)	:	**1.97**	Dry Density (Mg/m^3)	:	**2.00**
Void Ratio	:	**0.3463**	Void Ratio	:	**0.3217**

Specimen Details			
Description	Height (mm)	:	**19.02**
	Diameter (mm)	:	**74.98**
Brown slightly sandy slightly gravelly CLAY	Particle Density (Mg/m^3) (assumed)	:	**2.65**
	Swelling Pressure (kPa)	:	**NA**

Test Results		
Pressure Range (kPa)	Mv (m^2/MN)	Cv (m^2/yr)
0 - 50	**0.19**	**44**
50 - 100	**0.11**	**56**
100 - 200	**0.081**	**8.2**
200 - 400	**0.052**	**15**
400 - 50	**NA**	**NA**

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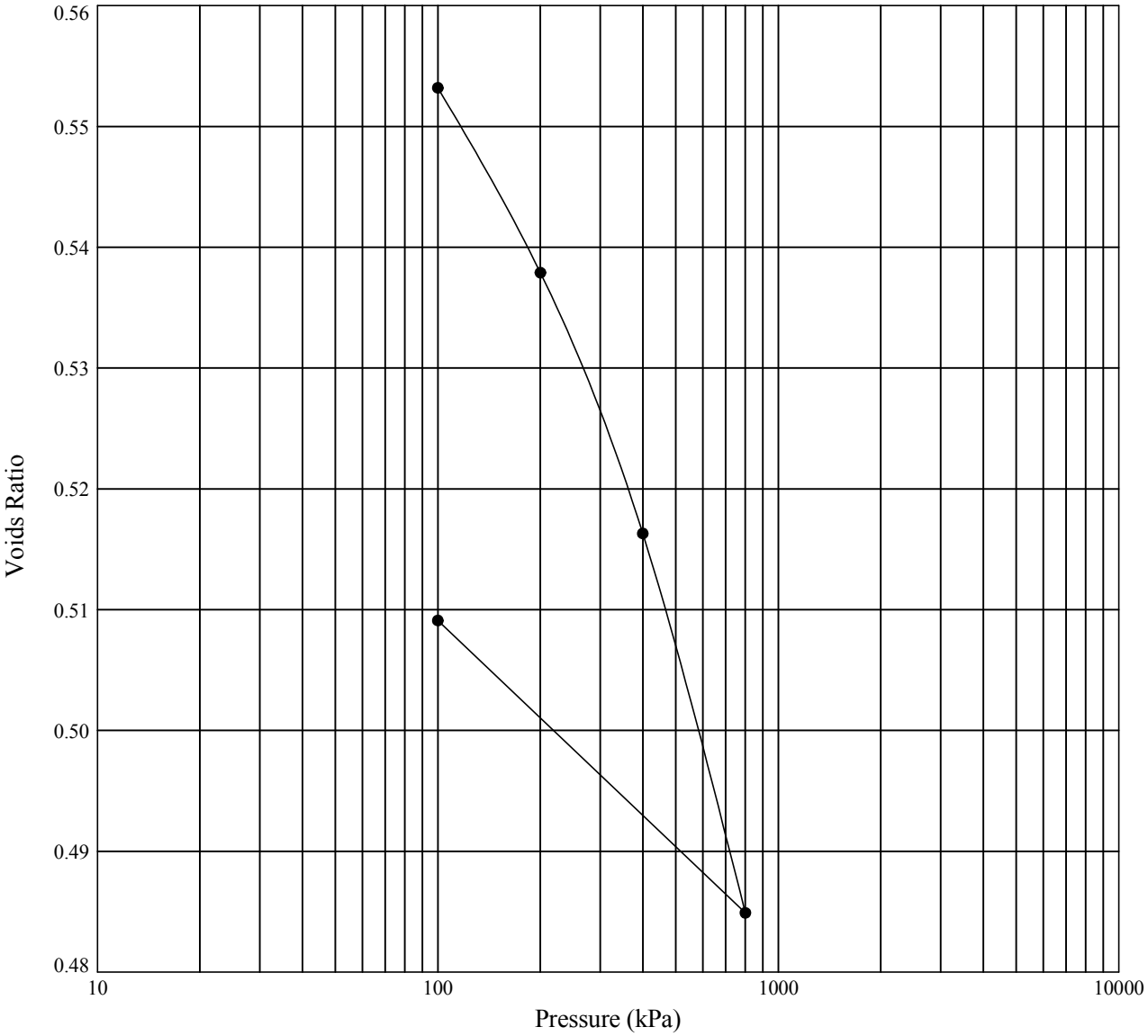
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ONE DIMENSIONAL CONSOLIDATION TEST

In accordance with BS1377:Part 5:1990

Position ID : **CP202** Sample Ref: **8** Sample Type: **U** Depth (m): **3.35**



Initial Specimen Condition			Final Specimen Condition		
Moisture Content (%)	:	**22**	Moisture Content (%)	:	**21**
Bulk Density (Mg/m^3)	:	**2.03**	Bulk Density (Mg/m^3)	:	**2.12**
Dry Density (Mg/m^3)	:	**1.67**	Dry Density (Mg/m^3)	:	**1.76**
Void Ratio	:	**0.5914**	Void Ratio	:	**0.5091**

Specimen Details			
Description	Height (mm)	:	**19.00**
	Diameter (mm)	:	**74.96**
Reddish brown slightly sandy CLAY	Particle Density (Mg/m^3) (assumed)	:	**2.65**
	Swelling Pressure (kPa)	:	**NA**

Test Results		
Pressure Range (kPa)	Mv (m^2/MN)	Cv (m^2/yr)
0 - 100	**0.24**	**65**
100 - 200	**0.099**	**20**
200 - 400	**0.070**	**26**
400 - 800	**0.052**	**24**
800 - 100	**NA**	**NA**

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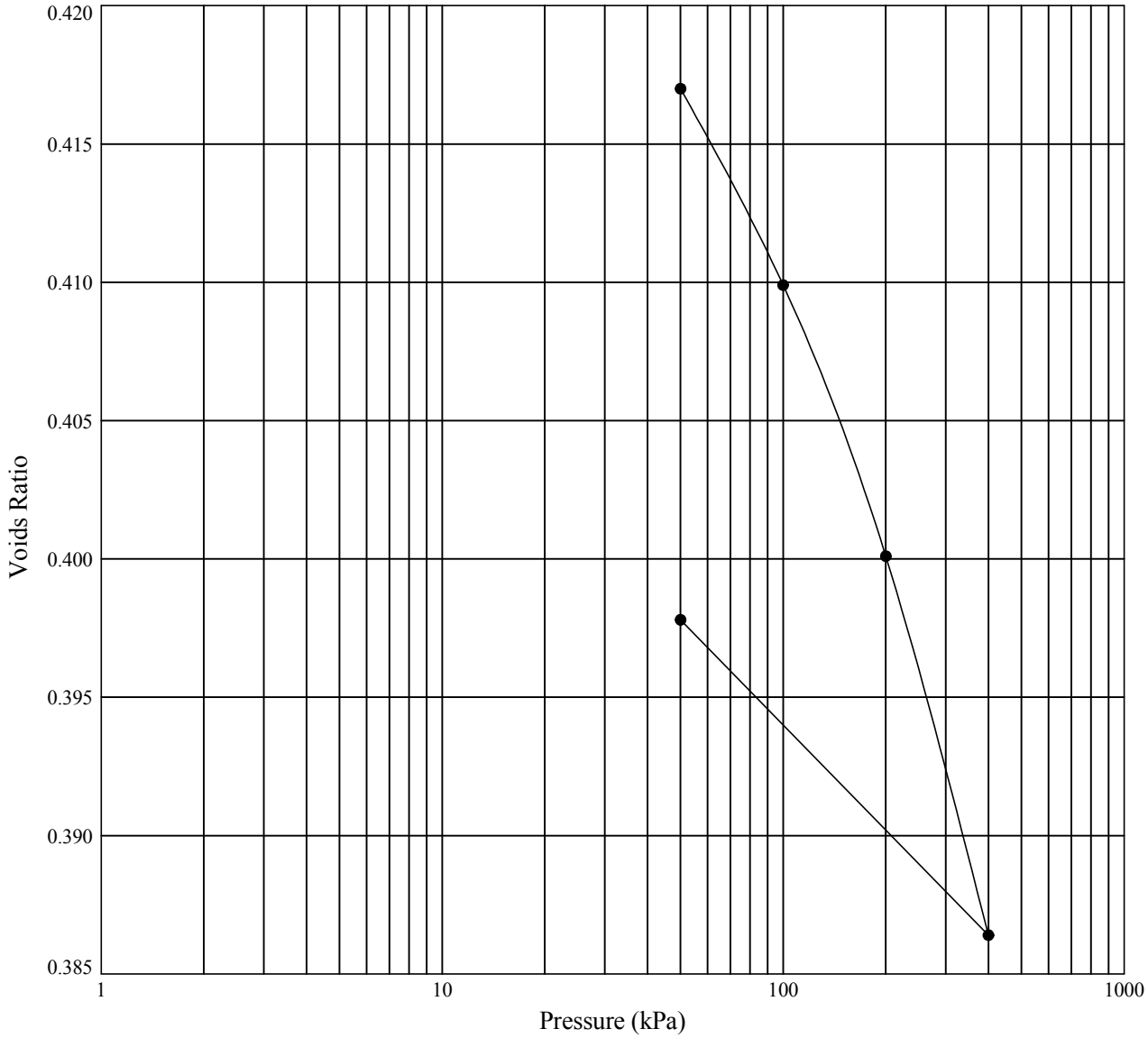
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ONE DIMENSIONAL CONSOLIDATION TEST

In accordance with BS1377:Part 5:1990

Position ID : **CP230** Sample Ref: **8** Sample Type: **U** Depth (m): **3.35**



Initial Specimen Condition			Final Specimen Condition		
Moisture Content (%)	:	**15**	Moisture Content (%)	:	**16**
Bulk Density (Mg/m^3)	:	**2.12**	Bulk Density (Mg/m^3)	:	**2.19**
Dry Density (Mg/m^3)	:	**1.84**	Dry Density (Mg/m^3)	:	**1.89**
Void Ratio	:	**0.4363**	Void Ratio	:	**0.3978**

Specimen Details			
Description	Height (mm)	:	**19.30**
Brown sandy CLAY	Diameter (mm)	:	**75.86**
	Particle Density (Mg/m^3) (assumed)	:	**2.65**
	Swelling Pressure (kPa)	:	**NA**

Test Results		
Pressure Range (kPa)	Mv (m^2/MN)	Cv (m^2/yr)
0 - 50	**0.27**	**102**
50 - 100	**0.10**	**24**
100 - 200	**0.070**	**18**
200 - 400	**0.049**	**24**
400 - 50	**NA**	**NA**

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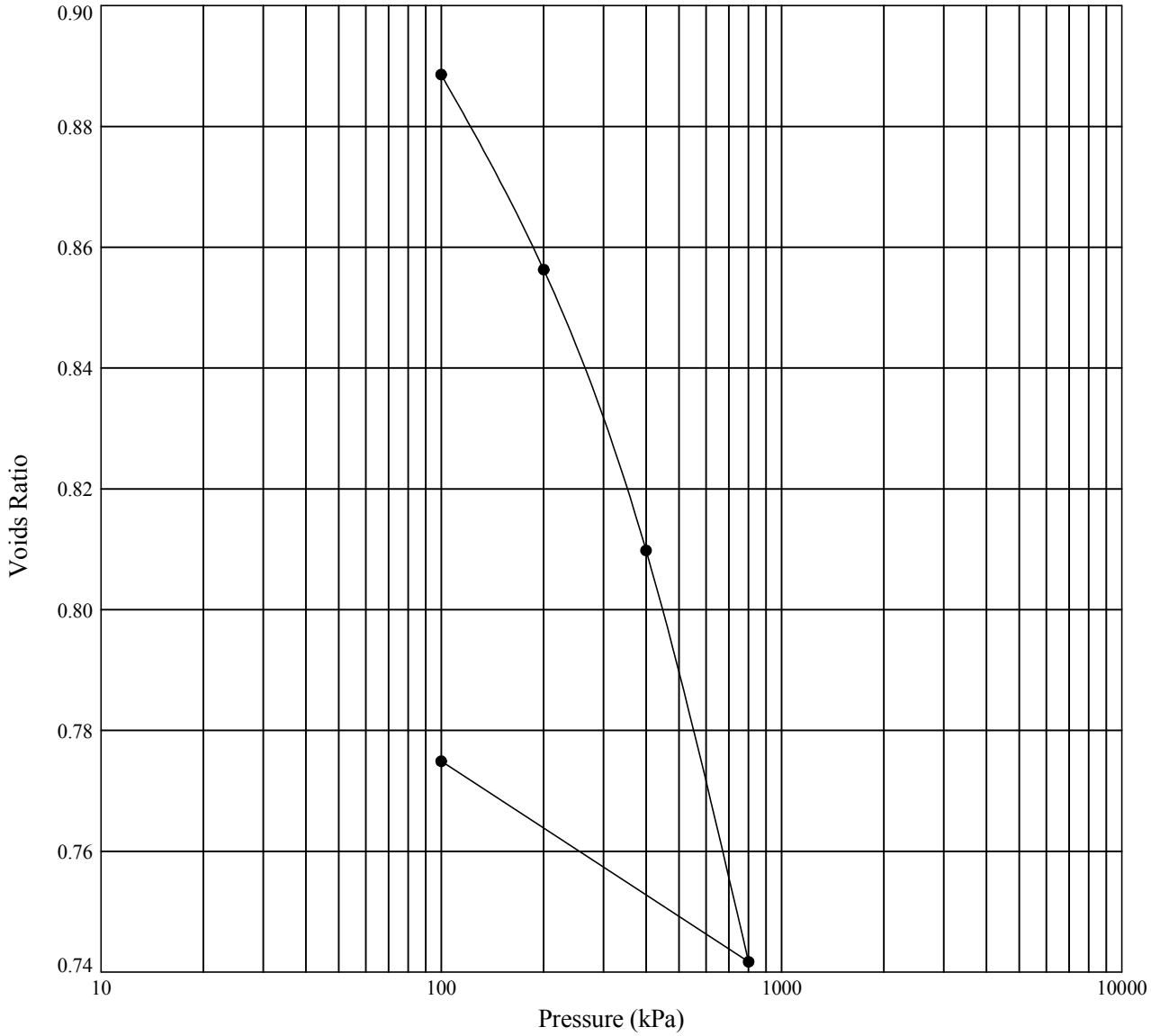
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ONE DIMENSIONAL CONSOLIDATION TEST

In accordance with BS1377:Part 5:1990

Position ID : **CP230** Sample Ref: **14** Sample Type: **U** Depth (m): **5.34**



Initial Specimen Condition			Final Specimen Condition		
Moisture Content (%)	:	**39**	Moisture Content (%)	:	**33**
Bulk Density (Mg/m^3)	:	**1.87**	Bulk Density (Mg/m^3)	:	**1.99**
Dry Density (Mg/m^3)	:	**1.34**	Dry Density (Mg/m^3)	:	**1.50**
Void Ratio	:	**0.9791**	Void Ratio	:	**0.7749**

Specimen Details			
Description	Height (mm)	:	**19.25**
Reddish brown mottled grey slightly gravelly slightly sandy CLAY	Diameter (mm)	:	**74.97**
	Particle Density (Mg/m^3) (assumed)	:	**2.65**
	Swelling Pressure (kPa)	:	**NA**

Test Results		
Pressure Range (kPa)	Mv (m^2/MN)	Cv (m^2/yr)
0 - 100	**0.46**	**49**
100 - 200	**0.17**	**46**
200 - 400	**0.13**	**22**
400 - 800	**0.094**	**25**
800 - 100	**NA**	**NA**

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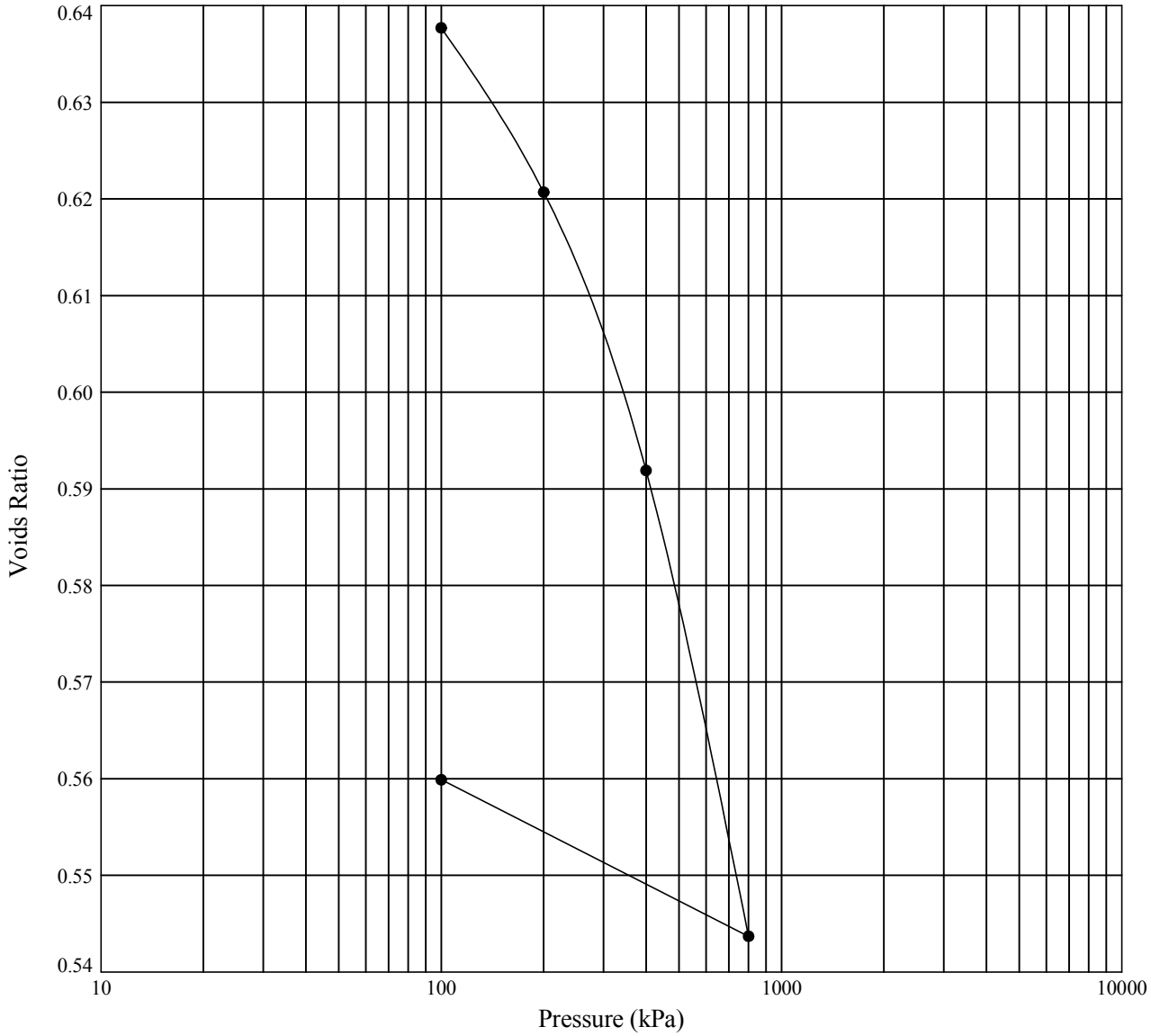
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ONE DIMENSIONAL CONSOLIDATION TEST

In accordance with BS1377:Part 5:1990

Position ID : **CP231** Sample Ref: **15** Sample Type: **U** Depth (m): **6.38**



Initial Specimen Condition			Final Specimen Condition		
Moisture Content (%)	:	**26**	Moisture Content (%)	:	**23**
Bulk Density (Mg/m^3)	:	**1.99**	Bulk Density (Mg/m^3)	:	**2.09**
Dry Density (Mg/m^3)	:	**1.58**	Dry Density (Mg/m^3)	:	**1.70**
Void Ratio	:	**0.6756**	Void Ratio	:	**0.5599**

Specimen Details			
Description	Height (mm)	:	**19.45**
Brown slightly sandy CLAY	Diameter (mm)	:	**74.97**
	Particle Density (Mg/m^3) (assumed)	:	**2.65**
	Swelling Pressure (kPa)	:	**NA**

Test Results		
Pressure Range (kPa)	Mv (m^2/MN)	Cv (m^2/yr)
0 - 100	**0.23**	**103**
100 - 200	**0.10**	**44**
200 - 400	**0.089**	**21**
400 - 800	**0.076**	**92**
800 - 100	**NA**	**NA**

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SUMMARY OF LABORATORY HAND PENETROMETER & VANE TEST RESULTS

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content (%)	Vane Type	Average Reading (kPa)	Sample Description
CP202	14	U	5.00	11	HVP	65	Brown slightly sandy slightly gravelly CLAY

Key : HVP = Hand Vane (Peak), HVR = Hand Vane (Remoulded), PP = Pocket Penetrometer.

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A.D.Frost	**ALAN FROST**	**15.11.13**	**744186**
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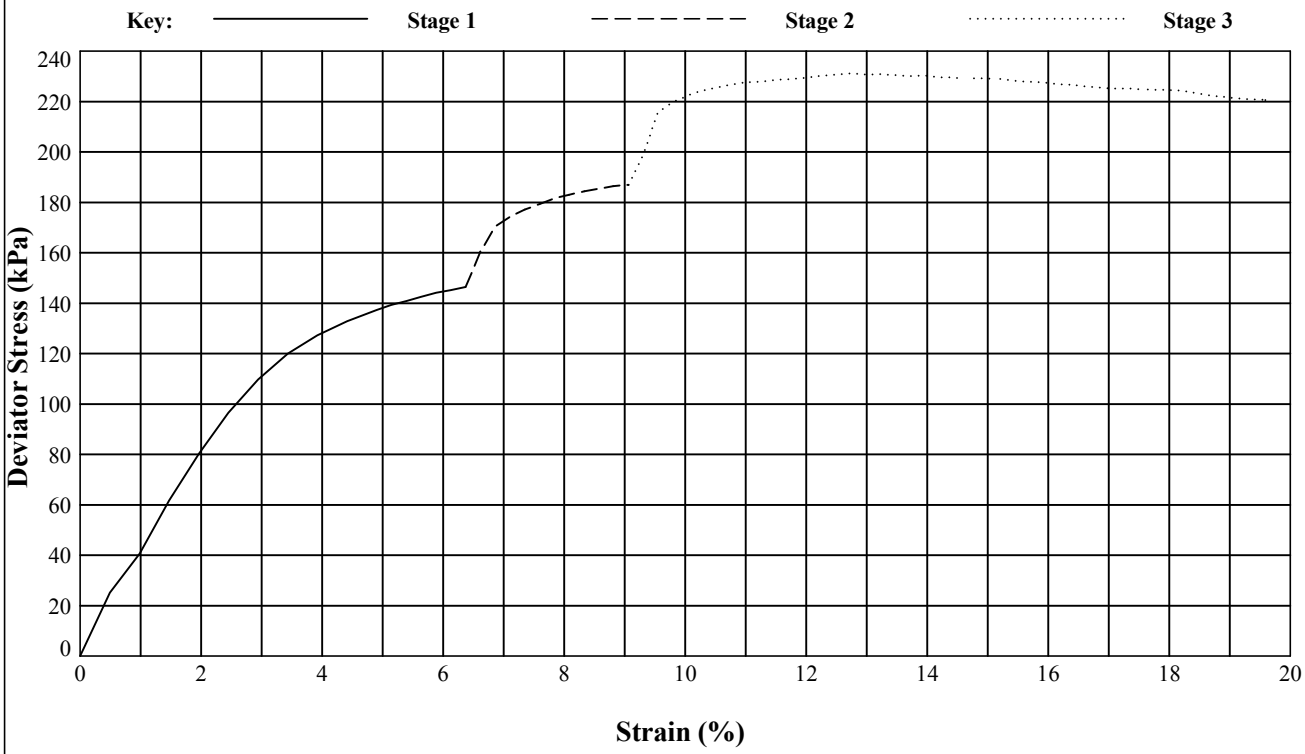
UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

In accordance with BS1377:Part 7:1990, Clause 9

Position ID : **CP202** Sample Ref: **8** Sample Type: **U** Depth (m): **3.14**

Description : **Reddish brown slightly sandy CLAY**

STAGE NUMBER			1	2	3
SAMPLE DETAILS	Sample Condition		Undisturbed		
	Orientation of sample		Vertical		
	Diameter	(mm)	102.59		
	Height	(mm)	204.20		
	Moisture Content	(%)	23		
	Bulk Density	(Mg/m^3)	2.07		
	Dry Density	(Mg/m^3)	1.69		
TEST DETAILS	Membrane Thickness	(mm)	0.63	0.63	0.63
	Rate of Axial Displacement	(%/min)	1.22	1.22	1.22
	Cell Pressure	(kPa)	60	120	240
	Membrane Correction	(kPa)	0.99	1.31	1.67
	Corrected Deviator Stress	(kPa)	146	187	231
	Undrained Shear Strength	(kPa)	73	94	116
	Strain at Failure	(%)	6.4	9.1	12.7
	Mode of Failure				Compound



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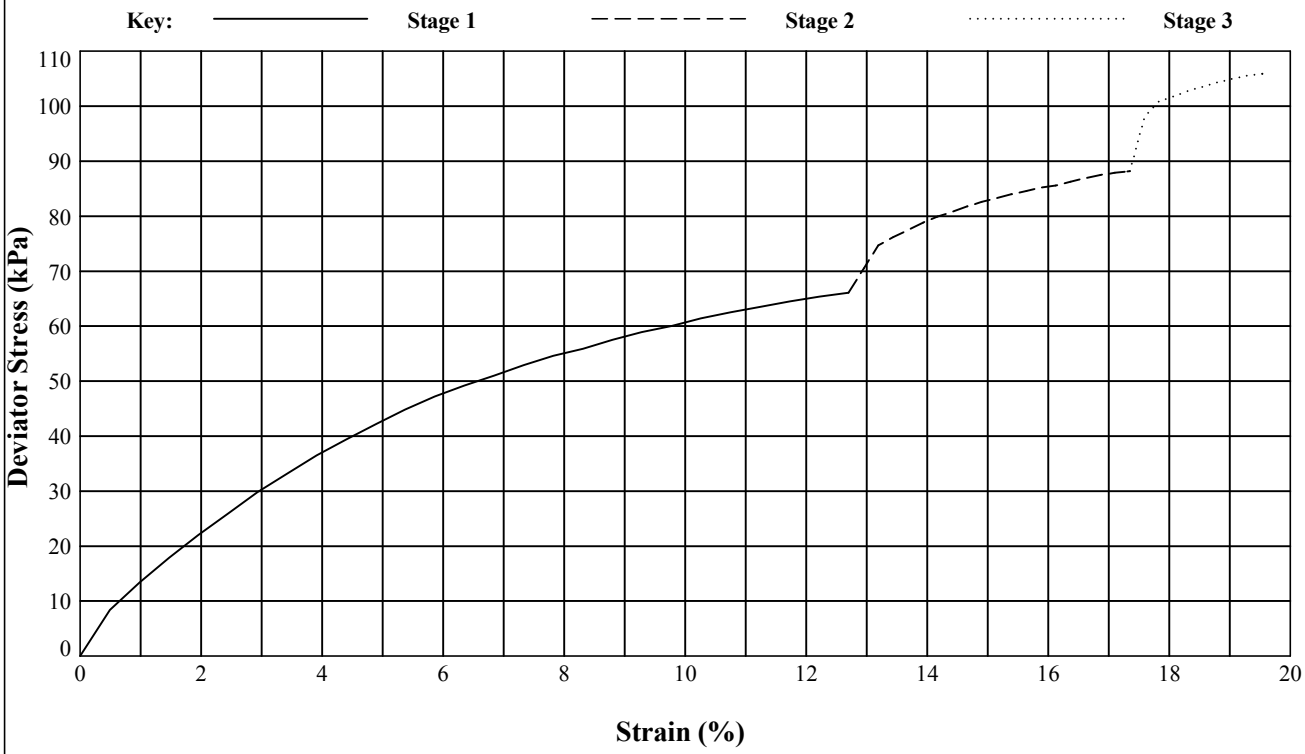
UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

In accordance with BS1377:Part 7:1990, Clause 9

Position ID : **CP227** Sample Ref: **10** Sample Type: **U** Depth (m): **4.13**

Description : **Reddish brown mottled grey sandy CLAY**

STAGE NUMBER			1	2	3
SAMPLE DETAILS	Sample Condition		Undisturbed		
	Orientation of sample		Vertical		
	Diameter	(mm)	102.87		
	Height	(mm)	204.66		
	Moisture Content	(%)	21		
	Bulk Density	(Mg/m^3)	2.11		
	Dry Density	(Mg/m^3)	1.75		
TEST DETAILS	Membrane Thickness	(mm)	0.56	0.56	0.56
	Rate of Axial Displacement	(%/min)	1.22	1.22	1.22
	Cell Pressure	(kPa)	80	160	320
	Membrane Correction	(kPa)	1.48	1.86	2.04
	Corrected Deviator Stress	(kPa)	66	88	106
	Undrained Shear Strength	(kPa)	33	44	53
	Strain at Failure	(%)	12.7	17.4	19.5
	Mode of Failure				Compound



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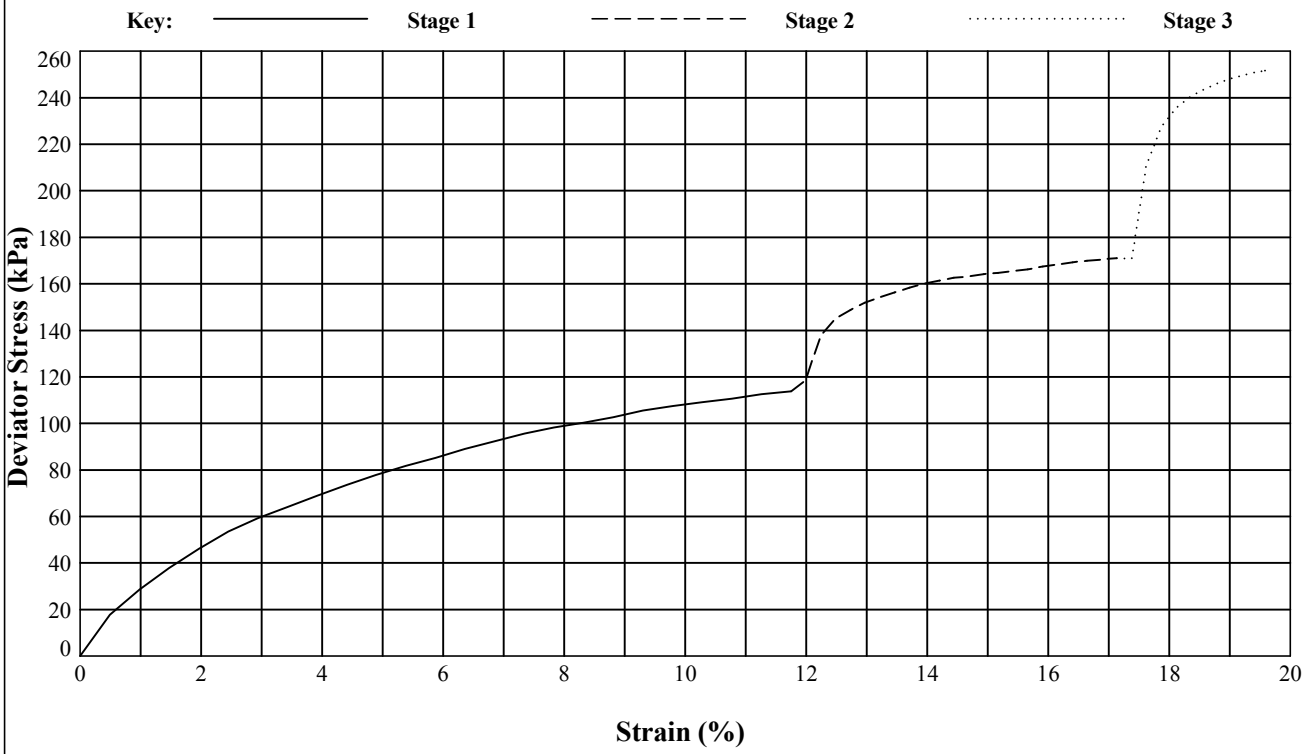
UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

In accordance with BS1377:Part 7:1990, Clause 9

Position ID : **CP230** Sample Ref: **8** Sample Type: **U** Depth (m): **3.04**

Description : **Brown sandy CLAY**

STAGE NUMBER			1	2	3
SAMPLE DETAILS	Sample Condition		Undisturbed		
	Orientation of sample		Vertical		
	Diameter	(mm)	102.83		
	Height	(mm)	204.30		
	Moisture Content	(%)	19		
	Bulk Density	(Mg/m^3)	2.03		
	Dry Density	(Mg/m^3)	1.70		
TEST DETAILS	Membrane Thickness	(mm)	0.55	0.55	0.55
	Rate of Axial Displacement	(%/min)	1.22	1.22	1.22
	Cell Pressure	(kPa)	50	100	200
	Membrane Correction	(kPa)	1.38	1.81	2.01
	Corrected Deviator Stress	(kPa)	114	171	252
	Undrained Shear Strength	(kPa)	57	86	126
	Strain at Failure	(%)	11.8	17.1	19.6
	Mode of Failure				Compound



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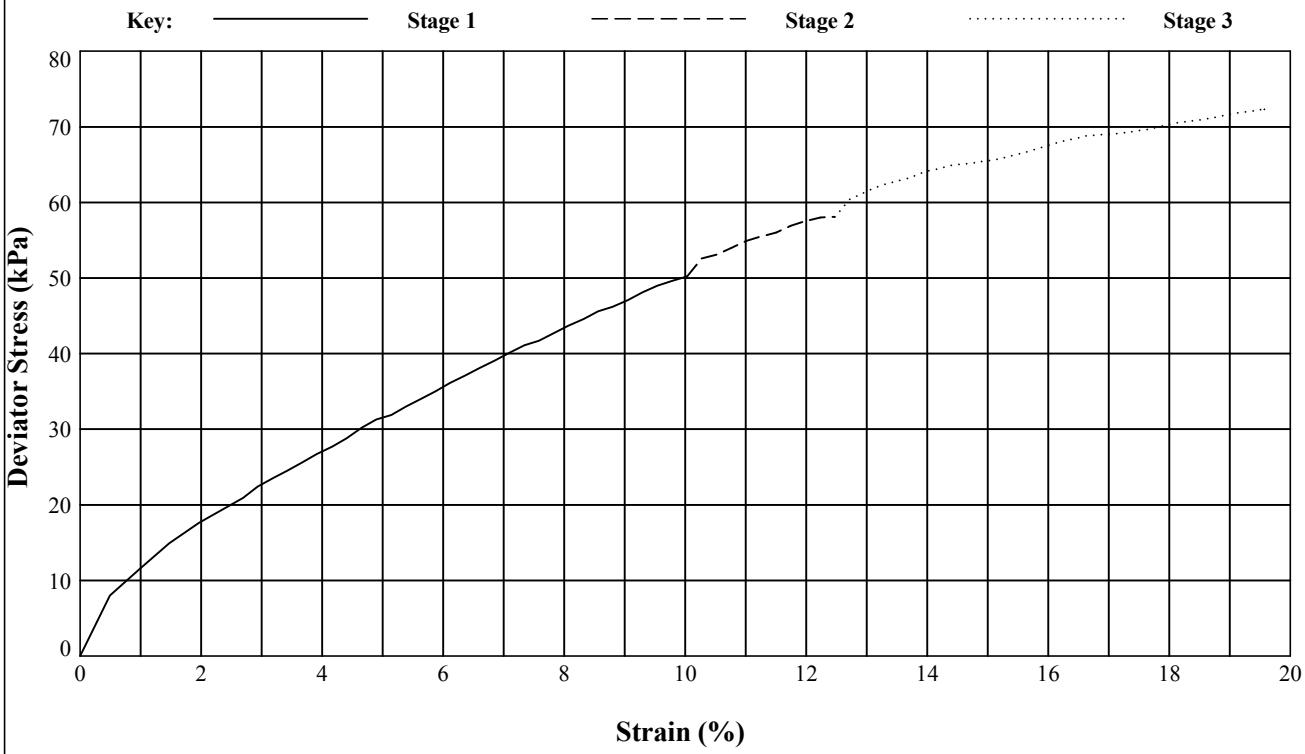
UNCONSOLIDATED QUICK UNDRAINED (MULTI-STAGE) TRIAXIAL COMPRESSION TEST

In accordance with BS1377:Part 7:1990, Clause 9

Position ID : **CP230** Sample Ref: **14** Sample Type: **U** Depth (m): **5.10**

Description : **Reddish brown mottled grey slightly sandy CLAY**

STAGE NUMBER			1	2	3
SAMPLE DETAILS	Sample Condition		Undisturbed		
	Orientation of sample		Vertical		
	Diameter	(mm)	104.12		
	Height	(mm)	204.43		
	Moisture Content	(%)	38		
	Bulk Density	(Mg/m^3)	1.90		
	Dry Density	(Mg/m^3)	1.38		
TEST DETAILS	Membrane Thickness	(mm)	0.56	0.56	0.56
	Rate of Axial Displacement	(%/min)	1.22	1.22	1.22
	Cell Pressure	(kPa)	100	200	300
	Membrane Correction	(kPa)	1.25	1.44	2.02
	Corrected Deviator Stress	(kPa)	50	58	72
	Undrained Shear Strength	(kPa)	25	29	36
	Strain at Failure	(%)	10.0	12.5	19.6
	Mode of Failure				Compound



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Contract	Contract Ref:
East Midlands Gateway - Zone 3	744186

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | Graph L - TRIAXIAL TEST - BS VERSION | 744186.GPJ - v8_05 | 15/11/13 - 07:39 | AF.
Structural Soils Ltd, Branch Office - Bristol Lab: 1a Princess Street, Bedminster, Bristol, BS3 4AG. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email: ask@soils.co.uk.

UNCONSOLIDATED QUICK UNDRAINED (SINGLE STAGE) TRIAXIAL COMPRESSION TEST

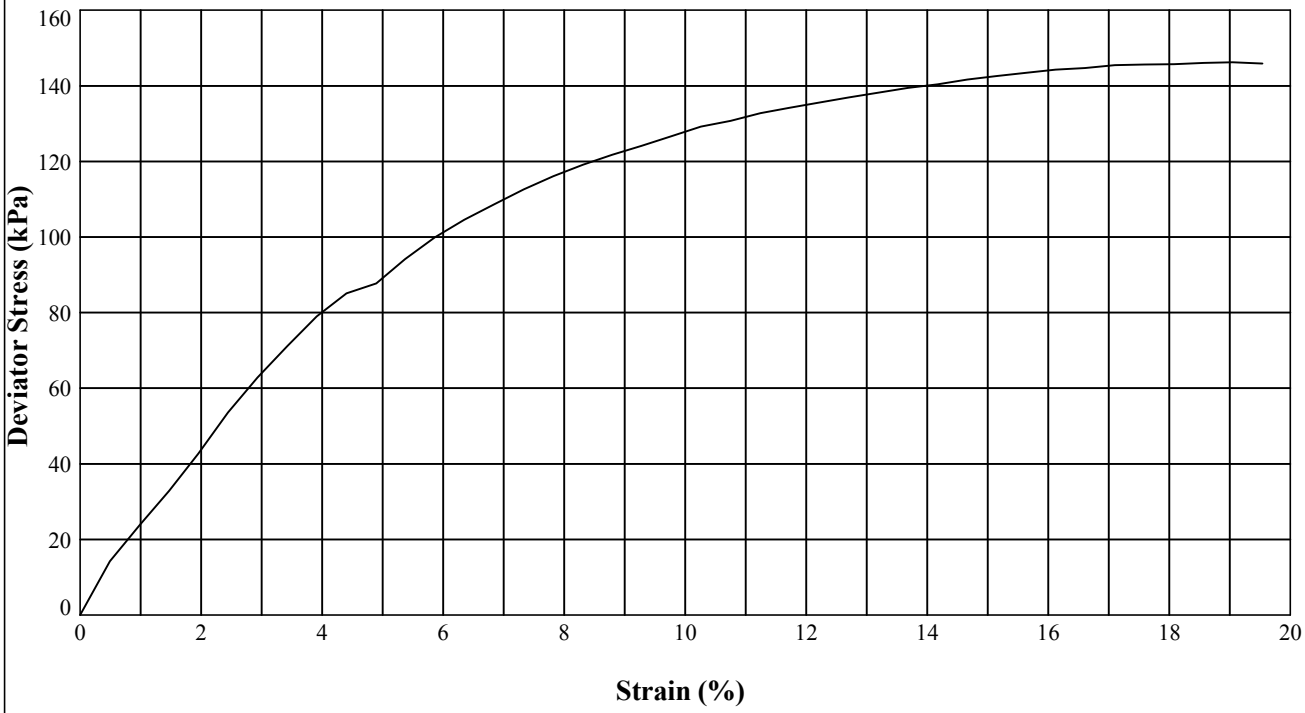
In accordance with BS1377:Part 7:1990, Clause 8

Position ID : **CP231** Sample Ref: **15** Sample Type: **U** Depth (m): **6.10**

Description : **Brown slightly sandy CLAY**

Remarks : **20% axial strain achieved with no sign of failure. Reported as a single stage test**

STAGE NUMBER			1	2	3
SAMPLE DETAILS	Sample Condition		Undisturbed		
	Orientation of sample		Vertical		
	Diameter	(mm)	103.51		
	Height	(mm)	204.68		
	Moisture Content	(%)	41		
	Bulk Density	(Mg/m^3)	1.86		
	Dry Density	(Mg/m^3)	1.32		
TEST DETAILS	Membrane Thickness	(mm)	0.62		
	Rate of Axial Displacement	(%/min)	1.22		
	Cell Pressure	(kPa)	100		
	Membrane Correction	(kPa)	2.20		
	Corrected Deviator Stress	(kPa)	146		
	Undrained Shear Strength	(kPa)	73		
	Strain at Failure	(%)	19.0		
	Mode of Failure		Compound		



Approved Signatories: J.BARRETT A.FROST M.STOKES S.HANDCOCK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
A.D.Frost	ALAN FROST	15/11/13

Contract	Contract Ref:
East Midlands Gateway - Zone 3	**744186**

GINT_LIBRARY_V8_05.GLB LibVersion: v8_05 - Lib0004 PrjVersion: v8_05 - Core+Logs+Geotech Lab-Bristol - 0004 | Graph L - TRIAXIAL TEST - BS VERSION | 744186.GPJ - v8_05 | 15/11/13 - 07:39 | AF.
Structural Soils Ltd, Branch Office - Bristol Lab: 1a Princess Street, Bedminster, Bristol, BS3 4AG. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email: ask@soils.co.uk.

SUMMARY OF POINT LOAD INDEX TEST RESULTS

(International Society for Rock Mechanics : 1985)

Exploratory Position ID	Depth (m)	Type of Test	Width or Length (W or L) (mm)	Platen Separation (D) (mm)	Failure Load (P) (kN)	Equivalent Diameter (D_e) (mm)	Point Load (I_s) (MN/m^2)	Size Factor (F)	Point Load Index ($I_{s(50)}$) (MN/m^2)	Moisture Content (%)	Rock Type
CP(R)201	10.86	D	105	85	3.660	85	0.51	1.27	0.64	7.7	MUDSTONE
CP(R)201	10.86	A	85	84	3.995	95	0.44	1.34	0.59	7.7	MUDSTONE
CP(R)201	22.26	D	61.78	86.95	1.085	87	0.14	1.28	0.18	8.3	MUDSTONE
CP(R)201	22.26	A	86.95	39.47	1.610	66	0.37	1.13	0.42	8.3	MUDSTONE
CP(R)202	21.82	D	91.5	85	3.450	85	0.48	1.27	0.61	5.6	MUDSTONE
CP(R)202	21.82	A	85	91	36.950	99	3.75	1.36	5.11	5.6	MUDSTONE
CP(R)209	20.00	D	48.61	85.6	1.190	86	0.16	1.27	0.21	15	MUDSTONE
CP(R)209	20.00	A	85.6	42.8	1.245	68	0.27	1.15	0.31	15	MUDSTONE

Key : A = Axial, D = Diametral, I = Irregular, B = Block, L = Parallel to planes of weakness, P = Perpendicular to planes of weakness. [NS] denotes Non Standard Test.

Approved Signatories: J.BARRETT M.ATHORNE A.FROST M.RANDERSON R.CLARKSON M.FISHER C.COLE M.STOKES

STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By		Date	Contract Ref:
M. Fisher.	**MAUREEN FISHER**	**29.11.13**	**781044**

Contract: **East Midlands Gateway - Zone 3**

APPENDIX H
CHEMICAL LABORATORY CERTIFICATES FOR SOIL ANALYSIS

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/04860
Issue Number: 2 **Date:** 19 November, 2013

Client:
RSK Environment Ltd Coventry
Humber Road, Abbey Park
Coventry
UK
CV3 4AQ

Project Manager: Darren Bench / Mariah Hocking / Marc Dixon
Project Name: East Midlands Gateway Zone 3
Project Ref: 312494
Order No: Not specified
Date Samples Received: 15/10/13
Date Instructions Received: 16/10/13
Date Analysis Completed: 28/10/13

Prepared by:
Lynette Toon
Administrative Assistant

Approved by:
Liz Oliver
Client Service Manager

Envirolab Job Number: 13/04860

Client Project Name: East Midlands Gateway Zone 3

Client Project Ref: 312494

Lab Sample ID	13/04860/1	13/04860/2	13/04860/3	13/04860/4	13/04860/5	13/04860/6	13/04860/7	13/04860/8	Units	Method ref
Client Sample No				15	14	16	5	13		
Client Sample ID	TP339	TP340	TP341	CP201	CP226	CP227	CP231	CP231		
Depth to Top	0.20	0.20	0.35	4.50	5.50	6.50	1.80	5.40		
Depth To Bottom	0.30	0.30	0.45	4.69						
Date Sampled	10-Oct-13	10-Oct-13	10-Oct-13	01-Oct-13	04-Oct-13	07-Oct-13	08-Oct-13	08-Oct-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - D	Soil - D	Solid	Soil - D		
Sample Matrix Code	4AE	4AE	5A	5A	5A	5	7	5		
% Stones >10mm$_A$ #	8.8	0.9	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	A-T-044
pH$_D$ M#	7.87	7.32	7.35	-	-	-	-	-	pH	A-T-031s
pH BRE$_D$ M#	-	-	-	8.73	8.63	8.50	7.78	8.48	pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D$ M#	-	-	-	11	17	<10	128	199	mg/l	A-T-026s
Sulphate BRE (acid sol)$_D$ M#	-	-	-	0.02	0.07	0.10	0.06	0.07	% w/w	A-T-028
Sulphur BRE (total)$_D$	-	-	-	<0.01	0.02	0.04	0.15	0.03	% w/w	A-T-024
Total Organic Carbon$_D$ M#	1.64	-	0.59	-	-	-	-	-	% w/w	A-T-032s
Arsenic$_D$ #	5	6	4	-	-	-	-	-	mg/kg	A-T-024
Cadmium$_D$ M#	<0.5	<0.5	<0.5	-	-	-	-	-	mg/kg	A-T-024
Copper$_D$ M#	8	11	6	-	-	-	-	-	mg/kg	A-T-024
Chromium$_D$ #	15	15	13	-	-	-	-	-	mg/kg	A-T-024
Chromium (hexavalent)$_D$	<1	<1	<1	-	-	-	-	-	mg/kg	A-T-040s
Lead$_D$ M#	22	30	13	-	-	-	-	-	mg/kg	A-T-024
Mercury$_D$	<0.17	<0.17	<0.17	-	-	-	-	-	mg/kg	A-T-024
Nickel$_D$ #	7	8	7	-	-	-	-	-	mg/kg	A-T-024
Selenium$_D$ #	<1	<1	<1	-	-	-	-	-	mg/kg	A-T-024
Zinc$_D$ M#	45	44	26	-	-	-	-	-	mg/kg	A-T-024

Envirolab Job Number: 13/04860

Client Project Name: East Midlands Gateway Zone 3

Client Project Ref: 312494

Lab Sample ID	13/04860/1	13/04860/2	13/04860/3	13/04860/4	13/04860/5	13/04860/6	13/04860/7	13/04860/8	Units	Method ref
Client Sample No				15	14	16	5	13		
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Depth To Bottom	0.30	0.30	0.45	4.69						
Date Sampled	10-Oct-13	10-Oct-13	10-Oct-13	01-Oct-13	04-Oct-13	07-Oct-13	08-Oct-13	08-Oct-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - D	Soil - D	Solid	Soil - D		
Sample Matrix Code	4AE	4AE	5A	5A	5A	5	7	5		
Pest-c										
Mevinphos	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Dichlorvos	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
alpha-Hexachlorocyclohexane (HCH)	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Diazinon	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
gamma-Hexachlorocyclohexane (HCH / Lindane)	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Heptachlor	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Aldrin	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
beta-Hexachlorocyclohexane (HCH)	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Methyl Parathion	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Malathion	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Fenitrothion	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Heptachlor Epoxide	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Parathion (Ethyl Parathion)	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
p,p-DDE	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
p,p-DDT	<100	-	<250	-	-	-	-	-	µg/kg	Subcon
p,p-Methoxychlor	<100	-	<250	-	-	-	-	-	µg/kg	Subcon
p,p-TDE (DDD)	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
o,p-DDE	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
o,p-DDT	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
o,p-Methoxychlor	<50	-	<600	-	-	-	-	-	µg/kg	Subcon
o,p-TDE (DDD)	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Endosulphan I	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Endosulphan II	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Endosulphan Sulphate	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Endrin	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Ethion	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Dieldrin	<50	-	<250	-	-	-	-	-	µg/kg	Subcon
Azinphos-methyl	<50	-	<250	-	-	-	-	-	µg/kg	Subcon

Envirolab Job Number: 13/04860

Client Project Name: East Midlands Gateway Zone 3

Client Project Ref: 312494

Lab Sample ID	13/04860/1	13/04860/2	13/04860/3	13/04860/4	13/04860/5	13/04860/6	13/04860/7	13/04860/8	Units	Method ref
Client Sample No				15	14	16	5	13		
Client Sample ID	TP339	TP340	TP341	CP201	CP226	CP227	CP231	CP231		
Depth to Top	0.20	0.20	0.35	4.50	5.50	6.50	1.80	5.40		
Depth To Bottom	0.30	0.30	0.45	4.69						
Date Sampled	10-Oct-13	10-Oct-13	10-Oct-13	01-Oct-13	04-Oct-13	07-Oct-13	08-Oct-13	08-Oct-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - D	Soil - D	Solid	Soil - D		
Sample Matrix Code	4AE	4AE	5A	5A	5A	5	7	5		
PAH 16										
Acenaphthene$_A^{M\#}$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02	<0.02	-	-	-	-	-	mg/kg	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04	-	-	-	-	-	mg/kg	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.05	<0.04	<0.04	-	-	-	-	-	mg/kg	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.06	<0.05	<0.05	-	-	-	-	-	mg/kg	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05	<0.05	-	-	-	-	-	mg/kg	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	<0.07	-	-	-	-	-	mg/kg	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06	<0.06	-	-	-	-	-	mg/kg	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04	-	-	-	-	-	mg/kg	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08	<0.08	-	-	-	-	-	mg/kg	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	<0.03	<0.03	-	-	-	-	-	mg/kg	A-T-019s
Naphthalene$_A^{M\#}$	<0.03	<0.03	<0.03	-	-	-	-	-	mg/kg	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	0.04	<0.03	-	-	-	-	-	mg/kg	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07	<0.07	-	-	-	-	-	mg/kg	A-T-019s
PAH (total 16)$_A^{M\#}$	0.11	<0.08	<0.08	-	-	-	-	-	mg/kg	A-T-019s

Envirolab Job Number: 13/04860

Client Project Name: East Midlands Gateway Zone 3

Client Project Ref: 312494

Lab Sample ID	13/04860/1	13/04860/2	13/04860/3	13/04860/4	13/04860/5	13/04860/6	13/04860/7	13/04860/8	Units	Method ref
Client Sample No				15	14	16	5	13		
Client Sample ID	TP339	TP340	TP341	CP201	CP226	CP227	CP231	CP231		
Depth to Top	0.20	0.20	0.35	4.50	5.50	6.50	1.80	5.40		
Depth To Bottom	0.30	0.30	0.45	4.69						
Date Sampled	10-Oct-13	10-Oct-13	10-Oct-13	01-Oct-13	04-Oct-13	07-Oct-13	08-Oct-13	08-Oct-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - D	Soil - D	Solid	Soil - D		
Sample Matrix Code	4AE	4AE	5A	5A	5A	5	7	5		
Triazines (x11)										
Ametryne	<0.2	-	<0.2	-	-	-	-	-	mg/kg	Subcon
Atraton	<0.1	-	<0.1	-	-	-	-	-	mg/kg	Subcon
Atrazine	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon
Cyanazine	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon
Prometon	<0.1	-	<0.1	-	-	-	-	-	mg/kg	Subcon
Prometryn	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon
Propazine	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon
Simazine	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon
Simetryn	<0.1	-	<0.1	-	-	-	-	-	mg/kg	Subcon
Terbuthylazine	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon
Terbutryn	<0.02	-	<0.02	-	-	-	-	-	mg/kg	Subcon

Envirolab Job Number: 13/04860

Client Project Name: East Midlands Gateway Zone 3

Client Project Ref: 312494

Lab Sample ID	13/04860/1	13/04860/2	13/04860/3	13/04860/4	13/04860/5	13/04860/6	13/04860/7	13/04860/8	Units	Method ref
Client Sample No				15	14	16	5	13		
Client Sample ID	TP339	TP340	TP341	CP201	CP226	CP227	CP231	CP231		
Depth to Top	0.20	0.20	0.35	4.50	5.50	6.50	1.80	5.40		
Depth To Bottom	0.30	0.30	0.45	4.69						
Date Sampled	10-Oct-13	10-Oct-13	10-Oct-13	01-Oct-13	04-Oct-13	07-Oct-13	08-Oct-13	08-Oct-13		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - D	Soil - D	Soil - D	Solid	Soil - D		
Sample Matrix Code	4AE	4AE	5A	5A	5A	5	7	5		
TPH CWG										
Ali >C5-C6$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Ali >C6-C8$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Ali >C8-C10$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Ali >C10-C12$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Ali >C12-C16$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Ali >C16-C21$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Ali >C21-C35$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Total Aliphatics$_A$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-022+23s
Aro >C5-C7$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Aro >C7-C8$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Aro >C8-C9$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Aro >C9-C10$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Aro >C10-C12$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Aro >C12-C16$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Aro >C16-C21$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Aro >C21-C35$_A^\#$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s
Total Aromatics$_A$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-022+23s
TPH (Ali & Aro)$_A$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-022+23s
BTEX - Benzene$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
BTEX - Toluene$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
BTEX - Ethyl Benzene$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
BTEX - m & p Xylene$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
BTEX - o Xylene$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
MTBE$_A^\#$	<0.01	<0.01	<0.01	-	-	-	-	-	mg/kg	A-T-022s
Mineral Oil (>C10-C35)$_A$	<0.1	<0.1	<0.1	-	-	-	-	-	mg/kg	A-T-023s

Envirolab Job Number: 13/04860

Client Project Name: East Midlands Gateway Zone 3

Client Project Ref: 312494

Lab Sample ID	13/04860/9								Units	Method ref
Client Sample No										
Client Sample ID	CP341									
Depth to Top	1.00									
Depth To Bottom	1.10									
Date Sampled	10-Oct-13									
Sample Type	Soil - D									
Sample Matrix Code	5									
% Stones >10mm$_A^{\#}$	<0.1								% w/w	A-T-044
pH BRE$_D^{M\#}$	7.90								pH	A-T-031s
Sulphate BRE (water sol 2:1)$_D^{M\#}$	25								mg/l	A-T-026s
Sulphate BRE (acid sol)$_D^{M\#}$	<0.02								% w/w	A-T-028
Sulphur BRE (total)$_D$	<0.01								% w/w	A-T-024

REPORT NOTES

Notes - Soil chemical analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
All analysis is performed on the sample as received for soil samples from outside the European Union and this supercedes any "D" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if present as discrete fibres/fragments. Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified a being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed.
Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

APPENDIX I
CHEMICAL LABORATORY CERTIFICATES FOR GROUNDWATER ANALYSIS

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 13/05152
Issue Number: 2c **Date:** 29 November, 2013

Client:
RSK Environment Ltd Coventry
Humber Road, Abbey Park
Coventry
UK
CV3 4AQ

Project Manager: Darren Bench/ Gareth Shaw
Project Name: East Midlands Gateway
Project Ref: 312494
Order No: Not specified
Date Samples Received: 24/10/13
Date Instructions Received: 25/10/13
Date Analysis Completed: 07/11/13

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Gill Scott
Laboratory Manager

UKAS TESTING 1247

Envirolab Job Number: 13/05050

Client Project Name: East Midlands Gateway

Client Project Ref: 312494

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
pH (w)$_A^\#$	6.78	7.50	7.14						pH	A-T-031w
Redox Potential (w)$_A$	178	182	205						mV	A-T-048
Electrical conductivity @ 20℃ (w) $_A^\#$	1750	3840	1310						µs/cm	A-T-037w
Dissolved oxygen$_A$	0.9	3.4	7.1						mg/l	A-T-048
Hardness$_A^\#$	882	1640	764						mg/l Ca CO3	A-T-049
Ammoniacal nitrogen (w)$_A^\#$	0.22	1.02	<0.02						mg/l	A-T-033w
Phenols - Total by HPLC (w)$_A$	<0.01	<0.01	<0.01						mg/l	A-T-050w
Arsenic (dissolved)$_A^\#$	54	4	<1						µg/l	A-T-025
Boron (dissolved)$_A^\#$	239	2270	62						µg/l	A-T-025
Cadmium (dissolved)$_A^\#$	<1	<1	<1						µg/l	A-T-025
Copper (dissolved)$_A^\#$	<1	<1	4						µg/l	A-T-025
Chromium (dissolved)$_A^\#$	1	<1	<1						µg/l	A-T-025
Chromium (hexavalent) (w)$_A^\#$	<0.05	<0.05	<0.05						mg/l	A-T-040w
Lead (dissolved)$_A^\#$	<1	<1	<1						µg/l	A-T-025
Mercury (dissolved)$_A^\#$	<0.1	<0.1	<0.1						µg/l	A-T-025
Nickel (dissolved)$_A^\#$	20	1	2						µg/l	A-T-025
Selenium (dissolved)$_A^\#$	<1	<1	<1						µg/l	A-T-025
Zinc (dissolved)$_A^\#$	20	4	10						µg/l	A-T-025

Envirolab Job Number: 13/05050

Client Project Name: East Midlands Gateway

Client Project Ref: 312494

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
PAH 16MS (w)										
Acenaphthene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Acenaphthylene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Anthracene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Benzo(a)anthracene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Benzo(a)pyrene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Benzo(b)fluoranthene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Benzo(ghi)perylene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Benzo(k)fluoranthene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Chrysene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Dibenzo(ah)anthracene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Fluoranthene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Fluorene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Indeno(123-cd)pyrene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Naphthalene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
Phenanthrene $(w)_A^{\#}$	0.01	<0.01	<0.01						µg/l	A-T-019w
Pyrene $(w)_A^{\#}$	<0.01	<0.01	<0.01						µg/l	A-T-019w
PAH (total 16) $(w)_A^{\#}$	0.01	<0.01	<0.01						µg/l	A-T-019w

Envirolab Job Number: 13/05050

Client Project Name: East Midlands Gateway

Client Project Ref: 312494

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
SVOC (w)										
1,2,4-Trichlorobenzene A	<1	<1	<1						µg/l	A-T-052
1,2-Dichlorobenzene A	<1	<1	<1						µg/l	A-T-052
1,3-Dichlorobenzene A	<1	<1	<1						µg/l	A-T-052
1,4-Dichlorobenzene A	<1	<1	<1						µg/l	A-T-052
2,4,5-Trichlorophenol A	<1	<1	<1						µg/l	A-T-052
2,4,6-Trichlorophenol A	<1	<1	<1						µg/l	A-T-052
2,4-Dichlorophenol A	<1	<1	<1						µg/l	A-T-052
2,4-Dimethylphenol A	<1	<1	<1						µg/l	A-T-052
2,4-Dinitrotoluene A	<1	<1	<1						µg/l	A-T-052
2,6-Dinitrotoluene A	<1	<1	<1						µg/l	A-T-052
2-Chloronaphthalene A	<1	<1	<1						µg/l	A-T-052
2-Chlorophenol A	<1	<1	<1						µg/l	A-T-052
2-Methylnaphthalene A	<1	<1	<1						µg/l	A-T-052
2-Methylphenol A	<1	<1	<1						µg/l	A-T-052
2-Nitrophenol A	<1	<1	<1						µg/l	A-T-052
4-Bromophenyl phenyl ether A	<1	<1	<1						µg/l	A-T-052
4-Chloro-3-methylphenol A	<1	<1	<1						µg/l	A-T-052
4-Methylphenol A	<1	<1	<1						µg/l	A-T-052
4-Nitrophenol A	<1	<1	<1						µg/l	A-T-052
Acenaphthene A	<1	<1	<1						µg/l	A-T-052
Acenaphthylene A	<1	<1	<1						µg/l	A-T-052
Anthracene A	<1	<1	<1						µg/l	A-T-052
Bis(2-chloroethyl)ether A	<1	<1	<1						µg/l	A-T-052
Bis(2-chloroethoxy)methane A	<1	<1	<1						µg/l	A-T-052
Bis(2-ethylhexyl)phthalate A	<2	<2	<2						µg/l	A-T-052
Benzo(a)anthracene A	<1	<1	<1						µg/l	A-T-052
Butylbenzyl phthalate A	<1	<1	<1						µg/l	A-T-052
Benzo(b)fluoranthene A	<1	<1	<1						µg/l	A-T-052
Benzo(k)fluoranthene A	<1	<1	<1						µg/l	A-T-052

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
Benzo(a)pyrene A	<1	<1	<1						µg/l	A-T-052
Benzo(ghi)perylene A	<1	<1	<1						µg/l	A-T-052
Carbazole A	<1	<1	<1						µg/l	A-T-052
Chrysene A	<1	<1	<1						µg/l	A-T-052
Dibenzofuran A	<1	<1	<1						µg/l	A-T-052
n-Dibutylphthalate A	<1	<1	<1						µg/l	A-T-052
n-Dioctylphthalate A	<5	<5	<5						µg/l	A-T-052
n-Nitroso-n-dipropylamine A	<1	<1	<1						µg/l	A-T-052
Diethyl phthalate A	<1	<1	9						µg/l	A-T-052
Dimethyl phthalate A	<1	<1	<1						µg/l	A-T-052
Dibenzo(ah)anthracene A	<1	<1	<1						µg/l	A-T-052
Fluorene A	<1	<1	<1						µg/l	A-T-052
Fluoranthene A	<1	<1	<1						µg/l	A-T-052
Hexachlorobutadiene A	<1	<1	<1						µg/l	A-T-052
Hexachlorobenzene A	<1	<1	<1						µg/l	A-T-052
Pentachlorophenol A	<1	<1	<1						µg/l	A-T-052
Phenol A	<1	<1	<1						µg/l	A-T-052
Hexachloroethane A	<1	<1	<1						µg/l	A-T-052
Nitrobenzene A	<1	<1	<1						µg/l	A-T-052
Naphthalene A	<1	1	<1						µg/l	A-T-052
Isophorone A	<1	<1	<1						µg/l	A-T-052
Hexachlorocyclopentadiene A	<1	<1	<1						µg/l	A-T-052
Phenanthrene A	<1	<1	<1						µg/l	A-T-052
Pyrene A	<1	<1	<1						µg/l	A-T-052
Indeno(1,2,3-cd)pyrene A	<1	<1	<1						µg/l	A-T-052
Bis(2-chloroisopropyl)ether A	<1	<1	<1						µg/l	A-T-052
2,4-Dinitrophenol A	<1	<1	<1						µg/l	A-T-052
4,6-Dinitro-2-methylphenol A	<1	<1	<1						µg/l	A-T-052
Perylene A	<1	<1	<1						µg/l	A-T-052

Envirolab Job Number: 13/05050

Client Project Name: East Midlands Gateway

Client Project Ref: 312494

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
VOC (w)										
Dichlorodifluoromethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Chloromethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Vinyl Chloride$_A^\#$	<1	<1	<1						µg/l	A-T-006
Bromomethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Chloroethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Trichlorofluoromethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
trans 1,2-Dichloroethene$_A^\#$	<1	<1	<1						µg/l	A-T-006
Dichloromethane$_A$	<100	<100	<100						µg/l	A-T-006
Carbon Disulphide$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,1-Dichloroethene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,1-Dichloroethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
cis 1,2-Dichloroethene$_A^\#$	<1	<1	<1						µg/l	A-T-006
Bromochloromethane$_A^\#$	<5	<5	<5						µg/l	A-T-006
Chloroform$_A^\#$	<25	<25	<25						µg/l	A-T-006
2,2-Dichloropropane$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,2-Dichloroethane$_A^\#$	<2	<2	<2						µg/l	A-T-006
1,1,1-Trichloroethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,1-Dichloropropene$_A^\#$	<1	<1	<1						µg/l	A-T-006
Benzene VOC$_A^\#$	<1	<1	<1						µg/l	A-T-006
Carbon Tetrachloride$_A^\#$	<1	<1	<1						µg/l	A-T-006
Dibromomethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,2-Dichloropropane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Bromodichloromethane$_A^\#$	<10	<10	<10						µg/l	A-T-006
Trichloroethene$_A^\#$	<1	<1	<1						µg/l	A-T-006
cis 1,3-Dichloropropene$_A^\#$	<1	<1	<1						µg/l	A-T-006
trans 1,3-Dichloropropene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,1,2-Trichloroethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Toluene VOC$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,3-Dichloropropane$_A^\#$	<1	<1	<1						µg/l	A-T-006

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
Dibromochloromethane$_A^\#$	<3	<3	<3						µg/l	A-T-006
1,2-Dibromoethane$_A^\#$	<1	<1	<1						µg/l	A-T-006
Tetrachloroethene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,1,1,2-Tetrachloroethane$_A$	<1	<1	<1						µg/l	A-T-006
Chlorobenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
Ethylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
m & p Xylene$_A^\#$	<1	<1	<1						µg/l	A-T-006
Bromoform$_A^\#$	<1	<1	<1						µg/l	A-T-006
Styrene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,1,2,2-Tetrachloroethane$_A$	<1	<1	<1						µg/l	A-T-006
o-Xylene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,2,3-Trichloropropane$_A^\#$	*<1*	*<1*	*<1*						µg/l	A-T-006
Isopropylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
Bromobenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
2-Chlorotoluene$_A^\#$	<1	<1	<1						µg/l	A-T-006
n-propylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
4-Chlorotoluene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,2,4-Trimethylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
4-Isopropyltoluene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,3,5-Trimethylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,2-Dichlorobenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,4-Dichlorobenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
sec-Butylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
tert-Butylbenzene$_A^\#$	<2	<2	<2						µg/l	A-T-006
1,3-Dichlorobenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
n-butylbenzene$_A^\#$	<1	<1	<1						µg/l	A-T-006
1,2-Dibromo-3-chloropropane$_A^\#$	<2	<2	<2						µg/l	A-T-006
1,2,4-Trichlorobenzene$_A^\#$	<3	<3	<3						µg/l	A-T-006
1,2,3-Trichlorobenzene$_A^\#$	<3	<3	<3						µg/l	A-T-006
Hexachlorobutadiene$_A^\#$	<1	<1	<1						µg/l	A-T-006

Envirolab Job Number: 13/05050

Client Project Name: East Midlands Gateway

Client Project Ref: 312494

Lab Sample ID	13/05050/3	13/05050/4	13/05050/6						Units	Method ref
Client Sample No	Shallow									
Client Sample ID	CPR229	CP209	CP202							
Depth to Top	1.49	20.00								
Depth To Bottom										
Date Sampled	22-Oct-13	22-Oct-13	22-Oct-13							
Sample Type	Water - W	Water - W	Water - W							
Sample Matrix Code										
TPH CWG										
Ali >C5-C6 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Ali >C6-C8 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Ali >C8-C10 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Ali >C10-C12 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Ali >C12-C16 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Ali >C16-C21 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Ali >C21-C35 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Total Aliphatics $(w)_A$	<5	<5	<5						µg/l	A-T-022+23w
Aro >C5-C7 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Aro >C7-C8 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Aro >C8-C9 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Aro >C9-C10 $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
Aro >C10-C12 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Aro >C12-C16 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Aro >C16-C21 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Aro >C21-C35 $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
Total Aromatics $(w)_A$	<5	<5	<5						µg/l	A-T-022+23w
TPH (Ali & Aro) $(w)_A$	<5	<5	<5						µg/l	A-T-022+23w
Mineral Oil (>C10-C35) $(w)_A^{\#}$	<5	<5	<5						µg/l	A-T-023w
BTEX - Benzene $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
BTEX - Toluene $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
BTEX - Ethyl Benzene $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
BTEX - m & p Xylene $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
BTEX - o Xylene $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w
MTBE $(w)_A^{\#}$	<1	<1	<1						µg/l	A-T-022w

REPORT NOTES

Notes - Soil analysis
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General
Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.
All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supercedes any "A" subscripts.
All analysis is performed on the sample as received for soil samples from outside the European Union and this supercedes any "D" subscripts.
Superscript "M" indicates method accredited to MCERTS.
For complex, multi-compound analysis, quality control results do not always fall within chart limits for every compound and we have criteria for reporting in these situations. If results are in italic font they are associated with such quality control failures and may be unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling.

TPH analysis of water by method A-T-007
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil
Asbestos in soil analysis is performed on an aliquot of the submitted sample and cannot guarantee to identify asbestos if present at low concentrations or as discrete fibres/fragments.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified a being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER.
Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our MCERTS accreditation.

Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

APPENDIX J
GAS AND GROUNDWATER MONITORING RESULTS

IN-SITU GAS MONITORING RESULTS

[Pressures]	Previous	During	Start	End	Equipment Used & Remarks
Round 1	-	Constant	1003	1003	Dipmeter + GA2000 SN-GA07744 + Weather: Overcast + Ground: Wet + Wind: None + Air Temp: 12DegC
Round 2	-	Constant	984	984	Dipmeter + GA2000 SN-GA07744 + Weather: Overcast + Ground: Wet + Wind: None + Air Temp: 15DegC
Round 3	-	Constant	1012	1012	Dipmeter + GA2000 SN-GA07744 + Weather: Sunny + Ground: Wet + Wind: None + Air Temp: 12DegC
Round 4	-	Constant	1020	1020	Dipmeter + GA2000 SN-GA07744 + Weather: Overcast + Ground: Wet + Wind: None + Air Temp: 10DegC

Exploratory Position ID	Monitoring Round	Measured Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP201	1	4.53	17/10/2013 11:27:19	1004	1004	-	DRY	0.1	0.0	20.8	0.0	0.0	0.0	
CP201	1	---	15 secs	-	-	-	-	1.5	0.0	16.7	0.0	0.0	0.0	
CP201	1	---	30 secs	-	-	-	-	1.5	0.0	16.0	0.0	0.0	0.0	
CP201	1	---	60 secs	-	-	-	-	1.5	0.0	15.8	0.0	0.0	0.0	
CP201	1	---	90 secs	-	-	-	-	1.5	0.0	15.8	0.0	0.0	0.0	
CP201	1	---	120 secs	-	-	-	-	1.5	0.0	15.7	0.0	0.0	0.0	
CP201	1	---	180 secs	-	-	-	-	1.5	0.0	16.0	0.0	0.0	0.0	
CP201	1	---	240 secs	-	-	-	-	1.6	0.0	15.9	0.0	0.0	0.0	
CP201	1	---	300 secs	-	-	-	-	1.6	0.0	15.9	0.0	0.0	0.0	
CP201	2	4.68	24/10/2013 15:20:00	1008	1008	$0.0_{(I)}$	DRY	0.0	0.0	20.7	0.0	0.0	0.0	
CP201	2	---	15 secs	-	-	$0.0_{(SS)}$	-	2.2	0.0	17.3	0.0	0.0	0.0	
CP201	2	---	30 secs	-	-	-	-	2.2	0.0	13.8	0.0	0.0	0.0	
CP201	2	---	60 secs	-	-	-	-	2.2	0.0	13.4	0.0	0.0	0.0	
CP201	2	---	90 secs	-	-	-	-	2.2	0.0	13.4	0.0	0.0	0.0	
CP201	2	---	120 secs	-	-	-	-	2.3	0.0	13.4	0.0	0.0	0.0	
CP201	2	---	180 secs	-	-	-	-	2.3	0.0	13.5	0.0	0.0	0.0	
CP201	2	---	240 secs	-	-	-	-	2.3	0.0	13.5	0.0	0.0	0.0	
CP201	2	---	300 secs	-	-	-	-	2.3	0.0	13.5	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Abbey Park
Humber Road
Coventry
CV3 4AQ

Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP201	3	4.66	31/10/2013 08:37:00	1007	1007	$-3.0_{(I)}$	DRY	0.1	0.0	20.8	0.0	0.0	0.0	
CP201	3	---	15 secs	-	-	$-3.0_{(SS)}$	-	2.1	0.0	18.0	0.0	0.0	0.0	
CP201	3	---	30 secs	-	-	-	-	2.4	0.0	13.2	0.0	0.0	0.0	
CP201	3	---	60 secs	-	-	-	-	2.4	0.0	12.8	0.0	0.0	0.0	
CP201	3	---	90 secs	-	-	-	-	2.5	0.0	12.8	0.0	0.0	0.0	
CP201	3	---	120 secs	-	-	-	-	2.5	0.0	12.8	0.0	0.0	0.0	
CP201	3	---	180 secs	-	-	-	-	2.5	0.0	12.8	0.0	0.0	0.0	
CP201	3	---	240 secs	-	-	-	-	2.5	0.0	12.8	0.0	0.0	0.0	
CP201	3	---	300 secs	-	-	-	-	2.5	0.0	12.8	0.0	0.0	0.0	
CP201	4	4.65	11/11/2013 12:09:00	1017	1017	$-0.1_{(I)}$	3.78	0.1	0.0	20.8	0.0	0.0	0.0	
CP201	4	---	15 secs	-	-	$0.0_{(SS)}$	-	0.2	0.0	19.6	0.0	0.0	0.0	
CP201	4	---	30 secs	-	-	-	-	0.2	0.0	16.8	0.0	0.0	0.0	
CP201	4	---	60 secs	-	-	-	-	0.3	0.0	11.7	0.0	0.0	0.0	
CP201	4	---	90 secs	-	-	-	-	0.4	0.0	11.6	0.0	0.0	0.0	
CP201	4	---	120 secs	-	-	-	-	0.5	0.0	11.6	0.0	0.0	0.0	
CP201	4	---	180 secs	-	-	-	-	0.6	0.0	11.6	0.0	0.0	0.0	
CP201	4	---	240 secs	-	-	-	-	0.7	0.0	11.4	0.0	0.0	0.0	
CP201	4	---	300 secs	-	-	-	-	0.7	0.0	11.5	0.0	0.0	0.0	
CP202	1	6.49	17/10/2013 10:52:00	1004	1004	-	6.43	0.1	0.0	20.8	0.0	0.0	0.0	
CP202	1	---	15 secs	-	-	-	-	0.2	0.0	20.3	0.0	0.0	0.0	
CP202	1	---	30 secs	-	-	-	-	0.2	0.0	20.3	0.0	0.0	0.0	
CP202	1	---	60 secs	-	-	-	-	0.2	0.0	20.3	0.0	0.0	0.0	
CP202	1	---	90 secs	-	-	-	-	0.2	0.0	20.2	0.0	0.0	0.0	
CP202	1	---	120 secs	-	-	-	-	0.2	0.0	20.2	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP202	1	---	180 secs	-	-	-	-	0.2	0.0	20.3	0.0	0.0	0.0	
CP202	1	---	240 secs	-	-	-	-	0.2	0.0	20.7	0.0	0.0	0.0	
CP202	1	---	300 secs	-	-	-	-	0.2	0.0	20.4	0.0	0.0	0.0	
CP202	2	6.48	22/10/2013 12:19:00	985	985	$0.0_{(I)}$	6.39	0.1	0.0	20.8	0.0	0.0	0.0	
CP202	2	---	15 secs	-	-	$0.0_{(SS)}$	-	0.1	0.1	20.4	1.0	0.0	0.0	
CP202	2	---	30 secs	-	-	-	-	0.0	0.1	19.5	1.0	0.0	0.0	
CP202	2	---	60 secs	-	-	-	-	0.1	0.1	19.3	1.0	0.0	0.0	
CP202	2	---	90 secs	-	-	-	-	0.1	0.0	19.3	0.0	0.0	0.0	
CP202	2	---	120 secs	-	-	-	-	0.1	0.0	19.3	0.0	0.0	0.0	
CP202	2	---	180 secs	-	-	-	-	0.1	0.1	19.3	1.0	0.0	0.0	
CP202	2	---	240 secs	-	-	-	-	0.1	0.0	19.4	0.0	0.0	0.0	
CP202	2	---	300 secs	-	-	-	-	0.1	0.0	19.5	0.0	0.0	0.0	
CP202	3	6.50	31/10/2013 08:10:00	1006	1007	$0.1_{(I)}$	5.85	0.1	0.0	20.8	0.0	0.0	0.0	
CP202	3	---	15 secs	-	-	$0.0_{(SS)}$	-	0.7	0.0	20.7	0.0	0.0	0.0	
CP202	3	---	30 secs	-	-	-	-	0.8	0.0	20.2	0.0	0.0	0.0	
CP202	3	---	60 secs	-	-	-	-	0.8	0.0	20.2	0.0	0.0	0.0	
CP202	3	---	90 secs	-	-	-	-	0.8	0.0	20.3	0.0	0.0	0.0	
CP202	3	---	120 secs	-	-	-	-	0.8	0.0	20.3	0.0	0.0	0.0	
CP202	3	---	180 secs	-	-	-	-	0.8	0.0	20.4	0.0	0.0	0.0	
CP202	3	---	240 secs	-	-	-	-	0.8	0.0	20.5	0.0	0.0	0.0	
CP202	3	---	300 secs	-	-	-	-	0.8	0.0	20.5	0.0	0.0	0.0	
CP202	4	6.47	11/11/2013 12:45:00	1017	1017	$0.0_{(I)}$	5.40	0.1	0.0	20.8	0.0	0.0	0.0	
CP202	4	---	15 secs	-	-	$-0.3_{(SS)}$	-	0.3	0.0	19.7	0.0	0.0	0.0	
CP202	4	---	30 secs	-	-	-	-	0.4	0.0	19.8	0.0	0.0	0.0	
CP202	4	---	60 secs	-	-	-	-	0.7	0.0	19.2	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

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Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP202	4	---	90 secs	-	-	-	-	0.7	0.0	19.2	0.0	0.0	0.0	
CP202	4	---	120 secs	-	-	-	-	0.8	0.0	19.1	0.0	0.0	0.0	
CP202	4	---	180 secs	-	-	-	-	0.8	0.0	19.1	0.0	0.0	0.0	
CP202	4	---	240 secs	-	-	-	-	0.8	0.0	19.2	0.0	0.0	0.0	
CP202	4	---	300 secs	-	-	-	-	0.8	0.0	19.1	0.0	0.0	0.0	
CP209	1	7.24	17/10/2013 13:14:00	1004	1004	-	1.14	0.0	0.0	20.8	0.0	0.0	0.0	
CP209	1	---	15 secs	-	-	-	-	0.0	0.0	19.2	0.0	1.0	0.0	
CP209	1	---	30 secs	-	-	-	-	0.0	0.0	19.3	0.0	0.0	0.0	
CP209	1	---	60 secs	-	-	-	-	0.0	0.0	19.8	0.0	2.0	0.0	
CP209	1	---	90 secs	-	-	-	-	0.0	0.0	19.9	0.0	0.0	0.0	
CP209	1	---	120 secs	-	-	-	-	0.0	0.0	19.8	0.0	0.0	0.0	
CP209	1	---	180 secs	-	-	-	-	0.0	0.0	19.9	0.0	0.0	0.0	
CP209	1	---	240 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP209	1	---	300 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP209	2	7.25	22/10/2013 09:50:00	987	987	$0.1_{(I)}$	1.03	0.0	0.0	20.8	0.0	0.0	0.0	
CP209	2	---	15 secs	-	-	$0.0_{(SS)}$	-	0.0	0.0	19.3	0.0	0.0	0.0	
CP209	2	---	30 secs	-	-	-	-	0.0	0.0	19.2	0.0	0.0	0.0	
CP209	2	---	60 secs	-	-	-	-	0.0	0.0	19.7	0.0	0.0	0.0	
CP209	2	---	90 secs	-	-	-	-	0.0	0.0	19.8	0.0	0.0	0.0	
CP209	2	---	120 secs	-	-	-	-	0.0	0.0	19.9	0.0	0.0	0.0	
CP209	2	---	180 secs	-	-	-	-	0.0	0.0	20.0	0.0	0.0	0.0	
CP209	2	---	240 secs	-	-	-	-	0.0	0.0	20.1	0.0	0.0	0.0	
CP209	2	---	300 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP209	3	7.30	30/10/2013 10:35:00	1007	1007	$-0.4_{(I)}$	0.96	0.0	0.0	20.8	0.0	0.0	0.0	

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IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP209	3	---	15 secs	-	-	-0.3$_{(SS)}$	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP209	3	---	30 secs	-	-	-	-	0.0	0.0	20.1	0.0	0.0	0.0	
CP209	3	---	60 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP209	3	---	90 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP209	3	---	120 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP209	3	---	180 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP209	3	---	240 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP209	3	---	300 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP209	4	7.23	11/11/2013 10:01:00	1017	1017	-0.1$_{(I)}$	0.74	0.1	0.0	20.8	0.0	0.0	0.0	
CP209	4	---	15 secs	-	-	0.0$_{(SS)}$	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP209	4	---	30 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP209	4	---	60 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP209	4	---	90 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP209	4	---	120 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP209	4	---	180 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP209	4	---	240 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP209	4	---	300 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP226	1	3.54	17/10/2013 14:05:49	1004	1004	-	1.26	0.0	0.0	20.8	0.0	0.0	0.0	
CP226	1	---	15 secs	-	-	-	-	0.4	0.0	19.4	0.0	0.0	0.0	
CP226	1	---	30 secs	-	-	-	-	0.4	0.0	18.8	0.0	0.0	0.0	
CP226	1	---	60 secs	-	-	-	-	0.4	0.0	18.6	0.0	0.0	0.0	
CP226	1	---	90 secs	-	-	-	-	0.4	0.0	18.7	0.0	0.0	0.0	
CP226	1	---	120 secs	-	-	-	-	0.4	0.0	18.5	0.0	0.0	0.0	
CP226	1	---	180 secs	-	-	-	-	0.4	0.0	18.5	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP226	1	---	240 secs	-	-	-	-	0.4	0.0	18.5	0.0	0.0	0.0	
CP226	1	---	300 secs	-	-	-	-	0.4	0.0	18.6	0.0	0.0	0.0	
CP226	2	3.44	24/10/2013 15:00:00	1008	1008	$0.0_{(I)}$	1.16	0.0	0.0	20.7	0.0	0.0	0.0	
CP226	2	---	15 secs	-	-	$0.0_{(SS)}$	-	0.0	0.0	19.6	0.0	0.0	0.0	
CP226	2	---	30 secs	-	-	-	-	0.0	0.0	18.3	0.0	0.0	0.0	
CP226	2	---	60 secs	-	-	-	-	0.0	0.0	18.7	0.0	0.0	0.0	
CP226	2	---	90 secs	-	-	-	-	0.0	0.0	19.2	0.0	0.0	0.0	
CP226	2	---	120 secs	-	-	-	-	0.0	0.0	19.4	0.0	0.0	0.0	
CP226	2	---	180 secs	-	-	-	-	0.0	0.0	19.7	0.0	0.0	0.0	
CP226	2	---	240 secs	-	-	-	-	0.0	0.0	20.0	0.0	0.0	0.0	
CP226	2	---	300 secs	-	-	-	-	0.0	0.0	20.1	0.0	0.0	0.0	
CP226	3	3.44	31/10/2013 11:30:00	1011	1011	$2.0_{(I)}$	1.08	0.0	0.0	20.8	0.0	0.0	0.0	
CP226	3	---	15 secs	-	-	$1.9_{(SS)}$	-	0.0	0.0	19.6	0.0	0.0	0.0	
CP226	3	---	30 secs	-	-	-	-	0.0	0.0	17.4	0.0	0.0	0.0	
CP226	3	---	60 secs	-	-	-	-	0.0	0.0	17.5	0.0	0.0	0.0	
CP226	3	---	90 secs	-	-	-	-	0.0	0.0	18.3	0.0	0.0	0.0	
CP226	3	---	120 secs	-	-	-	-	0.0	0.0	18.5	0.0	0.0	0.0	
CP226	3	---	180 secs	-	-	-	-	0.0	0.0	18.6	0.0	0.0	0.0	
CP226	3	---	240 secs	-	-	-	-	0.0	0.0	18.8	0.0	0.0	0.0	
CP226	3	---	300 secs	-	-	-	-	0.1	0.0	19.1	0.0	0.0	0.0	
CP226	4	3.48	11/11/2013 11:11:00	1017	1017	$-0.9_{(I)}$	1.13	0.1	0.0	20.8	0.0	0.0	0.0	
CP226	4	---	15 secs	-	-	$-0.7_{(SS)}$	-	0.2	0.0	16.1	0.0	11.0	0.0	
CP226	4	---	30 secs	-	-	-	-	0.2	0.0	16.0	0.0	0.0	0.0	
CP226	4	---	60 secs	-	-	-	-	0.2	0.0	16.2	0.0	4.0	0.0	
CP226	4	---	90 secs	-	-	-	-	0.2	0.0	17.1	0.0	5.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Abbey Park
Humber Road
Coventry
CV3 4AQ

Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP226	4	---	120 secs	-	-	-	-	0.1	0.0	17.4	0.0	2.0	0.0	
CP226	4	---	180 secs	-	-	-	-	0.1	0.0	17.8	0.0	2.0	0.0	
CP226	4	---	240 secs	-	-	-	-	0.1	0.0	17.9	0.0	0.0	0.0	
CP226	4	---	300 secs	-	-	-	-	0.1	0.0	18.0	0.0	0.0	0.0	
CP227	1	8.97	17/10/2013 12:45:00	1003	1003	-	1.96	0.1	0.0	20.8	0.0	0.0	0.0	
CP227	1	---	15 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP227	1	---	30 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP227	1	---	60 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP227	1	---	90 secs	-	-	-	-	0.0	0.0	20.7	0.0	0.0	0.0	
CP227	1	---	120 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP227	1	---	180 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP227	1	---	240 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP227	1	---	300 secs	-	-	-	-	0.0	0.0	20.8	0.0	0.0	0.0	
CP227	2	8.94	24/10/2013 14:32:00	1008	1008	$0.1_{(I)}$	1.88	0.0	0.0	20.7	0.0	0.0	0.0	
CP227	2	---	15 secs	-	-	$0.0_{(SS)}$	-	0.0	0.0	20.7	0.0	0.0	0.0	
CP227	2	---	30 secs	-	-	-	-	0.1	0.1	20.7	1.0	0.0	0.0	
CP227	2	---	60 secs	-	-	-	-	0.1	0.1	20.8	1.0	0.0	0.0	
CP227	2	---	90 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP227	2	---	120 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP227	2	---	180 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP227	2	---	240 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP227	2	---	300 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP227	3	8.93	30/10/2013 10:12:00	1007	1007	$0.2_{(I)}$	1.80	0.1	0.0	20.8	0.0	0.0	0.0	
CP227	3	---	15 secs	-	-	$0.1_{(SS)}$	-	0.1	0.0	20.5	0.0	0.0	0.0	

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RSK Environment Ltd
Abbey Park
Humber Road
Coventry
CV3 4AQ

Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP227	3	---	30 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	3	---	60 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	3	---	90 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	3	---	120 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	3	---	180 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	3	---	240 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	3	---	300 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP227	4	8.86	11/11/2013 09:26:00	1017	1017	$1.6_{(I)}$	1.64	0.1	0.0	20.8	0.0	0.0	0.0	
CP227	4	---	15 secs	-	-	$1.8_{(SS)}$	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP227	4	---	30 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP227	4	---	60 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP227	4	---	90 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP227	4	---	120 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP227	4	---	180 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP227	4	---	240 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP227	4	---	300 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP229	1	4.37	17/10/2013 13:44:01	1004	1004	-	1.62	0.0	0.0	20.8	0.0	0.0	0.0	
CP229	1	---	15 secs	-	-	-	-	1.1	0.0	14.4	0.0	0.0	0.0	
CP229	1	---	30 secs	-	-	-	-	1.1	0.0	10.8	0.0	0.0	0.0	
CP229	1	---	60 secs	-	-	-	-	1.1	0.0	10.2	0.0	0.0	0.0	
CP229	1	---	90 secs	-	-	-	-	1.1	0.0	10.1	0.0	0.0	0.0	
CP229	1	---	120 secs	-	-	-	-	1.2	0.0	10.2	0.0	0.0	0.0	
CP229	1	---	180 secs	-	-	-	-	1.2	0.0	10.0	0.0	0.0	0.0	
CP229	1	---	240 secs	-	-	-	-	1.2	0.0	10.0	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP229	1	---	300 secs	-	-	-	-	1.2	0.0	10.0	0.0	0.0	0.0	
CP229	2	4.36	22/10/2013 10:39:00	988	988	$1.0_{(I)}$	1.49	0.1	0.0	20.8	0.0	0.0	0.0	
CP229	2	---	15 secs	-	-	$0.6_{(SS)}$	-	0.7	0.0	18.6	0.0	0.0	0.0	
CP229	2	---	30 secs	-	-	-	-	1.0	0.0	13.8	0.0	0.0	0.0	
CP229	2	---	60 secs	-	-	-	-	0.6	0.0	16.3	0.0	0.0	0.0	
CP229	2	---	90 secs	-	-	-	-	0.6	0.0	16.8	0.0	0.0	0.0	
CP229	2	---	120 secs	-	-	-	-	0.5	0.0	17.0	0.0	0.0	0.0	
CP229	2	---	180 secs	-	-	-	-	0.5	0.0	17.9	0.0	0.0	0.0	
CP229	2	---	240 secs	-	-	-	-	0.4	0.0	18.2	0.0	0.0	0.0	
CP229	2	---	300 secs	-	-	-	-	0.3	0.0	18.8	0.0	0.0	0.0	
CP229	3	4.33	31/10/2013 11:05:00	1012	1011	$-0.3_{(I)}$	1.35	0.0	0.0	20.8	0.0	0.0	0.0	
CP229	3	---	15 secs	-	-	$-0.3_{(SS)}$	-	0.1	0.0	20.2	0.0	0.0	0.0	
CP229	3	---	30 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP229	3	---	60 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP229	3	---	90 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP229	3	---	120 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP229	3	---	180 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP229	3	---	240 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP229	3	---	300 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP229	4	4.31	11/11/2013 10:53:00	1017	1017	$11.2_{(I)}$	1.25	0.1	0.0	20.8	0.0	0.0	0.0	
CP229	4	---	15 secs	-	-	$1.9_{(SS)}$	-	0.5	0.0	20.3	0.0	0.0	0.0	
CP229	4	---	30 secs	-	-	-	-	0.4	0.0	20.4	0.0	0.0	0.0	
CP229	4	---	60 secs	-	-	-	-	0.3	0.0	20.5	0.0	0.0	0.0	
CP229	4	---	90 secs	-	-	-	-	0.3	0.0	20.5	0.0	0.0	0.0	
CP229	4	---	120 secs	-	-	-	-	0.3	0.0	20.5	0.0	0.0	0.0	

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RSK Environment Ltd
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Coventry
CV3 4AQ

Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP229	4	---	180 secs	-	-	-	-	0.3	0.0	20.6	0.0	0.0	0.0	
CP229	4	---	240 secs	-	-	-	-	0.3	0.0	20.6	0.0	0.0	0.0	
CP229	4	---	300 secs	-	-	-	-	0.3	0.0	20.5	0.0	0.0	0.0	
CP230	1	7.43	17/10/2013 13:02:41	1004	1004	-	2.49	0.1	0.0	20.8	0.0	0.0	0.0	
CP230	1	---	15 secs	-	-	-	-	0.6	0.0	19.3	0.0	0.0	0.0	
CP230	1	---	30 secs	-	-	-	-	0.5	0.0	18.7	0.0	0.0	0.0	
CP230	1	---	60 secs	-	-	-	-	0.3	0.0	19.3	0.0	0.0	0.0	
CP230	1	---	90 secs	-	-	-	-	0.3	0.0	19.8	0.0	0.0	0.0	
CP230	1	---	120 secs	-	-	-	-	0.3	0.0	19.8	0.0	0.0	0.0	
CP230	1	---	180 secs	-	-	-	-	0.3	0.0	19.7	0.0	0.0	0.0	
CP230	1	---	240 secs	-	-	-	-	0.3	0.0	19.8	0.0	0.0	0.0	
CP230	1	---	300 secs	-	-	-	-	0.3	0.0	19.8	0.0	0.0	0.0	
CP230	2	7.45	24/10/2013 14:45:00	1008	1008	$0.1_{(I)}$	2.19	0.0	0.0	20.8	0.0	0.0	0.0	
CP230	2	---	15 secs	-	-	$0.0_{(SS)}$	-	0.5	0.0	20.1	0.0	0.0	0.0	
CP230	2	---	30 secs	-	-	-	-	0.5	0.1	19.6	1.0	0.0	0.0	
CP230	2	---	60 secs	-	-	-	-	0.4	0.1	19.5	1.0	0.0	0.0	
CP230	2	---	90 secs	-	-	-	-	0.4	0.1	19.6	1.0	0.0	0.0	
CP230	2	---	120 secs	-	-	-	-	0.5	0.0	19.4	0.0	0.0	0.0	
CP230	2	---	180 secs	-	-	-	-	0.5	0.0	19.4	0.0	0.0	0.0	
CP230	2	---	240 secs	-	-	-	-	0.5	0.0	19.5	0.0	0.0	0.0	
CP230	2	---	300 secs	-	-	-	-	0.5	0.0	19.5	0.0	0.0	0.0	
CP230	3	7.46	30/10/2013 10:25:00	1006	1007	$-0.7_{(I)}$	2.14	0.1	0.0	20.7	0.0	0.0	0.0	
CP230	3	---	15 secs	-	-	$-0.4_{(SS)}$	-	0.3	0.0	20.0	0.0	0.0	0.0	
CP230	3	---	30 secs	-	-	-	-	0.3	0.0	19.4	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP230	3	---	60 secs	-	-	-	-	0.3	0.0	19.4	0.0	0.0	0.0	
CP230	3	---	90 secs	-	-	-	-	0.2	0.0	19.7	0.0	0.0	0.0	
CP230	3	---	120 secs	-	-	-	-	0.2	0.0	19.9	0.0	0.0	0.0	
CP230	3	---	180 secs	-	-	-	-	0.2	0.0	20.0	0.0	0.0	0.0	
CP230	3	---	240 secs	-	-	-	-	0.1	0.0	20.1	0.0	0.0	0.0	
CP230	3	---	300 secs	-	-	-	-	0.1	0.0	20.1	0.0	0.0	0.0	
CP230	4	7.42	11/11/2013 09:41:00	1017	1017	$2.0_{(I)}$	1.93	0.1	0.0	20.8	0.0	0.0	0.0	
CP230	4	---	15 secs	-	-	$1.9_{(SS)}$	-	0.1	0.0	20.0	0.0	0.0	0.0	
CP230	4	---	30 secs	-	-	-	-	0.2	0.0	20.0	0.0	0.0	0.0	
CP230	4	---	60 secs	-	-	-	-	0.2	0.0	20.0	0.0	0.0	0.0	
CP230	4	---	90 secs	-	-	-	-	0.2	0.0	20.1	0.0	0.0	0.0	
CP230	4	---	120 secs	-	-	-	-	0.2	0.0	20.1	0.0	0.0	0.0	
CP230	4	---	180 secs	-	-	-	-	0.2	0.0	20.0	0.0	0.0	0.0	
CP230	4	---	240 secs	-	-	-	-	0.2	0.0	20.2	0.0	0.0	0.0	
CP230	4	---	300 secs	-	-	-	-	0.2	0.0	20.1	0.0	0.0	0.0	
CP231	1	5.15	17/10/2013 13:33:18	1004	1004	-	1.23	0.0	0.0	20.8	0.0	0.0	0.0	
CP231	1	---	15 secs	-	-	-	-	0.2	0.0	18.7	0.0	0.0	0.0	
CP231	1	---	30 secs	-	-	-	-	0.2	0.0	17.1	0.0	0.0	0.0	
CP231	1	---	60 secs	-	-	-	-	0.2	0.0	16.7	0.0	0.0	0.0	
CP231	1	---	90 secs	-	-	-	-	0.2	0.0	16.6	0.0	0.0	0.0	
CP231	1	---	120 secs	-	-	-	-	0.2	0.0	16.8	0.0	0.0	0.0	
CP231	1	---	180 secs	-	-	-	-	0.2	0.0	16.9	0.0	0.0	0.0	
CP231	1	---	240 secs	-	-	-	-	0.2	0.0	16.8	0.0	0.0	0.0	
CP231	1	---	300 secs	-	-	-	-	0.2	0.0	16.8	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP231	2	5.15	24/10/2013 14:52:00	1006	1006	$0.0_{(I)}$	1.10	0.0	0.0	20.8	0.0	0.0	0.0	
CP231	2	---	15 secs	-	-	$0.0_{(SS)}$	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP231	2	---	30 secs	-	-	-	-	0.0	0.0	19.1	0.0	0.0	0.0	
CP231	2	---	60 secs	-	-	-	-	0.0	0.0	19.4	0.0	0.0	0.0	
CP231	2	---	90 secs	-	-	-	-	0.0	0.0	19.8	0.0	0.0	0.0	
CP231	2	---	120 secs	-	-	-	-	0.0	0.0	20.0	0.0	0.0	0.0	
CP231	2	---	180 secs	-	-	-	-	0.0	0.0	20.1	0.0	0.0	0.0	
CP231	2	---	240 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP231	2	---	300 secs	-	-	-	-	0.0	0.0	20.2	0.0	0.0	0.0	
CP231	3	5.14	31/10/2013 10:50:00	1011	1011	$0.2_{(I)}$	0.99	0.0	0.0	20.8	0.0	0.0	0.0	
CP231	3	---	15 secs	-	-	$0.1_{(SS)}$	-	0.0	0.0	20.4	0.0	0.0	0.0	
CP231	3	---	30 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP231	3	---	60 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP231	3	---	90 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP231	3	---	120 secs	-	-	-	-	0.0	0.0	20.4	0.0	0.0	0.0	
CP231	3	---	180 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP231	3	---	240 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP231	3	---	300 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP231	4	5.13	11/11/2013 10:23:00	1017	1017	$0.0_{(I)}$	0.87	0.1	0.0	20.8	0.0	0.0	0.0	
CP231	4	---	15 secs	-	-	$-0.1_{(SS)}$	-	0.1	0.0	20.4	0.0	3.0	0.0	
CP231	4	---	30 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP231	4	---	60 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP231	4	---	90 secs	-	-	-	-	0.1	0.0	20.5	0.0	12.0	0.0	
CP231	4	---	120 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP231	4	---	180 secs	-	-	-	-	0.1	0.0	20.6	0.0	4.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

RSK Environment Ltd
Abbey Park
Humber Road
Coventry
CV3 4AQ

Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP231	4	---	240 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP231	4	---	300 secs	-	-	-	-	0.1	0.0	20.5	0.0	1.0	0.0	
CP(R)201	1	24.30	17/10/2013 11:37:08	1007	1004	-	20.80	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)201	1	---	15 secs	-	-	-	-	0.9	0.0	20.0	0.0	0.0	0.0	
CP(R)201	1	---	30 secs	-	-	-	-	1.1	0.0	18.8	0.0	0.0	0.0	
CP(R)201	1	---	60 secs	-	-	-	-	1.1	0.0	18.9	0.0	0.0	0.0	
CP(R)201	1	---	90 secs	-	-	-	-	1.2	0.0	18.7	0.0	0.0	0.0	
CP(R)201	1	---	120 secs	-	-	-	-	1.2	0.0	18.5	0.0	0.0	0.0	
CP(R)201	1	---	180 secs	-	-	-	-	1.0	0.0	18.8	0.0	0.0	0.0	
CP(R)201	1	---	240 secs	-	-	-	-	0.9	0.0	19.1	0.0	0.0	0.0	
CP(R)201	1	---	300 secs	-	-	-	-	0.9	0.0	19.4	0.0	0.0	0.0	
CP(R)201	2	24.34	24/10/2013 15:31:00	1011	1008	$-4.0_{(I)}$	19.96	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)201	2	---	15 secs	-	-	$-4.1_{(SS)}$	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)201	2	---	30 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	2	---	60 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	2	---	90 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	2	---	120 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	2	---	180 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	2	---	240 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	2	---	300 secs	-	-	-	-	0.1	0.0	20.9	0.0	0.0	0.0	
CP(R)201	3	24.30	31/10/2013 08:47:00	1007	1007	$-0.9_{(I)}$	21.04	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)201	3	---	15 secs	-	-	$-0.8_{(SS)}$	-	0.6	0.0	20.5	0.0	0.0	0.0	
CP(R)201	3	---	30 secs	-	-	-	-	0.6	0.0	19.8	0.0	0.0	0.0	
CP(R)201	3	---	60 secs	-	-	-	-	0.6	0.0	19.7	0.0	0.0	0.0	

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RSK Environment Ltd
Abbey Park
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Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP(R)201	3	---	90 secs	-	-	-	-	0.6	0.0	19.8	0.0	0.0	0.0	
CP(R)201	3	---	120 secs	-	-	-	-	0.6	0.0	19.8	0.0	0.0	0.0	
CP(R)201	3	---	180 secs	-	-	-	-	0.6	0.0	19.8	0.0	0.0	0.0	
CP(R)201	3	---	240 secs	-	-	-	-	0.6	0.0	19.8	0.0	0.0	0.0	
CP(R)201	3	---	300 secs	-	-	-	-	0.6	0.0	19.9	0.0	0.0	0.0	
CP(R)201	4	24.30	11/11/2013 12:16:00	1017	1017	$1.7_{(I)}$	21.50	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)201	4	---	15 secs	-	-	$-4.9_{(SS)}$	-	0.2	0.0	20.5	0.0	20.0	0.0	
CP(R)201	4	---	30 secs	-	-	-	-	0.2	0.0	20.5	0.0	0.0	0.0	
CP(R)201	4	---	60 secs	-	-	-	-	0.3	0.0	20.4	0.0	2.0	0.0	
CP(R)201	4	---	90 secs	-	-	-	-	0.4	0.0	20.4	0.0	22.0	0.0	
CP(R)201	4	---	120 secs	-	-	-	-	0.5	0.0	20.2	0.0	0.0	0.0	
CP(R)201	4	---	180 secs	-	-	-	-	0.6	0.0	20.2	0.0	25.0	0.0	
CP(R)201	4	---	240 secs	-	-	-	-	0.7	0.0	20.1	0.0	23.0	0.0	
CP(R)201	4	---	300 secs	-	-	-	-	0.7	0.0	20.0	0.0	1.0	0.0	
CP(R)202	1	23.98	17/10/2013 11:03:31	1004	1004	-	16.74	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)202	1	---	15 secs	-	-	-	-	1.3	0.0	18.9	0.0	0.0	0.0	
CP(R)202	1	---	30 secs	-	-	-	-	1.3	0.0	18.5	0.0	0.0	0.0	
CP(R)202	1	---	60 secs	-	-	-	-	1.3	0.0	18.4	0.0	0.0	0.0	
CP(R)202	1	---	90 secs	-	-	-	-	1.3	0.0	18.4	0.0	0.0	0.0	
CP(R)202	1	---	120 secs	-	-	-	-	1.3	0.0	18.4	0.0	0.0	0.0	
CP(R)202	1	---	180 secs	-	-	-	-	1.4	0.0	18.6	0.0	0.0	0.0	
CP(R)202	1	---	240 secs	-	-	-	-	1.4	0.0	18.7	0.0	0.0	0.0	
CP(R)202	1	---	300 secs	-	-	-	-	1.4	0.0	18.4	0.0	0.0	0.0	
CP(R)202	2	23.98	22/10/2013 12:30:00	985	985	$0.1_{(I)}$	16.12	0.0	0.0	20.8	0.0	0.0	0.0	

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Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP(R)202	2	---	15 secs	-	-	$0.0_{(SS)}$	-	1.3	0.0	19.4	0.0	0.0	0.0	
CP(R)202	2	---	30 secs	-	-	-	-	1.4	0.0	18.1	0.0	0.0	0.0	
CP(R)202	2	---	60 secs	-	-	-	-	1.2	0.0	18.3	0.0	0.0	0.0	
CP(R)202	2	---	90 secs	-	-	-	-	1.2	0.0	18.3	0.0	0.0	0.0	
CP(R)202	2	---	120 secs	-	-	-	-	1.3	0.0	18.3	0.0	0.0	0.0	
CP(R)202	2	---	180 secs	-	-	-	-	1.1	0.0	18.2	0.0	0.0	0.0	
CP(R)202	2	---	240 secs	-	-	-	-	1.3	0.0	18.4	0.0	0.0	0.0	
CP(R)202	2	---	300 secs	-	-	-	-	1.5	0.0	18.0	0.0	0.0	0.0	
CP(R)202	3	23.97	30/10/2013 08:20:00	1007	1007	$-0.3_{(I)}$	16.54	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)202	3	---	15 secs	-	-	$-0.3_{(SS)}$	-	1.6	0.0	19.4	0.0	0.0	0.0	
CP(R)202	3	---	30 secs	-	-	-	-	1.8	0.0	17.6	0.0	0.0	0.0	
CP(R)202	3	---	60 secs	-	-	-	-	1.8	0.0	17.5	0.0	0.0	0.0	
CP(R)202	3	---	90 secs	-	-	-	-	1.9	0.0	17.4	0.0	0.0	0.0	
CP(R)202	3	---	120 secs	-	-	-	-	1.9	0.0	17.4	0.0	0.0	0.0	
CP(R)202	3	---	180 secs	-	-	-	-	1.9	0.0	17.5	0.0	0.0	0.0	
CP(R)202	3	---	240 secs	-	-	-	-	1.9	0.0	17.5	0.0	0.0	0.0	
CP(R)202	3	---	300 secs	-	-	-	-	1.9	0.0	17.5	0.0	0.0	0.0	
CP(R)202	4	23.97	11/11/2013 12:37:00	1017	1017	$2.9_{(I)}$	15.85	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)202	4	---	15 secs	-	-	$3.0_{(SS)}$	-	2.5	0.0	19.1	0.0	0.0	0.0	
CP(R)202	4	---	30 secs	-	-	-	-	3.1	0.0	15.4	0.0	0.0	0.0	
CP(R)202	4	---	60 secs	-	-	-	-	3.1	0.0	14.8	0.0	0.0	0.0	
CP(R)202	4	---	90 secs	-	-	-	-	3.1	0.0	14.8	0.0	0.0	0.0	
CP(R)202	4	---	120 secs	-	-	-	-	3.1	0.0	14.7	0.0	10.0	0.0	
CP(R)202	4	---	180 secs	-	-	-	-	3.1	0.0	14.7	0.0	0.0	0.0	
CP(R)202	4	---	240 secs	-	-	-	-	3.1	0.0	14.7	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP(R)202	4	---	300 secs	-	-	-	-	3.1	0.0	14.8	0.0	0.0	0.0	
CP(R)209	1	24.11	17/10/2013 13:21:00	1004	1004	-	1.12	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)209	1	---	15 secs	-	-	-	-	0.0	0.0	19.2	0.0	0.0	0.0	
CP(R)209	1	---	30 secs	-	-	-	-	0.0	0.0	18.3	0.0	0.0	0.0	
CP(R)209	1	---	60 secs	-	-	-	-	0.0	0.0	18.6	0.0	0.0	0.0	
CP(R)209	1	---	90 secs	-	-	-	-	0.0	0.0	18.8	0.0	0.0	0.0	
CP(R)209	1	---	120 secs	-	-	-	-	0.0	0.0	18.9	0.0	0.0	0.0	
CP(R)209	1	---	180 secs	-	-	-	-	0.0	0.0	19.2	0.0	0.0	0.0	
CP(R)209	1	---	240 secs	-	-	-	-	0.0	0.0	19.6	0.0	0.0	0.0	
CP(R)209	1	---	300 secs	-	-	-	-	0.0	0.0	19.7	0.0	0.0	0.0	
CP(R)209	2	24.12	22/10/2013 10:00:00	987	987	$0.2_{(I)}$	1.00	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)209	2	---	15 secs	-	-	$0.1_{(SS)}$	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP(R)209	2	---	30 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP(R)209	2	---	60 secs	-	-	-	-	0.0	0.0	20.4	0.0	0.0	0.0	
CP(R)209	2	---	90 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP(R)209	2	---	120 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)209	2	---	180 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)209	2	---	240 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)209	2	---	300 secs	-	-	-	-	0.0	0.0	20.7	0.0	0.0	0.0	
CP(R)209	3	24.01	30/10/2013 10:42:00	1011	1011	$-0.3_{(I)}$	0.74	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)209	3	---	15 secs	-	-	$-0.3_{(SS)}$	-	0.2	0.0	20.2	0.0	0.0	0.0	
CP(R)209	3	---	30 secs	-	-	-	-	0.2	0.0	19.6	0.0	0.0	0.0	
CP(R)209	3	---	60 secs	-	-	-	-	0.1	0.0	19.6	0.0	0.0	0.0	
CP(R)209	3	---	90 secs	-	-	-	-	0.1	0.0	19.8	0.0	0.0	0.0	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP(R)209	3	---	120 secs	-	-	-	-	0.1	0.0	19.9	0.0	0.0	0.0	
CP(R)209	3	---	180 secs	-	-	-	-	0.1	0.0	20.0	0.0	0.0	0.0	
CP(R)209	3	---	240 secs	-	-	-	-	0.1	0.0	20.0	0.0	0.0	0.0	
CP(R)209	3	---	300 secs	-	-	-	-	0.1	0.0	20.1	0.0	0.0	0.0	
CP(R)209	4	24.09	11/11/2013 10:13:00	1017	1017	$1.6_{(I)}$	0.70	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)209	4	---	15 secs	-	-	$1.9_{(SS)}$	-	0.5	0.0	20.4	0.0	0.0	0.0	
CP(R)209	4	---	30 secs	-	-	-	-	0.4	0.0	19.3	0.0	0.0	0.0	
CP(R)209	4	---	60 secs	-	-	-	-	0.4	0.0	19.7	0.0	0.0	0.0	
CP(R)209	4	---	90 secs	-	-	-	-	0.3	0.0	19.9	0.0	0.0	0.0	
CP(R)209	4	---	120 secs	-	-	-	-	0.3	0.0	19.9	0.0	2.0	0.0	
CP(R)209	4	---	180 secs	-	-	-	-	0.2	0.0	20.2	0.0	1.0	0.0	
CP(R)209	4	---	240 secs	-	-	-	-	0.2	0.0	20.3	0.0	4.0	0.0	
CP(R)209	4	---	300 secs	-	-	-	-	0.2	0.0	20.3	0.0	0.0	0.0	
CP(R)229	1	15.87	17/10/2013 13:51:22	1004	1004	-	1.49	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)229	1	---	15 secs	-	-	-	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP(R)229	1	---	30 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)229	1	---	60 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)229	1	---	90 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)229	1	---	120 secs	-	-	-	-	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)229	1	---	180 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)229	1	---	240 secs	-	-	-	-	0.0	0.0	20.6	0.0	0.0	0.0	
CP(R)229	1	---	300 secs	-	-	-	-	0.0	0.0	20.5	0.0	0.0	0.0	
CP(R)229	2	15.98	22/10/2013 10:48:00	988	988	$0.4_{(I)}$	1.50	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)229	2	---	15 secs	-	-	$0.6_{(SS)}$	-	0.1	0.0	20.7	0.0	0.0	0.0	

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Compiled By	Date	Checked By	Date	Contract Ref:
K. Foster	29/11/13		28/11/13	312494

Contract: **East Midlands Gateway**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Monitoring Round	Installation Depth (mbgl)	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulphide (ppm)	
CP(R)229	2	---	30 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP(R)229	2	---	60 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP(R)229	2	---	90 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP(R)229	2	---	120 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP(R)229	2	---	180 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP(R)229	2	---	240 secs	-	-	-	-	0.1	0.0	20.7	0.0	0.0	0.0	
CP(R)229	2	---	300 secs	-	-	-	-	0.1	0.0	20.8	0.0	0.0	0.0	
CP(R)229	3	15.76	31/10/2013 11:15:00	-	-	$0.2_{(I)}$	1.29	0.0	0.0	20.8	0.0	0.0	0.0	
CP(R)229	3	---	15 secs	-	-	$0.0_{(SS)}$	-	0.0	0.0	20.3	0.0	0.0	0.0	
CP(R)229	3	---	30 secs	-	-	-	-	0.1	0.0	20.2	0.0	0.0	0.0	
CP(R)229	3	---	60 secs	-	-	-	-	0.1	0.0	20.4	0.0	0.0	0.0	
CP(R)229	3	---	90 secs	-	-	-	-	0.1	0.0	20.4	0.0	0.0	0.0	
CP(R)229	3	---	120 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP(R)229	3	---	180 secs	-	-	-	-	0.1	0.0	20.4	0.0	0.0	0.0	
CP(R)229	3	---	240 secs	-	-	-	-	0.1	0.0	20.5	0.0	0.0	0.0	
CP(R)229	3	---	300 secs	-	-	-	-	0.1	0.0	20.6	0.0	0.0	0.0	
CP(R)229	4	15.70	11/11/2013 10:47:00	-	-	-	1.23	-	-	-	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

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Contract: **East Midlands Gateway**

GROUNDWATER MONITORING REPORT

Exploratory Position ID	Installation Date	Installation Depth (mbgl)	Response Zone	Installation Type	Instrument Diameter (mm)	Round	Date & Time of Monitoring	Water Depth (m bgl)	Groundwater Elevation (m AOD)	Remarks
CP201	01/10/2013	4.65	1.00 to 5.00		50	4	11/11/2013 12:09	3.78	71.48	
CP202	30/09/2013	6.49	1.00 to 6.50		50	1	17/10/2013 10:52	6.43	68.39	
CP202	30/09/2013	6.48	1.00 to 6.50		50	2	22/10/2013 12:19	6.39	68.43	
CP202	30/09/2013	6.50	1.00 to 6.50		50	3	31/10/2013 08:10	5.85	68.97	
CP202	30/09/2013	6.47	1.00 to 6.50		50	4	11/11/2013 12:45	5.40	69.42	
CP209	09/10/2013	7.24	1.00 to 4.40		50	1	17/10/2013 10:30	1.14	28.97	
CP209	09/10/2013	7.25	1.00 to 4.40		50	2	22/10/2013 09:50	1.03	29.08	
CP209	09/10/2013	7.30	1.00 to 4.40		50	3	30/10/2013 10:35	0.96	29.15	
CP209	09/10/2013	7.25	1.00 to 4.40		50	4	11/11/2013 10:01	0.74	29.37	
CP226	04/10/2013	3.54	1.00 to 3.70		50	1	17/10/2013 14:05	1.26	28.73	
CP226	04/10/2013	3.44	1.00 to 3.70		50	2	24/10/2013 15:00	1.16	28.83	
CP226	04/10/2013	3.44	1.00 to 3.70		50	3	31/10/2013 13:30	1.08	28.91	
CP226	04/10/2013	3.48	1.00 to 3.70		50	4	11/11/2013 11:11	1.13	28.86	
CP227	07/10/2013	8.97	7.80 to 9.80		50	1	16/10/2013 14:12	1.96	32.67	

Key: NDA denotes 'no data available'. Instrument Type Key:
Remarks: Absent borehole records indicates boreholes were dry at the time of the visits

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Contract: **East Midlands Gateway**

AGS

GROUNDWATER MONITORING REPORT

Exploratory Position ID	Installation Date	Installation Depth (mbgl)	Response Zone	Installation Type	Instrument Diameter (mm)	Round	Date & Time of Monitoring	Water Depth (m bgl)	Groundwater Elevation (m AOD)	Remarks
CP227	07/10/2013	8.94	7.80 to 9.80		50	2	24/10/2013 14:32	1.88	32.75	
CP227	07/10/2013	8.93	7.80 to 9.80		50	3	30/10/2013 10:12	1.80	32.83	
CP227	07/10/2013	8.86	7.80 to 9.80		50	4	11/11/2013 09:26	1.64	32.99	
CP229	10/10/2013	4.37	1.00 to 4.30		50	1	17/10/2013 13:44	1.62	28.69	
CP229	10/10/2013	4.36	1.00 to 4.30		50	2	22/10/2013 10:39	1.49	28.82	
CP229	10/10/2013	4.36	1.00 to 4.30		50	2 / 2	22/10/2013 10:57	1.49	28.82	Operator: GShaw, Weather: Overcast, Surface Conditions: Wet, General Remarks: 3xwell volume purged - full sample obtained
CP229	10/10/2013	4.33	1.00 to 4.30		50	3	31/10/2013 11:05	1.35	28.96	
CP229	10/10/2013	4.31	1.00 to 4.30		50	4	11/11/2013 10:53	1.25	29.06	
CP230	08/10/2013	7.43	4.60 to 7.60		50	1	17/10/2013 13:02	2.49	29.24	
CP230	08/10/2013	7.45	4.60 to 7.60		50	2	24/10/2013 14:45	2.19	29.54	
CP230	08/10/2013	7.46	4.60 to 7.60		50	3	30/10/2013 10:25	2.14	29.59	
CP230	08/10/2013	7.42	4.60 to 7.60		50	4	11/11/2013 09:41	1.93	29.80	
CP231	08/10/2013	5.15	1.00 to 5.40		50	1	17/10/2013 13:33	1.23	28.89	
CP231	08/10/2013	5.15	1.00 to 5.40		50	2	24/10/2013 14:52	1.10	29.02	
CP231	08/10/2013	5.14	1.00 to 5.40		50	3	31/10/2013 10:50	0.99	29.13	

Key: NDA denotes 'no data available'. Instrument Type Key:
Remarks: Absent borehole records indicates boreholes were dry at the time of the visits

GROUNDWATER MONITORING REPORT

Exploratory Position ID	Installation Date	Installation Depth (mbgl)	Response Zone	Installation Type	Instrument Diameter (mm)	Round	Date & Time of Monitoring	Water Depth (m bgl)	Groundwater Elevation (m AOD)	Remarks
CP231	08/10/2013	5.13	1.00 to 5.40		50	4	11/11/2013 10:23	0.87	29.25	
CP(R)201	02/10/2013	24.30	16.00 to 25.00		50	1	17/10/2013 11:37	20.80	54.46	
CP(R)201	02/10/2013	24.34	16.00 to 25.00		50	2	24/10/2013 15:31	19.96	55.30	
CP(R)201	02/10/2013	24.30	16.00 to 25.00		50	3	31/10/2013 18:47	21.04	54.22	
CP(R)201	02/10/2013	24.30	16.00 to 25.00		50	4	11/11/2013 12:16	21.50	53.76	
CP(R)202	01/10/2013	23.98	8.00 to 25.00		50	1	17/10/0147 11:03	16.74	58.08	
CP(R)202	01/10/2013	23.98	8.00 to 25.00		50	2	22/10/2013 12:30	16.12	58.70	
CP(R)202	01/10/2013	23.98	8.00 to 25.00		50	2 / 2	22/10/2013 13:25	16.12	58.70	Operator: GShaw, Weather: Overcast, Surface Conditions: Wet, General Remarks: 3xwell volume purged - full sample obtained
CP(R)202	01/10/2013	23.97	8.00 to 25.00		50	3	30/10/2013 08:20	16.54	58.28	
CP(R)202	01/10/2013	23.97	8.00 to 25.00		50	4	11/11/2013 12:37	15.85	58.97	
CP(R)209	08/10/2013	24.11	12.00 to 25.00		50	1	17/10/2013 13:14	1.12	28.95	
CP(R)209	08/10/2013	24.12	12.00 to 25.00		50	2	22/10/2013 10:00	1.00	29.07	
CP(R)209	08/10/2013	24.12	12.00 to 25.00		50	2 / 2	22/10/2013 11:30	1.00	29.07	Operator: GShaw, Weather: Overcast, Surface Conditions: Wet, General Remarks: 3xwell volume purged - full sample obtained
CP(R)209	08/10/2013	24.01	12.00 to 25.00		50	3	30/10/2013 10:42	0.74	29.33	
CP(R)209	08/10/2013	24.09	12.00 to 25.00		50	4	11/11/2013 10:13	0.70	29.37	

Key: NDA denotes 'no data available'. Instrument Type Key:
Remarks: Absent borehole records indicates boreholes were dry at the time of the visits

GROUNDWATER MONITORING REPORT

Exploratory Position ID	Installation Date	Installation Depth (mbgl)	Response Zone	Installation Type	Instrument Diameter (mm)	Round	Date & Time of Monitoring	Water Depth (m bgl)	Groundwater Elevation (m AOD)	Remarks
CP(R)229	09/10/2013	15.87	0.00 to 17.50		50	1	17/10/2013 13:51	1.49	28.80	
CP(R)229	09/10/2013	15.98	0.00 to 17.50		50	2	22/10/2013 10:53	1.50	28.79	
CP(R)229	09/10/2013	15.76	0.00 to 17.50		50	3	31/10/2013 11:15	1.29	29.00	
CP(R)229	09/10/2013	15.70	0.00 to 17.50		50	4	11/11/2013 10:53	1.23	29.06	

Key: NDA denotes 'no data available'. Instrument Type Key:
Remarks: Absent borehole records indicates boreholes were dry at the time of the visits

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Contract: **East Midlands Gateway**

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IN-SITU WATER MONITORING RESULTS

	Weather	Ground Conditions	Wind Conditions	Air Temperature (°C)	Equipment Used & Remarks
Round 2	Overcast	Wet	None	15	Dipmeter + GA2000 SN-GA07744

Exploratory Position ID	Pipe Ref	Pipe Diameter	Monitoring Round / Test Number	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring	Water Depth (mbgl)	pH	Conduc-tivity (uS/cm)	Temp-erature (°C)	Remarks
CP229	1	50	2 / 2	4.36	4.36	1.00 to 4.30	22/10/2013 10:57	1.49	7.21	1560	13.3	Operator: GShaw, Weather: Overcast, Surface Conditions: Wet, General Remarks: 3xwell volume purged - full sample
												obtained
CP(R)202	1	50	2 / 2	25.00	23.98	8.00 to 25.00	22/10/2013 13:25	16.12	6.10	265	11.7	Operator: GShaw, Weather: Overcast, Surface Conditions: Wet, General Remarks: 3xwell volume purged - full sample
												obtained
CP(R)209	1	50	2 / 2	25.00	24.12	12.00 to 25.00	22/10/2013 11:30	1.00	6.07	336	11.6	Operator: GShaw, Weather: Overcast, Surface Conditions: Wet, General Remarks: 3xwell volume purged - full sample
												obtained

Key: NDA denotes 'no data available'.

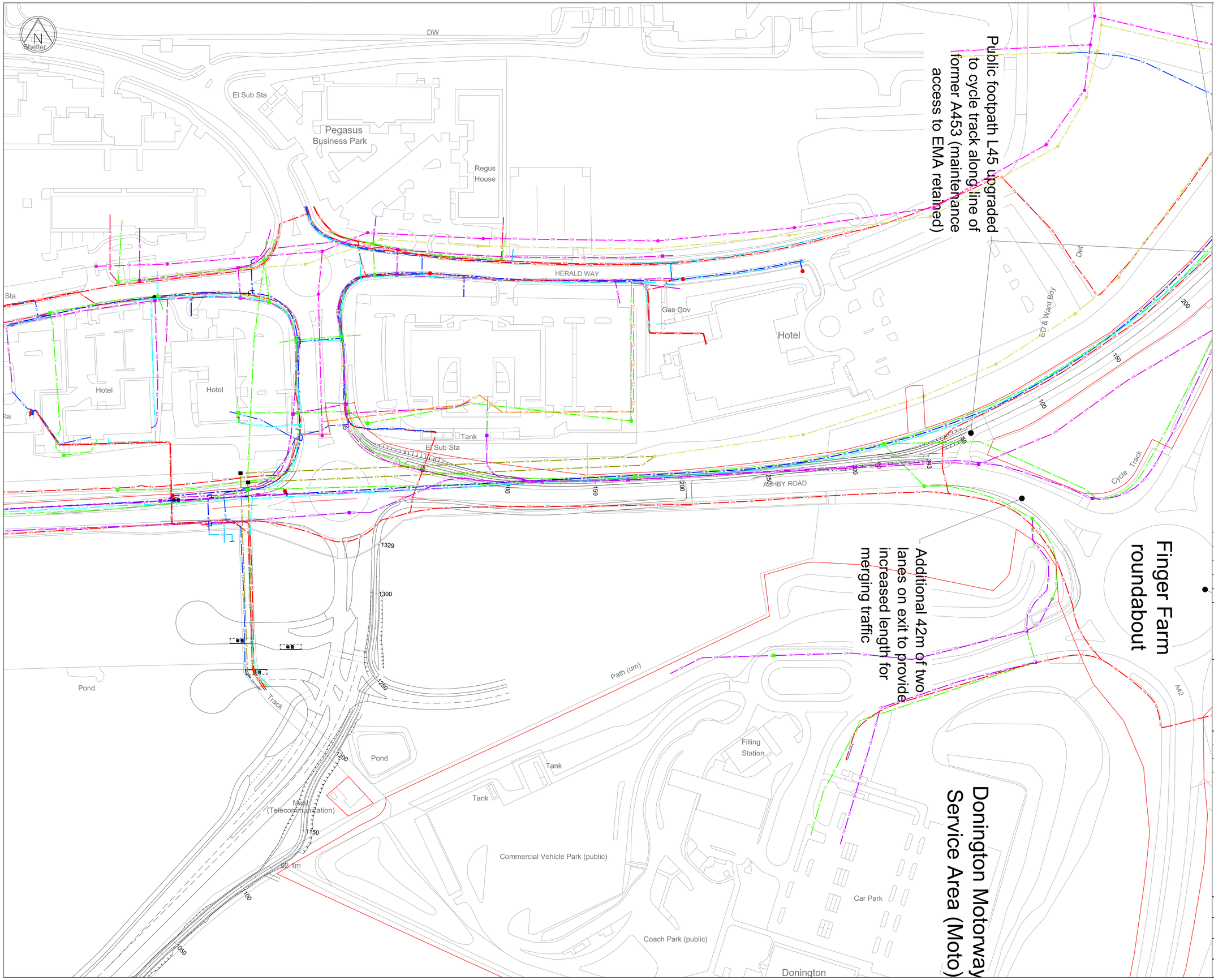
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Contract: **East Midlands Gateway**

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Appendix 5: Service Drawings



LEGEND

CADENT GAS

- Existing U/G LP Mains — GASLP
- Existing U/G MP Mains — GASMP

NATIONAL GRID ELECTRICITY DISTRIBUTION

- Existing U/G LV Cable — LV
- Existing U/G Service Cable — LV SERVICE
- Existing U/G HV Cable — HV
- Existing U/G Telecoms — TEL
- Existing U/G LV Cable OOU
- Existing U/G HV Cable OOU

OPENREACH

- U/G Plant — OR
- Joint Box
- Pole
- U/G Plant – Planned — OR
- Joint Box – Planned
- U/G Plant – Inferred — OR
- Joint Box – Inferred

SEVERN TRENT WATER – CLEAN

- Water Main — W
- Supply Pipe — SP
- Hydrant
- Wash Out
- Valve

SEVERN TRENT WATER – SEWER

- Public Foul Gravity/ Lateral Drain — FW
- Private Surface Gravity/ Lateral Drain — SW
- Pressure Public Foul — FW

VIRGIN MEDIA

- Duct — VIR
- Chamber

VODAFONE

- Existing Duct (Owned) — VOD
- Existing Duct (Leased) — VOD
- Chamber

ISSUE	DATE	REVISION DETAILS	DRN	CHK'D
C	20/08/25	Background Updated	JLR	-
B	19/12/24	Background Updated	JLR	-
A	30/09/24	Background Updated	JLR	-
Ist	06/08/24	1st Issue	JLR	-

Title

EAST MIDLANDS GATEWAY
(PHASE 2)
EMG2 ACCESS WORKS

Drawing

EXISTING UTILITY
COMPOSITE DRAWING

Job No.	UC24010	Date	AUGUST 2024
Drawn	JLR	Checked	-
Design	-	Appd	-

utilityconnections

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CLIENT	-
SCALE	1:1000 @ A1
DRAWING No.	4069-UCL-DR-MU-FEA-001
STATUS	FOR APPROVAL

Finger Farm roundabout

Additional 42m of two lanes on exit to provide increased length for merging traffic

Donington Park Services

M1

A42

Cycle Track

Gantry

Gantry

ED & Ward Bdy

Finger Farm ro

LEGEND

CADENT GAS

Existing U/G MP Mains — GAS(MP)

NATIONAL GRID ELECTRICITY DISTRIBUTION

Existing U/G LV Cable — LV

Existing U/G Service Cable — LV-S

Existing U/G HV Cable — HV

OPENREACH

U/G Plant — OR

Joint Box

U/G Plant - Inferred — OR

Joint Box - Inferred

SEVERN TRENT WATER - CLEAN

Water Main — W

SEVERN TRENT WATER - SEWER

Public Foul Gravity/ Lateral Drain — FW

VIRGIN MEDIA

Duct — VIR

Chamber

VODAFONE

Existing Duct (Owned) — VOD

Chamber

ISSUE	DATE	REVISION DETAILS	DRN	CHK'D
C	20/08/25	Background Updated	JLR	-
B	19/12/24	Background Updated	JLR	-
A	30/09/24	Background Updated	JLR	-
Ist	06/08/24	1st Issue	JLR	-

Title

EAST MIDLANDS GATEWAY
(PHASE 2)
FINGER FARM ROUNDABOUT

Drawing

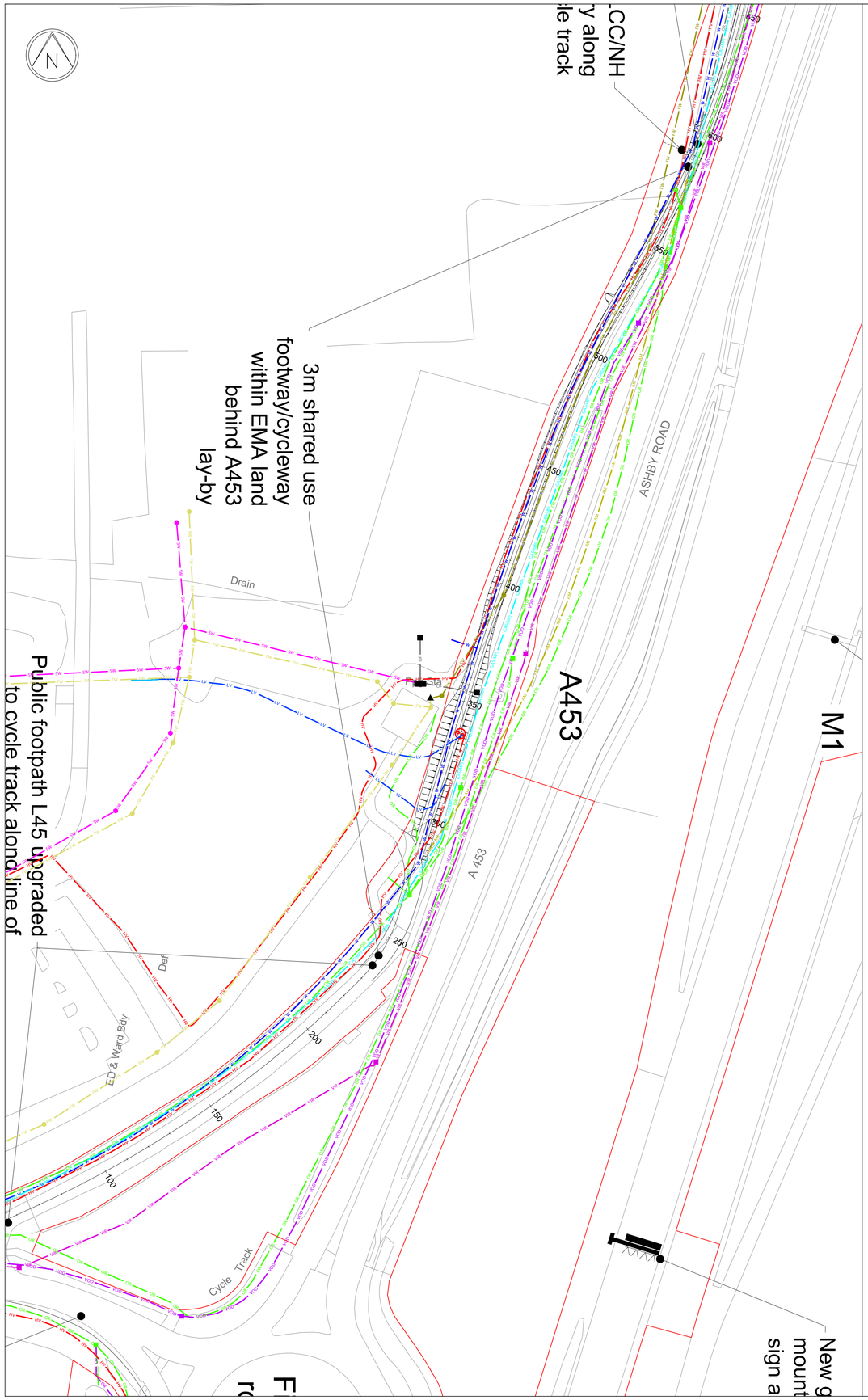
EXISTING UTILITY
COMPOSITE DRAWING

Job No.	UC24010	Date	AUGUST 2024
Drawn	JLR	Checked	-
Design	-	Appd	-

utilityconnections

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STATUS	FOR APPROVAL



LEGEND

CADENT GAS

- Existing U/G MP Mains (GASMP)

NATIONAL GRID ELECTRICITY DISTRIBUTION

- Existing U/G LV Cable (LV)
- Existing U/G Service Cable (LV-S)
- Existing U/G HV Cable (HV)
- Existing Overhead LV Cable (LV_OH)
- Existing Overhead HV Cable (HV_OH)

OPENREACH

- U/G Plant (OR)
- Joint Box
- Pole
- U/G Plant – Planned (OR)
- Joint Box – Planned
- U/G Plant – Inferred (OR)
- Joint Box – Inferred
- U/G Plant – Duct (OR)
- Overhead Plant (OR/OH)

SEVERN TRENT WATER – CLEAN

- Water Main (W)
- Abandoned Main (AM)
- Hydrant
- Wash Out
- Valve

SEVERN TRENT WATER – SEWER

- Public Foul Gravity/ Lateral Drain (FW)
- Private Surface Gravity/ Lateral Drain (SW)
- Pressure Public Foul (FW)
- Overflow Pipe (OF)

VIRGIN MEDIA

- Duct (VIR)
- Chamber

VODAFONE

- Existing Duct (Owned) (VOD)
- Chamber

ISSUE	DATE	REVISION DETAILS	DRN	CHK'D
C	20/08/25	Background Updated	JLR	-
B	19/12/24	Background Updated	JLR	-
A	30/09/24	Background Updated	JLR	-
Ist	06/08/24	1st Issue	JLR	-

Title

EAST MIDLANDS GATEWAY
(PHASE 2)
A453 FOOTWAY/CYCLEWAY LINK

Drawing

EXISTING UTILITY
COMPOSITE DRAWING

Job No.	UC24010	Date	AUGUST 2024
Drawn	JLR	Checked	-
Design	-	Appd	-

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CLIENT	-
SCALE	1:1000 @ A1
DRAWING No.	4069-UCL-DR-MU-FEA-001
STATUS	FOR APPROVAL

Appendix 6: Geotechnical Risk Register

Risk Classification and Required Action

Likelihood		Severity				
		1	2	3	4	5
		Minor	Moderate	Serious	Major	Catastrophic
1	Extremely unlikely	1	2	3	4	5
2	Unlikely	2	4	6	8	10
3	Likely	3	6	9	12	15
4	Extremely likely	4	8	12	16	20
5	Almost certain	5	10	15	20	25

Risk Classification	
Low (1-8)	Ensure assumed control measures are maintained and reviewed as necessary.
Medium (9-19)	Additional control measures are needed to reduce the risk rating to a level that is equivalent to a test of “reasonably required” for.
High (20-25)	Activity not permitted. Hazard to be avoided or risk to be reduced to tolerable level.

The risk classification is the product of the likelihood and the severity

Potential Severity of Harm Occurring		
1	Minor	Minor damage or loss - (no human injury)
2	Moderate	Moderate damage or loss - (slight injury or illness)
3	Serious	Substantial damage or loss - (Serious injury or illness)
4	Major	Major damage or loss - (Fatal injury)
5	Catastrophic	Catastrophic loss or damage - (Multiple fatalities)

The purpose of the register is to provide an assessment of the risk to the project posed by common ground related problems and identify suitable mitigation measures to control the risk to an acceptable level. The risk register will be developed and refined as the geotechnical design and assessment progresses such that the register will allow the management of the geotechnical risks.

The list of hazards identified in this Geotechnical Risk Register is non-exhaustive and has been selected on specific critical hazards that are relevant to this scheme having regard to health and safety, environmental, works program and cost considerations. The degree of risk is determined by combining the likelihood of the hazard occurring and the severity of its Impact: Risk = Likelihood x Severity that the hazard and associated mitigation will cause if it occurs. The scale against which the likelihood and severity are measured, and the resulting degree of risk determined, are presented below. The register is a live document that will be updated as the project develops to reflect additional data and experience.

No	Hazard	Consequence	Risk Owner	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Risk
1	Ground conditions on site vary from those considered in the design.	Foundation depth may be over cautious and difficult to install or under-cautious leading to potential instability.	Designer	3	3	9	Undertake PSSR to determine scope of ground investigation required.	1	3	4
2	Working near live highway / footway / cycleway	Potential danger to traffic	Contractor	2	4	8	Adopt a safe system of work.	1	4	4
3	Underground services / utilities	Damage to utilities could pose a potential danger to operatives. Inconvenience to utility customers. Delays to programme and reputational damage.	Contractor	3	4	12	Service plans to be consulted and services to be drawn on location-specific plans and section drawings. Services to be traced on site. Standard good site practice to be adopted.	1	4	4
4	Culvert Extension: Potential for instability due to poor design and/ or construction	Safety of road users, cost and inconvenience of repair.	Designer	2	3	6	Design and settlement prediction by established methods. Survey monitoring to be undertaken before, during and after installation of trenchless crossings.	1	3	3
5	Quality of fill for new earthworks	Could lead to slope instability or other problems. Additional cost Delays to construction	Designer, Contractor	4	3	12	Fill is to be site-won from the development area where possible. Existing ground investigation to be reviewed and more undertaken. Assessment required to include suitability for re-use as fill. If ground conditions in areas of cut are expected to be soft and waterlogged, modification of this material may be required to make it suitable for re use as fill.	2	3	6

No	Hazard	Consequence	Risk Owner	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Risk
6	Variable existing fill	Variability of existing M69 embankment fill (1970s) leading to localised variation in slope stability and settlement relating to new buildouts or cuttings.	Designer, Contractor	2	2	4	Geotechnical focussed ground investigation to assess conditions at locations of key proposals. Design to consider potential variation in existing fill. Contractor to identify unexpected ground conditions if encountered on site.	1	2	2
7	Groundwater impacting geotechnical performance of new works over the anticipated design life of 120 years	Potential for fluctuating / increasing groundwater levels due to climate change or other variables to impact on long term performance of structures / earthworks.	Designer, Contractor	2	3	6	Geotechnical design to include sensitivity analysis on groundwater levels/conditions. Contractor to consider drainage performance during construction sequencing.	1	3	3
8	Flood Risk	Potential for surface water and groundwater flooding in cuttings and at the toe of new and existing embankments.	Designer, Contractor, Asset Owner	4	3	12	Design to consider risk from flooding and localised mitigation measures to improve or maintain resilience of the asset.	2	3	6
9	Temporary Works or Retaining walls	Collapse of parts of the proposed works or existing infrastructure if not done correctly.	Contractor	3	4	12	To be considered further at design and construction stages. Temporary Works designs and implementation to be undertaken by suitably qualified engineers / contractor	1	4	4

No	Hazard	Consequence	Risk Owner	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Risk
10	Electricity pylon beside southbound on slip at junction 2 of M69.	Instability if affected by construction works with costly mitigation and disruption and risk to life at extreme.	Designer, Contractor, Asset Owner	3	4	12	Suitable investigation and design to ensure risks are managed. Contractor to consider and manage temporary works to minimise risk.	1	4	4

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