



Former Labour Exchange Earthworks Specification Report

Hale Construction Limited

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1. INTRODUCTION

1.1 Authorisation

Hydrock Consultants Ltd has been commissioned by Hale Construction Ltd (Hale) to prepare a Specification for the earthworks required during the remediation of the cut partially soil nailed slope that was installed in order to facilitate the construction of residential houses at Labour Exchange, Merthyr Tydfil (the Site). This Earthworks Specification forms part of wider engineering services project design works the Client has appointed Hydrock to undertake.

1.2 Specification

This Earthworks Specification deals with site-specific earthworks requirements. The following provides a method specification for the proposed earthworks at the site. The contractor is to perform all necessary acceptability and compliance testing (self-certification) to ensure works are carried out in accordance with the guidance in the Department for Transport (DfT) Manual of Contract Documents for Highway Works (MCHW) Volume 1 Specification for Highway Works (SHW), Series 600 Earthworks dated November 2009.

Other engineering requirements (both earthworks and non-earthworks) are shown on the other relevant drawings that form the contract documentation.

UK best practice is to be adopted in the compaction, much of this is embodied in the SHW and it supporting guidance notes.

1.3 Previous Investigation

The following site investigation reports have been completed by Hydrock Ltd:

- Geotechnical Ground Investigation Factual Report for Former Labour Exchange, Merthyr Tydfil, issued by Hydrock Consultants Limited, January 2018, ref. LEM-HYD-XX-GI-RP-G-1000-S2-P1;
- Geotechnical Interpretive Report on Ground Investigation for Former Labour Exchange Merthyr Tydfil issued by Hydrock Consultants Limited, July 2018, ref. LEM-HYD-XX-GI-RP-G-1001-S2-P1; and
- Geotechnical Design Report for Former Labour Exchange Merthyr issued by Hydrock Consultants, October 2018, ref. LEM-HYD-XX-XX-RP-G-1002-S2-P1.

The following relevant reports have been issued by others:

- Tweedie Evans Consulting Ltd, April 2014. Preliminary Geo-Environmental and Geotechnical Assessment Report
- Soil Nail Design with Associated Temporary Works Design Report for the site issued by Groundsolve Ltd on 16 October 2016.

Testing and assessment provided within these reports has been considered during the production of this Earthworks Specification.

1.4 Scope of Works

The proposed development was initially designed to comprise twelve detached residential houses with associated gardens and a block of flats toward the southern boundary of the site. A road was designed to access the twelve properties from the rear and this has involved the development of a soil nailed slope which forms the western boundary of the site.

The original development as described within the Geotechnical Interpretative Report issued by Hydrock on the 9 July 2018 has been adversely affected by the part-construction of a soil nailed cut slope which forms the western boundary of the site. Subsequent localised stability issues have been experienced at the site and including sloughing/voiding of material between and behind the soil nail bearing plates resulting in multiple nail tendon exposures and bulging of the retention geotextile (Maccaferri MacMat R – Geomat and double twisted steel mesh).

The original proposal shows the road level as 194mAOD with a soil nailed cut slope above it; however, the most current topographical survey shows the level as approximately 198mAOD, i.e. up to 4 meters above this level. Hydrock has been informed that the proposed development of the site was abandoned by the sub-contractor due to significant shallow failures within the cut slope face between the soil nail heads. This instability has been attributed to unexpected ground conditions which resulted in the washing out of soils due to surface water saturation of multiple granular lenses exposed by the cut slope. Correspondence between parties at the time suggests that ground conditions experienced during soil nailing were not expected by the designer however Hydrock would note that a robust design should have considered drainage of the slope as well as a robust facing system designed to work in conjunction with the reinforced slope to prevent erosion and degradation of the exposed surfaces between the nail head plates.

Due to these historical issues Hydrock have been commissioned to compile an earthworks specification to remediate and fill the cut slope back to a near-original state.

Maximum cut/fill depths are -1.00m and 6.73m respectively. The total cut volume is approximately 2520m³ and total fill volume is approximately 5777m³.

Engineered Fill will be required for much of the development, the requirements are detailed in Appendix 6/6.

The following outline scope of works are required as part of the earthwork's operations:

- construction of a retaining wall along the toe of the slope, which bounds Pen-y-darren Road;
- re-profiling of existing materials to form benches on which to place fill materials;
- filling with specified imported materials to build the slope back up to near-original level; and
- installation of drainage channels within the slope and behind the proposed retaining wall at the toe to remove excess groundwater from the slope.

Design details for the slope and drainage are provided in the Hydrock Geotechnical Design Report referenced in Section 1.3 above (ref. LEM-HYD-XX-XX-RP-G-1002).

1.5 Definitions

The various terms in this Specification relate to the following:

- Contractor: Principal Contractor (Hale Construction Limited)
- Overseeing Organisation: Client (Wales and West Housing)
- Supervisor: Representative for the Overseeing Organisation on-site (Hydrock)
- Topsoil: shall mean the top layer of soil that can support vegetation.
- Made Ground; shall mean existing soils that are present on site that have originated from previous deposition by man.

- Acceptable material; shall comprise all that which is acceptable for use in the Works and which is capable of being compacted in the manner specified elsewhere to form a stable fill. The classification of acceptable suitable material is detailed in Table 6/1.
- Engineered Fill: shall be defined as fill which is selected, placed and compacted to an appropriate specification so that it will exhibit the required engineering behaviour.
- Unacceptable Material shall comprise the following.
 - » Unacceptable material class U1A: Material that complies with Clause 601.2 of the SHW but does not comply with the permitted constituents and material properties of Table 6/1 of Appendix 6/1 or elsewhere in Appendix 6/1 for acceptable material.
 - » Unacceptable material class U1B: Contaminated materials that comply with Clause 601.2 of the SHW; including controlled wastes (defined in EPA 1990 Part IIA) whose level of contamination is above that given in either Appendix 6/14 or in Appendix 6/15 but excluding all hazardous wastes (as defined in Hazardous waste (England and Wales) Regulations 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).
 - » Unacceptable material class U2: Hazardous wastes (as defined in Hazardous waste (England and Wales) Regulations 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).

The Contractor shall be responsible for classifying and determining acceptability of all earthworks materials in accordance with the Specification on the basis of tests carried out both at the point of excavation and at the points of deposition for both on-site and imported materials.

The source(s) of imported material shall be agreed with the Supervisor before it is permitted for any materials to be brought to site.

1.6 Ground Levels

The Contractor shall satisfy himself that the existing ground levels as described on the drawings included with the Works Information are correct. Should the Contractor wish to dispute any levels he shall submit to the Supervisor a schedule of the position of the levels considered to be in error and a set of revised levels. The existing ground relevant to the disputed levels shall not be disturbed before the correct levels are determined. All level survey information and an assessment of volumes, as required by the Supervisor, shall be provided within 7 working days of request.

Upon completion of the works, a level survey of all areas shall be undertaken by the Contractor. All level survey information and an assessment of volumes, as required by the Supervisor, shall be provided within 7 working days of request.

1.7 Health and Safety

The works will be subject to Construction (Design and Management) 2015 Regulations.

The works shall be carried out in a manner as to safeguard all site employees. This shall include, but not be limited to the provision of:

- Site induction for all staff and visitors;
- Training / safety awareness courses;
- The issue of personnel protective equipment; and
- Suitable welfare facilities.

The works shall be carried out in a manner to protect against damage to property on site or in its immediate vicinity.

Appropriate temporary protection and warning signs shall be erected to warn of hazards that are a consequence of the works.

Throughout the works the contractor must operate and follow safe working practices for dealing with buried services in order to undertake excavations and earthworks operations safely. Prior to breaking ground, services plans are to be consulted and the area scanned using a Cable Avoidance Tool (CAT) and, if deemed necessary by the Contractor be subject to a Ground Penetrating Radar survey with detected signals marked on the ground and recorded on updated services plan drawings.

Furthermore, there is a risk of additional services, not marked on the plans, being encountered on site. The Contractor shall operate a safe system of work to account for the potential of unknown buried services when performing operations which involve breaking the ground.

Details of the Contractor's Health and Safety Risk Assessments and proposed welfare facilities shall be stated in the method statements.

1.8 Responsibility for the Works

The Contractor is to 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; or
- other third-party contractors undertaking works on the site.

The Contractor should ensure they have a copy of all reports detailed in Section 1.3.

2. THE SITE

2.1 Site Investigation

Hydrock has been provided with a Preliminary Geo-Environmental and Geotechnical Assessment report issued by Tweedie Evans Consulting in April 2014 and the Soil Nail Design report issued by GroundSolve Ltd in October 2016. This information has been supplemented with data obtained from additional ground investigation carried out by Hydrock to further develop the conceptual site model (CSM).

This specification should be read in conjunction with the documentation from all investigations, as referenced in Section 1.3, where applicable.

2.2 Ground Conditions

The ground conditions at the site are detailed within the previously issued Hydrock reports referenced in Section 1.3 and the Contractor is referred to these for further details. However, the stratigraphy at the site can broadly be summarised as:

- Made Ground – comprising soft and stiff, light brown sandy and silty gravelly CLAY containing clinker, fused coal ash and red brick;
- Upper Glacial Till (fine-grained) – comprising soft, firm and stiff orangish brown mottled light brown sandy gravelly CLAY and SILT/clayey GRAVEL;
- Lower Glacial Till (coarse-grained) – comprising cobbles and boulders of siltstone recovered as sub-rounded cobble sized fragments and subangular to sub-rounded gravel; and
- South Wales Lower Coal Measures – comprising very stiff dark grey gravelly SILT and strong greyish blue SILTSTONE recovered as coarse gravel and sub angular cobble sized fragments.

2.3 Groundwater

On-going monitoring shows a steady increase in groundwater levels at each borehole installation across the site between July and September 2018. It is likely to continue to rise to levels recorded during the initial stages of monitoring in January 2017 and to respond significantly to prolonged periods of heavy rainfall. See Figure 2.3 below for a summary of groundwater monitoring to date.

The groundwater regime for the site is complex, the groundwater is present within the upper Glacial Till and the more granular lower Glacial Till horizon. Additionally, localised perched water permeates through granular lenses within the upper cut/soil nailed slope. The final drainage solution should be designed to prevent the engineered fill component from becoming inundated by groundwater. If attenuation of the collected waters is necessary prior to discharge, then the attenuation solution should be robust, such that leakage is minimised.

For the slope analysis, groundwater has been modelled in the most relevant scenarios. This includes a worst-case scenario with groundwater entering the fill component.

Further detail regarding the groundwater regime is available in the previously issued Hydrock reports referenced in Section 1.3 and the Contractor is referred to these for details.

3. CLASSIFICATION OF EARTHWORKS MATERIALS

3.1 General

The earthworks operation will comprise re-profiling of site-won material and placement of a significant volume of imported fill.

Preliminary suitability of on-site material has been assessed using SHW Table 6/1 (attached) and on the basis of limited classification testing. This is discussed further in Section 3.2.

The required performance properties of imported fill have been determined by computational slope stability analysis and this is discussed further in Section 3.3.

3.2 Potential Site-Won Materials

The principal soil types identified within the proposed areas of cut/fill across the site together with provisional earthworks classifications are summarised in Table 4.1, though are subject to further testing by the Contractor in accordance with Table 1/5.

Table 3.1: Preliminary Earthworks Classification of Site-Won Materials

Strata	Provisional Earthworks Class in accordance with SHW Series 600	Comments
Topsoil	Class 5A (site-won) or 5B (imported)	-
Made Ground	Class 1 or 2	Limited classification testing to date
Upper Glacial Till	Predominantly Class 2C	Locally, possibly, Class 2A or 1A
Lower Glacial Till	Predominantly Class 1A	Locally, possibly, Class 2C
South Wales Lower Coal Measures	Possibly Class 2A	Limited classification testing to date

A significant amount of variability has been identified by the limited classification testing carried out to date and all excavated soils of their respective strata should be stockpiled separately prior to further classification and acceptability testing by the Contractor.

A volume of approximately 1820m³ and 447m³ of site won soils will be generated from the retaining wall excavations and drainage trenching works. A volume of 500m³ will also be generated from the removal of poorly placed Made Ground at the current carriageway level (198mAOD). A proportion of this may be reusable as General Fill in Zone D provided it meets specific criteria detailed in this report. The remainder will be removed from the site. Currently, a Materials Management Plan (MMP) does not exist for the site-works and this will need to be procured as soon as possible.

3.3 Imported Fill and Slope Geometry

A significant volume of imported fill will be required to return the slope to a near-original profile.

Hydrock has subdivided the entire slope into four zones based on slope stability assessment results, namely Zone A, B, C and D with maximum slope angles and specified internal angle of frictions for imported Class 6N Structural Granular Fill designated to each zone.

Further details are provided in the Hydrock Geotechnical Design Report (ref. LEM-HYD-XX-XX-RP-G-1002) and requirements for each zone are summarised in the Table 3.2 below:

Table 3.2: Recommended phi (ϕ) angle and slope gradients versus Engineered Fill Zone designation

Fill Zone Area Designation	Section Lines	Approximate Slope Gradients (degrees from horizontal plane)	Recommended Minimum (ϕ') Phi Angle for Imported Fill	Recommended Material Classification
A	1-1'	16	35 degrees	Class 6N
	2-2'	21-22		
B	3-3'	26	45 degrees	Class 6N
	4-4'	25-29		
C	5-5'	21-22	35 degrees	Class 6N
	6-6'	14-15		
	7-7'	13		
D	8-8'	9	25 degrees	Class 6N or site won material with a minimum undrained shear strength of 50kPa
	9-9'	9		

- Zone A – Class 6N1 imported engineered fill to have minimum angle of internal friction (ϕ') of 35°;
- Zone B – Class 6N2 imported engineered fill constructed using imported Class 6N fill with a minimum ϕ' angle of 45°;
- Zone C – Class 6N1 imported engineered fill to have minimum ϕ' of 35°;
- Zone D – Class 6N3 imported or Class 1/Class 2 (possibly site-won) fill, or better, with a minimum ϕ' of 25° and minimum undrained shear strength of 50kN/m².

Certificates confirming these fill properties should be obtained from source and filed in site records for later verification.

4. EARTHWORKS & COMPLIANCE

4.1 General Requirements

The existing soil nails and facing are to remain in-situ. Soil nail heads should be wrapped in Denso-Tape or similar approved before burial by the engineered fill component.

Any topsoil should be stripped and stockpiled separately prior to earthworks; the stockpiles should not exceed a duration of two years.

Excavations and areas to be filled shall be free from loose soil, rubbish and standing water.

Use of frozen materials or materials containing ice is not permitted. Fill is not to be placed on frozen surfaces.

All necessary precautions to be taken to ensure the stability of adjacent structures. Place and compact fill against structures, membranes or buried services in a sequence and manner which will ensure stability and avoid damage.

Plant employed for transporting, laying and compacting must be suited to the type of material being handled.

Lay differing materials separately so that only one type of material occurs in each layer.

Where, during the progress of the work, the difference in level between adjacent areas of filling exceeds 600mm and a height equivalent to the depth of a layer of compacted filling, suitable benching should be employed. Spreading and compaction of new filling should be undertaken to ensure maximum continuity with the previous filling.

Stockpiles and the formation level will need to be protected during inclement weather; all formations should be trimmed to falls to shed rain water and the surface sealed to limit infiltration.

Damage caused to filled material by construction traffic shall be kept to a minimum and made good where appropriate. The Contractor will be responsible for reporting any areas of damage/disaggregation etc, as a result of construction traffic.

4.2 Compaction Method (Method Specification)

It is envisaged that all suitable fill can be placed in accordance with a Method Placement as defined in SHW Table 6/4 and HA 70/94.

Preliminary material acceptability testing has been described in Section 3. However, the Contractor is required to undertake material acceptability testing of all earthworks materials in accordance with Table 1/5 (attached).

Periodic site visits and compliance testing will be carried out by the Principal Contractor or third party to provide guidance to the Contractor, though Hydrock do not accept any liability for failure to comply with the method specification.

4.3 Material Acceptability Testing

Earthworks materials are to comply with Series 600 of the Highways Agency 'The Manual of Contract Documents for Highway Works' and with the particular requirements of this Report. Permitted classes of construction materials are defined in the following tables (enclosed within this report):

- Table 6/1 - Acceptable Earthworks Materials: Classification and Compaction Requirements; and
- Table 6/2 - Grading Requirements for Acceptable Earthworks Materials;
- Appendix 1/5: Testing to be Carried Out by The Contractor

The shear strength properties of the engineered fill element should be confirmed at source and a certificate of confirmation provided to the Contractor and Supervisor. Class 2 material properties should be tested and confirmed using a Hand Shear Vane and Direct Shear Box apparatus.

Please refer to Appendix 1/5 for information regarding testing requirements.

All earthworks materials are to meet the acceptability limits as set out in the site-specific Tables 6/1 and Table 6/2 within this report.

Any of the materials set out in Table 6/1 may be used for Class 4 Landscape Fill, if required, subject to the material being compatible for use with the proposed landscape and planting requirements and/or the proposed surface finish. The suitability of imported materials must be confirmed by consulting Appendix 6/14 and 6/15, also in this report.

4.4 Special Requirements for Determining Acceptability

Acceptability testing of site-won and imported material is to be the responsibility of the Contractor and be carried out in accordance with Specification Table 6/1 and at the frequencies given in Table 1/5 in a UKAS/MCERTS 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. Each test position and location shall include the coordinated position corrected to National Grid Reference (NGR) and the reduced level corrected to Ordnance Datum (m OD) as well as any other pertinent identification such as layer number and test grid reference. The Contractor is to provide a drawing in AutoCAD presenting the location and date of all test samples as part of their reporting, which may be sub-divided into a series of drawings to aid in their presentation of data.

The Contractor is to maintain full records on each different type of imported materials including but not limited to, the location of the sources, the supplier's details, the acceptability testing and the location it has been incorporated within the works.

On completion of the works, an Earthworks Validation Report, following the general form of a Geotechnical Feedback Report (GFR) as defined by Design Manual for roads and bridges DMRB HD 22/08, is to be prepared by the Contractor and submitted to the Overseeing Organisation and shall include, as a minimum, the following:

1. General description of the earthworks, excavations, placement and compaction methodology and plant used.
2. Detailed weather conditions (to include daily maximum and minimum temperature, wind speed and direction, humidity, prevailing weather and daily rainfall as a minimum).
3. Formation and foundation treatment including ground improvement, drainage measures and treatment of soft areas.
4. Application of acceptability criteria and summary of the control test results for each specific earthworks material placed during the earthworks operations.

5. A copy of all relevant test results including grid location and level.
6. Drawings showing the location of each specific earthworks material placed during the earthworks operations and any feature or operation relevant to the earthworks.
7. An electronic copy of all the test results and monitoring associated with the earthworks operations.

4.5 Requirements for Groundwater Control

The Contractor is responsible for all groundwater control and management where this is required for the purposes of the construction works. This is particularly relevant, but is not limited to, dewatering of deep excavations and trenches, and the control of surface water.

The Contractor shall provide for such measures as may be necessary to ensure that groundwater, precipitation or any other water source does not accumulate in excavations or on subgrades.

The Contractor shall allow for such seasonal and other variations to the groundwater levels that might reasonably be anticipated.

Where, in the opinion of the Supervisor, earthworks have been adversely affected by the ingress of water during the earthworks contract so as to render the material unacceptable, the affected works shall be removed and made good at the Contractor's expense.

4.6 Requirements for Off-Site Removal of Materials

No material is to be removed from site without the prior agreement of the Supervisor.

Surplus material is to be temporarily stockpiled in areas designated for spoil storage and as agreed with the Supervisor. The earthworks design of any temporary stockpiles is the responsibility of the Contractor's Temporary Works Designer.

4.7 Requirements for Placement of Structural Fill

Class 6N materials shall be used as Structural Granular Fill in the locations described in Appendix 6/6.

The Contractor shall compact Class 6N materials to satisfy the compaction requirements as listed in Table 6/1, but subject to the restrictions in sub-Clauses 4 and 5 of Clause 612 in the SHW Series 600.

The Contractor shall restrict compaction plant used on fill to structures, within 2 m of a structure, to the following items as described in sub-Clause 612.10 and listed in Table 6/4:

- i) vibratory roller having a mass per metre width of roll, as determined by sub-Clause 612.10, not exceeding 1,300 kg with a total mass not exceeding 1,000 kg;
- ii) vibrating plate compactor having a mass not exceeding 1,000 kg;
- iii) vibro-tamper having a mass not exceeding 75 kg.

The compacted level of the fill within this zone shall not differ during construction from the compacted level of the remainder of the adjoining fill to structures by more than 250 mm.

4.8 Compaction Compliance

Table 6/1 defines the acceptability limits for the earthworks material to be used during this project, which are to be determined by the Contractor in advance of the main works.

Following classification of the fill sources and confirmation of the acceptability criteria, fill may be placed in accordance with Table 6/4.

Compliance testing should be carried out at the discretion of the Contractor in order to satisfy themselves that compaction is adequate. However, the Supervisor (Hydrock) will also carry out nominal compliance testing at a minimum frequency of 1 sand replacement density test per 500m³ of material placed to monitor the quality of compaction and offer guidance as deemed necessary.

If the material to be deposited as fill subsequently reaches a condition where it cannot be compacted to the requirements of this specification the contractor is to obtain the Supervisor's approval for:

1. making good by removing the material from site until it is in a suitable condition for reuse and replaced with suitable material or making good the material by mechanical or chemical means; or
2. ceasing work until the physical condition of the material is such that it can be compacted as described in this specification.

5. TABLES

Table 1/5: Testing to be carried out by the contractor

Clause	Work, Goods or Material		Test	Frequency	Comments
	Acceptable Limits				
	Class	General Description			
Acceptability Testing					
601, C631, to 637, 640	Class 1	General Granular Fill for Zone D only	MC, Grading & Uniformity Coefficient	1 per 500m³	The minimum number of tests will be 3 per source, before the source can be approved by the Engineer for use on site.
			Particle Density	1 per 1000m³	
			Chemical Analysis	5 per source	
			Direct Shear Device (Shear Box)	1 per 500m³	
	Class 2	General Cohesive Fill for Zone D only	MC/PI & Grading	1 per 500m³	Test frequency relates to the class of material from each source.
			2.5kg Proctor Compaction	1 per 500m³	
			Chemical Analysis	5 per source	
			Hand Shear Vane	1 per 500m³	
	Class 5A/5B	Topsoil (Various locations TBC)	Grading	1 per 100m³	If multiple sources of the same class are used, each source shall be tested at the frequency stated in Appendix 1/5.
			Chemical Analysis	and 8 tests per source	
	Class 6N	Selected Granular Fill for Zone A/B/C/D	Grading & Uniformity Coefficient	1 per 500m³	Where the volume of a single source used in the earthwork's operation is in excess of 3,000m³, once 3,000m³ has been used the frequency of testing may be reduced by the Engineer.
			2.5kg Proctor Compaction	Source Approval followed by 1 per 500m³	
			Certification/confirmation of shear strength properties required from Direct Shear Device (Shear Box)		

Notes:

1. Unless otherwise stated above, it shall be the Contractors responsibility to undertake all sampling and testing in this table. This shall include all materials to be incorporated into the permanent works, materials which require processing by mechanical, physical, chemical or other means to render it suitable for reuse within the permanent works (Class U1A & U1B) and Class U2 materials which are unsuitable for inclusion in the permanent works.
2. Every source material must be tested for geotechnical acceptability limits before the source can be approved by the Supervising Engineer for use within the permanent works. Where the volume of a single source used in the earthworks operation is in excess of 3,000m³, once a volume of 5,000m³ has been used the rate of testing may be reduced at the discretion of the Supervising Engineer.
3. Any material imported to site must be tested and assessed against the re-use criteria for geotechnical and chemical suitability, with results submitted to and approved by the Supervising Engineer before the source material is brought to site.
4. All testing must be UKAS or MCERTS accredited where possible.

5. Frequency of testing applies to each separate earthwork's material within each of the earthwork's material class.
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:
 - a. MC: natural moisture content;
 - b. OMC: optimum moisture content;
 - c. PI: Plasticity Index, consisting of Liquid Limit, Plastic Limit and Plasticity Index;
 - d. MDD: maximum dry density.
9. For **Chemical Testing** requirements, the Contractor shall refer to Appendix 6/14 and Appendix 6/15.
10. Cell pressures for Direct Shear Device testing to be 35kPa – 70kPa – 140kPa

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	Class	
				Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
						Lower	Upper				
1	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 6/4 Method 2 OMC determined by Proctor Compaction test	1	A
				(ii) uniformity coefficient	See note 5	10	-				
				(iii) mc & OMC/MDD	BS 1377-2 & 4	OMC -2%	OMC +2%				
				(iv) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
1	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 6/4 Method 3 OMC determined by Proctor Compaction test	1	B
				(ii) uniformity coefficient	See note 5	-	10				
				(iii) mc & OMC/MDD	BS 1377-2 & 4	OMC -2%	OMC +2%				
				(iv) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
1	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 6/4 Method 3	1	C
				(ii) uniformity coefficient	See note 5	-	10				
				(iii) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					

GENERAL GRANULAR FILL

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	Class	
				Property (See Exceptions in Previous Column)	Defined and Tested In Accordance with:	Acceptable limits Within:					
						Lower	Upper				
2	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 6/4 Method 1 MDD determined using 2.5kg Proctor Compaction test and to include measurement of particle density 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) MC & OMC/MDD	BS 1377-2 & 4	PL-4% 105% MDD and 10% air voids	95% MDD				
				(iii) undrained shear strength (c)	SHW Clause 633	50 kN/m ²	-				
				(iv) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
2	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 6/4 Method 2 MDD determined using 2.5kg Proctor Compaction test and to include measurement of particle density	2	B	
				(ii) MC & OMC/MDD	BS 1377-2 & 4	105% MDD and 10% air voids	PL-4% 95% MDD				
				(iii) undrained shear strength (c)	SHW Clause 633	80 kN/m ²	-				
				(iv) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
2	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 6/4 Method 2 MDD determined using 2.5kg Proctor Compaction test and to include measurement of particle density	2	C	
				(ii) MC & OMC/MDD	BS 1377-2	105% MDD and 10% air voids	95% MDD				
				(iii) undrained shear strength (c)	SHW Clause 633	50 kN/m ²	-				
				(iv) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					

GENERAL COHESIVE FILL

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	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	D	-	Silty cohesive material	General fill	Any material, or combination of materials (excluding those listed in SHW Clause 6.1.2 (i) (b)) other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2		SHW Table 6/4 Method 3 MDD determined using 2.5kg Proctor Compaction test and to include measurement of particle density	2	D	-
							(ii) MC & OMC/MDD	BS 1377-2 & 4	105% MDD and 10% air voids	95% MDD				
							(iii) undrained shear strength of remoulded material (c _u)	SHW Clause 633	50 kN/m²	-				
							(iv) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
LANDSCAPE	4	-	-	Various	Fill to Landscape Areas	Any material, or combination of materials, other than chalk, complying with (i) and (ii) or (i) and (iii)	(i) grading	BS 1377-2	-	125mm	SHW Clause 620	4	-	-
							(ii) undrained shear strength of remoulded material	Hand shear vane (see note 7)	40 kN/m²					
							(iii) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
TOPSOIL	5	A	-	Topsoil, or turf, existing on site	Topsolling	Topsoil or turf designated as Class 5A in the Contract	(i) grading	SHW Clause 618	-	Clause 618	In agreement with the Ecological Consultant	5	A	-
							(ii) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					
		5	B	-	Imported topsoil	Topsolling	General purpose grade complying with BS 3882	(i) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15		In agreement with the Ecological Consultant	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	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	N	1	Selected well graded granular material	Earthworks Fill to Zones A/C	Natural gravel, natural sand, crushed rock, (other than argillaceous rock, chalk or colliery spoil), crushed concrete or any combination thereof. Recycled aggregates except recycled asphalt.	(i) grading	BS 1377-2 (on-site)	SHW Table 6/2		End product 95% of Maximum Dry Density. MDD determined using 2.5kg Proctor Compaction test and to include measurement of particle density.	6	N	1
		BS EN 933-2 (off-site)	SHW Table 6/5											
	(ii) uniformity coefficient	See note 5	10				-							
	(iii) undrained shear parameters (c and ϕ)													
	(iv) effective angle of friction (ϕ') and effective cohesion (c')	SHW Clause 636	Minimum (ϕ') = 35 degrees											
	(v) MC & OMC/MDD	BS 1377-2 & 4	105% of MDD				95% of MDD							
			(vi) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15									
SELECTED GRANULAR FILL	6	N	2	Selected well graded granular material	Earthworks Fill to Zone B	Natural gravel, natural sand, crushed rock, (other than argillaceous rock, chalk or colliery spoil), crushed concrete or any combination thereof. Recycled aggregates except recycled asphalt.	(i) grading	BS 1377-2 (on-site)	SHW Table 6/2			6	N	2
		BS EN 933-2 (off-site)	SHW Table 6/5											
	(ii) uniformity coefficient	See note 5	10											
	(iii) undrained shear parameters (c and ϕ')													
	(iv) effective angle of friction (ϕ') and effective cohesion (c')	SHW Clause 636	Minimum (ϕ') = 45 degrees											

						(v) MC & OMC/MDD	BS 1377-2 & 4	105% of MDD	95% of MDD				
						(vi) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					

SELECTED GRANULAR FILL	6	N	3	Selected well graded granular material	Earthworks Fill to Zone D	Natural gravel, natural sand, crushed rock, (other than argillaceous rock, chalk or colliery spoil), crushed concrete or any combination thereof. Recycled aggregates except recycled asphalt.	(i) grading	BS 1377-2 (on-site)	SHW Table 6/2			6	N	3
								BS EN 933-2 (off-site)	SHW Table 6/5					
							(ii) uniformity coefficient	See note 5	10					
							(iii) undrained shear parameters (c and ϕ')							
							(iv) effective angle of friction (ϕ') and effective cohesion (c')	SHW Clause 636	Minimum (ϕ') = 25 degrees					
							(v) MC & OMC/MDD	BS 1377-2 & 4	105% of MDD	95% of MDD				
							(vi) Chemical Analysis	App 6/14 & 6/15	App 6/14 & 6/15					

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. Otherwise, shear strength testing requirements are 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 Supervising Engineer.
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).

TABLE 6/2: (05/04) Grading Requirements for Acceptable Earthworks Materials Other Than Classes 6F4, 6F5 and 6S

Percentage by Mass Passing the Size Shown																				
Class	Size (mm)		Size (mm) BS Series												Size (microns) BS Series				Size (microns)	Class
	500	300	125	90	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63	2
1A		100	95-100																<15	1A
1B			100																<15	1B
1C	100		10-95													0-25			<15	1C
2A & 2B			100											80-100					15-100	2A & 2B
2C			100											15-80					15-80	2C
2D			100																80-100	0-20 2D
6A	100									0-100		0-85				0-45			0-5	6A
6B	100		0-10																	6B
6C			100			0-100					0-100		0-35	0-10		0-2				6C
6D										100		89-100		60-100	30-100	15-80	5-48	0-15 except 0-20 for crushed rock		6D
6E & 6R			100	85-100						25-100						10-100			<15	6E & 6R
6F1					100	75-100				40-95		30-85				10-50			<15	6F1
6F2			100	80-100	65-100	45-100				15-60		10-45				0-25			0-12	6F2
6F3			100	80-100	65-100	45-100				15-60		10-45				0-25			0-12	6F3
6H								100				60-100			15-45	0-25		0-5		6H
6I & 6J			100		85-100				25-100					15-100		9-100			<15	6I & 6J
6K								100											0-10	6K
6L										100		89-100		60-100	30-100	15-100	5-70	0-15 except 0-20 for crushed rock		6L

TABLE 6/2: (11/05) Grading Requirements for Acceptable Earthworks Materials (continued)

Percentage by Mass Passing the Size Shown																					
Class	Size (mm)		Size(mm) BS Series													Size (microns) BS Series				Size (microns)	Class
	500	300	125	90	75	37.5	28	20	14	10	6.3	5	3.35	2	1.18	600	300	150	63	2	
6M					100														0-10		6M
6N & 6P					100														<15		6N & 6P
6S					100									60-100		30-90		4-45	0-16		6S

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 1 to Method 6)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 1		Method 2		Method 3		Method 4		Method 5		Method 6		
			D	N#	D	N#	D	N#	D	N	D	N	N for D = 110 mm	N for D = 150 mm	N for D = 250 mm
Smoothed wheeled roller (or vibratory roller operating without vibration)	1	Mass per metre width of roll: over 2100 kg up to 2700 kg	125	8	125	10	125	10*	175	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	125	6	125	8	125	8*	200	4	unsuitable	unsuitable	16	unsuitable	unsuitable
	3	over 5400 kg	150	4	150	8	unsuitable	unsuitable	300	4	unsuitable	unsuitable	8	16	unsuitable
Grid roller	1	Mass per metre width of roll: over 2700 kg up to 5400 kg	150	10	unsuitable	12	150	10	250	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	150	8	125	12	unsuitable	unsuitable	325	4	unsuitable	unsuitable	20	unsuitable	unsuitable
	3	over 8000 kg	150	4	150	12	unsuitable	unsuitable	400	4	unsuitable	unsuitable	12	20	unsuitable
Deadweight tamping roller	1	Mass per metre width of roll: over 4000 kg up to 6000 kg	225	4	150	12	250	4	350	4	unsuitable	unsuitable	12	20	unsuitable
	2	over 6000 kg	300	5	200	12	300	3	400	4	unsuitable	unsuitable	8	12	20
Pneumatic-tyred roller	1	Mass per wheel: over 1000 kg up to 1500 kg	125	6	unsuitable	10*	150	10*	240	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	150	5	unsuitable	12	unsuitable	unsuitable	300	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	3	over 2000 kg up to 2500 kg	175	4	125	10	unsuitable	unsuitable	350	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	4	over 2500 kg up to 4000 kg	225	4	125	10	unsuitable	unsuitable	400	4	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	5	over 4000 kg up to 6000 kg	300	4	125	10	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	12	unsuitable	unsuitable
	6	over 6000 kg up to 8000 kg	350	4	150	8	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	12	unsuitable	unsuitable
	7	over 8000 kg up to 12000 kg	400	4	150	8	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	10	16	unsuitable
	8	over 12000 kg	450	4	175	6	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable	8	12	unsuitable
Vibratory tamping roller	1	Mass per metre width of a vibrating roll: over 700 kg up to 1300 kg	100	12	100	12	150	12	100	10	unsuitable	unsuitable	unsuitable	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	125	12	125	12	175	12*	175	8	unsuitable	unsuitable	12	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	150	12	150	12	200	12*	unsuitable	unsuitable	unsuitable	unsuitable	8	12	unsuitable
	4	over 2300 kg up to 2900 kg	150	9	150	9	250	12*	unsuitable	unsuitable	400	5	6	10	unsuitable
	5	over 2900 kg up to 3600 kg	200	9	200	9	275	12*	unsuitable	unsuitable	500	6	6	10	unsuitable
	6	over 3600 kg up to 4300 kg	225	9	225	9	300	12*	unsuitable	unsuitable	600	6	4	8	unsuitable
	7	over 4300 kg up to 5000 kg	250	9	250	9	300	9*	unsuitable	unsuitable	700	6	3	7	12
	8	over 5000 kg	275	9	275	9	300	7*	unsuitable	unsuitable	800	6	3	6	10

TABLE 6/4: Method Compaction for Earthworks Materials: Plant and Methods (Method 7)
(This Table is to be read in conjunction with sub-Clause 612.10)

Type of Compaction Plant	Ref No.	Category	Method 7	
			N for D = 150 mm	N for D = 250 mm
Smooth wheeled roller (or vibratory roller operating without vibration)	1	Mass per metre width of roll: over 2100 kg up to 2700 kg	unsuitable	unsuitable
	2	over 2700 kg up to 5400 kg	unsuitable	unsuitable
	3	over 5400 kg	12	unsuitable
Grid roller	1	Mass per metre width of roll: over 2700 kg up to 5400 kg	unsuitable	unsuitable
	2	over 5400 kg up to 8000 kg	16	unsuitable
	3	over 8000 kg	8	unsuitable
Deadweight tamping roller	1	Mass per metre width of roll: over 4000 kg up to 6000 kg	4	8
	2	over 6000 kg	3	6
Pneumatic-tyred roller	1	Mass per wheel: over 1000 kg up to 1500 kg	unsuitable	unsuitable
	2	over 1500 kg up to 2000 kg	12	unsuitable
	3	over 2000 kg up to 2500 kg	6	unsuitable
	4	over 2500 kg up to 4000 kg	5	unsuitable
	5	over 4000 kg up to 6000 kg	4	16
	6	over 6000 kg up to 8000 kg	unsuitable	8
	7	over 8000 kg up to 12000 kg	unsuitable	4
	8	over 12000 kg	unsuitable	4
Vibratory tamping roller	1	Mass per metre width of vibrating roll: over 700 kg up to 1300 kg	unsuitable	unsuitable
	2	over 1300 kg up to 1800 kg	unsuitable	unsuitable
	3	over 1800 kg up to 2300 kg	16	unsuitable
	4	over 2300 kg up to 2900 kg	12	unsuitable
	5	over 2900 kg up to 3600 kg	10	unsuitable
	6	over 3600 kg up to 4300 kg	8	16
	7	over 4300 kg up to 5000 kg	7	14
	8	over 5000 kg	6	12
Vibratory roller	1	Mass per metre width of vibrating roll: over 270 kg up to 450 kg	unsuitable	unsuitable
	2	over 450 kg up to 700 kg	unsuitable	unsuitable
	3	over 700 kg up to 1300 kg	unsuitable	unsuitable
	4	over 1300 kg up to 1800 kg	unsuitable	unsuitable
	5	over 1800 kg up to 2300 kg	12	unsuitable
	6	over 2300 kg up to 2900 kg	10	unsuitable
	7	over 2900 kg up to 3600 kg	10	unsuitable
	8	over 3600 kg up to 4300 kg	8	unsuitable
	9	over 4300 kg up to 5000 kg	8	unsuitable
	10	over 5000 kg	6	12
Vibratory plate compactor	1	Mass per m ² of base plate: over 880 kg up to 1100 kg	unsuitable	unsuitable
	2	over 1100 kg up to 1200 kg	unsuitable	unsuitable
	3	over 1200 kg up to 1400 kg	unsuitable	unsuitable
	4	over 1400 kg up to 1800 kg	10	unsuitable
	5	over 1800 kg up to 2100 kg	8	unsuitable
	6	over 2100 kg	6	unsuitable
Vibro-tamper	1	Mass: over 50 kg up to 65 kg	unsuitable	unsuitable
	2	over 65 kg up to 75 kg	unsuitable	unsuitable
	3	over 75 kg up to 100 kg	unsuitable	unsuitable
	4	over 100 kg	8	unsuitable

TABLE 6/5: (11/05) Off-Site Grading Requirements for Class 6 Acceptable Earthworks Materials

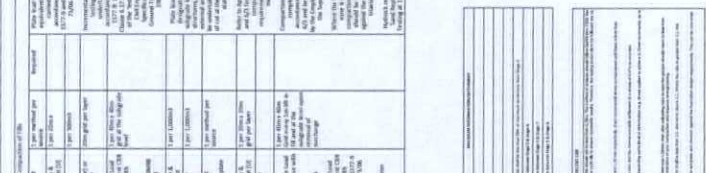
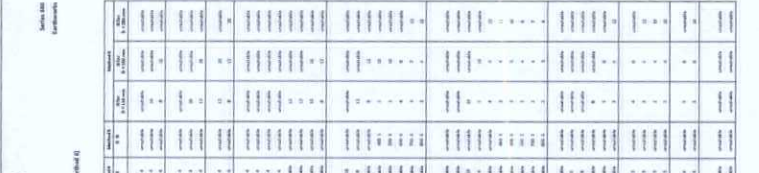
Percentage by Mass Passing the Size Shown																				
Class	Size (mm)		Size(mm) BS EN 933-2 Series.													Size (microns) BS EN 933-2 Series				Class
	500	300	125	80	63	40	31.5	20	16	10	8	6.3	4	2	1	500	250	125	63	
	500	300								0-100		0-85					0-45			63
6A	100																		0-5	6A
6B	100		0-10																	6B
6C			100			0-100						0-100	0-35	0-10			0-2			6C
6D										100			85-100	60-100	30-100	15-80	5-48	0-15 except 0-20 for crushed rock		6D
6E & 6R			100	85-100						25-100							10-100		<15	6E & 6R
6F3			100	75-99		50-90		30-75		15-60				0-35					0-12	6F3
6F4					100		75-99		50-90		30-75		15-60		0-35				<15	6F4
6F5			100	75-99		50-90		30-75		15-60				0-35			0-25	0-5	0-12	6F5
6H								100				60-100			15-45					6H
6I & 6J			100	85-100					25-100					15-100			9-100		<15	6I & 6J
6K								100											0-10	6K
6L										100			85-100	60-100	30-100	15-100	5-70	0-15 except 0-20 for crushed rock		6L
6M				100															0-10	6M
6N & 6P				100															<15	6N & 6P
6S														60-100		30-90		8-45	0-16	6S

APPENDIX 0/3: LIST OF NUMBERED APPENDECIES REFERRED TO IN THE SPECIFICATION

Appendix No/Table No.	Appendix Title	
	PRELIMINARIES	
1/5	Testing to be Carried out by the Contractor	Used
	EARTHWORKS	
6/1	Requirements for Acceptability & Testing etc. of Earthworks Materials	Used
6/2	Requirements for Dealing with Class U1B and Class U2 Unacceptable Materials	Used
6/3	Requirements for Excavation, Deposition, Compaction (Other than Dynamic Compaction)	Used
6/4	Requirements for Class 3 Materials	Not Used
6/5	Geotextiles Used to Separate Earthworks Materials	Used
6/6	Fill to Structures and Fill Above Structural Foundations	Used
6/7	Sub-formation and Capping and Preparation and Surface Treatment of Formation	Not Used
6/8	Topsoiling	Used
6/9	Earthwork Environmental Bunds, Landscape Areas, Strengthening Embankments	Used
6/10	Ground Anchorages, Crib Walling and Gabions	Not Used
6/11	Swallow Holes and Other Naturally Occurring Cavities and Disused Mine Workings	Not Used
6/12	Instrumentation & Monitoring	Used
6/13	Ground Improvement	Not Used
6/14	Limiting Values for Pollution of Controlled Waters	Used
6/15	Limiting Values for Harm to Human Health and the Environment	Used

APPENDIX 0/4: DRAWINGS

COMPACTION CONTROL AND MINIMUM PERFORMANCE FOR METHOD PLACEMENT AND END PRODUCT COMPACTION



EARTHWORKS CUT TO FILL

Volume

- Estimated cut volume (contingency) 5000 m³
- Estimated cut volume (contingency) 251,260 m³
- Estimated double cut volume 44 m³
- Estimated double cut volume 277,130 m³
- Total estimated fill volume 277,130 m³

SURFACE LEVEL DATA			
NUMBER	MINIMUM LEVEL	MAXIMUM LEVEL	COLOR
1	-1.55	-0.50	Dark Blue
2	-1.00	0.00	Blue
3	0.00	1.00	Light Blue
4	1.00	2.00	Yellow
5	2.00	3.00	Orange
6	3.00	4.00	Red-Orange
7	4.00	5.00	Red
8	5.00	6.00	Dark Red
9	6.00	6.75	Dark Red

APPENDIX 1/5: SITE EXTENTS AND LIMITATIONS OF USE

APPENDIX 1/24: QUALITY MANAGEMENT SYSTEM

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 2.0, 3.0 and 4.0.
- 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 earthwork's materials shall be carried out at 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 to be completed at 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 earthwork's 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 earthwork's 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 earthwork's 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

1.0 ACCEPTABLE LIMITS

- 1.1 Excavated materials on site shall be tested in accordance with Table 1/5 to confirm acceptability and material class. Acceptability criteria are detailed in Table 6/1
- 1.2 Reference to zoning plan for Class 2 and Engineered Fill as per Drawing No. LEM-HYD-XX-GI-DR-G-1020 (Appendix 0/4)
- 1.3 Requirements for cell pressures relating to shear box testing referred to in Table 1/5 to be confirmed by Supervisor
- 1.4 Where practicable, all Topsoil material shall be stripped from the works area and stockpiled for reuse as Class 5A material, providing it meets the acceptability criteria for the material. The classification and confirmation of acceptability of site arisings where required by the Overseeing Organisation, shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.5 Granular material excavated on site may be re-used in the fill works providing it meets the relevant acceptability criteria. The classification and confirmation of acceptability of site arisings shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.6 Cohesive material excavated on site may be re-used in the fill works providing it meets the relevant acceptability criteria. The classification and confirmation of acceptability of site arisings shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.7 Acceptability criteria are detailed in Table 6/1.
- 1.8 Method compaction or End Product shall be adopted as appropriate based on the requirements of Table 1/5, Table 6/4 and Clause 612.
- 1.9 Class 5B may be used on site as topsoil material. The classification and confirmation of acceptability of imported fill material shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.10 Earthworks material shall comprise well graded granular material (Class 1A) or cohesive fill (Class 2A / 2B / 2C). The classification and confirmation of acceptability of this material shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.11 Reinforced soil fill shall comprise selected uniformly graded granular fill (Class 6I / 6J). The classification and confirmation of acceptability of this material shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.12 Backfill to structures shall comprise selected well graded granular fill (Class 6N 1/2/3). The classification and confirmation of acceptability of this material shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.13 Starter layers shall comprise selected uniformly graded granular material (Class 6C). The classification and confirmation of acceptability of this material shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.

- 1.14 Capping material, where required shall comprise selected granular material (Class 6F1 / 6F2). The classification and confirmation of acceptability of this material shall be carried out by the Contractor in accordance with Table 6/1 and Appendix 1/5.
- 1.15 The Contractor shall demonstrate the acceptability of the in-situ Class 5A topsoil material and the imported 5B material (if required). The Contractor shall submit test results to the Overseeing Organisation before commencing the Earthworks, the relevant tests being listed in Appendix 1/5.
- 1.16 The Contractor shall make available independent UKAS accredited testing services for any additional testing of solid or liquid samples required by the relevant Waste Regulation Authority, or the licensed receiving waste disposal or soil treatment facilities, or as instructed by the Overseeing Organisation.
- 1.17 No material shall be imported to site or incorporated into the works until its geotechnical and contamination properties and suitability have been agreed by the Overseeing Organisation. Prior to the import of fill material, the Contractor shall ensure the following:
- Geotechnical laboratory testing, as listed in Appendix 1/5, is carried out on the materials at the frequencies detailed in Appendix 1/5.
 - Contamination laboratory testing as listed in Appendix 1/5, 6/14 and 6/15 at the frequencies detailed in Appendix 1/5.
- 1.18 Two copies of all laboratory test results shall be submitted to the Supervisor within ten working days from taking the samples. All results are to be submitted as paper copies and in a digital format to meet the requirements of the Supervisor.
- 1.19 Presentation of the results shall be in accordance with BS 1377 with the following additions;
- type of test and method adopted;
 - date and time of test; co-ordinates and level (with respect to Ordnance Datum) of test position;
 - indication of weather and site conditions and description of the soil.
- 1.20 The following materials are deemed to be unacceptable fill Class U1A:
- Cohesive soils with a liquid limit in excess of 90% or plasticity index in excess of 65;
 - Any material containing topsoil, wood (including stumps), peat or lignite (topsoil shall be stockpiled separately);
 - Any material with bio-degradables;
 - Desiccated soils from within zones of tree root influence;
 - Any material with scrap metal;
 - Frozen or waterlogged substances;
 - Material that cannot be properly compacted because of its particle size or shape;
 - Slag resulting as a by-product of steel production;
 - Material, which, in the opinion of the Supervisor, has significant coal content.
- 1.21 The Contractor shall carry out visual assessment for the presence of unsuitable material as defined in the item above. Such material shall be excluded from the earthworks fill. Where exposure, proving or testing identifies unacceptable material at source, the Contractor shall separate the unacceptable material from acceptable fill material(s).

- 1.22 The Contractor shall take and analyse samples of material to be excavated in advance of the remedial works and will test and characterise these materials for disposal. Further testing may be required if volumes of excavated material exceed those predicted prior to the start of the works. The need for any additional testing shall be determined by the Overseeing Organisation.
- 1.23 Fill material, which is not suitable for placing immediately should be stockpiled for use until such time as treatment can be applied to the material to render it suitable.
- 1.24 Surplus material shall be taken by the Contractor for offsite disposal. Appropriate testing for the waste classification or re-use offsite shall be carried out by the Contractor.
- 1.25 Where possible, unacceptable material shall be processed by mechanical, chemical or other means to render the material acceptable for use in the Permanent Works.

APPENDIX 6/2: REQUIREMENTS FOR DEALING WIRTH CLASS U1B AND CLASS U2 UNACCETABLE MATERIALS

1.0 DEALING WITH CLASS U1B AND U2 MATERIALS

- 1.1 Class U2 material will be that deemed unacceptable following the requirements for testing as set out in Appendix 6/1 and after discussion with the Regulatory authorities.
- 1.2 Subject to a risk assessment and complying with the relevant regulations and approval of the appropriate authorities, reclassification to Class 1 and 2 fill may be permitted subject to any restrictions imposed by the Environment Agency or the local EHO.
- 1.3 The Contractor shall make all necessary enquiries and arrangements for the disposal off- site of all Class U2 materials and shall liaise with the Environment Agency prior to initiating the removal of any material off-site.
- 1.4 The Contractor shall immediately inform the Designer of the discovery of asbestos or any other form of suspected gross contamination (for example drums of an unknown, or known/suspected hazardous material). The Contractor shall define in his Method Statement the procedures, including testing and storage, that will be followed when asbestos or any other material suspected to be grossly contaminated (based on visual or olfactory evidence) is discovered.
- 1.5 A method statement will be in place detailing the procedure for storing and disposing of any groundwater or surface water encountered during excavation.
- 1.6 The Contractor shall liaise with the Environment Agency or relevant water company (Severn Trent Water) with regards to obtaining consent to discharge any water encountered to controlled waters or the foul sewer. No discharging will be permitted prior to consent being given. The Contractor shall allow for dealing with the legal disposal and/or treatment of groundwater should such consent not be given.
- 1.7 In the event that the asbestos containing material or any other potentially contaminated material is encountered during the works, the Contractor shall immediately advise the Overseeing Organisation who will instruct on a course of action. This may include removal of the potentially contaminated material to a separate stockpile constructed on an impermeable geosynthetic, subsequent sampling and laboratory testing at an interval to be agreed by the Overseeing Organisation dependant on volume, and advice provided on the disposal requirements for the material.
- 1.8 Suspected Class U1B and U2 materials shall be stockpiled separately with an impermeable geosynthetic at its base prior to offsite disposal.
- 1.9 Potentially contaminated and contaminated stockpile areas should be provided with a suitable water run-off collection system to ensure contaminated waters do not impact the site.
- 1.10 The Contractor shall carry out check laboratory testing of materials for disposal offsite to confirm its status with respect to waste disposal. The testing shall be as in Appendix 1/5 with the addition of waste acceptance criteria testing (WAC) as required for off-site disposal.

- 1.11 Generally, all controlled wastes shall be handled and disposed in accordance with the Environmental Protection (Duty of Care) Regulations 1991 and the accompanying Code of Practice. Special Wastes and asbestos shall also be subject to other relevant controls including those referred to in this specification.
- 1.12 Waste materials shall only be transported off-site by a carrier registered under the Controlled Waste (Registration of Carriers and Seizure of Vehicles) regulations 1991. A copy of the appropriate registration certificate shall be supplied to the Overseeing Organisation for approval prior to the start of the works. All open vehicles used for transporting wastes off-site shall be sheeted securely prior to leaving the site areas.
- 1.13 The Contractor shall ensure at all times:
 - The exposure of site personnel and the general public to hazards is avoided; and
 - Contamination outside the site boundary is prevented.
 - Waste is kept safe;
 - Waste is collected regularly;
 - Waste carrier is registered with the Environment Agency;
 - Records of waste transfers are kept for at least two years;
 - Waste is only taken to a waste disposal facility licenced to receive it;
 - All reasonable measures are taken to prevent the escape of waste;
 - They provide their own analytical validation of the chemical or biological compositions of waste leaving the site;
 - A designated official is made responsible for co-ordinating and ensuring that all appropriate precautions are taken to avoid the escape of any hazardous substances.
- 1.14 The use of conventional excavation methods should be appropriate for the proposed works.
- 1.15 Where asbestos containing material, or any other contaminated material, is encountered the material shall be stockpiled separately with an impermeable separator membrane at its base prior to offsite disposal or re-use. Stockpiles shall be located as agreed with the Supervisor.
- 1.16 Any potentially contaminated ground and contaminated stockpile areas shall be provided with a suitable water run-off collection system to ensure contaminated waters do not impact the site.
- 1.17 All soil and groundwater laboratory testing shall be undertaken at a UKAS accredited laboratory, soils testing should be MCERTS accredited.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION AND COMPACTION

1.0 GENERAL INFORMATION

- 1.1 Refer to Works Package for details of work extents.
- 1.2 Prior to any excavation of material on the site the Contractor shall submit a full method statement to the Overseeing Organisation for their approval. The Method Statement shall include, but shall not be limited to:
 - Health and Safety Requirements including appropriate monitoring;
 - Sequence of Excavation and Replacement;
 - Type of Plant;
 - Temporary Works, including stockpiling;
 - Transportation of Materials;
 - Groundwater Control and Disposal (if applicable);
 - Identifying the relevant construction procedures in the Contractor's own Quality Management System.
- 1.3 The Contractor shall ensure that a suitably experienced Works Manager is in full time attendance on site for the duration of the works.
- 1.4 The Contractor shall be responsible for monitoring and controlling the earthworks including the undertaking of the compliance testing detailed in Appendix 1/5, and the collection and laboratory testing of material samples as detailed in Appendix 1/5. The Overseeing Organisation shall inspect the works at regular intervals throughout the project duration. All testing certificates, survey data and earthwork records shall be made available to the Overseeing Organisation for review during these inspections.

2.0 EXCAVATION

- 2.1 Blasting is not permitted as an alternative to normal excavation methods.
- 2.2 All excavations shall be formed with a fall to promote drainage.
- 2.3 Any existing carriageway drainage shall be identified and temporarily sealed off where it encroaches onto the earthworks area. Provision shall be made for temporary drainage bagging to be installed during any periods of heavy rain where it is considered the carriageway is in danger of inundation.
- 2.4 All surfaces excavated to formation level shall be surveyed in using a Total Station or similar to provide X, Y and Z coordinates for As Built records.
- 2.5 Faces of earthworks which are to receive topsoil shall have measures carried out in accordance with Clause 603.7 as appropriate.
- 2.6 Stockpiled materials shall be protected from the weather. Any materials not protected from the weather shall not be used until they have been allowed to dry out sufficiently so that they can be placed and compacted in accordance with the Specification.
- 2.7 General granular and cohesive fills shall be stored in separate stockpiles. Mixing of different types of fill shall not be permitted.

- 2.8 Excavated material that is unacceptable for reuse shall be separated from acceptable material. A suitably sized flat area of the site shall be provided for storage of unacceptable material prior to disposal.
- 2.9 Materials that are acceptable with treatment shall, if being stored prior to treatment, be separated from acceptable materials. For volumes of material where the man-made inclusions have been separated from reworked natural material, the resultant acceptable material, if not being placed immediately, may be stored with other acceptable material.
- 2.10 Any soft or compressible soils or existing fill which is unacceptable as a formation material with a hand shear vane less than 60kN/m² shall be removed and placed by the Contractor in a suitable location agreed by the Supervisor.
- 2.11 In areas of cut following excavation, the natural formation level shall be proof rolled.

3.0 TEMPORARY WORKS

- 3.1 The Contractor shall be responsible for the design of any temporary works necessary for the Contract.

4.0 FILLING

- 4.1 Fill shall be used as shown in the drawings forming part of the Works Information, and these should be read in conjunction with Table 6/1;
- 4.2 Cobbles, boulders, rock or waste fragments whose largest dimension is greater than two-thirds of the loose layer thickness shall not be incorporated into the fill.
- 4.3 All areas which are to receive fill shall be proof rolled prior to placement of fill. If material at formation is deemed by the Supervisor to be unsuitable as a formation layer i.e. it is soft with shear strength less than 60kN/m², or the roller is showing excessive movement of the formation, then the material shall be removed and treated as wet fill.
- 4.4 Embankment infilling will be constructed evenly over their full width and their fullest possible extent and the Contractor will control and direct constructional plant and other vehicular traffic uniformly over them. Damage by constructional plant and other vehicular traffic will be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.
- 4.5 Areas of fill shall be benched into existing undisturbed ground and previous sections of fill.
- 4.6 Benching shall be provided for the total length of the earthworks, as indicated in the Works Package submitted. The Contractor shall ensure the continuity of the benching across the embankment and ensure the stability of the temporary works.
- 4.7 The maximum bench height shall be 0.5m, and the orientation of the cross fall of the benching shall have a 1(v) in 10(h) fall in the downhill direction of the natural slope on which it is cut. The width of benches varies according to the slope and shall be determined on site.
- 4.8 No fill shall be placed and left uncompacted at the end of a working day. Compacted fill shall be graded to falls to ensure free runoff of rainwater without ponding and shall be appropriately sealed.

5.0 COMPACTION

- 5.1 Compaction of backfill will be in accordance with Table 1/5, Table 6/4 and Clause 612.
- 5.2 Trafficking of the fill by any plant other than compaction plant shall not constitute or be a substitute for compaction plant.

6.0 COMPLIANCE TESTING

- 6.1 The locations of all in situ tests shall be agreed between the Contractor and the Supervisor. Test results shall be referenced according to a numbered system agreed with the Supervisor. If a given test location is inaccessible at the time of testing, an alternative location will be agreed with the Supervisor as far as is practicable
- 6.2 All field test locations shall be surveyed using a Total Station or similar by the Contractor.
- 6.3 Field dry density tests are required for the compacted fill. Field density testing may be carried out using a Nuclear Density Meter (NDM), by sand replacement tests or core cutter. In the event that the NDM is used, the Contractor shall provide to the Supervisor on a weekly basis the data used for the calibration of the NDM in accordance with BS1377 part 9. The end product requirements shall be controlled by in situ and laboratory testing as follows:
 - In situ dry density using the sand replacement method and nuclear method (BS 1377: Part 9:1990, section 2) and moisture content determinations (BS1377: Part 2:1990, section 3); and
 - Where required these tests shall be augmented by moisture content-dry density relationships (BS1377: Part 4:1990, section 3) and particle density (BS1377: Part 2:1990, section 8).
- 6.4 Two draft copies of all in situ tests shall be presented to the Supervisor within 48 hours of the testing being performed. All laboratory and in situ test results are to be submitted as paper copies and in digital format.
- 6.5 Presentation of the results shall be in accordance with BS 1377 with the following additions:
 - Type of test and method adopted;
 - Date and time of test;
 - Co-ordinates and level (with respect to Ordnance Datum) of test position;
 - Indication of weather and site conditions and description of the soil
- 6.6 Should any results lie outside the selected compaction criteria, the Contractor shall provide the Supervisor with proposals for rectifying the existing situation and for improving future performance.
- 6.7 California Bearing Ratio (CBR) testing shall be undertaken at 40m intervals at the top of the subgrade along the centreline of the proposed pavement. CBR tests shall be carried out in accordance with BS 1377: Part 9. Each test shall be carried out in accordance with BS1377: Part 9, Method 4.3.
- 6.8 The average difference in level between the actual finished level and the specified finished level of the finished surface shall be $\pm 10\text{mm}$, with no individual point being more than $\pm 30\text{mm}$.
- 6.9 The Contractor shall ensure the rapid dispersal of water which is shed, or enters on to the foundation, earthworks or completed formation during construction, from any source, including existing land drains.
- 6.10 Adequate means for trapping silt shall be provided on any temporary system discharging into permanent drainage systems.

- 6.11 The Contractor shall provide where necessary temporary water courses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provisions shall include carrying out the work of forming the cuttings and embankments in such a manner that their surfaces have at all times a sufficient minimum crossfall and where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.
- 6.12 If in the opinion of the Supervisor, or if the results of control tests indicate that weather conditions (such as frost or heavy rain) have caused deterioration of finished work such that the work no longer meets the Specification, then the Contractor shall at their own cost take such steps as are necessary to bring the fill to Specification requirements.

7.0 COMPLIANCE TESTING

- 7.1 The Contractor shall undertake a topographical survey of the completed works and supply As-Built drawings to the Overseeing Organisation. The drawings shall be supplied in both hardcopy and electronic format compatible with AutoCAD. Records of all testing shall be provided. The information provided shall include as a minimum:
- Records and plans of excavations, including depth of excavations and volume of material excavated;
 - Records of actual finished ground levels, including plans;
 - Records of sampling locations, including plans;
 - Results of all earthworks compliance testing;
 - The source and classification of each imported material;
 - For varying sources or classifications; the locations within the works of each fill source or classification, and the dates over which it was placed.

APPENDIX 6/5: GEOTEXTILES USED TO SEPARATE EARTHWORKS MATERIALS

1.0 GENERAL INFORMATION

- 1.1 Flexible drainage blanket to be in contact with current cut face and tied in to toe drain. Permeable membrane to face the cut surface, impermeable membrane to face engineered fill. Geotextile to be ABG Deck-Drain or similar approved – see Hydrock Drawing No. LEM-HYD-XX-XX-DR-C-0003 for area coverage.
- 1.2 Erosion control using Greenfix Geojute or similar approved by Landscape Architect to be used on seeded slopes greater than 25 degrees.
- 1.3 Erosion control using Greenfix Geocoir or similar approved by Landscape Architect to be used in planted slopes greater than 25 degrees.

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

1.0 GENERAL INFORMATION

- 1.1 For retaining wall structure - Class 6N1 (Zone A/C), Class 6N2 (Zone B) and Class 6N3 (Zone D) shall be used as backfill.
- 1.2 Please refer to Drawing No. LEM-HYD-XX-GI-DR-G-1018 and 1019 for drawing references for fill above structural foundations
- 1.3 A full slope stability assessment has been carried out for the slope in the permanent case – please refer to Hydrock report No. LEM-HYD-XX-XX-RP-G-1002 and Appendix D for the assessment output.
- 1.4 Structural design drawings are located in Appendix B of the Geotechnical Design Report No. LEM-HYD-XX-XX-RP-G-1002-S2.

APPENDIX 6/8: TOPSOILING

1.0 GENERAL INFORMATION

- 1.1 Drawings showing topsoiling to be confirmed in the Landscape Specification to be issued by the Landscape Architect.
- 1.2 Where practicable, existing Topsoil shall be stripped from the embankment slopes by the Contractor prior to excavation. If suitable, this material shall be stockpiled for later reuse as Class 5A Acceptable Earthworks Material.
- 1.3 Imported Class 5B shall be permitted providing it complies with BS3882.
- 1.4 Topsoil and sub-soil shall be stripped and stored in accordance with BS4428 Section 2.5 and with Clause 13.6 of HA 56/92 soil shall be spread in accordance with Chapter 13 of HA 56/92. Excavated topsoil should be kept separate from excavated sub-soil.
- 1.5 Topsoil shall be placed to a thickness of 150mm or as otherwise stated in the landscape specification.
- 1.6 The Contractor will prevent topsoil from being compacted, becoming adulterated with subsoil, rubbish, stone or hardcore, being contaminated with petrol, lime, cement or other injurious substances. The Contractor will remove from site any adulterated or contaminated topsoil and replace it with approved imported topsoil as necessary. Impacted top soil is not permitted for any other purpose.
- 1.7 Only lightweight tracked plant shall be permitted for spreading topsoil.
- 1.8 The earthworks outline shall be graded to smooth flowing contours to achieve tolerances specified for the finished level of topsoil and are to be tied in with adjoining soil areas. All stone, wood and other hard material over 50mm in any dimension shall be removed.
- 1.9 Final topsoil grading, preparation and seeding operations shall be carried out in accordance with the requirements of the Specification for Highway works, Series 3000 Landscape and Ecology, as applicable.
- 1.10 Multiple handling of topsoil must be minimised.

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

1.0 LANDSCAPE AREAS

- 1.1 Landscaped area drawings to be confirmed by Landscape Architect.
- 1.2 Earthworks material acceptability is outlined in Appendix 6/1. Excavation, deposition and compaction requirements are provided in Appendix 6/3
- 1.3 The soil nails and cut slope are to be left in place. Soil nail head bolts should be sealed in Denso-Tape or similar approved before burial by the engineered fill component.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

1.0 INCLINOMETER INSTALLATION RH02

- 1.1 The inclinometer installed in RH02 is to be continuous monitored once a week during the earthworks program by a Hydrock engineer. Monitoring results are to be included within a weekly site report to be issued to all relevant parties.

2.0 STANDPIPE INSTALLATION RH01

- 2.1 The standpipe installed in RH01 is to be continuous monitored once a week during the earthworks program by a Hydrock engineer. Monitoring results are to be included within a site report to be issued to all relevant parties on a weekly basis.

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

The Contractor's attention is referred to following regarding the limiting values for pollution of Controlled Waters for site-won and imported materials. Tabled values only apply to imported materials and the Principal Contractor must ensure that imported materials meet the lower of the EQS values or as identified through risk assessment in support of import (either under DoWCoP or NRW permit).

Chemical of Potential Concern (µg/l)	EQS	Chemical of Potential Concern (µg/l)	EQS
Ag (dissolved)	0.05	pH (max.)	9
As (dissolved)	50	Anthracene	0.1
B (dissolved)	2000	Benzo(a)pyrene	0.00017
Cd (dissolved)	0.25	Fluoranthene	0.0063
Co (dissolved)	3	Naphthalene	2
Cr (VI) (dissolved)	3.4	Phenol	7.7
Cr (III) (dissolved)	4.7		
Cu (dissolved)	1		
Fe (dissolved)	1000		
Hg (dissolved)	0.07		
Mn (dissolved)	123		
Ni (dissolved)	4		
Pb (dissolved)	1.2		
Sn (dissolved)	25		
V (dissolved)	60		
Zn (dissolved)	10.9		
Cyanide (free)	1		
Chloride (Cl-)	250000		
Fluoride (F-)	5000		
Sulfate (SO ₄)	400000		
pH (min.)	6		

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

The Contractor's attention is referred to following report regarding the limiting values for harm to human health and the environment for site-won and imported materials:

Determinants	GAC (mg/kg)			Hydrock Source (of original GAC)
Metals				
Arsenic	37			SGV report + CLEA 1.06
Cadmium	14			SGV report + CLEA 1.06
Mercury	170			SGV report + CLEA 1.06
Chromium	Cr (VI)	6.1		LQM/CIEH + CLEA 1.06
	Cr (III)	890		
Selenium	360			SGV report + CLEA 1.06
Lead	200			C4SL
Boron	300			LQM/CIEH + CLEA 1.06
Nickel	130			SGV report + CLEA 1.06
Copper	2500			LQM/CIEH + CLEA 1.06
Zinc	3900			LQM/CIEH + CLEA 1.06
Vanadium	410			LQM/CIEH + CLEA 1.06
Organics				
	Soil Organic Matter (SOM)			
	1%	2.5%	6%	
PAH				
Acenaphthene	220	520	1100	
Acenaphthylene	180	430	940	
Anthracene	2400	5500	11000	
Benz(a)anthracene	4.2	6.7	8.6	
Benzo(a)pyrene	1.5	1.5	1.5	
Benzo(b)fluoranthene	7.6	9.4	10	
Benzo(ghi)perylene	64	69	71	

Benzo(k)fluoranthene	12	14	15	LQM/CIEH + CLEA 1.06
Chrysene	7.7	11	13	
Dibenz(a,h)anthracene	1.1	1.3	1.4	
Fluoranthene	290	560	900	
Fluorene	170	410	880	
Indeno(1,2,3,cd)pyrene	4.3	5.5	6.2	
Naphthalene	2.2	5.2	12	
Phenanthrene	97	220	440	
Pyrene	620	1200	2000	
Petroleum Hydrocarbons				
Total TPH	10			Screening value only – Speciated TPH testing required if exceeded
Other				
pH	>5, <9			
Asbestos	<0.001%			

6. REFERENCES

BRITISH STANDARDS INSTITUTION. 1994. Methods of test for Soils for Civil Engineering Purposes Parts 1 to 9. BS 1377. BSI, London.

HIGHWAYS AGENCY. 2016. Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1, Amendment February 2016. Highway Agency, London.

