



Earthworks Specification Radlett, SRFI Area 2 – Landscape Bunds

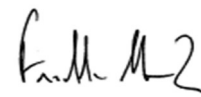
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This document has been prepared and checked in accordance with Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS EN ISO 45001:2018)

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Comments

1-1-4	May 2023	Issued for review and comment.
1-2-1	July 2023	Incorporating client review comments. Issued as preliminary in support of environmental permit application.

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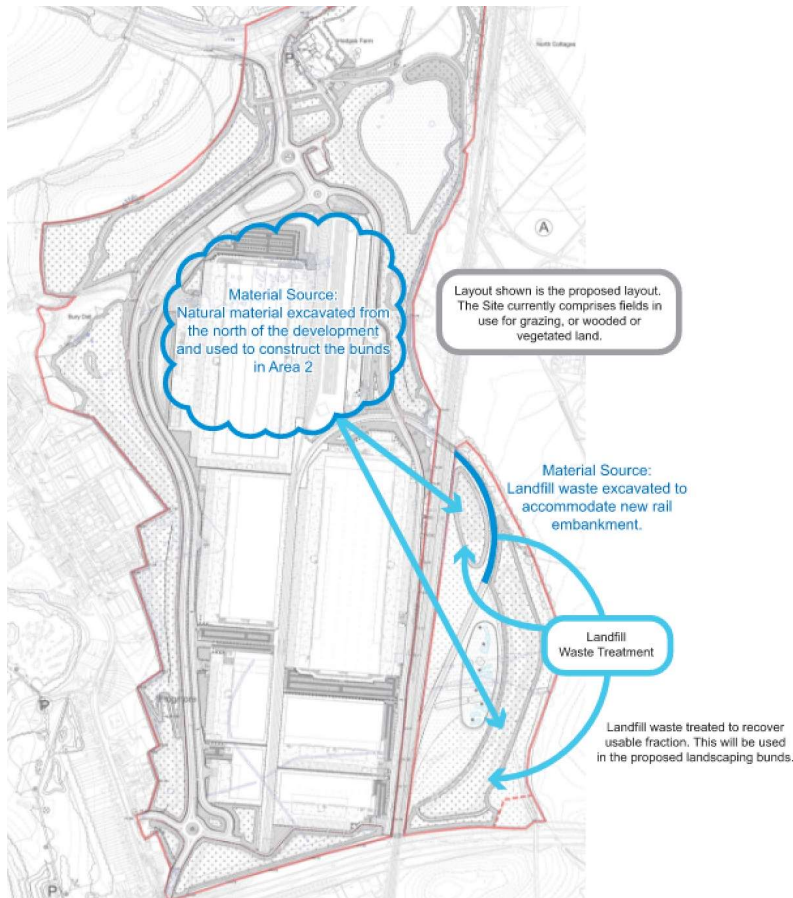
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PREAMBLE TO THE SPECIFICATION

1. This Specification is issued as **preliminary** pending completion of ground investigation in Area 1 and materials testing. This may result in the deletion of some material classes from Appendix 6/1.
2. HELIOSLOUGH LIMITED (the Client) has instructed Waterman Infrastructure & Environment Ltd (Waterman) to prepare an Earthworks Strategy and associated Earthworks Specification relating to Landscape Bunds to be formed on a site referred to as Radlett, Area 2 located at North Orbital Road, Upper Colne Valley, Hertfordshire, AL2 2ET (the Site).
3. The Site comprises part of a larger development area the Client intends to develop as a Strategic Rail Freight Interchange (SRFI). This will comprise an intermodal rail terminal and a rail and road served large distribution facility comprising several large warehouses to be situated in Area 1.
4. To achieve the rail connection to Area 1, a new rail chord will be constructed that leaves the Midland Main Line (MML) railway crossing Area 2 in a northerly direction before sweeping westwards beneath the MML at the north end of Area 2 to terminate at a new freight intermodal terminal in Area 1.
5. As well as constructing the new rail chord, two large landscaping bunds (to 80mAOD) will be constructed, one positioned in the north of Area 2 between the MML and the new rail chord and the second larger landscaping bund to the south and east of the rail chord and extending to the south of Area 2.
6. The north and south landscape bunds shall be formed to achieve a finished level of 80m AOD, resulting in total heights varying from typically 7m to 9m up to a maximum of approximately 12.0m. Side slopes shall be 1(v) in 3(h) with a single intermediate berm at 1(v) in 8(h) incorporated in the southern bund. Reference should be made to Document RAD-WAT-A2EX-XX-RP-C-0015 and Drawing RAD-WAT-A2EX-XX-DR-C-0004 for further details.
7. Historically Area 2 has been subject to landfilling, with municipal waste landfills operating at the Site. To facilitate construction of the rail chord, landfill waste will be removed and replaced with engineered fill.
8. The area where landfill waste will be removed is to be confirmed and will be influenced by the evolving design of the rail chord (by others) and landscaping bunds (by Waterman).
9. Fill material to form the bunds shall be derived from suitable site-won material from areas of cut in Area 1, plus processed excavated landfill waste from below the rail chord in Area 2, as indicated schematically in Figure 1.

Figure 1: Schematic Fill Source & Deposition Locations



10. Excavated landfill waste will likely require significant processing to render it suitable for-use, comprising removal of organic and deleterious material (maximum 4% T.O.C) to recover granular and cohesive fractions only. This may require the use of specialist segregation and screening plant on site, together with required environmental approvals.
11. Use of processed landfill material will require to be in accordance with Waterman Document *"Detailed Remediation Method Statement, Area 2, Radlett"*, Ref: RAD-WAT-A2EX-XX-SP-I-0024.
12. The suitability of materials from Area 1 for re-use should be confirmed after completion of a Ground Investigation campaign, currently underway.
13. All materials must be suitable from an environmental and human health perspective, in addition to the geotechnical requirements detailed herein.
14. Where landfill waste remains in-situ, the landscape bunds will settle due to compression and decomposition of the underlying material. The magnitude of settlement is likely to be in the order of 235mm to 395mm. Reference should be made to the Landscape Bunds Geotechnical Design Report (Document RAD-WAT-A2EX-XX-RP-C-016) for further details. If the level of settlement is considered too significant, mitigation measures will be required which may include ground improvement, such as semi-rigid inclusions, or additional excavation and replacement of landfill material.
15. The envisaged construction sequence for the landscape bunds is set out below:
 1. Strip and stockpile topsoil below landscape bund footprints.

2. Excavate and replace existing landfill waste, where required to construct the rail chord embankment. Excavated landfill waste will be processed to segregate suitable materials for use.
 3. Place and compact acceptable site won bulk fill in layers as per SHW Series 600, Table 6/4, to finished profile less 0.90m for sub-soil / topsoil thickness.
 4. Place and compact sub-soil.
 5. Place topsoil, potentially with incorporation of soil cell retaining system such as Maccaferri MacWeb or similar approved.
16. The Specification shall be the 'Specification for Highway Works', published by the Stationery Office (formerly HMSO) as Volume 1 of the Manual of Contract Documents for Highway Works.
 17. Relevant Specification Appendices are presented within the pages following.
 18. Where a Clause is altered any original Table/Figure referred to in the Clause shall apply unless the Table/Figure is also altered. Where a Table/Figure is altered any reference in a Clause to the original Table/Figure shall apply to the altered Table/Figure.
 19. Where a Clause in the Specification relates to work goods or materials which are not required for the Works it shall be deemed not to apply.
 20. Any Appendix referred to in the Specification which is not used shall be deemed not to apply.
 21. Where a Clause in the Specification is prefixed by an # this indicates that this particular Clause has a substitute National Alteration for one or more of the Overseeing Organisation of Scotland, Wales or Northern Ireland. The use of substitute or additional National Clauses is permitted only within countries to which they specifically apply and they are deemed to replace corresponding Clauses in the main text of the Specification or to be included within the Specification as appropriate. The substitute clauses are located at the end of the relevant Series together with the additional National Clauses of the Overseeing Organisation.

APPENDIX 0/4: LIST OF DRAWINGS

1. The following drawings are enclosed at the rear of this specification.

Drawing Number	Title
RAD-WAT-A2EX-XX-DR-C-0004	AREA 2 BUNDS CROSS SECTIONS
RAD-WAT-A2EX-XX-DS-C-0003	AREA 2 BUNDS LONG SECTION
RAD-WAT-A2EX-XX-DR-C-0007	AREA 2 BUNDS CUT AND FILL
RAD-WAT-A2EX-XX-DR-C-0028	AREA 2 BUNDS MONITORING LOCATIONS

APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR

1. The Contractor will be required to carry out all off and on-site testing of materials to be used in the permanent Works.
2. Tests comparable to those specified in this Appendix will be necessary for any equivalent work, goods or materials proposed by the Contractor (See sub-Clause 105.4).
3. Testing shall be by a United Kingdom Accreditation Service (UKAS) or MCERTS accredited laboratory and testing materials.
4. Tests for work, goods or materials as scheduled under one clause are required for all such work, goods or materials in the Works.
5. The Contractor shall supply to The Engineer a copy of the test results within 24 hours of the completion of each test.
6. For End Product Compaction, in-situ density field tests shall be carried out using a nuclear surface density gauge in accordance with BS 1377, Part 9, Clause 2.5. The tests shall be undertaken incrementally as filling progresses, at the frequency indicated in this Appendix. The results shall be calibrated by sand replacement density tests undertaken in accordance with BS 1377, Part 9, Clause 2.2 at a rate of one in every twenty Nuclear Density Tests. The results shall be referenced to a target maximum dry density to be pre-established from laboratory testing in accordance with BS 1377, Part 4.

Clause No.	Work, Goods or Material		Test	Frequency of Testing	Test Certificate
601, 613, 622, 631 to 640	Acceptable Material				
	Class	General Description			
	1	General Granular Fill	Grading/uniformity coefficient	Twice a week	Required
			Moisture Content	2 per 1000m ³ , up to max. 5 per day	Required
			Optimum Moisture Content	3 per class or subclass of material	Required
	1C only		Los Angeles Coefficient	3 per source only	Required
	2	General Cohesive Fill	Grading/uniformity coefficient	Twice a week	Required
			Moisture Content / MCV / PL / Undrained shear strength	2 per 1000m ³ , up to max. 5 per day	Required
	3	General chalk fill	Moisture Content	2 per 1000m ³ , up to max. 5 per day	Required
			SMC	Daily	Required
	5	Topsoil	Grading	1 per 1,000m ³	Required
	6F2	Selected Granular Fill	Grading	1 per 500 tonnes	Required
			Optimum Moisture Content	3 per class or subclass of material	Required
			Moisture Content	2 per 1000m ³	Required
			Los Angeles Coefficient	3 per source only	Required
			Class Ra (asphalt) content	3 per source only	Required
			Bitumen content	3 per source only	Required

Clause No.	Work, Goods or Material	Test	Frequency of Testing	Test Certificate	
	6F5	Selected Granular Fill	Grading	1 per 500 tonnes	Required
			Optimum Moisture Content	3 per class or subclass of material	Required
			Moisture Content	2 per 1000m ³	Required
			Los Angeles Coefficient	3 per source only	Required
			Class Ra (asphalt) content	3 per source only	Required
			Bitumen content	3 per source only	Required
			Volume stability of blast furnace slag	3 per source only	Required
			Volume stability of steel (BOF) and (EAF) slag	3 per source only	Required
			Other aggregate requirements	3 per source only	Required
	6N	Selected Granular Fill	Grading/uniformity coefficient	1 per 50 tonnes	Required
			PI/LL (N)	Daily	Required
			LA Coefficient	1 per 50 tonnes	Required
			omc/mc, mc or MCV (N)	1 per 50 tonnes	Required
			Organic matter / water soluble sulphate (WS)	Weekly*	Required
Oxidisable sulphides content and total potential sulphate content (N)			Weekly*	Required	

Clause No.	Work, Goods or Material		Test	Frequency of Testing	Test Certificate
			pH/chloride ion content (N)	Weekly*	Required
			Resistivity (N)	As required	Required
			Undrained and drained shear parameters (N)	1 per 50 tonnes	Required
609, 621	Geotextiles		Tensile load	1 per 400m ²	Required
			Permeability	1 per 400m ²	Required
			Pore size	1 per 400m ²	Required
612	Compaction of fills				Required
		Method compaction	Field dry density / CBR	1 per 500m ³	Required
		End product compaction	Optimum mc (2.5kg rammer/vibrating hammer method) (N)	Each class or sub class of material*	Required
			Field dry density / CBR	1 per 250m ³	Required

SERIES 600 - EARTHWORKS

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

GENERAL

- Information regarding ground conditions within the site boundary has been obtained by intrusive ground investigation and is reported within the following documents:

Organisation	Document Ref	Title
Waterman Infrastructure & Environment Ltd	RAD-WAT-A2EX-XX-RP-I-0003	Ground Conditions Report, Radlett, SRFI Area 2
Waterman Infrastructure & Environment Ltd	RAD-WAT-A2EX-XX-RP-I-0009	Geotechnical Design Report, Radlett, SRFI Area 2
Waterman Infrastructure & Environment Ltd	RAD-WAT-A2EX-XX-RP-C-016	Landscape Bunds: Geotechnical Design Report, Radlett, SRFI Area 2

- Further ground investigation is being undertaken for the area of proposed cut in Area 1 of the Radlett site. This will provide additional information on material re-use characteristics.
- All materials must be suitable from an environmental and human health perspective, in addition to those requirements specified within this Appendix.
- Permitted classes of earthwork materials for use in the works are listed, together with material properties required for acceptability, in Table 6/1 included in this Appendix.
- Class U1A material shall be processed (i.e. screened, crushed etc.) to form acceptable Class 1A materials for use within construction of the bunds. Where Class U1A, Class U1B or Class U2 materials are to be disposed of off-site this shall be to an approved and licensed landfill facility or to an alternative and agreed location under an approved waste transfer permit.
- The maximum permissible organic content for fill material to be incorporated into the landscape bunds shall be 4% total organic carbon.

REQUIREMENTS FOR DETERMINING ACCEPTABILITY

- The classification and confirmation of acceptability of the earthworks materials shall be carried out by The Contractor, at the point of excavation for on-site materials, and at the point of deposition for imported materials. The Contractor shall be responsible for monitoring the continuing acceptability of the earthworks materials in accordance with the frequency of testing given in Appendix 1/5. Where the quantity of material used in the Works is less than that stated in the frequency schedule, The Contractor shall perform two number tests of each type required, on the quantity used. If in the opinion of the Engineer, material has altered its classification or become unacceptable for whatever reason, he may require The Contractor to repeat the classification and acceptability tests.
- Copies of all test certificates shall be submitted to the Engineer within 24hrs of the test being completed. If in the opinion of the Engineer material has altered its classification or become unacceptable for whatever reason, he may require The Contractor to repeat the classification and acceptability tests given in Appendix 1/5.

Table 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements									
Class	General Material Description	Use in the works	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 Granular Fill									
1A	Well graded granular material	General Fill	Any material, or combination of materials, other than material designated as Class 3 in the Contract. Recycled Aggregate.	(i) grading	BS 1377:Part 2	Table 6/2	Table 6/2	Table 6/4 Method 2	1A-
				(ii) uniformity coefficient	See Note 5	10	-		
				(iii) mc	BS 1377:Part 2	OMC -2%	OMC+2%		
1B	Uniformly graded granular material	General Fill	Any material, or combination of materials, other than Chalk. Recycled Aggregate	(i) grading	BS 1377:Part 2	Table 6/2	Table 6/2	Table 6/4 Method 3	1B-
				(ii) uniformity coefficient	See Note 5	-	10		
				(iii) mc	BS 1377:Part 2	OMC -2%	OMC+2%		
1C	Coarse granular material	General Fill	Any material, or combination of	(i) grading	BS 1377:Part 2	Table 6/2	Table 6/2	Table 6/4 Method 5	1C-

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

Class	General Material Description	Use in the works	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				
			materials, other than material designated as Class 3 in the Contract. Recycled Aggregate.	(ii) uniformity coefficient	See Note 5	5	-		
				(iii) Los Angeles Coefficient	Clause 635	-	50		
General Cohesive Fill									
2A	Wet cohesive material	General Fill	Any material, or combination of materials, other than chalk.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 1 except for materials with liquid limit greater than 50, determined by BS1377: Part 2, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used.	2A
				(ii) plastic limit (PL)	BS 1377: Part 2	-	-		
				(iii) mc	BS 1377: Part 2 See Note 4	PL -4%	To enable compaction to clause 612		
				(iv) MCV	Clause 632	8	15		

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

Class	General Material Description	Use in the works	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
			(v) Undrained shear strength of remoulded material	Clause 633	50kN/m ²	150kN/m ²			
2B	Dry cohesive material	General Fill	Any material, or combination of materials, other than chalk.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2B
				(ii) plastic limit (PL)	BS 1377: Part 2	-	-		
				(iii) mc	BS 1377: Part 2 See Note 4	To enable compaction to clause 612	PL -4%		
				(iv) MCV	Clause 632	8	15		
				(v) Undrained shear strength of remoulded material	Clause 633	50kN/m ²	150kN/m ²		

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

Class	General Material Description	Use in the works	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		
2C	Stony cohesive material	General Fill	Any material, or combination of materials, other than chalk.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 2	2C
				(ii) plastic limit (PL)	BS 1377: Part 2	-	-		
				(iii) mc	BS 1377: Part 2 See Note 4	OMC -2%	OMC+2%		
				(iv) MCV	Clause 632	8	-		
				(v) Undrained shear strength of remoulded material	Clause 633	50kN/m ²	-		
2D	Silty cohesive material	General Fill	Any material, or combination of materials, other than chalk.	(i) grading	BS 1377: Part 2	Tab 6/2	Tab 6/2	Tab 6/4 Method 3	2D
				(iii) mc	BS 1377: Part 2 See Note 4	OMC -2%	OMC+2%		

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

Class	General Material Description	Use in the works	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				
				(iv) MCV	Clause 632	8	15		
				(v) Undrained shear strength of remoulded material	Clause 633	50kN/m ²	150kN/m ²		
General Chalk Fill									
3	Chalk	General Fill	Chalk and associated materials all designated as Class 3 in the Contract	(i) mc	BS 1377: Part 2 See Note 4	-	To enable compaction to clause 612	Tab 6/4 Method 4. All types of vibratory rollers of Categories over 1800kg shall not be used.	3
				(ii) IDD	Clause 634	1.55Mg/m ³	1.95Mg/m ³		
Topsoil									
5A	Topsoil, or turf, existing on site	Topsoiling	Topsoil or turf designated as Class 5A in the Contract.	(i) grading	Clause 618	-	Clause 618	-	5A-

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

Class	General Material Description	Use in the works	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									
6F2	Selected granular material	Capping	Any material, or combination of materials – including recycled aggregates with not more than 50% by mass of recycled bituminous planings and granulated asphalt, but excluding materials that contain tar and tar-bitumen binders, unburnt colliery spoil and	(i) grading	BS 1377:Part 2	Table 6/2	Table 6/2	Table 6/4 Method 6	6F2
				(ii) optimum mc	BS 1377: Part 4 (vibrating rammer method)	-	-		
				((iii) mc	BS 1377: Part 2	OMC – 2%	OMC		
				(iv) Los Angeles Coefficient	Clause 635	-	50		
				(v) Class Ra (asphalt) content	Clause 710	-	50%		

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

Class	General Material Description	Use in the works	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
			argillaceous rock. Property (i) in the next column shall not apply to chalk. Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(vi) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	2%		
6F5	Selected granular material	Capping	Unbound mixture complying with BS EN 13285. Any material, or combination of materials – including recycled aggregates with not more than 50% by mass of recycled bituminous	(i) Size designation and overall grading category	BS EN 13285 – 0/80 and G_E	Table 6/5	Table 6/5	Table 6/4 Method 6	6F5
				(ii) Maximum fines and oversize categories	BS EN 13285 – UF_{12} and OC_{75}	Table 6/5	Table 6/5		
				(iii) Los Angeles Coefficient	BS EN 13242 – LA_{50}	-	50		

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

Class	General Material Description	Use in the works	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	
			planings and granulated asphalt, but excluding materials that contain tar and tar-bitumen binders, unburnt colliery spoil, Property (vi) in the next column shall not apply if the Class Ra (asphalt) content of any recycled aggregate is 20% or less.	(iv) Volume stability of blast furnace slag	BS EN 13242 – free from dicalcium silicate and iron disintegration	-	-	
				(v) Volume stability of steel (BOF) and (EAF) slag	BS EN 13242 – V ₅	-	-	
				(vi) Other aggregate requirements	BS EN 13242 – Category _{NR} (no requirement)	-	-	
				(vii) Laboratory dry density and optimum water content	BS EN 13285, clause 5.3 – declared values	-	-	
				(viii) Water content	BS EN 1097-5	-	-	

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

Class	General Material Description	Use in the works	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		
				(ix) Class Ra (asphalt) content	Clause 710	-	50%		
				(x) bitumen content	BS EN 12697-1 or BS EN 12697-39	-	2%		
6N-	Selected granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, well burnt colliery spoil or any combination thereof None of these constituents	(i) grading	BS 1377: Part 2 (on-site)	Table 6/2	Table 6/2	Table 6/4 Method 5	6N-
					BS EN 933-2 (off-site)	Table 6/5	Table 6/5		
				(ii) uniformity coefficient	See Note 3	10	-		
				(iii) Los Angeles Coefficient	Clause 635	-	40		

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

Class	General Material Description	Use in the works	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	
			shall include argillaceous rock. Recycled aggregate except recycled asphalt.	iv) effective angle of friction(Φ') and effective cohesion (c')	Clause 636	$\Phi' = 36^\circ$ $c' = 0\text{kN/m}^2$	-	
			Where material is imported onto site which is not "as dug" it shall be aggregate conforming to BS EN 13242 from one or more of the following source codes, see Notes 8, 9 and 10: P (natural aggregates- except shale siltstone or slate, see Note 7); A2 (crushed concrete)					

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

Class	General Material Description	Use in the works	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			
			D2 (air cooled blast furnace slag)					
			G1 (red coal shale)					

Footnotes to Table 6/1

1. (02/16) App = contract specific Appendix
2. (02/16) Tab = Table
3. (02/16) Where in the Acceptable Limits column reference is made to App 6/1, only those properties having limits ascribed to them in contract specific Appendix 6/1 shall apply. Where contract specific Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply.
4. (02/16) Where BS 1377: Part 2 is specified for mc, this shall mean BS 1377: Part 2 where the material is a soil or BS EN 1097-5 where the material is required to conform to a harmonised European Standard.
5. (02/16) Uniformity coefficient is defined as the ratio of the particle diameters D60 to D10 on the particle-size distribution curve, where:
 - a. D60 = particle diameter at which 60% of the soil by weight is finer
 - b. D10 = particle diameter at which 10% of the soil by weight is finer
6. (02/16) The limiting values for Class U1B material are given in contract specific Appendix 6/14 and contract specific Appendix 6/15.
7. (02/16) For works in Wales see sub-Clause 601.21W.
8. (02/16) Where material source codes are referenced these are as listed in Table 6/7.
9. (02/16) Where materials are required to be aggregates conforming to BS EN 13242 materials certificated as being compliant with BS EN 13285 are acceptable for use provided that they meet all the specification requirements and the Declaration of Performance for constituent parts to BS EN 13242 are provided to the Overseeing Organisation.
10. (02/16) Materials shall comply with the current Environmental Regulations at the time of use. Reference shall be made to Annex ZA (informative) of BS EN 13242.
11. MCV acceptability criteria to be confirmed following completion of additional ground investigation.

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

GENERAL

1. Disposal of U1B material will be off site at a suitably licensed waste landfill site undertaken by suitably licensed carriers. The Contractor will provide all certificates and licences to the Engineer for his approval in advance of removal and dumping from site. All costs associated with dealing with Class U1B material will be carried by The Contractor.
2. Class U2 material has not been identified within the Ground Investigation. However, should Class U2 (as defined in Clause 601.3) be found on site then The Contractor will comply with the requirements of Clause 602.18.

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

GENERAL

- The following drawings show earthwork requirements:

Drawing Number	Title
RAD-WAT-A2EX-XX-DR-C-0004	AREA 2 BUNDS CROSS SECTIONS
RAD-WAT-A2EX-XX-DS-C-0003	AREA 2 BUNDS LONG SECTION
RAD-WAT-A2EX-XX-DR-C-0007	AREA 2 BUNDS CUT AND FILL
RAD-WAT-A2EX-XX-DR-C-0028	AREA 2 BUNDS MONITORING LOCATIONS

WATERCOURSES INCLUDING DITCHES

- Drawing No. RAD-WAT-A2EX-XX-DR-C-0006 shows the location and extents of the watercourse, which is to be modified. The ditch will be infilled and a new culvert is proposed to replace the open watercourse.

COMPACTION

- Compaction is to comply with Clause 612.
- The compaction of placed materials shall be controlled by in-situ and laboratory testing as specified in Appendix 1/5.
- Fill shall be placed and compacted in near horizontal layers of the thicknesses required to achieve the required level of compaction and as far as practicable be brought up at a uniform rate.
- The objective of the compaction process shall be to achieve the following criteria:
 - Minimum 95% of Maximum Dry Density established from BS1377: Part 4.

COMPACTION VERIFICATION

- The compaction of placed materials shall be controlled by in-situ and laboratory testing as specified in Appendix 1/5. Field tests shall be carried out using a nuclear surface density gauge in accordance with Clause 612.15, incrementally as filling progresses, at the frequency indicated in Appendix 1/5. The results of nuclear surface density gauge tests shall be calibrated with sand replacement density tests (to BS1377 Part 9) at a rate of one in every twenty nuclear density tests.

LIMITING DISTANCE FOR DEPOSITION OF MATERIALS

- To comply with Clauses 601.15, 601.16 and 601.17.

LOCATIONS OF EXCAVATIONS PERMITTED TO BE BATTERED

- To comply with Clause 602.12.

BENCHING

- All fill to be placed on side long ground shall be placed on benched formation. Benches shall be cut so as to have horizontal steps which fall 1(v) in 20(h) in the downslope direction.

APPENDIX 6/4: REQUIREMENTS FOR CLASS 3 MATERIAL

GENERAL

1. No earthworks involving Class 3 material or trafficking of areas which consist of Class 3 material, unless they are protected, shall be carried out during the periods September to March. Additionally, during periods of heavy rain.
2. Site won chalk may require improvement and / or stabilisation with lime / cement to render it suitable for incorporation in the works. This is to be determined on completion of ground investigation and laboratory testing currently ongoing.
3. Class 3 material may only be layered with other material classes on approval from The Engineer.
4. At the end of each working day of filling, exposed Class 3 material laid that day shall be rolled with two passes of a smooth wheeled roller having a mass per metre width of roll exceeding 2100kg.

APPENDIX 6/5: GEOTEXTILES USED TO SEPARATE EARTHWORKS MATERIALS

GENERAL

1. A geotextile is defined as a fabric applied for stabilisation, containment, separation, drainage and /or infiltration.
2. Geotextiles may be required to stabilise the formation where topsoil is left in-situ prior to construction of the bunds. A topsoil retention system may also be required to stabilise topsoil placed on the surface of the bunds.
3. The Contractor shall ensure that the geotextile complies with the requirements set out in the specification and that the geotextile is sufficiently robust to withstand the working method of placing geotextile and the subsequent placing of materials.
4. Geotextiles shall be kept in the wrappings provided by the manufacturer until required for use in the works and shall be protected at all times against physical or chemical damage. Other materials shall not be stacked on top of stored rolls. Labelling shall be in accordance with BS EN ISO 10320:2019
5. The Contractor shall ensure that geotextile is not exposed to direct sunlight for more than the number of days written in the geotextile CE certificate in accordance with EN 13253:2014 or a maximum of one day if not tested.

TOPSOIL RETENTION SOIL CELLS (if required)

6. If required soil cells shall for topsoil retention shall be of HDPE strips ultrasonically bonded together to form a 3D cellular containment matrix. Minimum wall tensile strength shall be 23kN/m. Wall height shall be 200mm. Maccaferri MacWeb 3020 or similar.
7. If required soil cells shall be infilled with topsoil complying with Specification Appendix 6/8, after pinning to the surface in accordance with manufacturer recommendations.

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

GENERAL

1. Fill to structures (culverts and headwalls) shall be Class 6N selected granular material in accordance with Appendix 6/1.

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

1. Formation surface level tolerance shall be +/- 50mm (as per Clause 616.1). Sub-formation shall have the same longitudinal gradient, crossfall and surface level tolerances as the formation.

APPENDIX 6/8: TOPSOILING, GRASS AND TURFING

1. Sub-soil and Topsoil layers are to be 900mm thick, comprising 500mm Sub-soil and 400mm Topsoil.
2. Topsoil placement may require incorporation of a soil cell retaining system, such as Maccaferri MacWeb or similar approved (Appendix 6/5).

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

Not Used

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

Not Used

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

Not Used

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

1. The Contractor shall record the following;
 - Any evidence of instability in the slopes surrounding the works area;
 - Any evidence of potential instability within completed sections of slope;
 - The consistency of ground conditions exposed through the course of the works against those assumed in design / shown on design drawings;
 - General groundwater observations and the presence of any localised seepages;
 - Prevailing weather conditions including short and long-range forecasts, with works to stop during period of high rainfall or forecast high winds.
 - Settlement and slope monitoring as per the requirements of this Appendix. If movements are greater than pre-determined limits, the Contractor shall await instruction from The Engineer.
2. The scope of instrumentation provided below is indicative and is to be confirmed on completion of final design.

Vibrating Wire Piezometers

3. Piezometers will be required below areas of fill to monitor pore water pressures in response to placement of fill. The Contractor will be required to control and stage placement of fill such that there are no excess pore water pressures created. The locations of piezometers are to be agreed taking cognisance of site operations, but shown indicatively on Drawing RAD-WAT-A2EX-XX-DR-C-0028.
4. Piezometers to be installed as defined in BS5930.
5. Piezometers shall be a proprietary multi-level vibrating wire (VW) piezometer system, such as that manufactured by Geosense or similar approved. Vibrating wire piezometers shall have a porous ceramic element of the low air entry type and be supplied to site pre-saturated. The Contractor shall confirm saturation by boiling the ceramic elements in water for at least two hours and storing the ceramic elements in de-aired water. The Contractor shall ensure that the tips are maintained in a saturated state throughout installation.
6. The multi-level VW piezometers shall be installed using the “fully grouted in” method described by Contreras et al. (2008). Any borehole housing VW piezometers shall be grouted using cement-bentonite grout throughout the full length of the hole, up to the base of the headworks.
7. The VW installation at a given borehole shall be fully grouted in-place within 1 work shift. It is recommended that careful planning and checking of the grouting equipment prior to backfilling commencement is undertaken, so that the chance of breakdown during the backfilling process is minimized, and it is recommended that starts such works adequately early in the work shift.
8. Any un-grouted piezometers left in a borehole overnight shall be deemed non-acceptable and shall be replaced with piezometers with ceramic elements saturated by boiling in water as described above. In case such replacement is not feasible (for example, in the case of a partly grouted hole), a new borehole drilled adjacent to the original borehole may be needed in order to complete the as-specified piezometer installation.
9. Use of bentonite pellets shall not be permitted for backfilling VW piezometer boreholes.

10. Reference shall be made to Mikkelsen (2002) and Contreras et al (2008) regarding the cement-bentonite grout mix, mixing sequence and backfilling method. A trial mix shall be undertaken on site. Under no circumstances shall the permeability of the bentonite-cement grout mix be higher than 1×10^{-9} m/s.
11. Each piezometer shall be connected to a single, continuous length of armoured cabling which shall be long enough to reach from the piezometer tip to the ground surface. Joints in the cable will not be permitted. The cables shall be securely and permanently labelled with the depth of the piezometer tip so that where multiple instruments are installed in the same borehole, these can be clearly identified.
12. Monitoring shall be by continuous data logger, with The Contractor bearing all responsibility for monitoring pore water pressures in response to placement of fill.

Slope Movement Monitors

13. Slope movement monitoring targets shall be installed where indicated on Drawing RAD-WAT-A2EX-XX-DR-C-0028.
14. Targets shall comprise of Triaxial Tiltmeter Sensors or Laser Survey Targets.

Settlement Monitoring

15. Settlement monitoring is required in order to monitor levels of movement during construction of the bunds. Settlement monitoring shall be by means of rod and plates plus surface pins at locations shown on Drawing RAD-WAT-A2EX-XX-DR-C-0028.
16. All monitoring points will be adequately protected from damage during the course of the works and shall be clearly visible.
17. Data shall be recorded to +/- 2mm. All monitoring results are to be referred back to the Engineers for review and checking within 24 hours. Data to be provided in Microsoft Excel format.

Monitoring requirements

18. Monitoring requirements are detailed in the following tables.

Monitoring during construction

Monitoring type	Monitoring Equipment	Frequency	Target
Pore water pressure	Vibrating wire piezometers (VWP)	Continuous data logger	Targets levels and pore water pressures to be established using background readings taken from VWP to be installed at enabling works phase prior to construction of the bunds.
Settlement	Rod and plate	Weekly	Refer to "Settlement Trigger Values and Actions"

Monitoring post-construction

Monitoring type	Monitoring Equipment	Frequency	Target
Settlement	Rod and plate	Weekly, to be reviewed as monitoring progresses	Refer to "Settlement Trigger Values and Actions"
	Surface pins	Weekly, to be reviewed as monitoring progresses	
Slope movement	Triaxial tiltmeter sensors / laser survey targets	Weekly, to be reviewed as monitoring progresses, up to 2 years	Zero movement within limits of survey / equipment accuracy.
<i>Settlement close-out monitoring</i>	Surface pins	Weekly, to be reviewed as monitoring progresses, up to 2 years	Target of not greater than 30mm after 2 years, to be confirmed based on data collected / confirmation of settlement trend v design prediction during construction stage monitoring

Settlement Trigger Values and Actions

Trigger	Settlement (mm)	Action
North bund (LS2)		
Green	Less than or equal to 168mm	The Contractor will carry out and issue monitoring reports to the Supervising Engineer, as per the stated frequencies of the Monitoring Proposal.
Amber	Greater than 168mm, but less than or equal to 210mm	<p>In the event of an amber trigger level being breached, the Contractor will firstly investigate and verify that the recorded readings are correct and report back by the end of the same shift.</p> <p>Where confirmed as true readings, the Contractor will provide the Supervising Engineer with details of the recorded movement, work progressing on site and immediate actions taken.</p> <p>Within 24hrs, the Supervising Engineer and the Contractor shall carry out condition survey of the bunds to assess any changes evident. Thereafter, the Supervising Engineer and the Contractor shall determine remedial measures to prevent further movement.</p>
Red	Greater than 210mm	<p>In the event of a red trigger level being breached, the Contractor will firstly investigate and verify that the recorded readings are correct and report back by the end of the same shift.</p> <p>Where confirmed as true readings, the Contractor will shall immediately stop works, make the area safe and inform the Supervising Engineer.</p> <p>A meeting is to take place between the contractor supervising Engineer and geotechnical designers and client (client representative) within 2hrs. Depending on the outcome of the meeting the following will take place;</p> <p>Carry out remedial measures as agreed will client/client representative .</p> <p>Continue monitoring and arrange additional manual monitoring surveys until asset movements or deformations have stabilised.</p> <p>Carry out survey of assets to assess the condition following remedial measures or repair work as necessary.</p>

Trigger	Settlement (mm)	Action
		Agree with client/client representative a safe method of working or modifications to the proposed development to complete the work.
South Bund (LS1)		
Green	Less than or equal to 316mm	As above.
Amber	Greater than 316mm, but less than or equal to 395mm	As above.
Red	Greater than 395mm	As above.



APPENDIX 6/13: GROUND IMPROVEMENT

Not Used

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

1. Construction phase activities change the natural topography and vegetative cover of the landscape, which can lead to increased erosion and sediment transport, resulting in water pollution if not properly managed.
2. All material re-used by The Contractor shall meet the Material Re-Use Criteria detailed in the Waterman report "*Detailed Remediation Method Statement, Area 2, Radlett*", Ref: RAD-WAT-A2EX-XX-SP-I-0024.

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

1. All material re-used by The Contractor shall meet the Material Re-Use Criteria detailed in the Waterman report "*Detailed Remediation Method Statement, Area 2, Radlett*", Ref: RAD-WAT-A2EX-XX-SP-I-0024.



DRAWINGS