Langley Inert Landfill

Stability Risk Assessment Report

A103725

CEMEX UK Materials Limited
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Prepared on behalf of WYG Environment Planning Transport Limited.

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</table>

Contents

LIST OF TABLES

1.0 INTRODUCTION

1.1 Report Context

1.1.1 The operator of the installation is CEMEX UK Materials Limited (CEMEX).

1.1.2 WYG Environment Planning Transport Ltd. (WYG) has undertaken a Stability Risk Assessment (SRA) to form part of an Environmental Permit Application for lands at Langley Airfield, east of Langley, Slough.

1.1.3 The SRA has been produced by suitably experienced and qualified Geotechnical Engineers using reasonable skill and care. It is important to note that there are limitations to the data available and this has been explained within the SRA Report where necessary.

1.1.4 It is understood that the void, to be backfilled with inert waste, will be formed by sand and gravel extraction works. Systematic filling with inert waste will commence on completion of mineral extraction work provided the necessary regulatory permissions are received. It is further anticipated that planning restrictions prevent dewatering of the site during either the mineral extraction or inert waste placement phases of the works meaning both mineral extraction and waste placement will take place both above and below groundwater.

1.1.5 The following document sections and drawings have been supplied by CEMEX (the Client) and referred to in the compilation of this Report:

- Land at Langley Airport: Geological Assessment Report (Report Ref: 1606-T151_LANG_GEO_REPORT (20 July 2016)).
- Location Content Plan (P1/739/1 (Rev E)) and Aerial Plan (P1/739/2 (Rev E)).
- Envirocheck Report: Datasheet & Drawings: Order Number 71701570_1_1 (Dated 24th August 2015).
- Exploratory Hole Location Plans – CEMEX Geological Services Department – CEMEX UK Operations Ltd. Borehole No. BH01/12 – BH21/12; BH A/12 – BH L/12; WOB01 – WOB06.
- Phasing Plans – Method of Working and Restoration Phases (Site Setup) – Drawing No's P1/739/4B (Dated June 2017).
- Site Restoration Plan (Drawing No. P1/739/5 (Rev C)) Issued 21st February 2017 which is enclosed with the main application.
- Section 13 – Hydrogeological Assessment (Volume 2A Report) which was prepared in support of the planning application (reference CM/51/16).

1.1.6 Cross reference has also been made to sections of the Environmental Permit Application - Environmental Setting and Site Design (ESSD) Report which has been prepared by WYG on behalf of CEMEX.

1.2 Conceptual Stability Site Model

Site Location

1.2.1 This Stability Risk Assessment refers to the area that is included within the Environmental Permit Application Boundary shown in Figures 1A & 1B in Appendix E (Further details provided by the Client in Appendix 8E – Phasing Plans – Method of Working and Restoration Phases (Site Setup) – Drawing No's P1/739/4B. Dated June 2017)).

1.2.1 The application site is located approximately 1km west from Riching's Park and is centred on approximate National Grid Reference (NGR) 502750, 179540. Nearest postcode for site is SL0 9DL.

1.2.2 Current access to the site is achieved from a field gate off North Park Road located to the south of the site. Access to the proposed development will be achieved via a new access road that will be constructed to the south of the site off North Park Road, as approved under planning permission (reference CM/51/16).

1.2.3 The boundary of the site is formed by trees and vegetation and a stream, Withy Bridge Brook, which runs along the western boundary. The northern boundary is formed by the Bristol to Paddington railway line. Such features will act as a barrier to prevent unauthorised access to the site.

Regional Geology

1.2.4 The 1:50,000 scale British Geological Survey Map (Sheet No. 269, Windsor, Solid and Drift Edition) indicates the drift deposits mapped at near surface across the site of Langley Airfield. At a central position where the 'Withy Bridge Brook' traverses from north north-west to south south-east across the site. Head deposits (Clays, Silts, Sands and Gravels) are anticipated to follow the line of a small valley or ditch adjacent to the brook.

1.2.5 To the South West of the brook the mapping denotes an area of the Langley Silt Member (of clays and silts) which commonly overlies a River Terrace (sand and gravel) deposit.

1.2.6 Immediately to the east of the brook the mapping indicates that there are no superficial deposits and the London Clay formation is anticipated to be present at surface; perhaps only covered by a thin topsoil or subsoil layer.

1.2.7 Further to the north east the site is underlain by a thickening layer of Lynch Hill Gravel (sands and gravels).

1.2.8 The London Clay Formation (typically up to 100m thick) underlies the superficial deposits.

1.2.9 Numerous boreholes records are available in the BGS GeoIndex Onshore online database; some of which indicate the presence of shallow "Clay Ballast" overlain by topsoil located across central areas of the site.

<u>Local Geology</u>

1.2.10 Drawing No. 1606-T151_LANG_BHS.LSS (Appendix F) shows the 2012 exploratory hole positions and the thickness of overburden (OB) and Mineral (MIN) encountered in each borehole. The plan also includes spot heights and contours from a topographical survey of the ground surface across this site.

1.2.11 The overburden deposits comprise topsoil (typically 0.4m thick) across the site and head deposits of silty loamy and mottled clays towards the east of the site.

1.2.12 The mineral deposits consist of orange fine to coarse sand and gravel often bound with silty and clayey matrix at shallower depths.

1.2.13 A summary of the ground conditions encountered during this investigation is presented in Table SRA1.

Table SRA1 Local Stratigraphy identified in Langley Airfield (From Exploratory Records)

Stratum	Stratigraphy						Notes
	From (mbgl)		To (mbgl)		Thickness (m)		
	Min	Max	Min	Max	Min	Max	
Topsoil/Subsoil	GL		0.2	0.5	0.2	0.5	Thickest BH D/12 & BH16/12.
Overburden (Silty clays, loamy & mottled clays)	0.2	0.5	0.6	8	0.2	2.4	Present at locations: BH01/12; BH03/12; BH04/12; BH05/12; BH06/12; BH10/12.
Mineral Components (Sand & Gravel members)	1.4	2.5	4.8	9.1	1.5	6.9	Present Throughout.
Basal Formation (London Clay)	1.8	9.1	>10.5				Very shallow encounter across the north of the site. Thickness not proven. Likely extends up to 100m bgl as indicated on geological mapping.

GL – Ground Level

<u>Hydrogeology</u>

1.2.14 The Environment Agency website indicates that Langley Airfield partially overlies a Principal Aquifer interpreted as the Lynch Hill Gravel Member. The London Clay Formation is a Non-Aquifer.

1.2.15 Water strikes as recorded in the exploratory logs of the 2012 Site Investigation ranged from 1.8m bgl to 5.3m bgl.

1.2.16 Monitored groundwater levels are tabulated in the CEMEX Hydrogeological Assessment Section 13.62. Water levels recorded from WOB01 to WOB06 ranged from 1.01, btc to 5.77m btc (below top of casing). All the water monitoring boreholes are situated to the East (adjacent to Richings Park) and North of the site.

1.2.17 It is of note that the topographical levels across the site varies between 24.50m AOD to 33.50m AODand that the groundwater level does approximately follow the variation in ground level.

1.2.1 Basal Sub-Grade Model

1.2.2 In the area of Langley Airfield, the underlying Lynch Hill Gravel Member is to be excavated as part of the mineral extraction works. Therefore, the basal subgrade will comprise the London Clay Formation.

1.2.3 Groundwater has been recorded within the Langley Silt & Lynch Hill Gravel Member at depths between 1.05m and 4.70mbgl.

1.2.4 The full thickness of the London Clay Formation has not been proven in any of the local boreholes; however published sources (e.g. BGS) indicate a minimum thickness of approximately 100m should be expected beneath the site.

1.2.2 Side Slopes Sub-Grade Model

1.2.3 The side slope subgrade model will comprise Lynch Hill Gravel Member overlying London Clay Formation. There is a discontinuous layer of superficial silty Sand, interpreted as Lynch Hill sub-layer, above the Lynch Hill Gravel Member (Table SRA1). It is anticipated that this may be sorted / sieved and also utilised as a mineral.

1.2.4 Groundwater has been recorded between 1.05m and 4.70mbgl within the Lynch Hill Gravel Member. As a conservative approach a groundwater table at 1.0mbgl has been adopted for slope stability assessment.

1.2.5 The typical thickness of the Lynch Hill Gravel Member is between 7.50m and 8.50m. Therefore, the side slope subgrade will be modelled with a maximum side slope gradient of 1(v):2(h) and a typical height of 11.00m including 1.50m thick overburden and 1.00m over-dig into the London Clay Formation.

1.2.3 Basal Lining System Model

1.2.4 No basal lining system will be incorporated into the facility design as the basal subgrade will comprise the low permeability London Clay Formation.

1.2.4 Side Slope Lining System Model

1.2.5 The side slope liner has been modelled as being placed against the 1(v): 2(h) side slope Sub-Grade.

1.2.6 The side slope liner will be formed using selected imported fine-grained material (i.e. excavated London Clay from construction projects). It is unlikely that a single source material for the construction of the side slope liner will be available; therefore, a selection protocol will be used to assess acceptability of any material.

1.2.7 The side slope liner will be constructed in each phase of working, maintaining a distance of at least 20m ahead of waste tipping. Liner material for placement below standing water level will be bulldozed over an advancing face and allowed to form at its natural angle of repose. Liner material placed above the standing water level will be compacted by multiple passes of earth moving plant.

1.2.8 A minimum thickness of side slope liner with a coefficient of permeability of $1x10^{-6}$m/s (typical for clay) of 10m is required to achieve equivalence with the Landfill Directive. However, a thickness of 20m has been designed for the crest of the liner as a conservative approach.

1.2.9 The thickness of the side slope liner at the base of the void is dependent on the material's natural angle of repose. However, based on typical geotechnical data it is likely to be a minimum of 20m (as has been modelled in SLIDE to achieve a FOS greater than unity).

1.2.5 Waste Mass Model

1.2.6 It is understood that waste to be deposited at Langley will come from known sources typically large earthworks contracts. Based on data collected from other CEMEX operated inert landfill sites it is anticipated that a portion of the imported waste will comprise naturally occurring soils and other portions will comprise concrete, bricks, tiles, glass and ceramics. These materials will be mixed on site to form a waste 'matrix'.

1.2.7 Inert waste material for disposal below standing water level will be placed at approximately original ground level before being bulldozed into the water. Waste slopes below standing water level will form at a natural angle of repose.

1.2.8 Inert waste material for placement above the standing water level will be placed to achieve the final landform (before final site restoration) during a second phase of landfilling. The toe of the advancing upper face will be maintained at least 20m from the crest of the lower submerged slope. Fill above the water level will be compacted by repeated passes of earthmoving equipment and slopes above the water table will be restricted to a maximum gradient of 1(v): 2(h).

1.2.9 Capping System Model

1.2.10 In accordance with the requirements of the Landfill Directive, an engineered cap (clay or plastic) is not required.

1.2.11 On completion of filling to final levels, the site will be restored to agricultural land at original ground levels with two small lakes within a framework of woodland belts and parkland.

1.2.12 Due to the nature of the waste, gas monitoring and related control systems are not required.

2.0 STABILITY RISK ASSESSMENT

2.1 Risk Screening

2.1.1 Basal Sub-Grade Screening

2.1.2 A stability analysis of the basal subgrade is not required but the material will be included in the analysis of the Side Slope Subgrade, the Side Slope Liner and the Waste Mass.

2.1.3 The basal subgrade will be formed of the in-situ London Clay Formation. As the void is to be formed by excavation for mineral extraction there will be a net unloading of the London Clay but this will largely be reversed by deposition of waste.

2.1.2 Basal Lining System Screening

2.1.3 No basal liner is to be constructed at this site.

2.1.3 Side Slope Sub-Grade Screening

2.1.4 The side slopes will be formed as part of the sand and gravel extraction process and will comprise the Lynch Hill Gravel Member.

2.1.5 The presence of groundwater within the Langley Silt Member and Lynch Hill Gravel Member at a max level of 1.0m below existing ground level means that the lower side slope subgrade will be formed below groundwater levels.

2.1.6 The side slopes will be formed at a gradient of 1(v): 2(h) for long term stability but may be steepened up to 1(v): 1(h) temporarily where the risk of slope instability can be managed.

2.1.7 Slope stability analysis of the subgrade slope is considered necessary.

2.1.4 Side Slope Lining System Screening

2.1.5 An artificially established side lining system will be constructed at the Langley Inert Landfill site. The liner will be constructed using selected predominantly fine-grained materials from different sources.

2.1.6 The liner material will be placed below standing water by bulldozing over the exposed face created by the mineral extraction works and allowed to consolidate under its own weight to form a final face gradient equal to its natural angle of repose. Above the standing water level the material will be placed and compacted by repeated passes of earth moving plant. The minimum liner thickness at the crest and toe will be 20m but may be considerably thicker at the toe depending on its angle of repose (a minimum 20m thick crest and toe have been modelled in SLIDE).

2.1.7 Slope stability assessment of the side slope lining is considered necessary.

2.1.5 Waste Mass Screening

2.1.6 Inert waste placed at the site will largely comprise a mixture of natural soils from local earthworks projects and other inert materials (tiles, bricks, glass, concrete, ceramics etc).

2.1.7 The inert waste will be placed both above and below the standing groundwater level. Below the standing groundwater level the waste will be allowed to consolidate under its own weight whilst above the standing groundwater level the inert waste will be compacted by multiple passes of earthmoving plant.

2.1.8 Slope stability analysis of both the "short term" and "long term" waste faces will be carried out as part of this Stability Risk Assessment.

2.1.6 Capping System Screening

2.1.7 There is no requirement for an engineered cap as this site. Restoration soils will be placed to achieve a landform similar to the pre-extraction levels. Due to the type of the waste to be placed at the site no gas or uplift pressures will be generated within the waste mass.

2.1.8 Based on the above no detailed analysis of the restoration landform is considered necessary.

2.2 Lifecycle Phases

2.2.1 Phasing of subgrade slopes

The site of the landfill proposed at Langley has been divided up into construction phases (See Appendix H). These construction excavation phases are spilt, as shown, for the purposes of forming a favoured construction methodology for each excavation in sequence. The aims of the phases are as follows:

- To ensure a sealed liner along the external boundary of the Langley Farm site – No landfill waste will be either physically exposed or migrate beyond the external boundary.
- Conduct the landfilling process in an organised manner that involves infilling from the extremities of the site to the centre of the site (towards where the site processing compound is located).
- The plans show the process involves excavating to a basal level for each phase area (including subsoil and overburden stripping), placement of an impermeable liner around the edge of the phase and then infilling the remainder of the excavation with waste, and finally restoring the excavation to original ground level.

2.2.2 Phasing of waste placement, geometry and timeframe

It is understood that for each phase the excavation will remain open until filled with waste and any planned adjacent phases will not be used until the active phase is filled and restored. The infilling of the excavation with waste will follow the London Clay liner around the "perimeter" of that phase. Thereafter, the centre of the phase will be filled, in stages, from basal level up as waste material arrives on site. There is no fixed timeframe although both short term and long term conditions have been considered for the Waste Mass Model & Analyses.

2.2.3 Leachate, Landfill Gas & Daily Cover

Review of Leachate, Landfill Gas and Daily Cover are not required for the Landfill proposed at Langley.

2.3 Data Summary

2.3.1 Site specific data

Geotechnical data recorded on site or through laboratory testing have been used as part of the geotechnical parameter selection process. This includes a review of the borehole log descriptions and particle size distribution test results.

2.3.2 Published data

Where deemed appropriate to complement site data or due to the general lack of site-specific geotechnical test data published values have been sought and used where possible. Sources are noted in each tabulation for each selected parameter value.

2.3.3 Assumed data

In some cases, parameters and values have had to be assumed due to a limitation of the site-specific data and a lack of readily available data for some materials/cases analysed.

2.3.4 Uncertainties & limitations in data

There is no test data on how clay liner and cohesive waste would behave when being bulldozed below water. It is anticipated that the angle of repose will be greater in the short term before the clay lumps are saturated than the long term when the internal friction of the clay particles is at play. The actual behaviour should be observed and recorded during construction.

2.4.1 Justification for Modelling Approach and Software

2.4.2 Two-dimensional limit equilibrium stability analysis has been used in the assessment of the stability of the subgrade side slope, subgrade liner and waste mass. The method of analysis used in each particular case was determined from an examination of the form of failure being considered.

2.4.3 The stability analyses of the slopes were carried out using the SLIDE computer programme.

2.4.4 The Morgenstern and Price Method and the Simplified Bishop Method were used in the analyses for both total stress and effective stress conditions.

2.4.5 The Factors of Safeties (FoS) tabulated are results of the critical slip surface following a iterative search.

2.4.6 A simple assessment of the potential settlement of the subgrade liner due to a lack of compaction or bulking of the as-placed liner material beneath the water table has been carried out.

2.5 Justification of Geotechnical Parameters Selected for Analysis

2.5.1 Geotechnical parameters have been selected in accordance with Eurocode 7 by applying partial factors to the characteristic values of parameters. Characteristic values are defined as a careful estimate of the value affecting the occurrence of a limit state and are obtained initially using insitu and/or laboratory test results. Then, starting from measured data, characteristic values can additionally be evaluated by engineering experience. Serviceability limit states (deformation) are not considered in detail.

2.5.1 Parameters Selected for Basal Sub-Grade Analysis

2.5.2 The basal subgrade will be included in the analysis of side slope subgrade, side slope subgrade liner and waste mass. Characteristic properties for the basal subgrade are presented in Table SRA2.

2.5.3 There is no stand-alone basal subgrade analysis (i.e. for heave, swelling or re-compression of the basal layer).

Table SRA2 Basal Subgrade Stability – Summary of Geotechnical Data

Parameter			Characteristic Value		Source
Unit Weight		γ_k	$19kN/m^3$		BS8002 Table 1 (Medium weight density value)
Shear Strength	Total	c_{uk} , ϕ_{uk}	$75kN/m^2$	0°	Lower bound value for stiff Clays (See CEMEX logs for recorded descriptions)
	Effective	c'_k , ϕ'_k	$5kN/m^2$	23°	Guided by published values for (weathered) London Clay (Carder & Barker, 2005)
Modulus of Compressibility		m_{vlk}	$0.20m^2/MN$		Published value for (top end) medium compressibility Clay (See Table 2.11; pg. 77; Tomlinson 7th Edition)

2.5.4 Parameters selected for Side Slopes Sub-Grade Analysis

2.5.5 Side Slope Subgrade analyses will be carried out on the side slopes formed in the Lynch Hill Gravel Member and London Clay Formation. The characteristic geotechnical parameters to be used in the analysis subgrade are presented in Table SRA3.

Table SRA3 Side Slope Subgrade Stability – Summary of Characteristic Geotechnical Data

Stratum	Parameter			Characteristic Value		Source
Langley Silt Member	Unit Weight		γ_k	$19kN/m^3$		BS8002 Table 1 (Low weight density value for silt / sand)
	Shear Strength	Total	c_{uk} , ϕ_{uk}	$0kN/m^2$	30°	Assume 30 + A + B (No angularity or grading)
		Effective	c'_k , ϕ'_k	$0kN/m^2$	30°	Assume 30 + A + B (No angularity or grading)
Lynch Hill Gravel Member	Unit Weight		γ_K	20kN/m3		BS8002 Table 1 (Medium weight density value for gravels)
	Shear Strength		c_k, ϕ_k	$0kN/m^2$	35°	Published values (BS8002 – 30 + A + B)
London Clay Formation	Unit Weight		γ_k	$19kN/m^3$		BS8002 Table 1 (Medium weight density value for clays)
	Shear Strength	Total	c_{uk} , ϕ_{uk}	$75kN/m^2$	0°	Lower bound value for stiff Clays (See CEMEX logs for recorded descriptions)
		Effective	c'_k , ϕ'_k	$5kN/m^2$	23°	Guided by Published values for London Clay (Carder & Barker, 2005)

2.5.3 Parameters Selected for Basal Liner Analysis

2.5.4 No parameters have been selected as no stability analysis is required.

2.5.4 Parameters selected for Side Slopes Liner Analysis

2.5.5 The side slopes liner is to be constructed using appropriate fine-grained material. Typical values for clay materials have been used to define the characteristic geotechnical values of the side slope liner material. It should be noted that liner material placed above and below the standing water level have been assigned different geotechnical characteristic values to represent saturation and softening (Table SRA 4).

Table SRA4 Side Slopes Liner Stability – Summary of Characteristic Geotechnical Data

<table>
<tr><th colspan="2">Stratum</th><th colspan="3">Parameter</th><th colspan="2">Characteristic Value</th><th>Source</th></tr>
<tr><td rowspan="6">Selected Fine Grained Material (e.g. London Clay from earthwork site elsewhere in London)</td><td rowspan="3">Above Standing Water</td><td colspan="2">Unit Weight</td><td>γ_k</td><td colspan="2">18kN/m^3</td><td>BS8002 Table 1</td></tr>
<tr><td rowspan="2">Shear Strength</td><td>Total</td><td>c_{uk} , ϕ_{uk}</td><td>40kN/m^2</td><td>0˚</td><td>Based on compacted remoulded London Clay having a minimum consistency of firm; classified as a 2A General Fill SHWS600</td></tr>
<tr><td>Effective</td><td>c_k, ϕ_k</td><td>0kN/m^2</td><td>23˚</td><td>Guided by Published values for London Clay (Carder & Barker, 2005)</td></tr>
<tr><td rowspan="3">Below Standing Water</td><td colspan="2">Unit Weight</td><td>γ_k</td><td colspan="2">17kN/m^3</td><td>Loosely placed</td></tr>
<tr><td rowspan="2">Shear Strength</td><td>Clay lumps</td><td>c_k , ϕ_k</td><td>0kN/m^2</td><td>28˚</td><td>Assumed for the short term</td></tr>
<tr><td>Effective</td><td>c'_k , ϕ'_k</td><td>1kN/m^2</td><td>23˚</td><td>Assumed</td></tr>
</table>

2.5.5 Parameters selected for Waste Analyses

2.5.6 The waste will largely comprise fine-grained materials from known sources with some portion of other inert wastes understood to be tiles, brick, glass and concrete etc. The material will be placed both above and below standing water level therefore two sets of characteristic geotechnical values are presented for the Waste Mass.

Table SRA5 Waste Mass Stability – Summary of Characteristic Geotechnical Data

<table>
<tr><th colspan="2">Stratum</th><th colspan="3">Parameter</th><th colspan="2">Characteristic Value</th><th>Source</th></tr>
<tr><td rowspan="5">Waste Mass</td><td rowspan="3">Above Standing Water</td><td colspan="2">Unit Weight</td><td>γ_k</td><td colspan="2">18kN/m^3</td><td rowspan="3">Based on compacted remoulded London Clay having a minimum consistency of firm; classified as a 2A General Fill SHWS600.</td></tr>
<tr><td rowspan="2">Shear Strength</td><td>Total</td><td>c_{uk} , ϕ_{uk}</td><td>40kN/m^2</td><td>0˚</td></tr>
<tr><td>Effective</td><td>c_k, ϕ_k</td><td>0kN/m^2</td><td>25˚</td></tr>
<tr><td rowspan="2">Below Standing Water</td><td colspan="2">Unit Weight</td><td>γ_k</td><td colspan="2">17kN/m^3</td><td rowspan="2">Assumed. FoS investigated to be lower than unity for zero c' & ϕ_k of 28.</td></tr>
<tr><td>Shear Strength</td><td>Clay lumps</td><td>c_k , ϕ_k</td><td>1kN/m^2</td><td>28˚</td></tr>
</table>

			Effective	c'_k , ϕ'_k	0kN/m^2	23°	

2.5.6 Parameters selected for Capping Analyses

2.5.7 None selected as no further analysis of the capping is required.

2.6 Selection of Appropriate Factors of Safety

2.6.1 The stability analyses have been carried out in accordance with EC7. The United Kingdom has adopted Design Approach 1 (DA1) Combination 1 & 2 (C1 & C2) whereby partial factors are applied to actions, material properties and resistances, and a resultant factor of safety of 1.00 is required.

2.6.2 A surcharge of 10kPa on the tops of the slopes of the side slopes subgrade, side slope liner and waste mass has been modelled in SLIDE following guidance in Eurocode 7. The appropriate partial factor value has been applied by the SLIDE software depending in the particular partial factor suite under analysis.

Table SRA6 Partial Factors used in Design on Accordance with the UK National Annex to EC7

Design Approach	Combination	Partial Factor Sets	Partial Factor Value			
1	1	A1 + M1 + R1	Actions A1			
			Permanent (G)	Unfavourable	$\gamma_{G;dst}$	1.35
				Favourable	$\gamma_{G;stb}$	1.00
			Variable (Q)	Unfavourable	$\gamma_{Q;dst}$	1.50
				Favourable	$\gamma_{G;dst}$	0
			Materials M1			
			Coefficient of shearing resistance (*tan*ϕ)		$\gamma_{\phi'}$	1.00
			Effective cohesion (c')		$\gamma_{c'}$	1.00
			Undrained shear strength (c_u)		γ_{cu}	1.00
			Resistance R1			
			Resistance		$\gamma_{R;e}$	1.00
	2	A2 + M2 + R1	Actions A2			
			Permanent (G)	Unfavourable	$\gamma_{G;dst}$	1.00
				Favourable	$\gamma_{G;stb}$	1.00
			Variable (Q)	Unfavourable	$\gamma_{Q;dst}$	1.30
				Favourable	$\gamma_{G;dst}$	0
			Materials M2			
			Coefficient of shearing resistance (*tan*ϕ)		$\gamma_{\phi'}$	1.25
			Effective cohesion (c')		$\gamma_{c'}$	1.25
			Undrained shear strength (c_u)		γ_{cu}	1.40
			Resistance R1			
			Resistance		$\gamma_{R;e}$	1.00

2.6.1 Factor of Safety for Basal Sub-Grade

2.6.2 No analysis undertaken.

2.6.2 Factor of Safety for Side Slopes Sub-Grade

2.6.3 Both the short (undrained) and long term (drained) stability of the side slope subgrade have been assessed using the Slide software for a range of circular failures using total and effective stress parameters.

2.6.4 The analysis has included an accidental overdig of 1.00m into the basal subgrade and the effect of subsequent softening of this material (1m thick Softened London Clay layer in model).

2.6.5 Results of the Side Slope Subgrade analyses are presented in Appendix 1 and summarised below.

Table SRA7 Side Slope Subgrade Stability – Summary of Results

Run	File Name	Stress Condition	Factor of Safety (FOS)		Notes
			C1	C2	
01	DA 1 C1 - Undrained	Total (Undrained)	1.325		Selected side slope subgrade maximum face angle of 26.6˚ (1 in 2). Depth of excavation of 10m assumed worst case (excluding overdig). Requires a negligible buffer (i.e say 0.5m) from the edge of the crest where no site plant can traverse.
02	DA 1 C2 - Undrained	Total (Undrained)		1.026	
03	DA 1 C1 - Drained	Effective (Drained)	1.278		Selected side slope subgrade maximum face angle of 26.6˚ (1 in 2). A 26-degree slope would be safe. Requires a negligible buffer (i.e say 0.5m) from the edge of the crest where no site plant can traverse.
04	DA 1 C2 - Drained	Effective (Drained)		1.271	
05	DA 1 C1 – Drained – Soft Upper Clay	Effective (Drained)	1.121		Softening of the Upper 1m level of the London Clay
06	DA 1 C2 – Drained – Soft Upper Clay	Effective (Drained)		1.075	
07	DA 1 C1 – Drained – 1m Overdig	Effective (Drained)	1.258		Accidental Overdig 1.00m in softened London Clay (No significant change on FOS caused by Overdig)
08	DA 1 C2 – Drained – 1m Overdig	Effective (Drained)		0.874	
09	Temporary 1 in 1 - Global	Temporary Slope	c.0.938		Temporary slope using partial factors of unity. Assessment allows a degree of freedom for the contractor to excavate up to a 1 in 1 gradient.

2.6.6 The side slopes should be formed at a gradient of 1(v): 2(h) for long term stability but may be steepened up to 1(v): 1(h) temporarily where the risk of slope instability can be managed or accepted.

2.6.3 Factor of Safety for Basal Lining System

2.6.4 No output Factors of Safety as no analysis undertaken.

2.6.4 Factor of Safety for Side Slope Lining System

2.6.5 Initially the side slope liner material will be end tipped and allowed to consolidate under its own weight at its natural angle of repose.

2.6.6 The stability of the side slope liner was analysed using the computer programme SLIDE to calculate the factor of safety against failure entirely within the liner for a range circular failure surfaces using both the Morgenstern and Price & Simplified Bishop Methods.

2.6.7 The side slope liner stability analysis will initially investigate the placement of the material below standing water level and then investigate the effect of placing additional material above the standing water level. Effective stress conditions only will be analysed for the below water analysis whilst both total and effective stress conditions will be considered in the above water model.

2.6.8 Results of the side liner analyses are presented in Appendix 2 and summarised below.

Table SRA8 Side Slopes Liner Stability – Summary of Results

Run	File Name	Stress Condition	Factor of Safety (FOS)		Notes
			C1	C2	
09	Side Slope Liner – DA1 C1 – Drained – Underwater Only	Effective (Drained)	1.577 (Surface)		Underwater Placement of material consolidation under self-weight. Liner face angle = 1(v): 3(h)
10	Side Slope Liner – DA1 C2 – Drained – Underwater Only	Effective (Drained)		1.324 (Surface)	
11	Side Slope Liner – DA1 C1 – Undrained - Upper Added	Total / Effective	1.426 (Deep Seated)		Placement of upper liner material, 20.00m crest width, short term undrained conditions.
12	Side Slope Liner – DA1 C2 – Undrained - Upper Added	Total / Effective		1.228 (Deep Seated)	
13	Side Slope Liner – DA1 C1 – Drained - Upper Added	Effective (Drained)	1.433 (Deep seated)		Placement of upper liner material, 20.00m crest width, long term drained conditions.
14	Side Slope Liner – DA1 C2 – Drained - Upper Added	Effective (Drained)		1.146 (Surface)	
15	Side Slope Liner – DA1 C1 – Drained – 5m instep bench	Effective (Drained)	1.319 (Deep Seated)		Placement of upper liner material, design 20.00m crest width and 5.00m bench, long term drained conditions.
16	Side Slope Liner – DA1 C2 – Drained – 5m instep bench	Effective (Drained)		1.052 (Surface)	

2.6.5 Factor of Safety for Waste Mass

2.6.6 Waste Slopes - Short Term Stability

2.6.7 Waste stability must be assessed as part of the design process for the short-term waste slope configuration. Stability assessment is required for failure modes wholly within the waste body. The analyses of the failures wholly within the waste were based on Table 3.43 "Failure Wholly within the Waste" of the Environmental Agency R&D Technical Report P1-385/TR2.

2.6.8 The waste will be placed both above and below the standing water level (assume in the models a maximum water level at 1.0m bgl) such that the face angle formed below the standing water level will be dependent on the material properties of the waste and will achieve a stable slope with a factor of safety of 1.00.

2.6.9 The maximum gradient of the short-term waste slopes during placement operations will be restricted to 1 (v): 2 (h).

2.6.10 Given the composition (inert materials), landfill gas pressures are unlikely to develop within the waste mass.

2.6.11 The results of the SLIDE stability analyses are presented in Appendix 3 and in Table SRA 9.

Table SRA9 Waste Mass Short Term – Slope Stability - Summary of Results

Run	File Name	Stress Condition	Factor of Safety (FoS)		Notes
			C1	C2	
17	Stability Waste – Waste Mass Added	Total (for waste) / Effective (for liner)	1.064	1.051	Short Term Waste Mass Face at 1 (v):2 (h) Waste Mass undrained.
18	Stability Waste – Waste Mass Added – Leach 1m	Total (for waste) / Effective (for liner)	1.038	0.914	Rising pore water level in Waste Mass + 1.00m above standing water.

2.6.12 From the analysis of the short-term waste mass slopes it can be seen that a 1(v):2(h) slope is stable.

2.6.13 <u>Waste Slopes – Long Term Stability</u>

2.6.14 Waste slopes left for long periods (although not permanently) should be considered. In order to represent these conditions an effective stress stability analysis has been carried out. Initially the waste mass has been modelled using the long term drained conditions and then the effect of softening has been considered.

2.6.15 The results of the Long-Term Waste Mass Slope analyses are presented in Appendix 3 and a précis of the results is shown in Table SRA 10.

Table SRA10 Waste Mass Long Term - Slope Stability – Summary of Results

Run	File Name	Stress Condition	Factor of Safety (FOS)		Notes
			C1	C2	
19	Stability Waste – WM drained	Effective (drained)	0.849		Long Term Waste Mass Face at 1(v): 2(h) includes design water level at 1.0m bgl and nominal 10kPa surcharge up to a 0.5m offset buffer from crest of waste mass.
20	Stability Waste – WM drained	Effective (drained)		0.662	

2.6.16 Settlement of Waste Mass (and Side Slopes Liner)

2.6.17 Both the Side Slope Liner and the Waste Mass are to be placed beneath the standing water level by tipping and allowing the material to consolidate under its own weight. The fine-grained material of the liner and the waste mass may be composed of discrete lumps or clods of clay and the as-tipped material is likely to have a substantial volume of contained voids. Assuming a bulking factor of between 1.35 to 1.40, on a qualitative basis, for every metre of material placed 400mm of settlement may occur whilst the inter "clod" void spaces close. Therefore, considering the placement of between 7.5m and 8.5m of material below standing water level settlements of between 3.0m and 3.40m may occur.

2.6.18 Settlements within the compacted clay liner / waste material placed above the water table are likely to be much smaller.

2.6.3 Factor of Safety for Capping System

2.6.4 No analysis undertaken for capping system as no requirement.

2.7 Assessment

2.7.1 The chosen methodology of assessment has been approached conservatively due to uncertainties in the data and activities that may occur during the works. Therefore, the outcome of the assessment is generally to confirm a likely worst case scenario for each model.

2.7.2 The analysis indicates that when clay lumps are saturated in the waste mass, a 1(v):2(h) face would not be stable.

2.7.1 Basal Sub-Grade Assessment

2.7.2 No slope stability assessment has been undertaken for the basal subgrade alone. Only the basal subgrade has been incorporated as part of assessments of the side slope subgrade, side slope liner and waste mass where deemed appropriate. Any settlements of the basal subgrade will be limited to the elastic recompression of the London Clay which will not affect the integrity of this in-situ material.

2.7.3 Side Slope Sub-Grade Assessment

2.7.4 The side-slope subgrade will be formed by the extraction of the Langley Silt (Mineral and / or Overburden) and the Lynch Hill Gravel Member (Mineral).

2.7.5 All the side slope subgrade SLIDE analyses indicate that the Combination 2 partial factor set offers the more onerous of the two approaches recommended within the National Annex to EC7.

2.7.6 SLIDE Runs 01 – 04 (Table SRA 7) indicate that the post mineral extraction slopes should not exceed 1(v): 2(h) to ensure long term stability.

2.7.7 SLIDE Runs 05 – 08 illustrate the effect of accidental overdig and softening of the London Clay basal subgrade. The results of the analyses indicate that the side slope subgrade will remain stable even in the unlikely event of systematic overdig into the London Clay and or softening of the basal London Clay Formation.

2.7.8 Although the majority of the extractable mineral is within 9 - 10m of the ground surface SLIDE runs 07 -08 show that the side slope subgrade will remain stable with slope heights up to 11m.

2.7.9 It is concluded that the side slope subgrade will be stable at heights of up to 11.00m provided the side slope gradient does not exceed 1(v): 2(h) (Maximum of 26.6° degrees).

2.7.10 For temporary slopes where the risk of slope instability can be managed or accepted, the slope gradient may be steepened up to 1(v): 1(h).

2.7.3 Basal Liner Assessment

2.7.4 Not assessed.

2.7.4 Side Slope Liner Assessment

2.7.5 The side slope liner is to be constructed by end tipping selected fine-grained material below the standing water level and compacting the liner material above it. A minimum thickness of 20.00m will be achieved at the crest of the liner, whilst the thickness at the toe of the liner will be largely dependent on its natural angle of repose (which will be at least 20m).

2.7.6 Initially the stability of the side slope liner beneath the standing water level was investigated using the software program SLIDE. The results indicate that partial factor combination C2 offers the most onerous conditions and to achieve a factor of safety of 1.00 the face angle of the side slope liner material is 1(v) : 3(h)°. Although a factor of safety of 1.00 is indicative of a material on the point of failure if a slope is allowed to attain its own natural angle of repose by definition this will be at a factor of safety of 1.00.

2.7.7 SLIDE Runs 09 -16 (Table SRA 8) indicate that there is no effect to the liner stability from by the placement of the upper liner material with the factor of safety remaining above 1.00 (for a surface failure scenario). The SLIDE program also computes the potential for a deep seated circular failure scenario for short term and long term conditions both of which compute FoS above 1.00.

2.7.8 SLIDE Runs 15 & 16 investigate the effect of including a 5.00m bench and set back between the upper and lower side slope liner material. The analyses indicate that using combination 2 factors, a slight increase in factor of safety from 1.208 to 1.321 can be achieved by adopting the benched geometry.

2.7.9 In conclusion, the side slope liner is stable using the method of construction proposed although large settlements should be expected during the end tipping phase of the construction as the material softens and voids close. The results of these settlements may lead to a requirement for some post-construction liner placement in order to maintain the required liner crest level.

2.7.10 In conclusion, the side slope liner is stable using the method of construction proposed although large settlements should be expected during the end tipping phase of the construction as the material softens and voids close. The results of these settlements may lead to a requirement for some post-construction liner placement in order to maintain the required liner crest level.

2.6.5 Waste Assessment

2.6.6 Inert waste will be placed above and below the standing water level. Below the standing water level the waste material will form a face angle equivalent to its natural angle of repose that will be stable with a factor of safety of 1.00.

2.6.7 Temporary waste slopes formed above the standing water level should be restricted to a face angle of less than 1(v): 2 (h). Under these conditions an ultimate limit state equilibrium SLIDE analysis indicated a minimum factor of safety of 0.914 (for DA1 C2 plus 1.0m leachate rise). All other short term waste mass runs are greater than unity.

2.6.8 Although the term leachate is used in the case of inert waste it refers to the inclusion of natural water either by percolation or inclusion during placement. One SLIDE analyses have been carried out to represent an increase in pore water level (SLIDE Runs 18) and demonstrate that increases in water level does have an effect on the overall stability of the slope. However, it is considered unlikely that a full pore water rise of 1m will occur and if so suitable procedures can be used to monitor any adverse rise in pore water levels.

2.6.9 If temporary waste faces are left unsupported in the long term they should be considered as permanent. SLIDE analyses have been carried out on permanent waste face using the appropriate Design Approach 1 combination 1 and 2 partial factors.

2.6.10 The results of the permanent waste face analysis indicate that using combination 2 partial factors a permanent waste face at 1(v): 2(h) is unstable returning a factor of safety of 0.849 (C1) and 0.662 (C2).

2.6.11 Long term waste slopes will return to their natural angle of repose under water which is likely to be around 1(v): 3 (h).

2.6.6 Capping Assessment

2.6.7 Not assessed.

3.0 MONITORING

3.1 The Risk-Based Monitoring Scheme

3.2 Monitoring of the stability of the site is proposed in the form set out below. The objectives are to identify any instances of overall settlement of the structure in excess of that expected from the settlement predictions, and to identify instability of the waste mass itself at the earliest possible juncture.

3.1.1 Basal Sub-Grade Monitoring

3.1.2 The basal subgrade will remain below the standing water level and therefore no visual monitoring of this element will be possible.

3.1.2 Side Slope Sub-Grade Monitoring

3.1.3 The side slopes should be visually monitored for instability both during the mineral extraction works and waste placement operations. In the event of any instances of instability appropriate action should be taken which may include buttressing the toe of the slope using selected fine grained liner material or reducing the side slope angle.

3.1.4 Care should be taken when plant is operating close to the crest of any side slope. Close inspection of the ground surface should be undertaken with particular attention being paid to the formation of tension cracks. If any features are identified all plant and vehicle movements in the area should be halted and a detailed inspection by a suitably qualified person carried out.

3.1.3 Basal Lining System Monitoring

3.1.4 Not required. See Side Slope Lining System Monitoring.

3.1.4 Side Slope Lining System Monitoring

3.1.5 Much of the side slope liner will be placed beneath the standing water level within the void by tipping selected material and allowing it to consolidate under its own weight. This will lead to larger settlement than would normally be expected with material placed in a conventional manner.

3.1.6 Visual inspection of the side slope liner material placed above the standing water level should be undertaken until the liner is buttressed by the placement of the inert waste material. Particular attention should be paid to the area immediately adjacent to standing water especially during waste placement operations any tension cracking should be reported immediately and tipping operations in the area of the feature ceased immediately.

3.1.5 Waste Mass Monitoring

3.1.6 Visual monitoring of both temporary and permanent waste faces should be carried out on a regular basis during placement. In the event of any instability being identified appropriate action should be undertaken which is likely to comprise reducing the angle of the waste slope.

3.1.7 As much of the inert waste will be placed below the standing water level without compaction large settlement of the waste mass should be expected as the waste consolidates under gravity. Although these settlements are predicted regular monitoring of all waste surfaces should be undertaken and additional placement carried out to maintain the required finished landform / level.

3.1.6 Capping System Monitoring

3.1.7 The condition of the surface of all restored areas will be monitored on a regular basis as part of the site inspection regime.

3.1.8 The surface will be checked for incipient signs of failure that might result from occurrence of differential settlement within these deposits. These would include cracking, development of depressions or ponding and seepage of water. In the event that any symptom of incipient failure is detected the Environment Agency will be informed and a site action plan for remediation agreed.

3.1.9 The Surface of the restored areas will be monitored by land survey techniques on a regular basis. These checks will be on a biannual basis for the first two years and then on an annual basis to the fifth year after restoration (with the frequency reviewed with the Environment Agency).

4.0. APPENDICES

4.1 Appendix A – Report Conditions

APPENDIX A - REPORT CONDITIONS
STABILITY RISK ASSESSMENT

This report is produced solely for the benefit of the **CEMEX UK MATERIALS LIMITED** and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of future changes in the condition of the site.

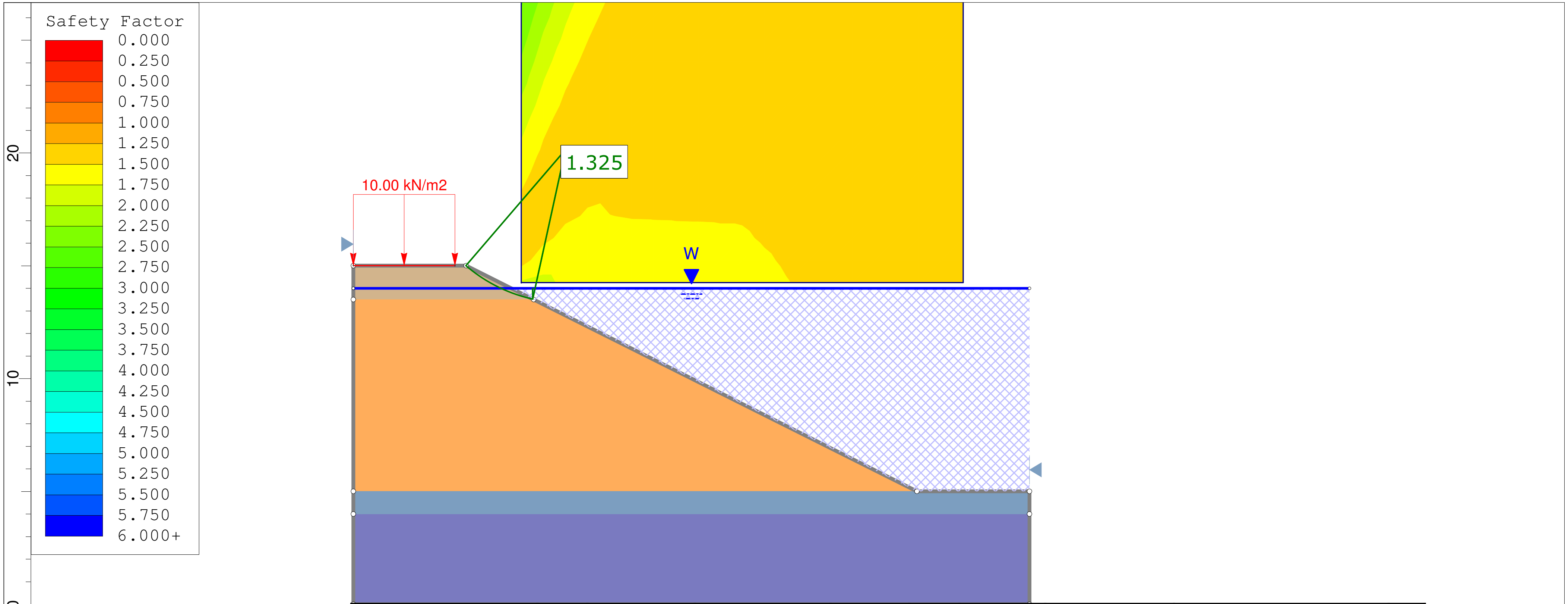
This report is based on a visual site inspection, reference to accessible referenced historical records, information supplied by those parties referenced in the text and preliminary discussions with local and Statutory Authorities. Some of the opinions are based on unconfirmed data and information and are presented as the best that can be obtained without further extensive research. Where ground contamination is suspected but no physical site test results are available to confirm this, the report must be regarded as initial advice only, and further assessment should be undertaken prior to activities related to the site. Where test results undertaken by others have been made available these can only be regarded as a limited sample. The possibility of the presence of contaminants, perhaps in higher concentrations, elsewhere on the site cannot be discounted.

Whilst confident in the findings detailed within this report because there are no exact UK definitions of these matters, being subject to risk analysis, we are unable to give categoric assurances that they will be accepted by Authorities or Funds etc. without question as such bodies often have unpublished, more stringent objectives. This report is prepared for the proposed uses stated in the report and should not be used in a different context without reference to WYG Environment Planning Transport Ltd. In time, improved practices or amended legislation may necessitate a re-assessment.

The assessment of ground conditions within this report is based upon the findings of the study undertaken. We have interpreted the ground conditions in between locations on the assumption that conditions do not vary significantly. However, no investigation can inspect each and every part of the site and therefore changes or variances in the physical and chemical site conditions as described in this report cannot be discounted.

The report is limited to those aspects of land contamination specifically reported on and is necessarily restricted and no liability is accepted for any other aspect especially concerning gradual or sudden pollution incidents. The opinions expressed cannot be absolute due to the limitations of time and resources imposed by the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contamination (past or present) exists further extensive research will be required before the effects can be better determined.

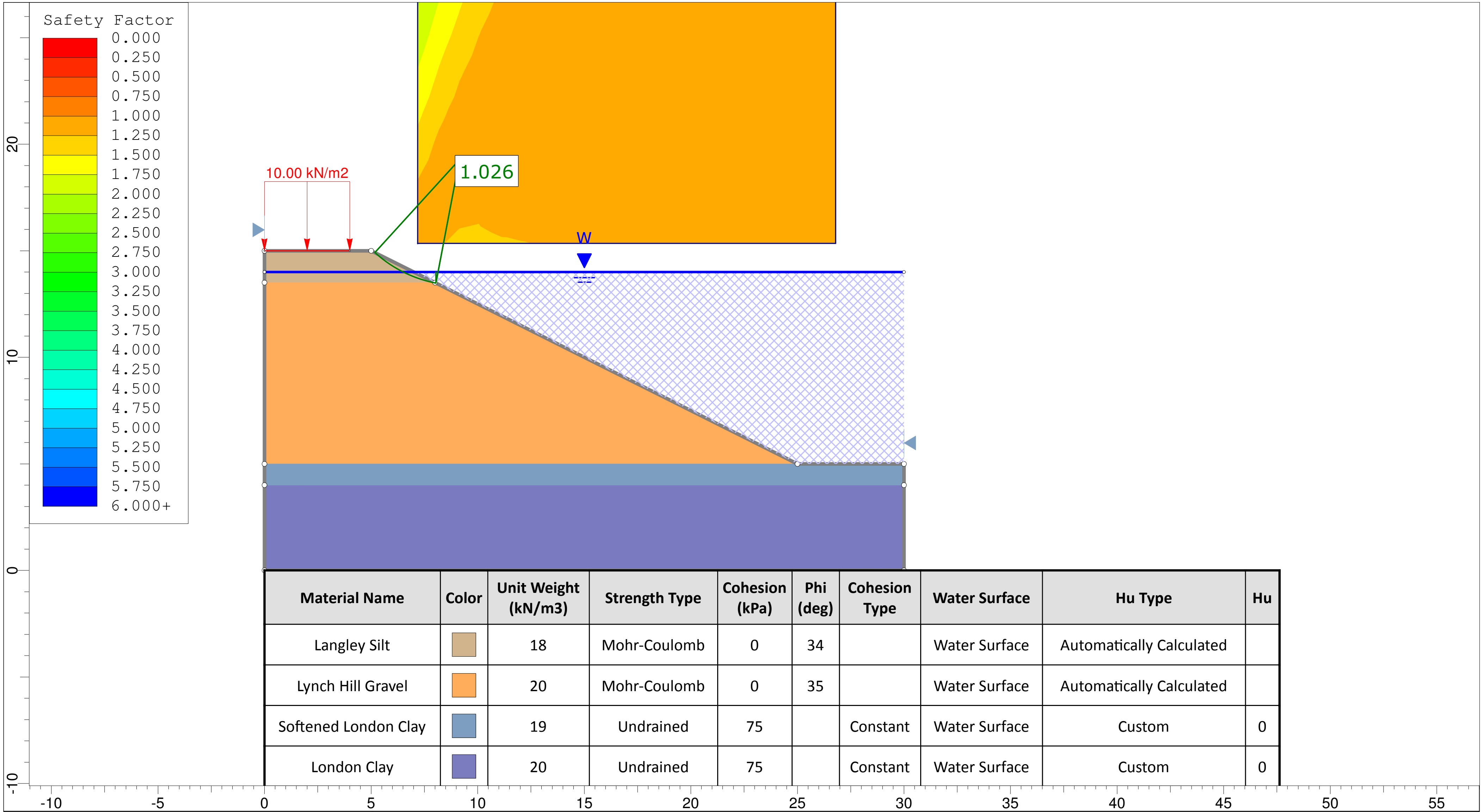
4.2 Appendix B – SLIDE Worksheets – Side Slope Subgrade



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	34		Water Surface	Automatically Calculated	
Lynch Hill Gravel		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		20	Undrained	75		Constant	Water Surface	Custom	0

SLIDEINTERPRET 7.010

Project	Langley Inert - Worst Case Geometry		
Analysis Description	DA1 C1 Undrained - 1 in 2 Slope		
Drawn By MGS	*Scale* 1:250	*Company*	WYG Ltd
Date	08/08/2017, 13:37:49	*File Name*	DA1 C1 - Undrained.slim



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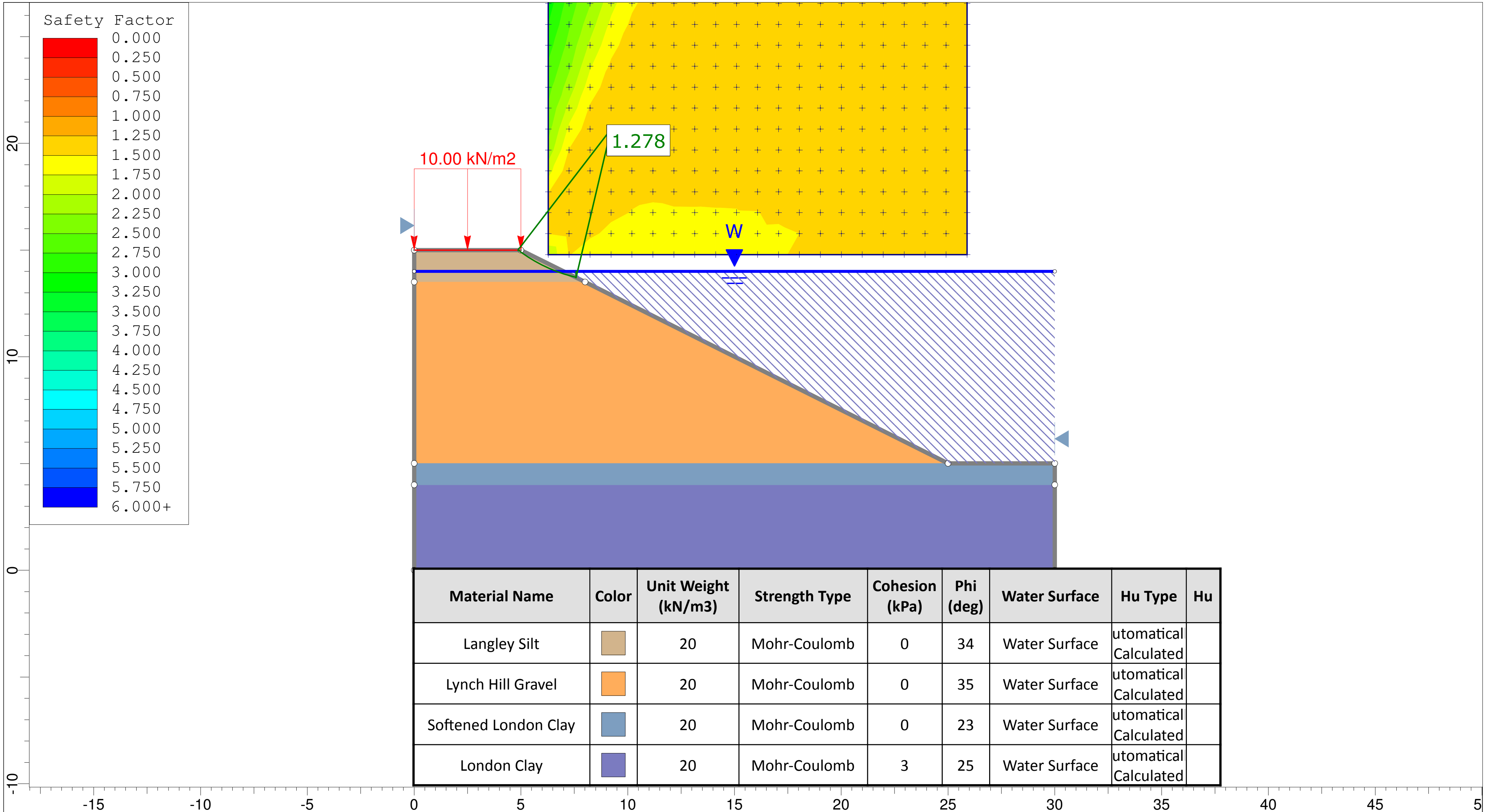
Langley Silt		18	Mohr-Coulomb	0	34		Water Surface	Automatically Calculated	
Lynch Hill Gravel		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		20	Undrained	75		Constant	Water Surface	Custom	0

SLIDEINTERPRET 7.010

Project	Langley Inert - Worst Case Geometry
Analysis Description	DA1 C1 Undrained - 1 in 2 Slope
Drawn By	MGS
Scale	1:250
Company	WYG Ltd
Date	08/08/2017, 13:37:49
File Name	DA1 C2 - Undrained.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Langley Silt		20	Mohr-Coulomb	0	34	Water Surface	utomatical Calculated	
Lynch Hill Gravel		20	Mohr-Coulomb	0	35	Water Surface	utomatical Calculated	
Softened London Clay		20	Mohr-Coulomb	0	23	Water Surface	utomatical Calculated	
London Clay		20	Mohr-Coulomb	3	25	Water Surface	utomatical Calculated	

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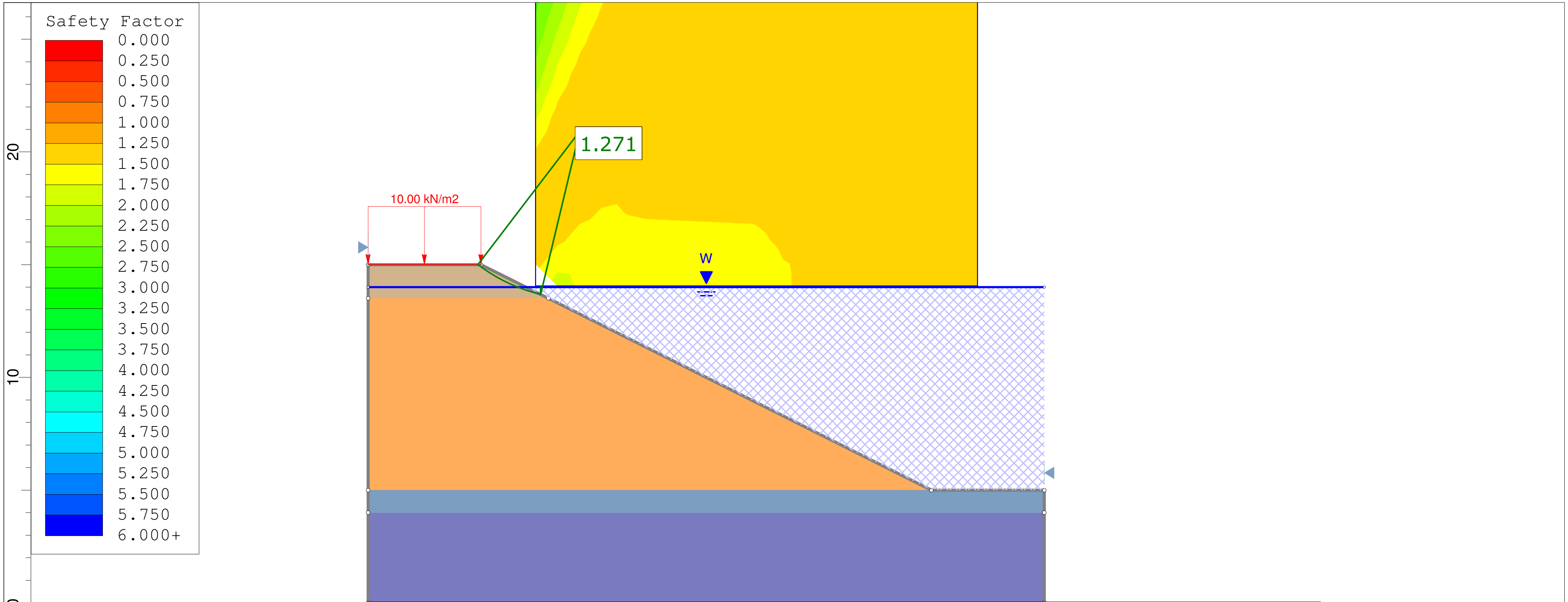
SLIDEINTERPRET 7.010

Project Langley Inert - Worst Case Geometry

Analysis Description DA1 C1 Drained - 1 in 2 Slope

Drawn By MGS | *Scale* 1:250 | *Company* WYG Ltd

Date 08/08/2017, 13:37:49 | *File Name* DA1 C1 - Drained.slim

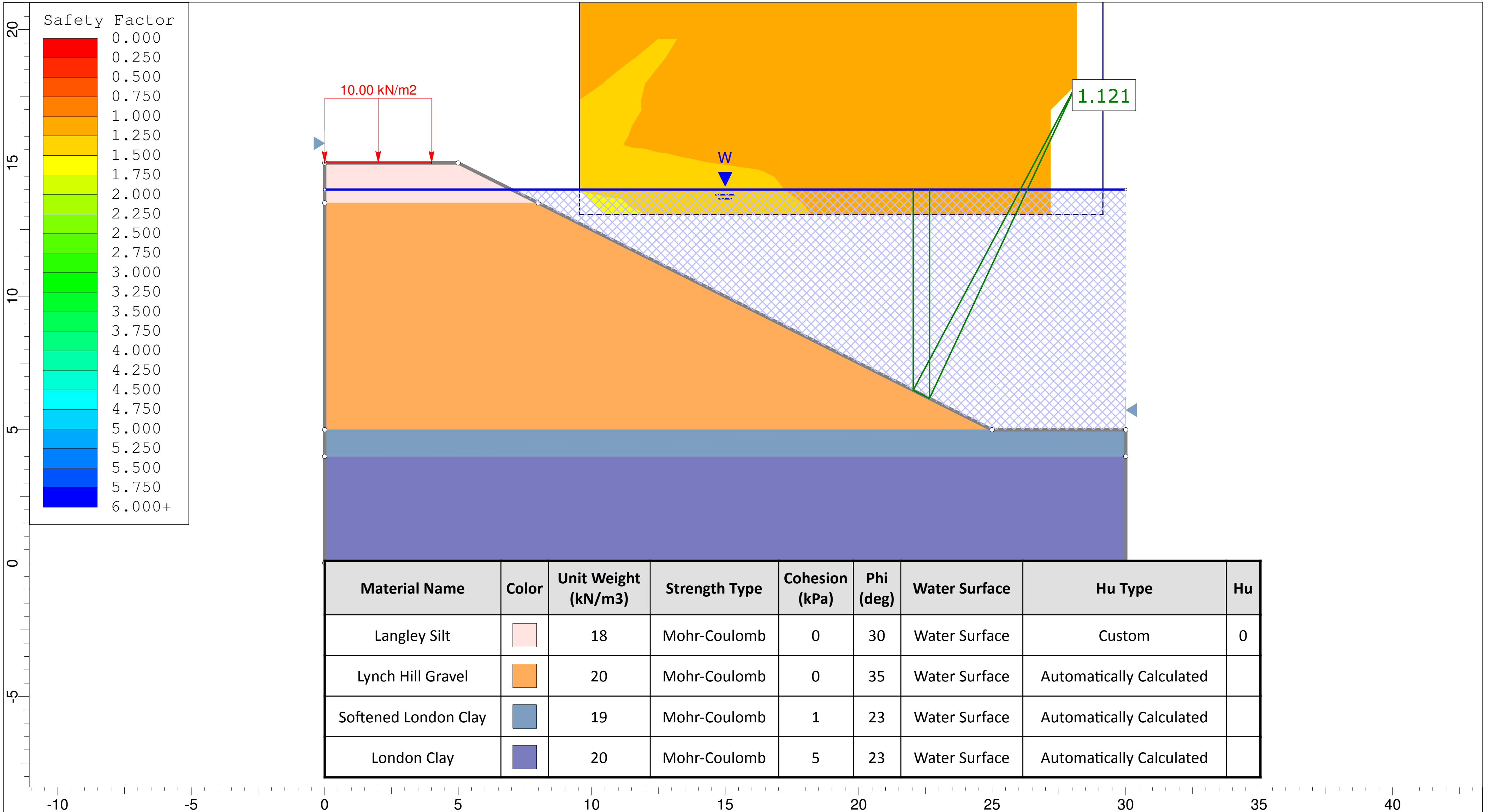


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Langley Silt		18	Mohr-Coulomb	0	34	Water Surface	Automatically Calculated
Lynch Hill Gravel		20	Mohr-Coulomb	0	35	Water Surface	Automatically Calculated
Softened London Clay		20	Mohr-Coulomb	0	23	Water Surface	Automatically Calculated
London Clay		20	Mohr-Coulomb	3	25	Water Surface	Automatically Calculated

-10 -5 0 5 10 15 20 25 30 35 40 45 50

Project	Langley Inert - Worst Case Geometry		
Analysis Description	DA1 C2 Drained - 1 in 2 Slope		
Drawn By MGS	*Scale* 1:250	*Company*	WYG Ltd
Date	08/08/2017, 13:37:49	*File Name*	DA1 C2 - Drained.slim

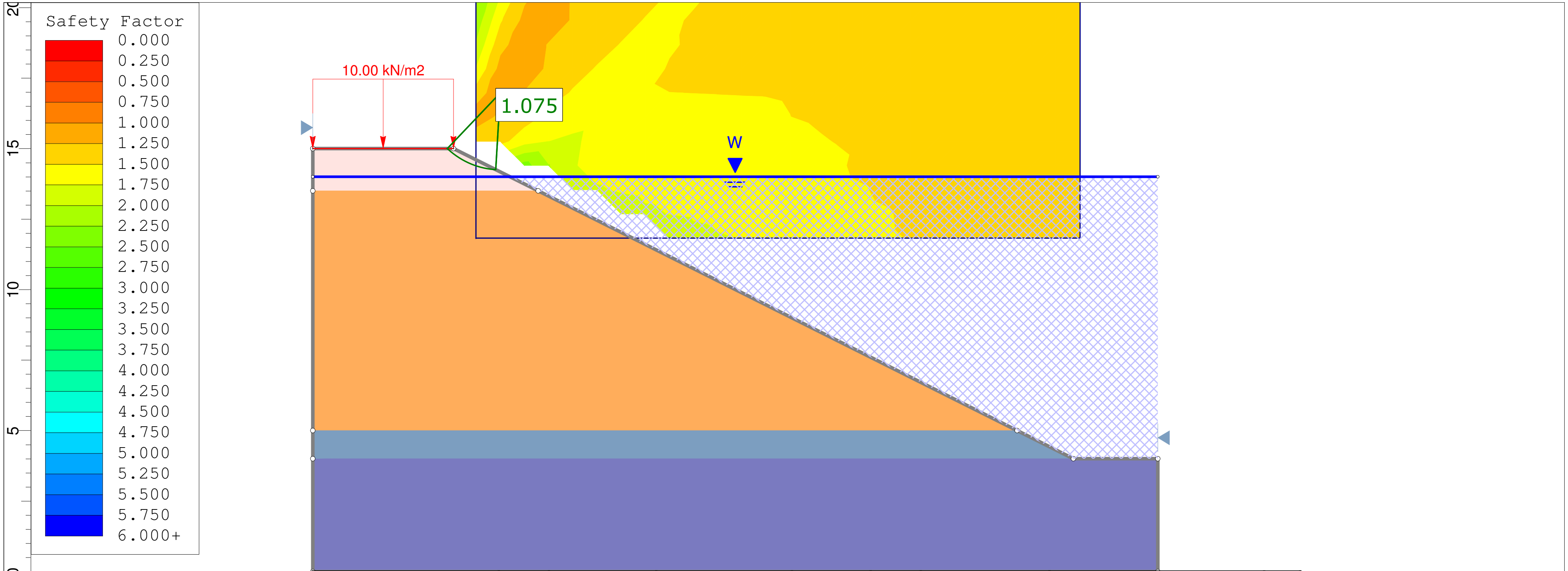
SLIDEINTERPRET 7.010



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30	Water Surface	Custom	0
Lynch Hill Gravel		20	Mohr-Coulomb	0	35	Water Surface	Automatically Calculated	
Softened London Clay		19	Mohr-Coulomb	1	23	Water Surface	Automatically Calculated	
London Clay		20	Mohr-Coulomb	5	23	Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

Project	Waterplash Farm - Worst Case Geometry
Analysis Description	DA1 C2 Drained - 1 in 2 Slope
Drawn By	MGS
Scale	1:200
Company	WYG Ltd
Date	08/08/2017, 13:37:49
File Name	DA1 C1 - Drained - Soft Upper Clay.slim

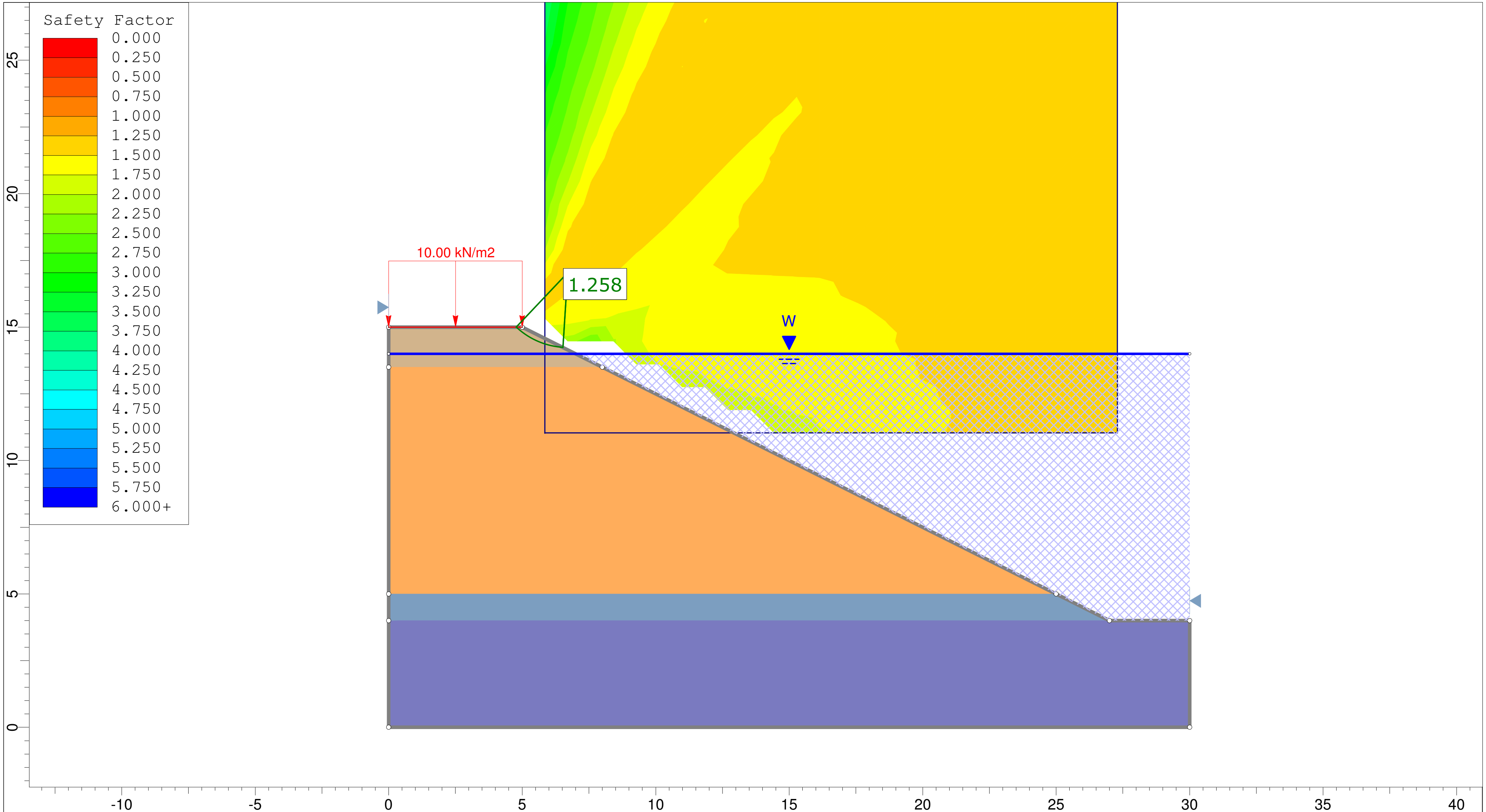


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30	Water Surface	Custom	0
Lynch Hill Gravel		20	Mohr-Coulomb	0	35	Water Surface	Automatically Calculated	
Softened London Clay		19	Mohr-Coulomb	1	23	Water Surface	Automatically Calculated	
London Clay		20	Mohr-Coulomb	5	23	Water Surface	Automatically Calculated	

-10 -5 0 5 10 15 20 25 30 35 40

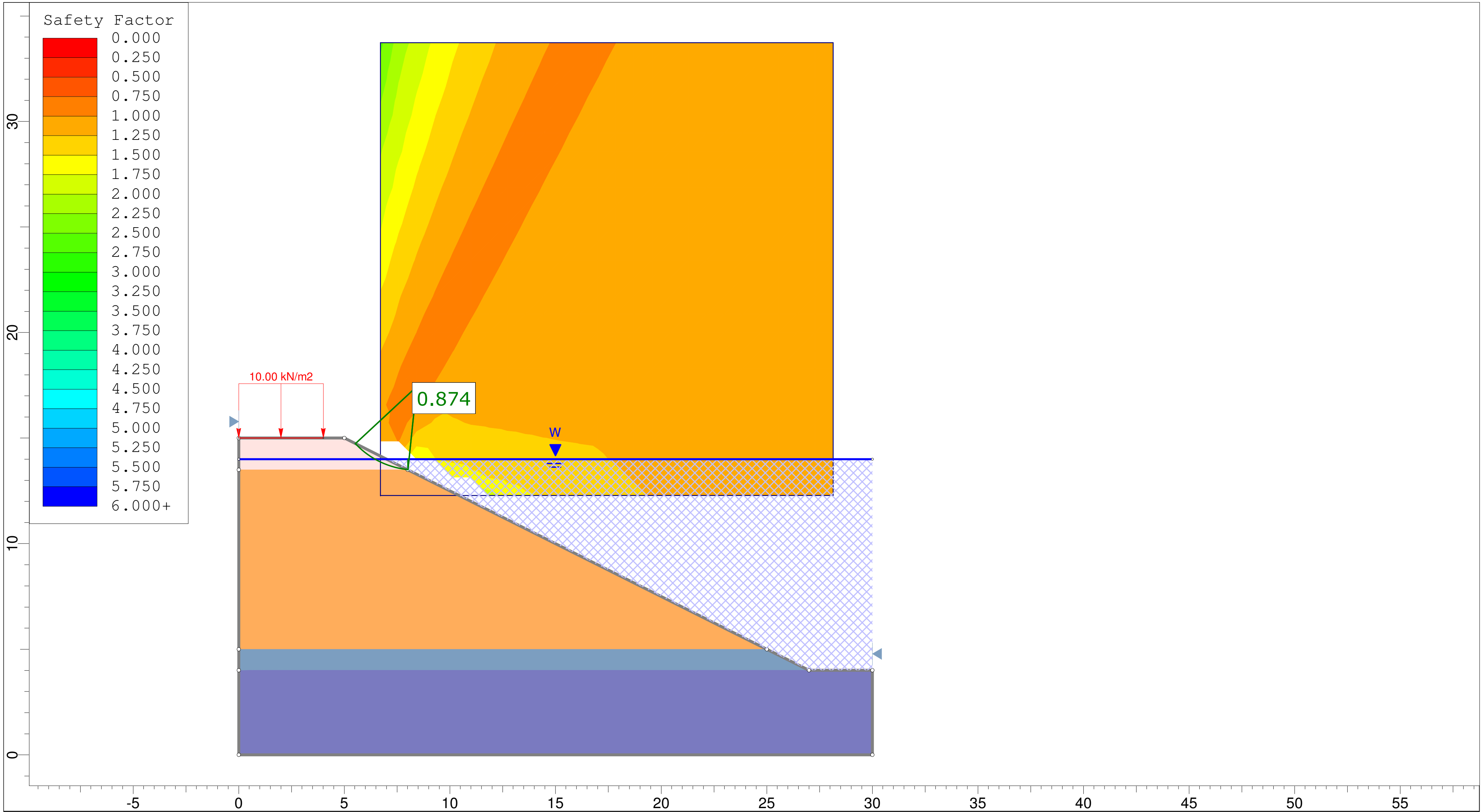
SLIDEINTERPRET 7.010

Project	Waterplash Farm - Worst Case Geometry
Analysis Description	DA1 C2 Drained - 1 in 2 Slope
Drawn By	MGS
Scale	1:200
Company	WYG Ltd
Date	08/08/2017, 13:37:49
File Name	DA1 C2 - Drained - Soft Upper Clay.slim



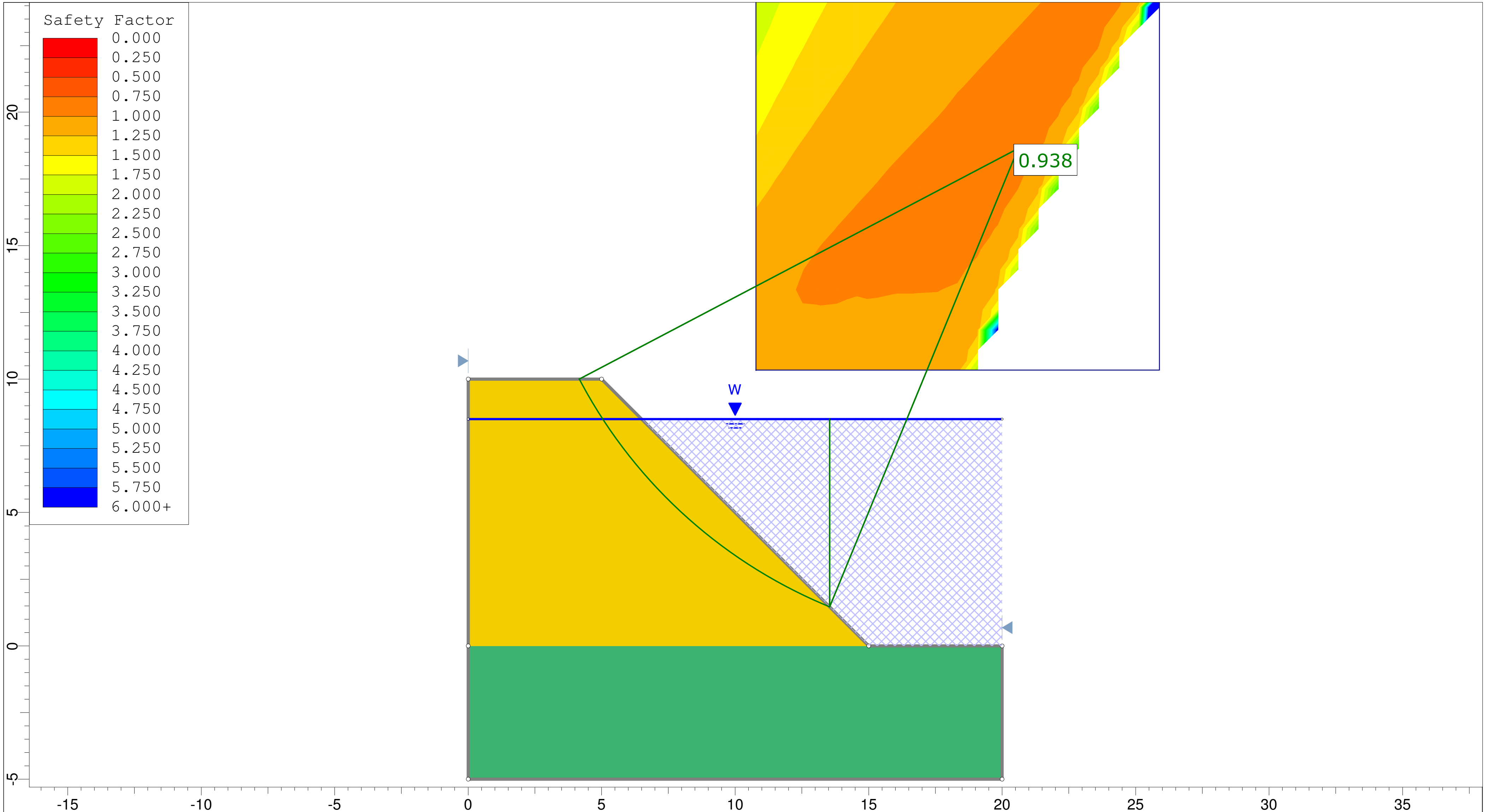
Project	Waterplash Farm - Worst Case Geometry		
Analysis Description	DA1 C1 Drained - 1 in 2 Slope		
Drawn By: MGS	Scale: 1:200	Company	WYG Ltd
Date	08/08/2017, 13:37:49	File Name	DA1 C1 - Drained - 1m overdig.slim

SLIDEINTERPRET 7.010



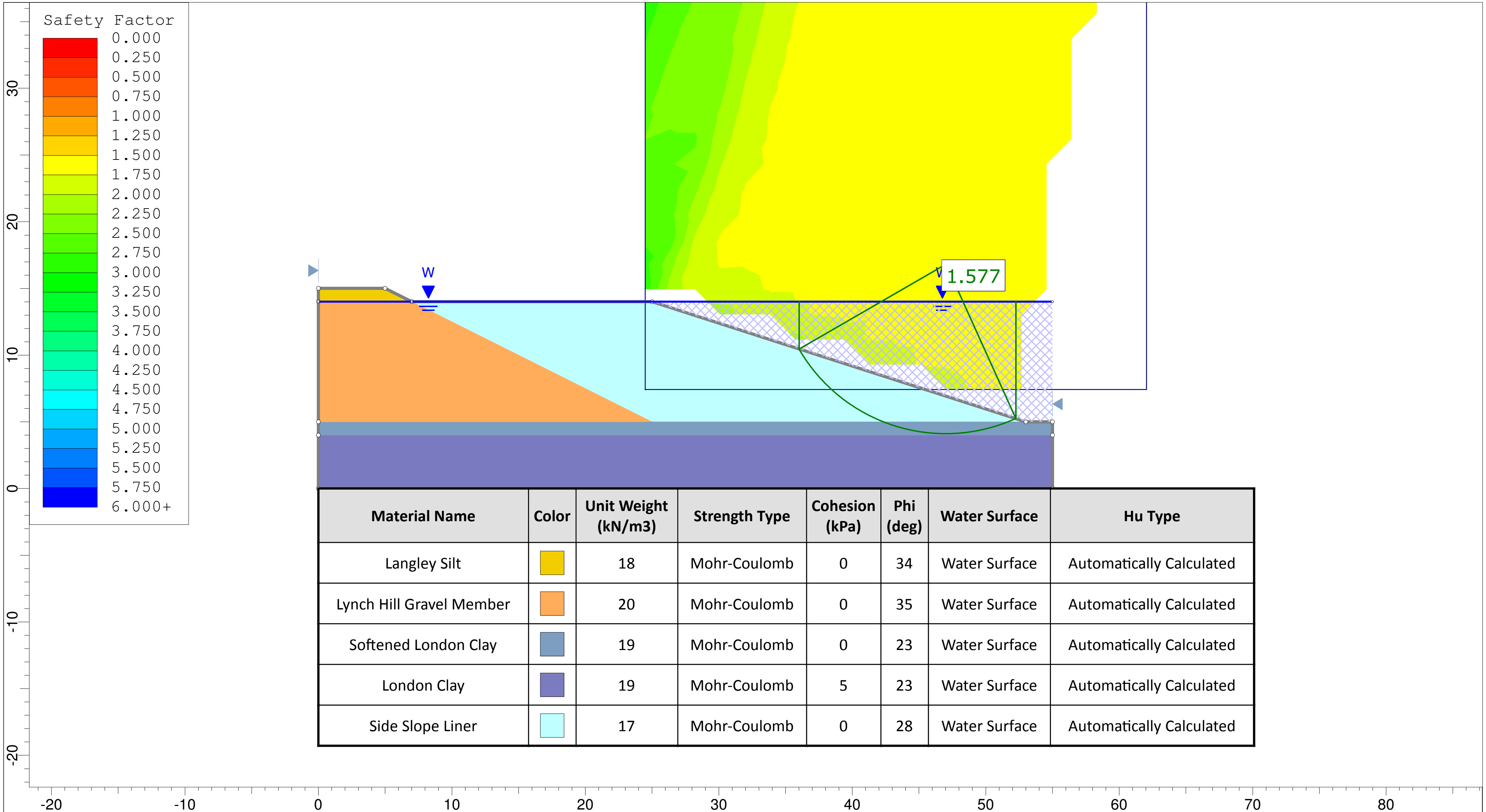
Project	Waterplash Farm - Worst Case Geometry		
Analysis Description	DA1 C2 Drained - 1 in 2 Slope		
Drawn By	MGS	Scale	1:252
Company	WYG Ltd		
Date	08/08/2017, 13:37:49	File Name	DA1 C2 - Drained - 1m overdig.slim

SLIDEINTERPRET 7.010



SLIDEINTERPRET 7.010	*Project* Langley Inert Landfill		
	Analysis Description Temporary Global - 1 in 1		
	Drawn By MGS	*Scale* 1:200	*Company* WYG
	Date 18/09/2017, 10:07:54		*File Name* Temporary 1 in 1 - Global.slim

4.3 Appendix C – SLIDE Worksheets – Side Slope Liner



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
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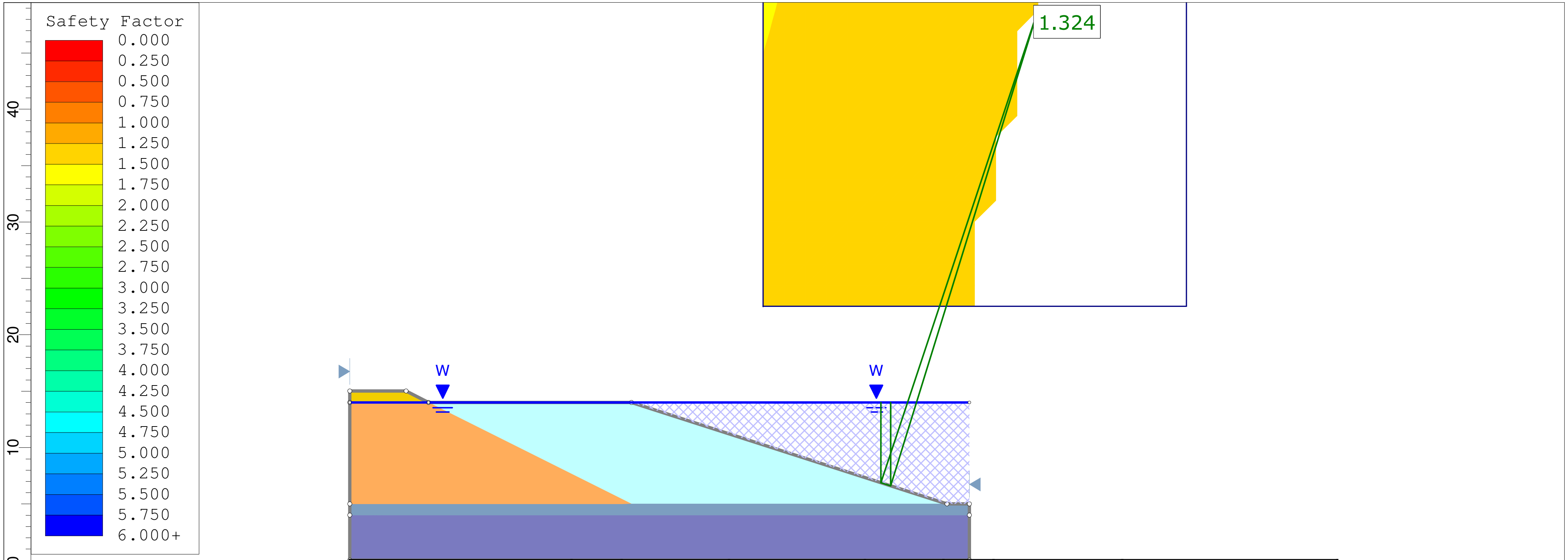
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35	Water Surface	Automatically Calculated
Softened London Clay		19	Mohr-Coulomb	0	23	Water Surface	Automatically Calculated
London Clay		19	Mohr-Coulomb	5	23	Water Surface	Automatically Calculated
Side Slope Liner		17	Mohr-Coulomb	0	28	Water Surface	Automatically Calculated

SLIDEINTERPRET 7.010

Project	Side Slope Liner - DA1 C1 Drained - below water only
Analysis Description	DA1 C1 Drained
Drawn By	MGS
Scale	1:400
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Side Slope Liner - DA1 C1 - Drained - Underwater Only.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Langley Silt		19	Mohr-Coulomb	0	34	Water Surface	Automatically Calculated
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35	Water Surface	Automatically Calculated
Softened London Clay		19	Mohr-Coulomb	0	23	Water Surface	Automatically Calculated
London Clay		19	Mohr-Coulomb	5	23	Water Surface	Automatically Calculated
Side Slope Liner		17	Mohr-Coulomb	0	28	Water Surface	Automatically Calculated

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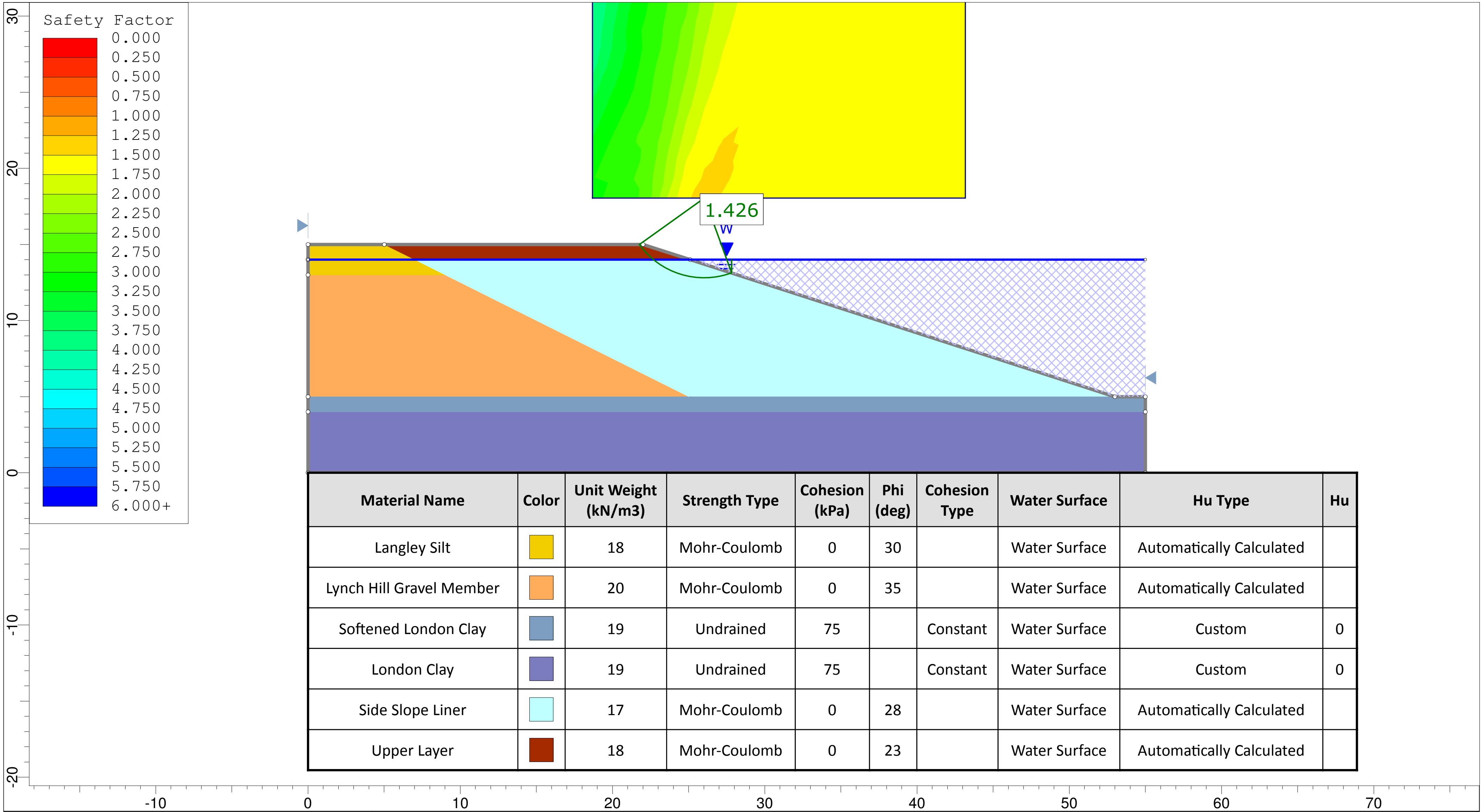
Project	Side Slope Liner - DA1 C1 Drained - below water only		
Analysis Description	DA1 C2 Drained		
Drawn By MGS	*Scale* 1:500	*Company* WYG Ltd	
Date 09/08/2017, 10:28:53	*File Name* Side Slope Liner - DA1 C2 - Drained - Underwater Only - Copy.slim		

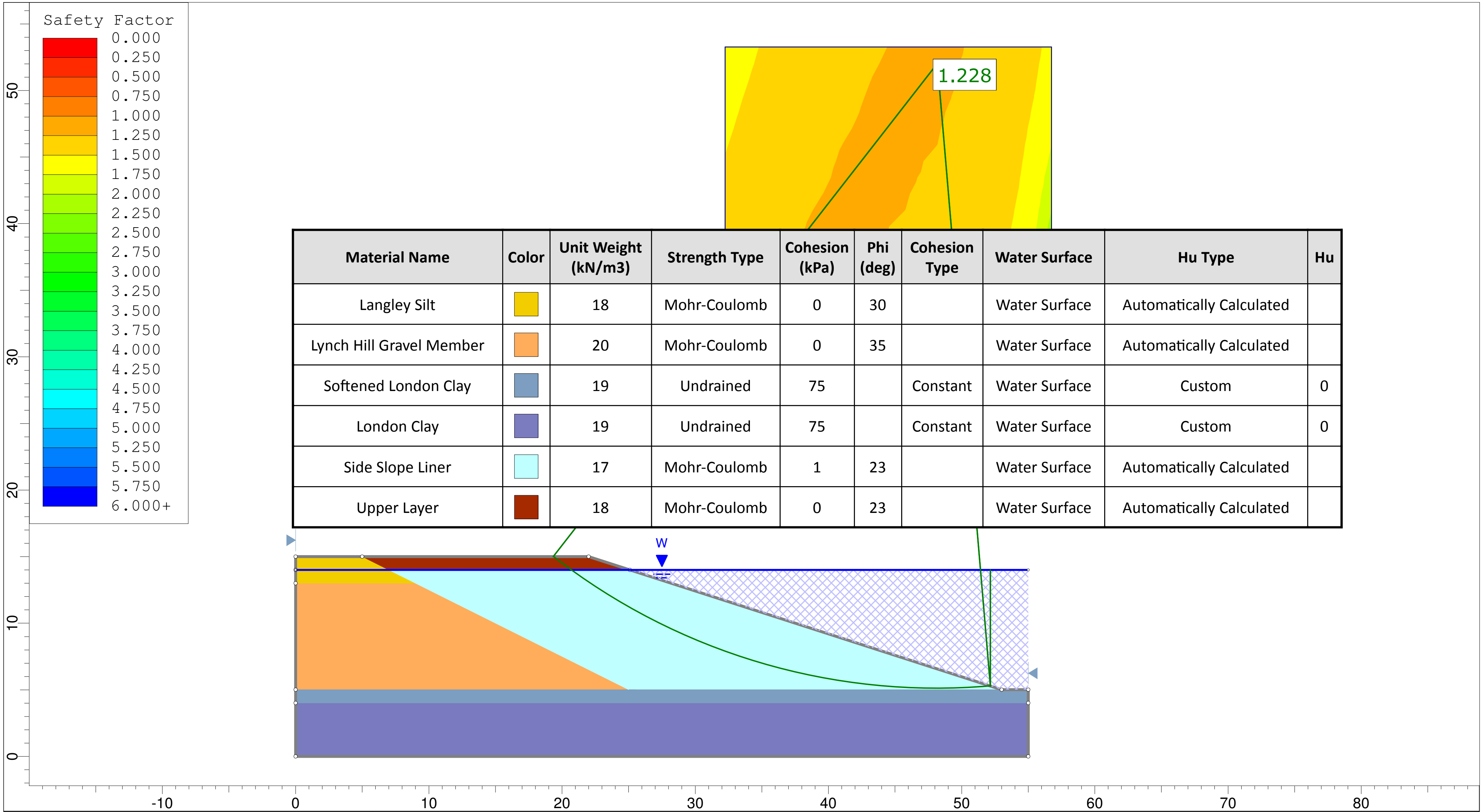


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

rocscience

SLIDEINTERPRET 7.010

Project	Side Slope Liner - DA1 C1 Undrained - below water only
Analysis Description	DA1 C1 Undrained
Drawn By	MGS
Scale	1:350
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Side Slope Liner - DA1 C1 - Undrained - Upper Added.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	1	23		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

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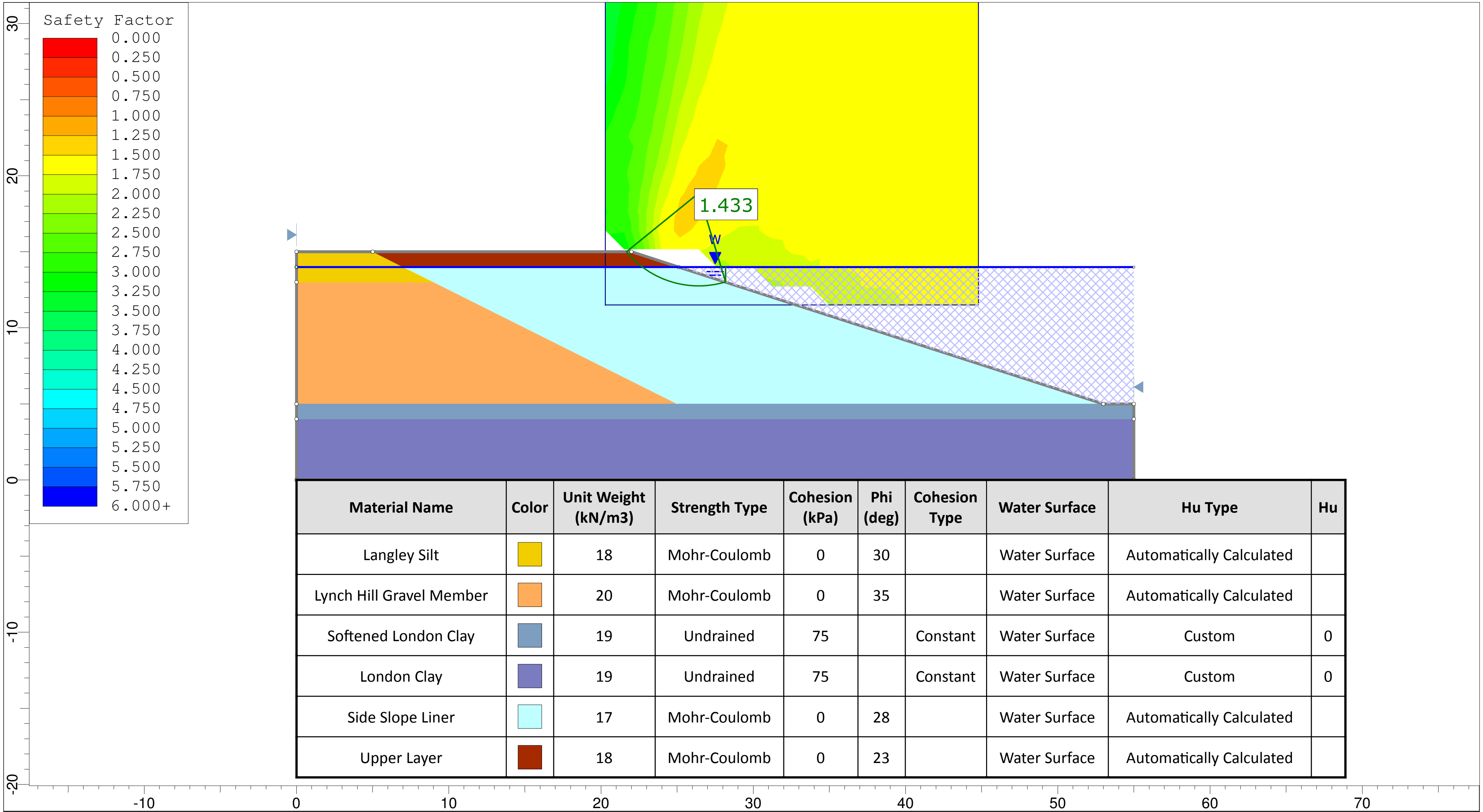
SLIDEINTERPRET 7.010

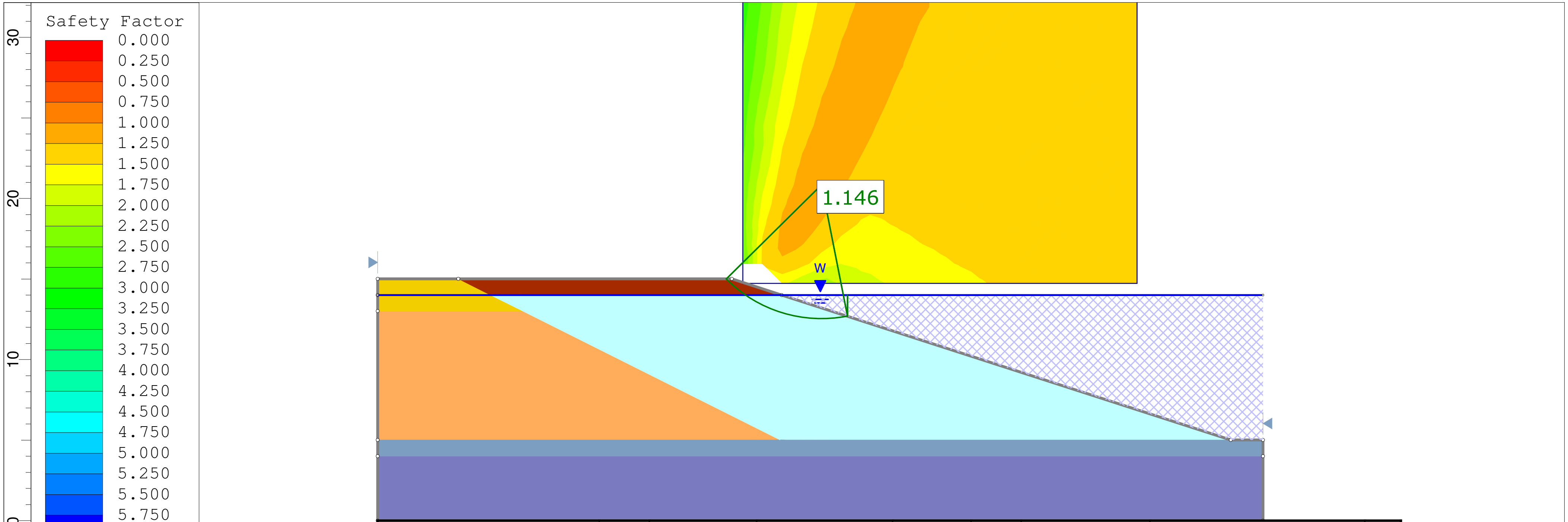
Project	Side Slope Liner - DA1 C2 Undrained - below water only
Analysis Description	DA1 C2 Undrained
Drawn By	MGS
Scale	1:400
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Side Slope Liner - DA1 C2 - Undrained - Upper Added.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

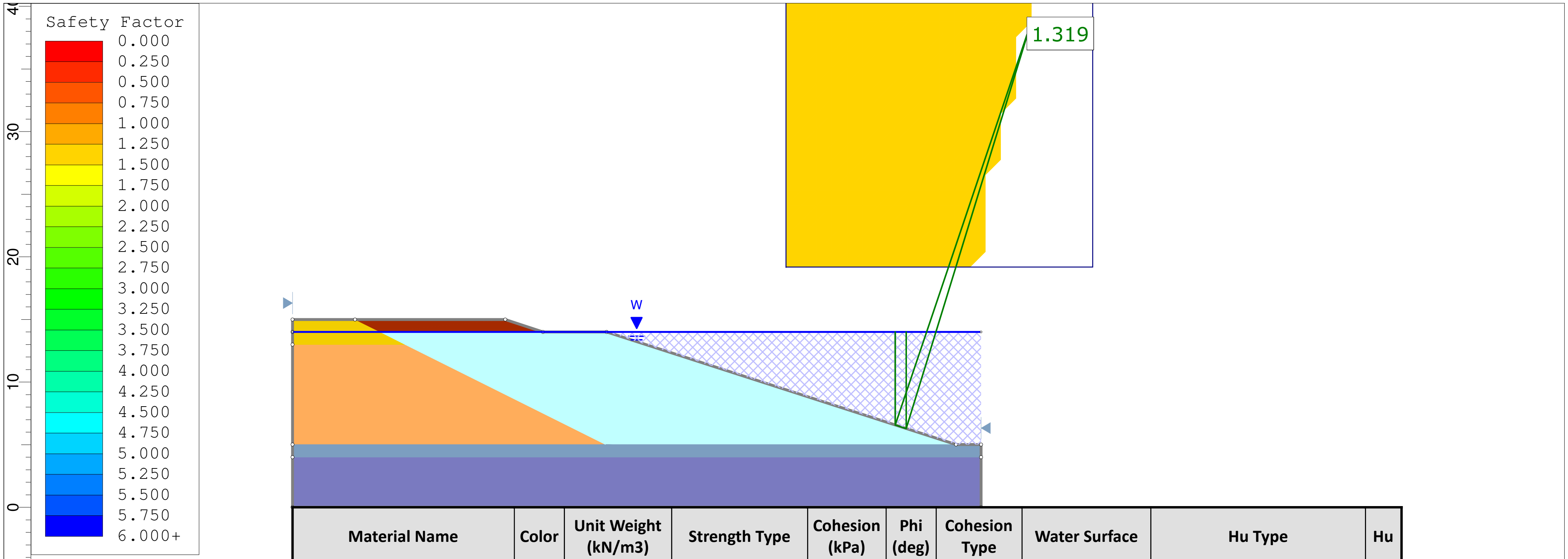
Project	Side Slope Liner - DA1 C1 Drained - below water only		
Analysis Description	DA1 C1 Drained		
Drawn By MGS	*Scale* 1:350	*Company*	WYG Ltd
Date	09/08/2017, 10:28:53	*File Name*	Side Slope Liner - DA1 C1 - Drained - Upper Added.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30	Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35	Water Surface	Automatically Calculated	
Softened London Clay		19	Mohr-Coulomb	0	23	Water Surface	Automatically Calculated	
London Clay		19	Mohr-Coulomb	5	23	Water Surface	Automatically Calculated	
Side Slope Liner		17	Mohr-Coulomb	0	28	Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23	Water Surface	Custom	1

Project	Side Slope Liner - DA1 C2 Drained - below water only
Analysis Description	DA1 C2 Drained
Drawn By	MGS
Scale	1:350
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Side Slope Liner - DA1 C2 - Drained - Upper Added.slim

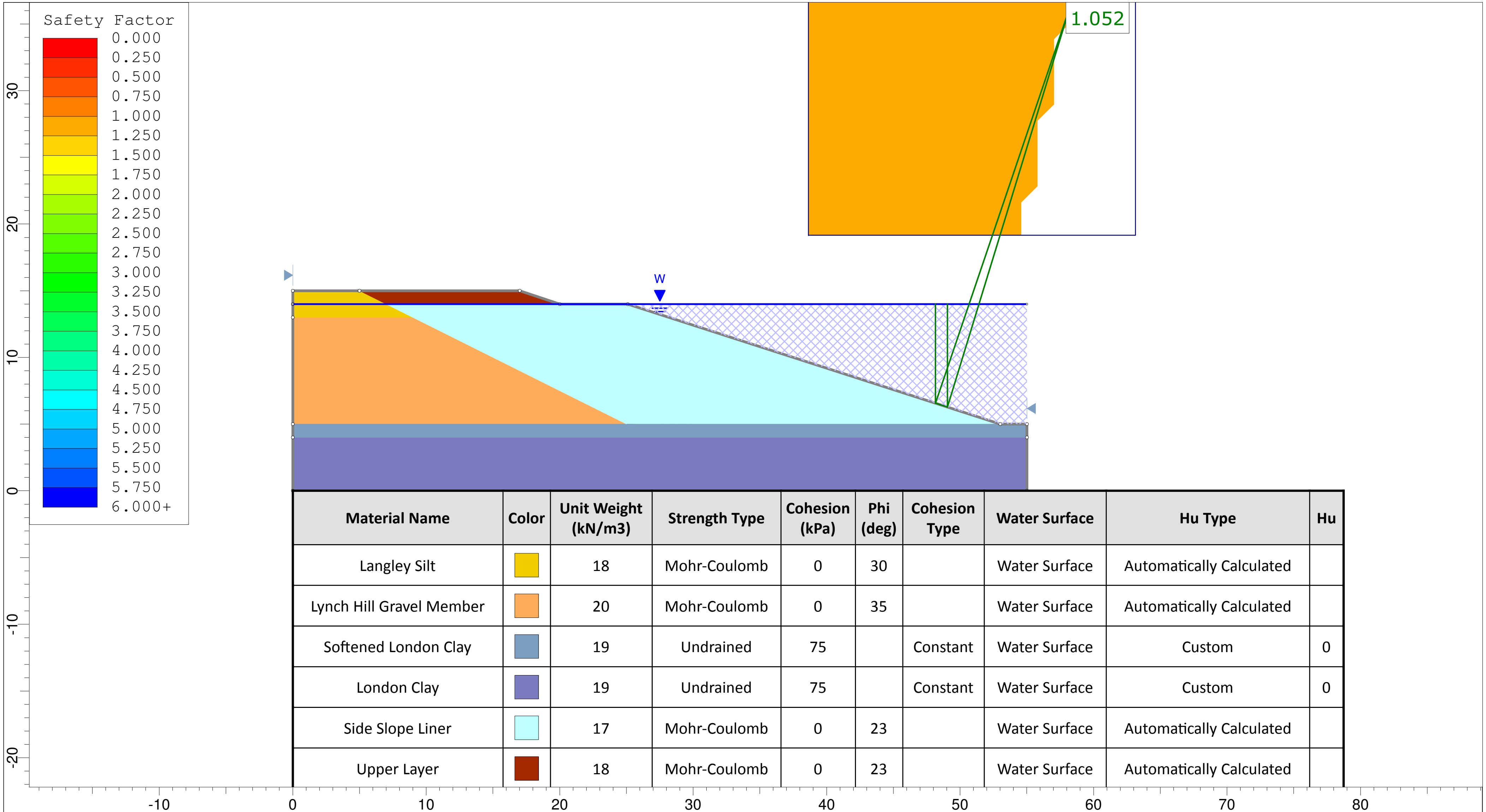
SLIDEINTERPRET 7.010



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

Project	Side Slope Liner - DA1 C1 Drained - below water only
Analysis Description	DA1 C1 Drained
Drawn By	MGS
Scale	1:450
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Side Slope Liner - DA1 C1 - Drained - 5m instep.slim

SLIDEINTERPRET 7.010

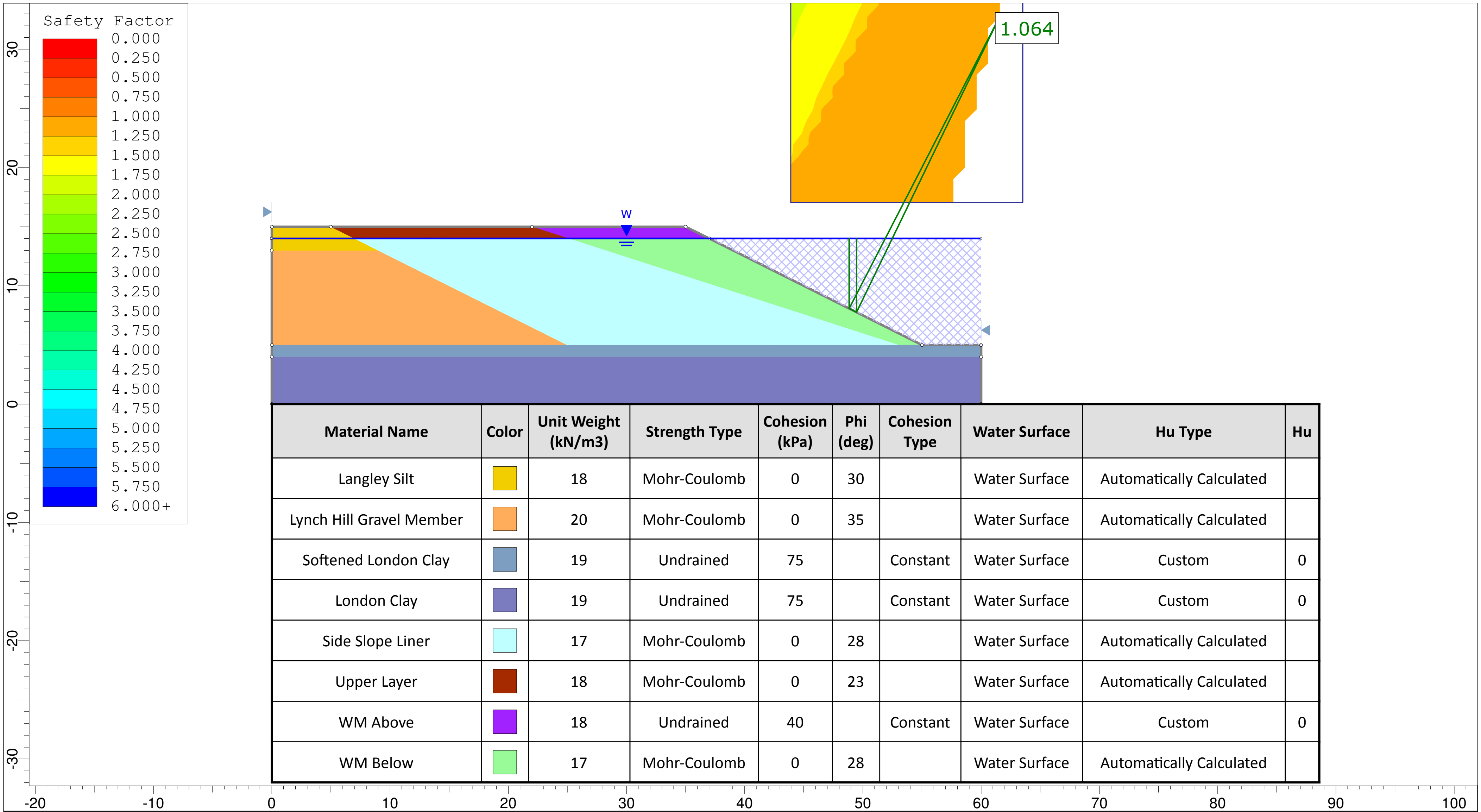


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

Project	Side Slope Liner - DA1 C2 Drained - below water only
Analysis Description	DA1 C2 Drained
Drawn By	MGS
Scale	1:400
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Side Slope Liner - DA1 C2 - Drained - 5m instep.slim

SLIDEINTERPRET 7.010

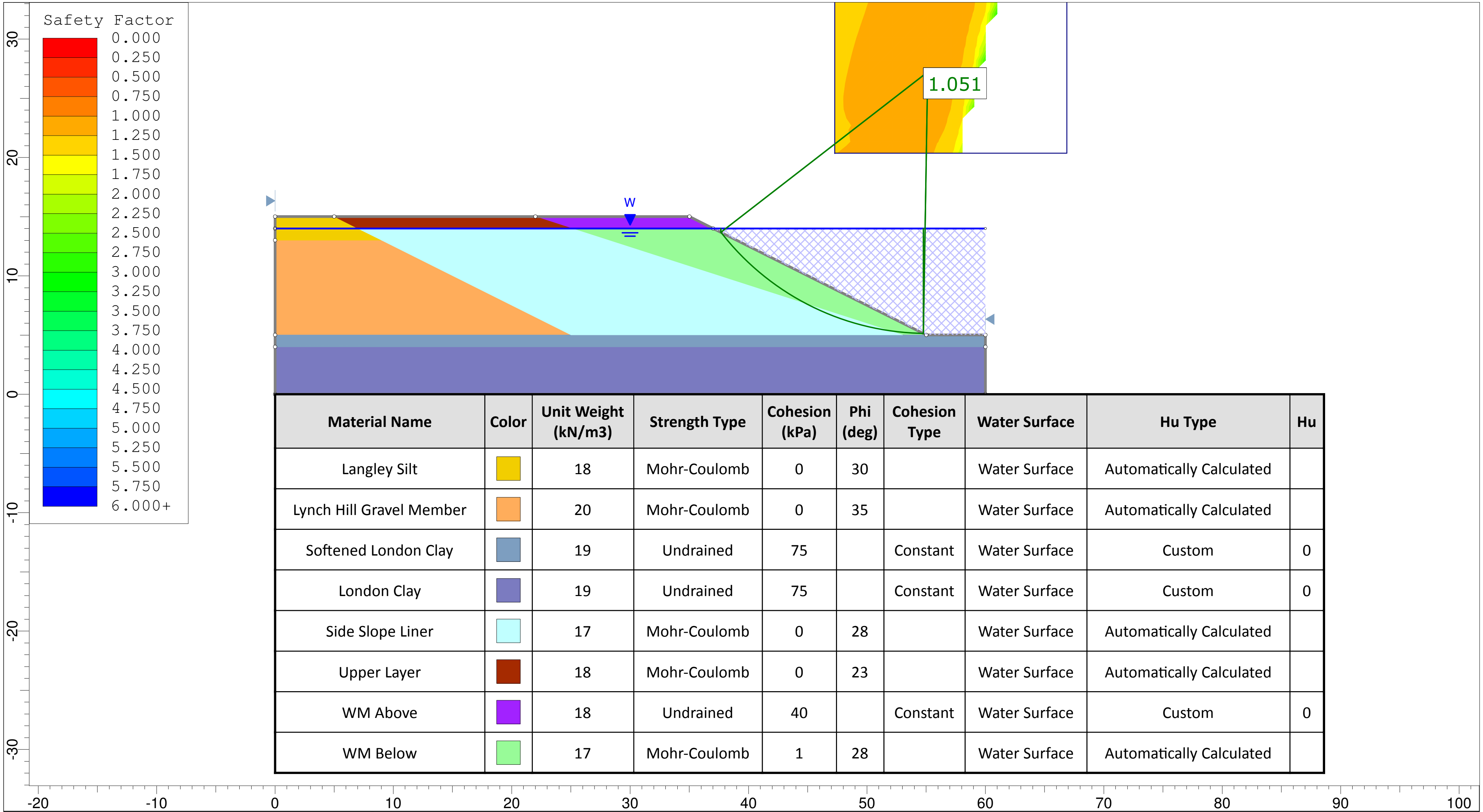
4.4 Appendix D – SLIDE Worksheets – Waste Mass



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
WM Above		18	Undrained	40		Constant	Water Surface	Custom	0
WM Below		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

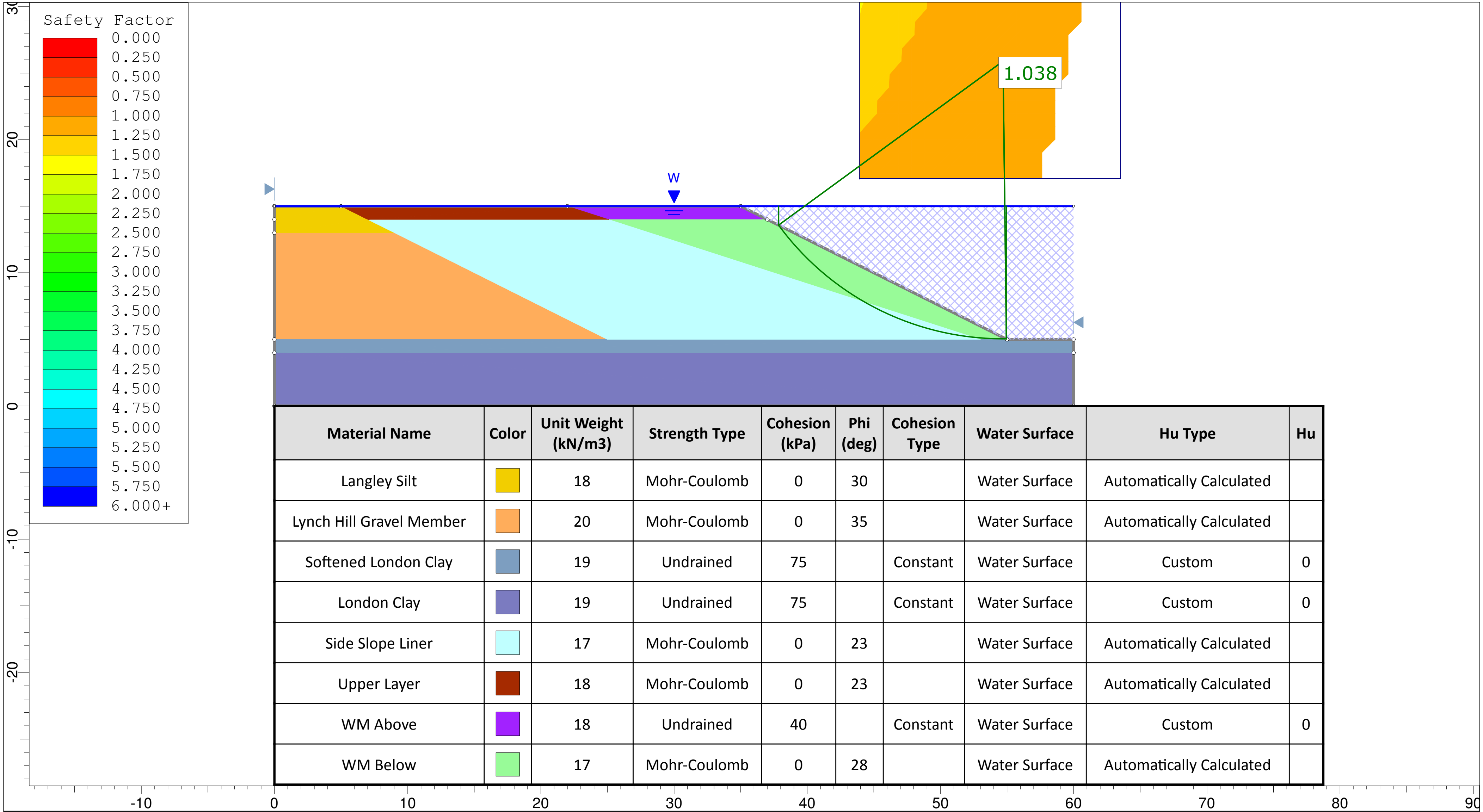
Project	Waste Mass - DA1 C1 Drained - WM Added		
Analysis Description	DA1 C1 Drained - WM Added		
Drawn By	MGS	*Scale*	1:450
Company	WYG Ltd		
Date	09/08/2017, 10:28:53	*File Name*	Waste Mass - DA1 C1 - Drained - Und WM added.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
WM Above		18	Undrained	40		Constant	Water Surface	Custom	0
WM Below		17	Mohr-Coulomb	1	28		Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

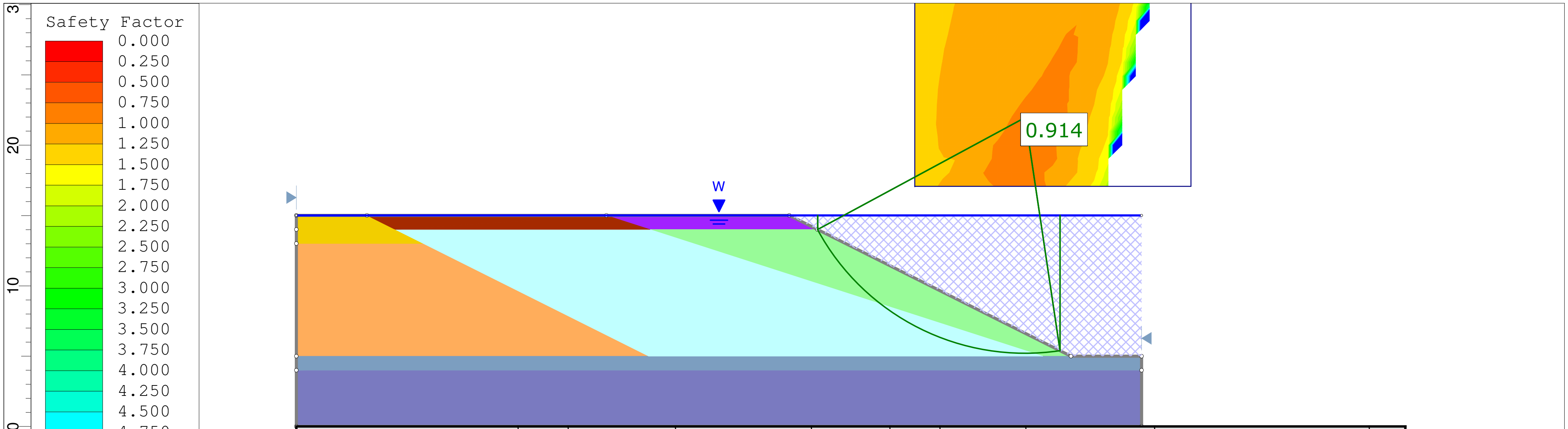
Project	Waste Mass - DA1 C2 Drained - WM Added		
Analysis Description	DA1 C2 Drained - WM Added		
Drawn By MGS	*Scale* 1:450	*Company*	WYG Ltd
Date	09/08/2017, 10:28:53	*File Name*	Waste Mass - DA1 C2 - Drained - Und WM added.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
WM Above		18	Undrained	40		Constant	Water Surface	Custom	0
WM Below		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

Project	Waste Mass - DA1 C1 Drained - WM Added
Analysis Description	DA1 C1 Drained - WM Added
Drawn By	MGS
Scale	1:400
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Waste Mass - DA1 C1 - Drained - Und WM added + 1m leach.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
WM Above		18	Undrained	40		Constant	Water Surface	Custom	0
WM Below		17	Mohr-Coulomb	1	28		Water Surface	Automatically Calculated	

-10 0 10 20 30 40 50 60 70 80 9

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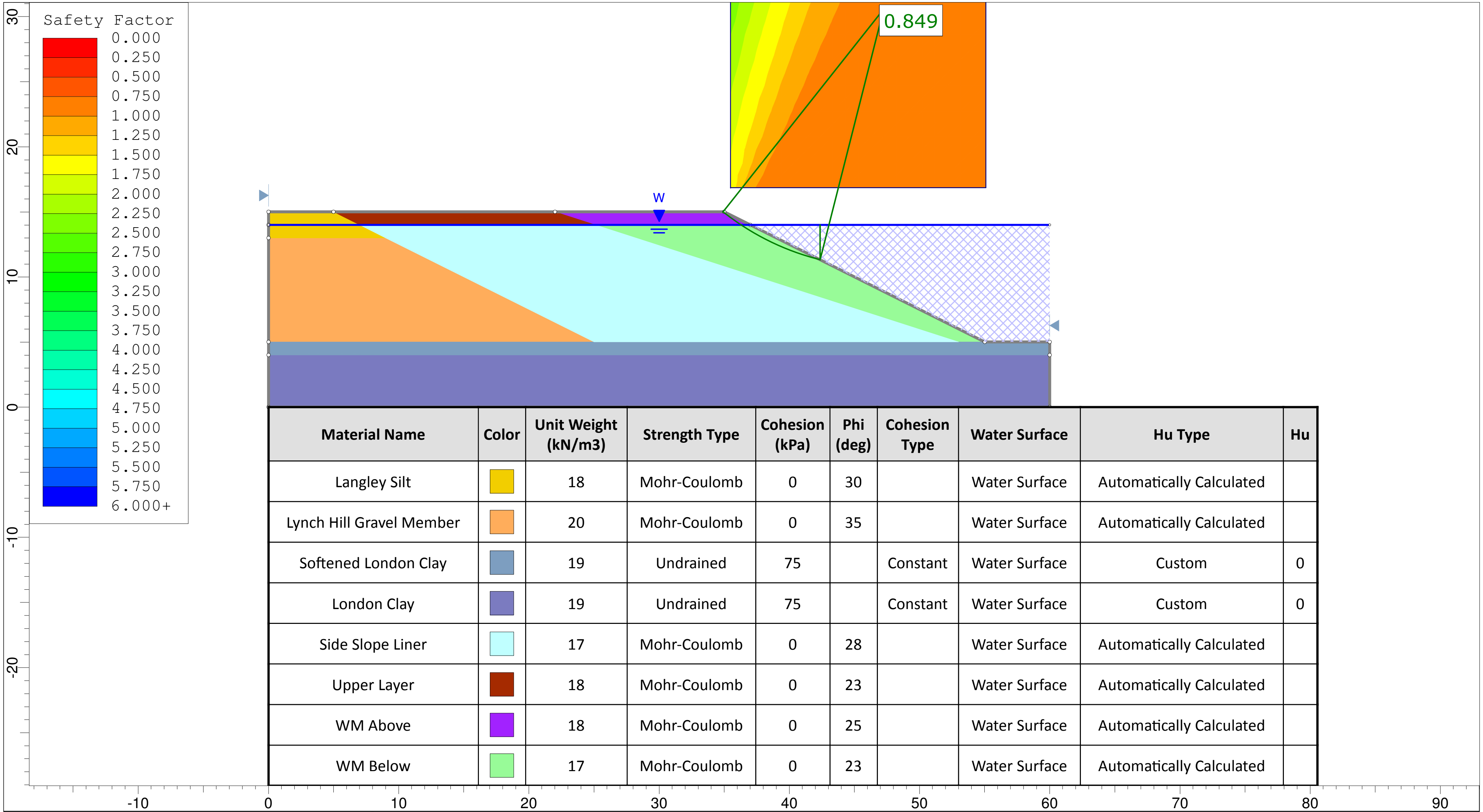
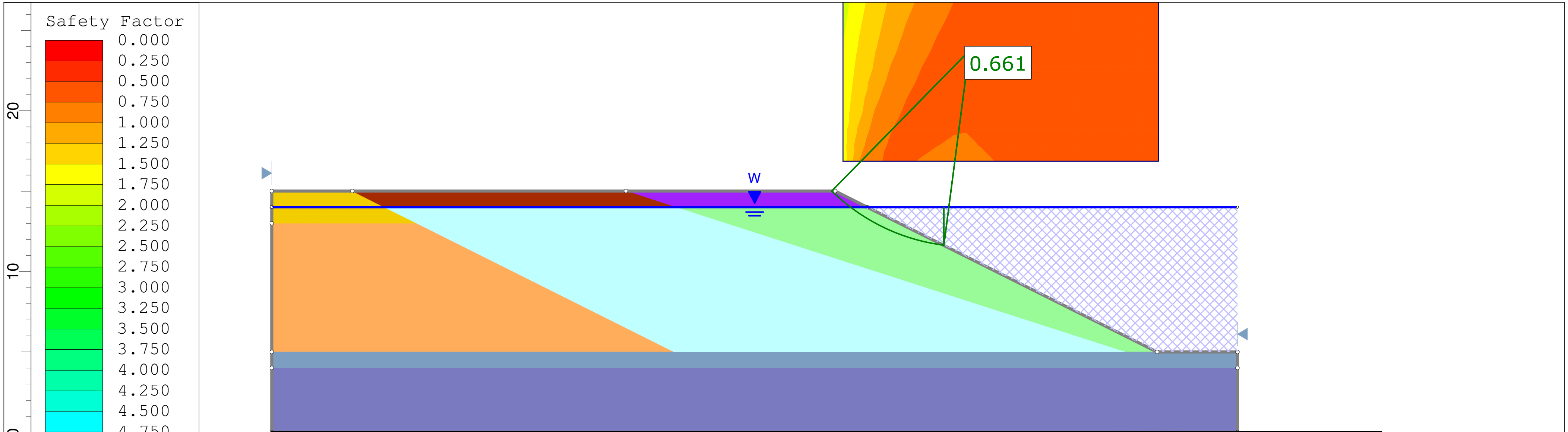
Project	Waste Mass - DA1 C2 Drained - WM Added		
Analysis Description	DA1 C2 Drained - WM Added		
Drawn By	MGS	*Scale*	1:400
Company	WYG Ltd		
Date	09/08/2017, 10:28:53	*File Name*	Waste Mass - DA1 C2 - Drained - Und WM added + 1m leach.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
WM Above		18	Mohr-Coulomb	0	25		Water Surface	Automatically Calculated	
WM Below		17	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

Project	Waste Mass - DA1 C1 Drained - WM Added
Analysis Description	DA1 C1 Drained - WM Added
Drawn By	MGS
Scale	1:409
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Waste Mass - DA1 C1 - Drained - WM drained.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Hu
Langley Silt		18	Mohr-Coulomb	0	30		Water Surface	Automatically Calculated	
Lynch Hill Gravel Member		20	Mohr-Coulomb	0	35		Water Surface	Automatically Calculated	
Softened London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
London Clay		19	Undrained	75		Constant	Water Surface	Custom	0
Side Slope Liner		17	Mohr-Coulomb	0	28		Water Surface	Automatically Calculated	
Upper Layer		18	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	
WM Above		18	Mohr-Coulomb	0	25		Water Surface	Automatically Calculated	
WM Below		17	Mohr-Coulomb	0	23		Water Surface	Automatically Calculated	

SLIDEINTERPRET 7.010

Project	Waste Mass - DA1 C2 Drained - WM Added
Analysis Description	DA1 C2 Drained - WM Added
Drawn By	MGS
Scale	1:350
Company	WYG Ltd
Date	09/08/2017, 10:28:53
File Name	Waste Mass - DA1 C2 - Drained - WM drained.slim

4.5 Appendix E - Figure 1A & 1B – OS & Aerial Site Location Maps

Revisions				
C	Red boundary has been updated	TP	May 16
D	The title box has been updatd	TP	June 16
E	Red and blue boundaries have been updated	TP	July 16

Planning Department
CEMEX UK Operations Limited
CEMEX House, Coldharbour Lane
Thorpe, Egham, Surrey
TW20 8TD
Telephone 01932 568833
Facsimile 01932 568933

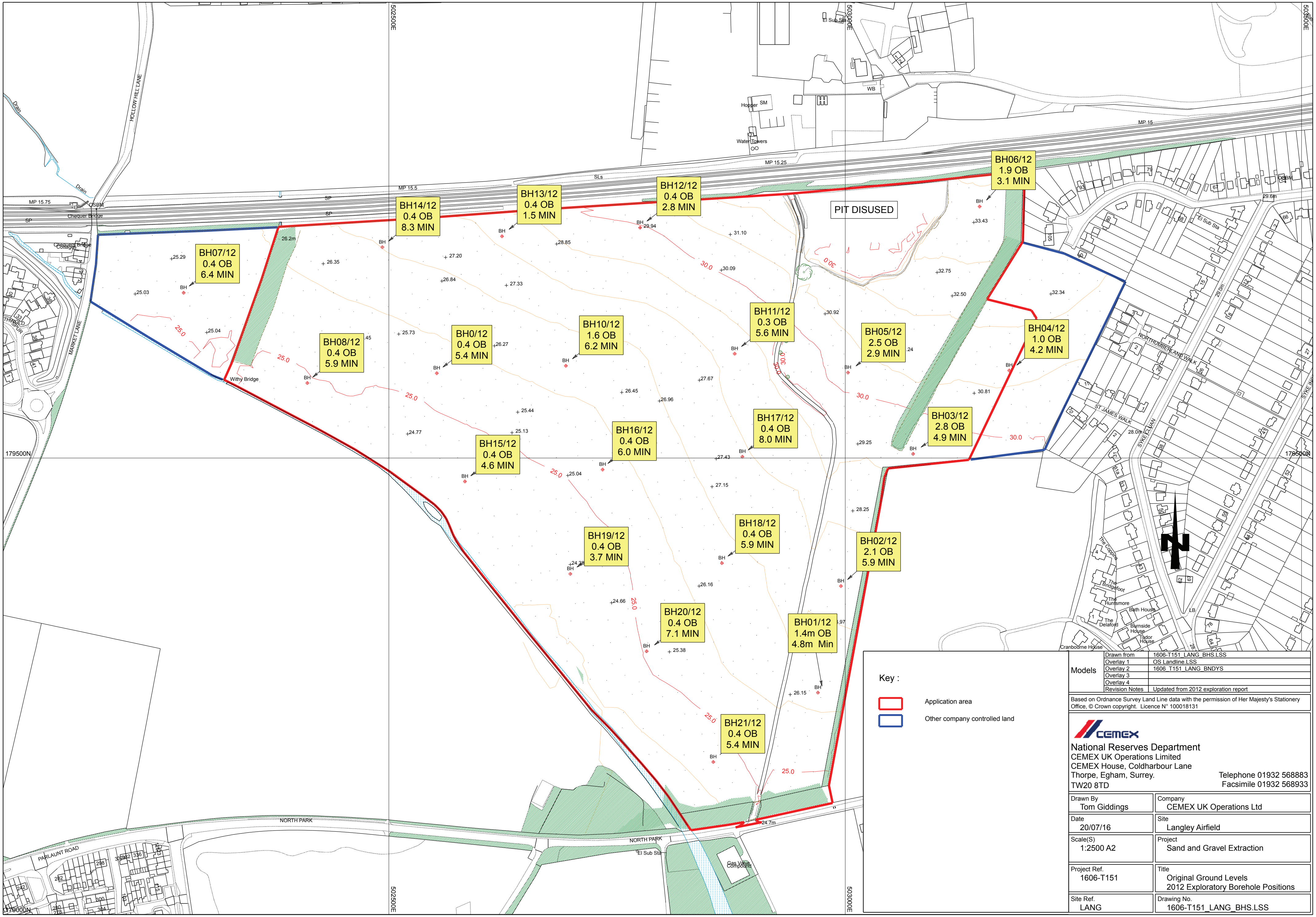
Drawn By: T Paiman	Company: CEMEX UK Operations Limited
Date: July 2016	Site: Land off North Park road, Richings Park
Scale: 1:50000 @ A4	Project: Mineral Extraction
Chkd:	Title: Location Context Plan
OS Ref:	Dwg No: P1/739/1 Rev E

Revisions				
	C	The red boundary has been updated	TP	May 16
	D	The title box has been updated	TP	June 16
	E	Red and blue boundaries have been updated	TP	July 16

Planning Department
CEMEX UK Operations Limited
CEMEX House, Coldharbour Lane
Thorpe, Egham, Surrey
TW20 8TD
Telephone 01932 568833
Facsimile 01932 568933

Drawn By:	T Paiman	Company:	CEMEX UK Operations Limited
Date:	July 2016	Site:	Land off North Park road, Richings Park
Scale:	1:10000 @ A3	Project:	Mineral Extraction
Chkd:		Title:	Aerial Plan
OS Ref:		Dwg No:	P1/739/2 Rev E

4.6 Appendix F – Original Ground Levels - 2012 Exploratory Borehole Positions (Drawing No. 1606-T151_LANF_BHS.LSS)



Models	
Drawn from	1606-T151_LANG_BHS.LSS
Overlay 1	OS Landline.LSS
Overlay 2	1606_T151_LANG_BNDYS
Overlay 3	
Overlay 4	
Revision Notes	Updated from 2012 exploration report

CEMEX
National Reserves Department
CEMEX UK Operations Limited
CEMEX House, Coldharbour Lane
Thorpe, Egham, Surrey.
TW20 8TD
Telephone 01932 568883
Facsimile 01932 568933

Drawn By: Tom Giddings	Company: CEMEX UK Operations Ltd
Date: 20/07/16	Site: Langley Airfield
Scale(S): 1:2500 A2	Project: Sand and Gravel Extraction
Project Ref.: 1606-T151	Title: Original Ground Levels 2012 Exploratory Borehole Positions
Site Ref.: LANG	Drawing No.: 1606-T151_LANG_BHS.LSS

4.7 Appendix G – Hydrogeological Data

Hydrogeology

13.62 During the Site Investigation in 2012, water was struck in all of the boreholes onsite, groundwater encountered between 2.2 and 5.3 m below ground level. The Groundwater level monitoring boreholes were drilled in 2015 and the data shows that water was struck between 1.8 and 3.8 m below ground level. The water level data shows a very limited saturated thickness over the monitoring period (Table 40). The locations of the groundwater monitoring boreholes and SI boreholes are shown in Figure 11.

Table 40 Saturated thickness of groundwater in the monitoring boreholes

	WOB01			WOB02			WOB03		
	Dip (mbtc)*	Plumb Depth (mbtc)	Saturated thickness (m)	Dip (mbtc)	Plumb Depth (mbtc)	Saturated thickness (m)	Dip (mbtc)	Plumb Depth (mbtc)	Saturated Thickness (m)
14/04/2015	2.71	5.31	2.6	4.67	7.05	2.38	2.75	5.22	2.47
12/05/2015	2.82	5.3	2.48	4.94	7.06	2.12	3	5.2	2.2
09/06/2015	2.93	5.31	2.38	5.08	7.06	1.98	3.23	5.19	1.96
07/07/2015	3.03	5.27	2.24	5.22	6.99	1.77	3.38	5.17	1.79
11/08/2015	3.08	5.77	2.69	5.31	6.99	1.68	3.46	5.17	1.71
11/09/2015	3.06	4.4	1.34	5.3	7.02	1.72	3.44	4.98	1.54
27/10/2015	3.07	4.39	1.32	5.33	7.02	1.69	3.52	4.88	1.36
02/11/2015	3.03	4.39	1.36	5.33	7.03	1.7	3.5	4.91	1.41
09/12/2015	2.96	4.39	1.43	5.23	7.02	1.79	3.49	4.87	1.38
13/01/2016	2.62	4.38	1.76	4.98	7.03	2.05	2.57	4.86	2.29
04/02/2016	2.63	4.41	1.78	4.78	7.06	2.28	2.69	5.23	2.54
01/03/2016	2.62	4.37	1.75	4.74	7.08	2.34	2.62	5.24	2.62
18/04/2016	2.55	4.39	1.84	4.63	7.02	2.39	2.5	5.18	2.68
19/05/2016	2.68	4.42	1.74	4.76	7.08	2.32	2.84	5.23	2.39

Table 40 Continued...

	WOB04			WOB05			WOB06		
	Dip (mbtc)*	Plumb Depth (mbtc)	Saturated thickness (m)	Dip (mbtc)	Plumb Depth (mbtc)	Saturated thickness (m)	Dip (mbtc)	Plumb Depth (mbtc)	Saturated Thickness (m)
14/04/2015	3.03	4.89	1.86	4.18	6.89	2.71	1.22	4.63	3.41
12/05/2015	3.21	4.76	1.55	4.24	5.97	1.73	1.39	4.54	3.15
09/06/2015	3.39	4.71	1.32	4.42	6.31	1.89	1.5	4.63	3.13
07/07/2015	3.59	5.13	1.54	4.56	6.81	2.25	1.53	4.58	3.05
11/08/2015	3.54	4.75	1.21	4.4	6.82	2.42	1.43	4.58	3.15
11/09/2015	3.4	4.83	1.43	4.27	5.96	1.69	1.31	4.62	3.31
27/10/2015	3.53	4.73	1.2	4.3	5.93	1.63	1.44	4.64	3.2
02/11/2015	3.53	4.77	1.24	4.25	5.94	1.69	1.38	4.63	3.25
09/12/2015	3.45	4.77	1.32	4.2	5.92	1.72	1.37	4.63	3.26
13/01/2016	2.94	4.76	1.82	4.1	5.93	1.83	1.5	4.63	3.13
04/02/2016	2.91	5.2	2.29	4.14	6.23	2.09	1.19	4.68	3.49
01/03/2016	2.97	5.02	2.05	4.13	6.15	2.02	1.15	4.68	3.53
18/04/2016	2.84	4.95	2.11	4.09	6.08	1.99	1.01	4.64	3.63
19/05/2016	2.98	5.21	2.23	4.11	6.23	2.12	1.14	4.67	3.53

*mbtc: metres below top of casing

Aquifer Status

13.64 The superficial deposits of Langley Silt Member are classified as unproductive strata. The Lynch Hill Gravel Member and Shepperton Gravel Member (which are part of the Maidenhead Formation) are described as Principal aquifers according to the Environment Agency (2015). Principal Aquifers identified by the Environment Agency as “layers of rock or drift deposits that have high intergranular and/or fracture permeability. This means they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale”.

13.65 The underlying London Clay bedrock is relatively impermeable and is described as unproductive strata (EA, 2015).

Aquifer Properties

13.66 The Maidenhead Formation forms the main aquifer within the area. It generally comprises sand and gravel with some silt and clay. There are no permeability data specific to these deposits available in the standard literature.

Figure 15 Groundwater levels in the monitoring boreholes

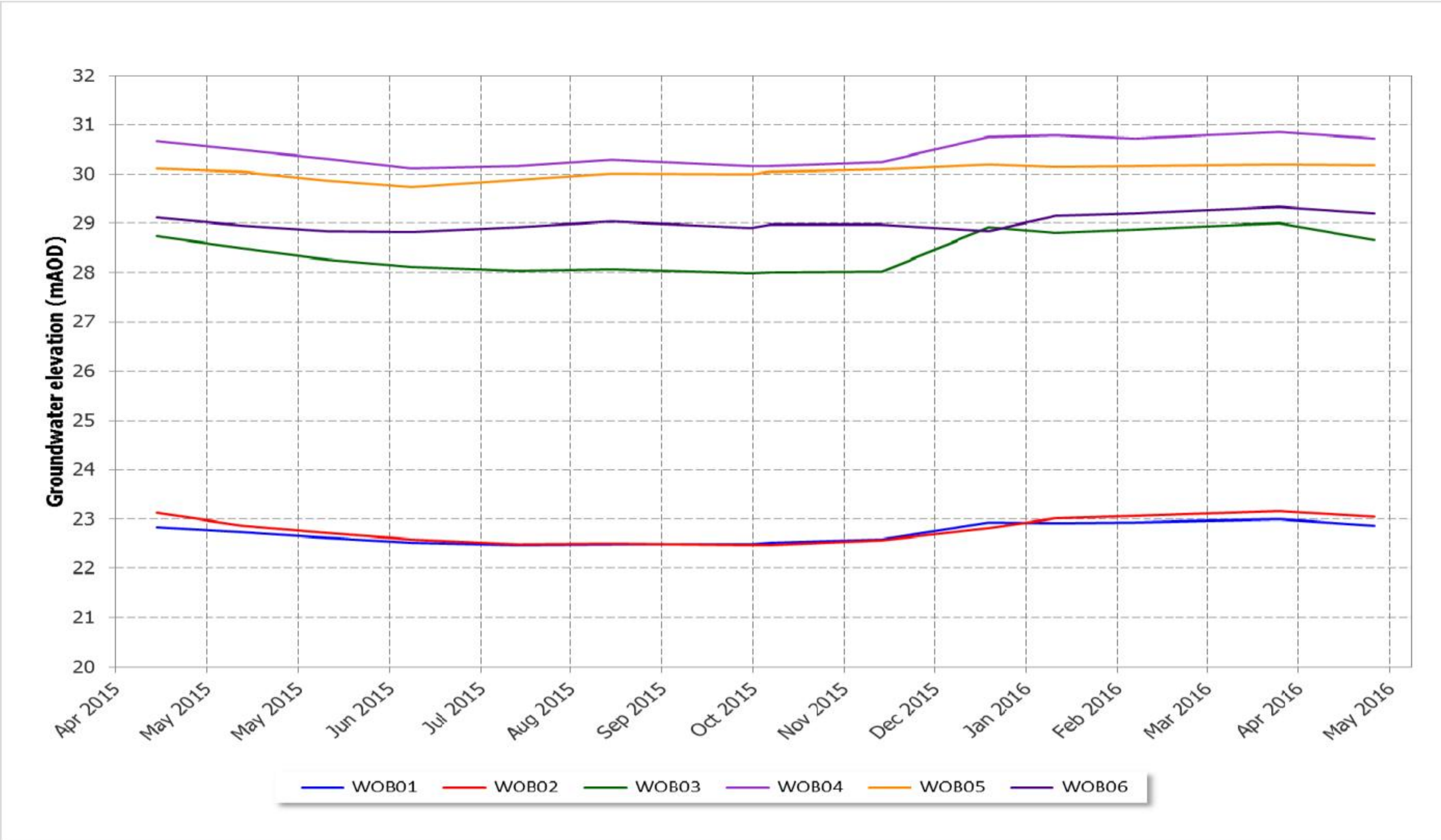
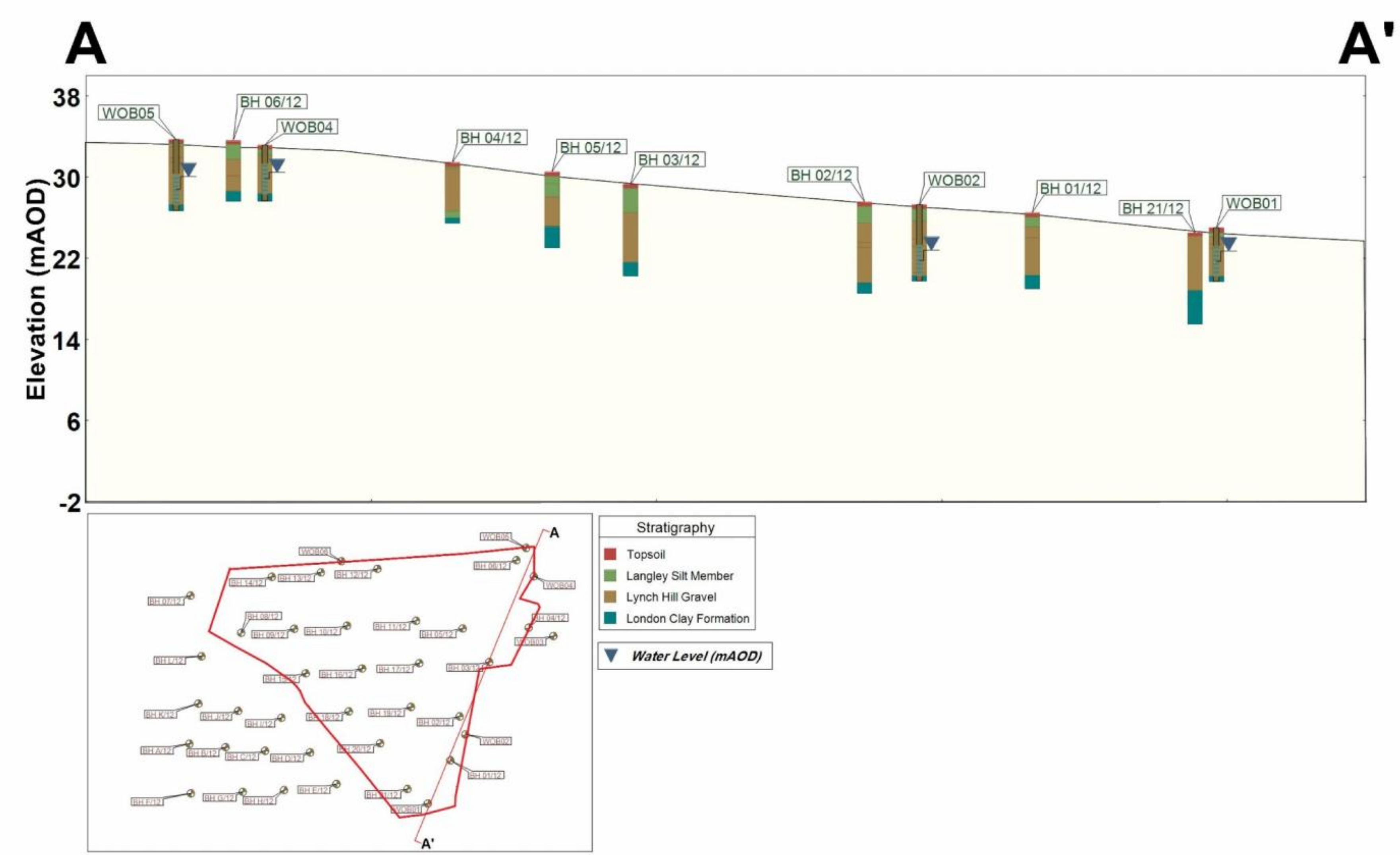


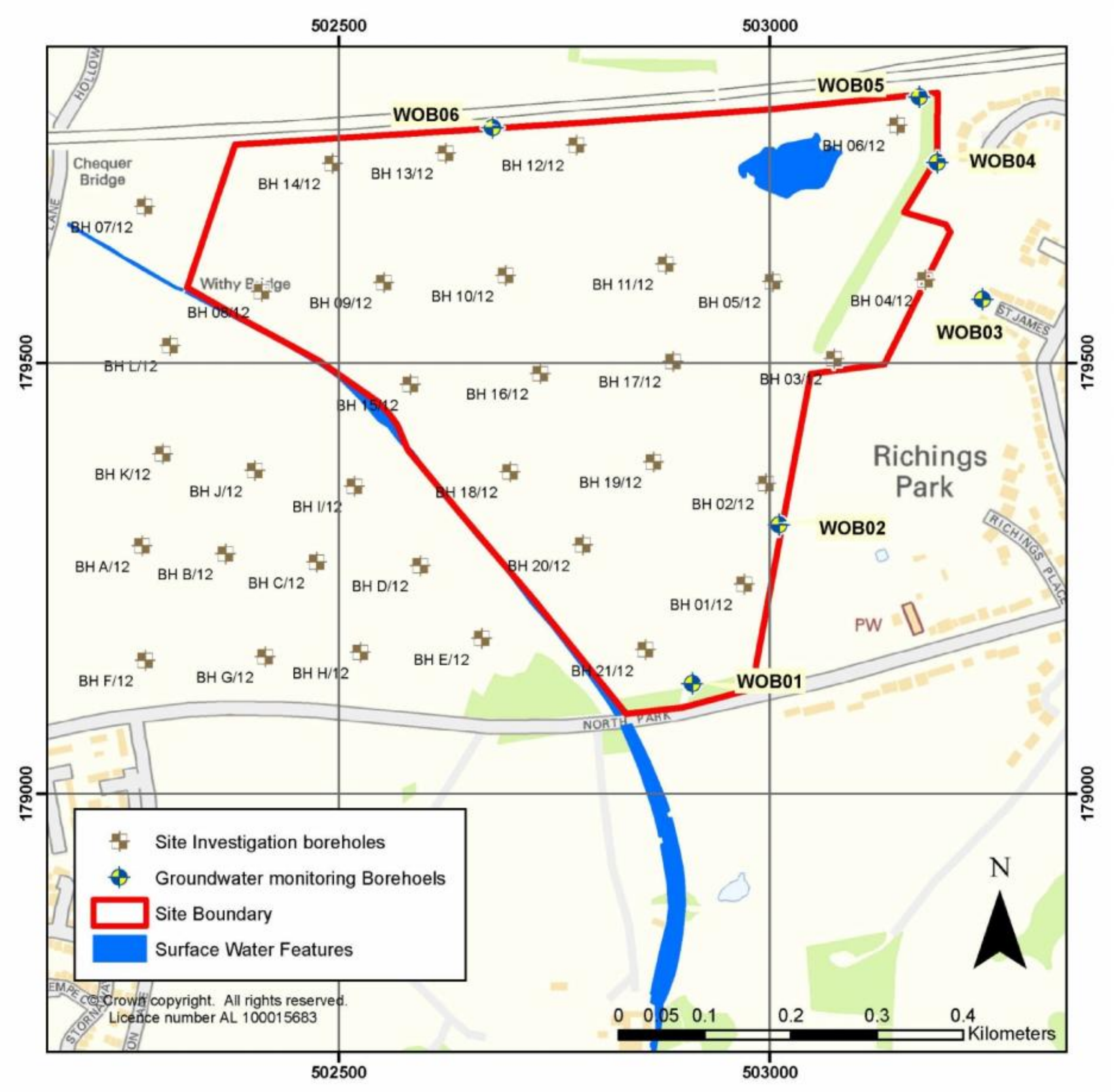
Figure 16 Groundwater levels in north-south cross-section



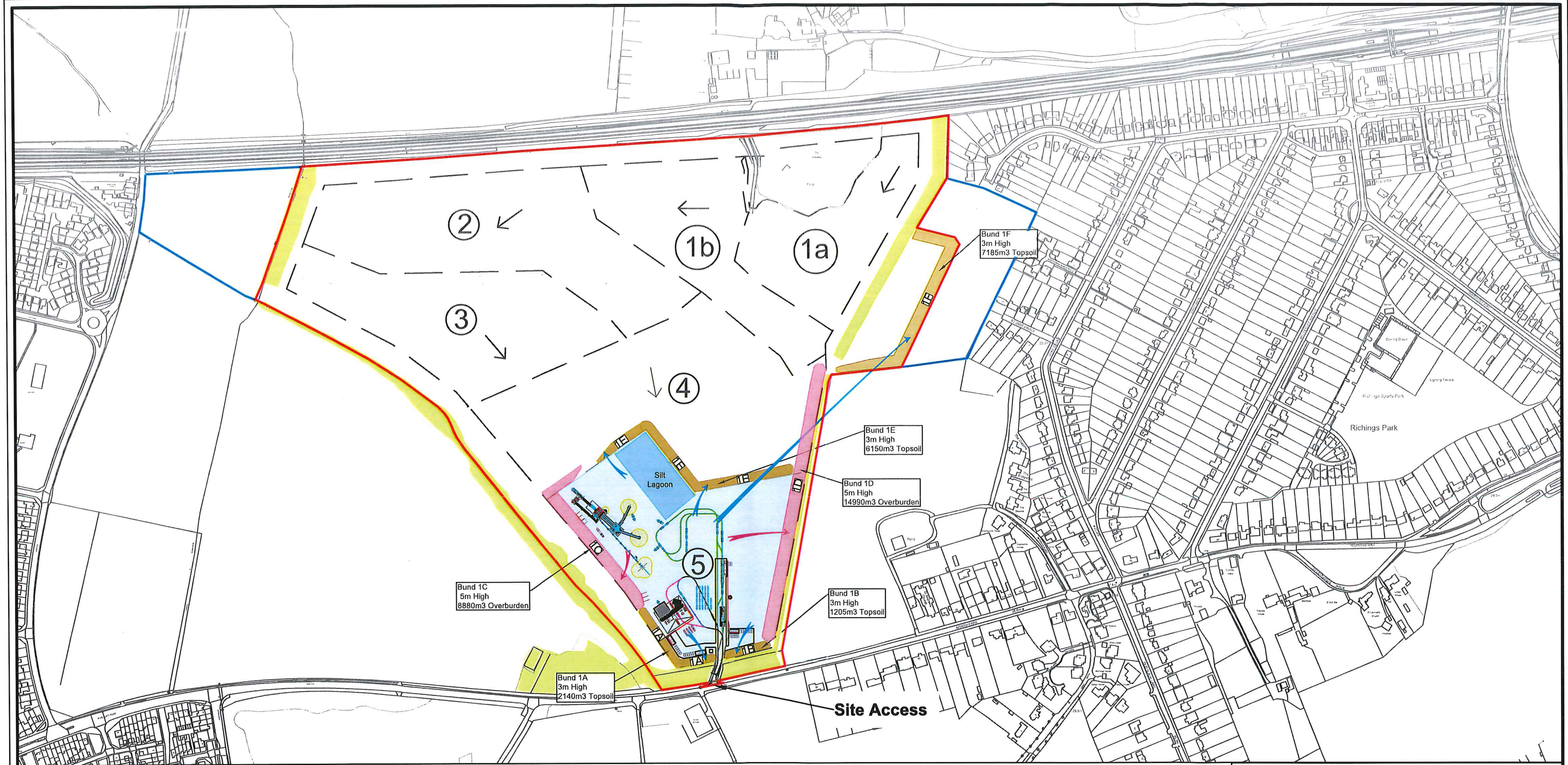
Discharge consents

13.77 There are a total of 163 discharge consents within 3 km of the Site according to the data received from the EA (see Landmark report in Appendix D). These points are plotted on (Figure 18).

Figure 17 Licensed Groundwater Abstractions



4.8 Appendix H – Phasing Plans



Legend	
Application Boundary	
Other Company's Controlled Land	
Extraction Boundary	
Direction of Working	
Overburden Bund	
Topsoil Bund	
Overburden Soil Movement	
Topsoil Movement	
Plant Site Operation Area	
Silt Lagoon	
Mineral Extraction	
Infilling	
Restored Land	
Existing Vegetation	
Awaiting Restoration	
Conveyor	
Spur Conveyor	
Phase Sequence	

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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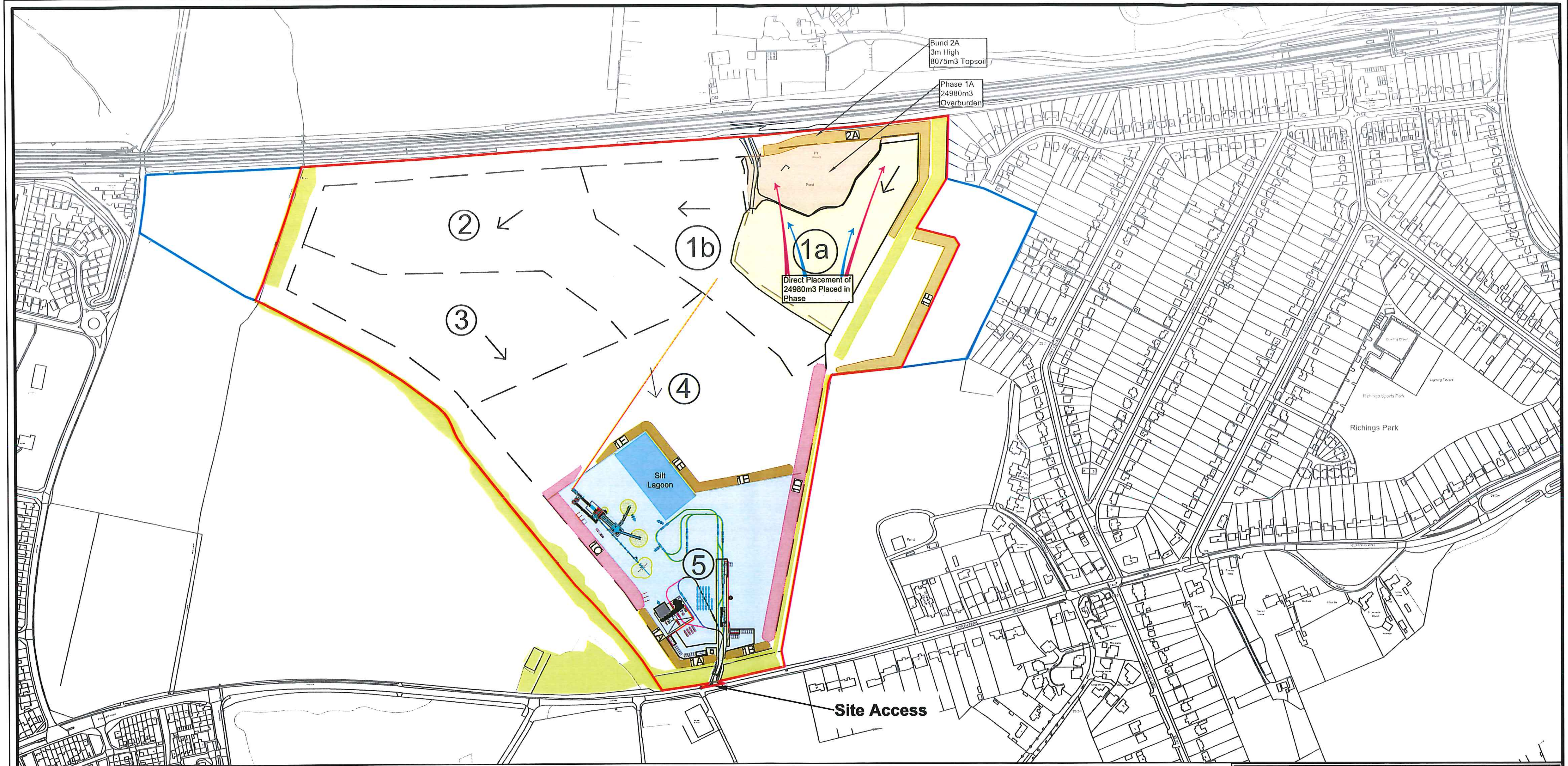
Date: June 2017	Site: Land off North Park road, Richings Park
Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases **Site Setup**
OS Ref:	Dwg No: P1/739/4B Site Setup



Legend			
Application Boundary	Overburden Bund	Plant Site Operation Area	Restored Land
Other Company's Controlled Land	Topsoil Bund	Silt Lagoon	Existing Vegetation
Extraction Boundary	Overburden Soil Movement	Mineral Extraction	Awaiting Restoration
Direction of Working	Topsoil Movement	Infilling	Conveyor
			Spur Conveyor
			Phase Sequence

Revisions				
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	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Chkd:	Title: Method of Working and Restoration Phases **Phase 1a (Year 1-Year 1 Month 6)**
OS Ref:	Dwg No: P1/739/4B Phase 1a

- Application Boundary
- Other Company's Controlled Land
- Extraction Boundary
- Direction of Working
- Overburden Bund
- Topsoil Bund
- Overburden Soil Movement
- Topsoil Movement
- Plant Site Operation Area
- Silt Lagoon
- Mineral Extraction
- Infilling
- Restored Land
- Existing Vegetation
- Awaiting Restoration
- Conveyor
- Spur Conveyor
- Phase Sequence

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases **Phase 1b (Year 1 Month 7-Year 1 Month10)**
OS Ref:	Dwg No: P1/739/4B Phase 1b

Application Boundary	Overburden Bund
Other Company's Controlled Land	Topsoil Bund
Extraction Boundary	Overburden Soil Movement
Direction of Working	Topsoil Movement

Plant Site Operation Area	Restored Land
Silt Lagoon	Existing Vegetation
Mineral Extraction	Awaiting Restoration
Infilling	Conveyor
	Spur Conveyor
	Phase Sequence

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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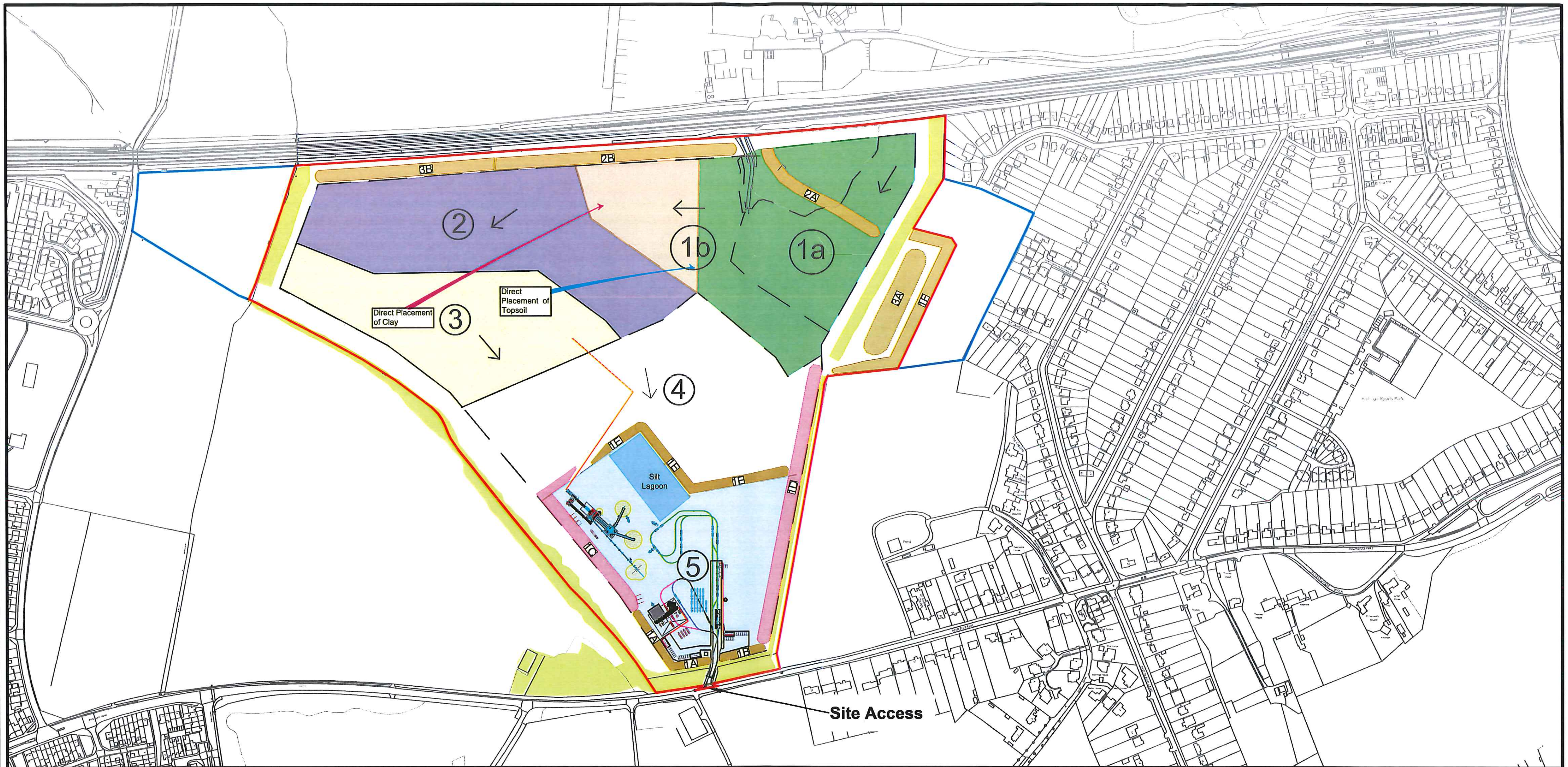
Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases Phase 2 (Year1 Month11-Year2 month10)
OS Ref:	Dwg No: P1/739/4B Phase 2



Application Boundary	Overburden Bund	Plant Site Operation Area
Other Company's Controlled Land	Topsoil Bund	Silt Lagoon
Extraction Boundary	Overburden Soil Movement	Mineral Extraction
Direction of Working	Topsoil Movement	Infilling

Restored Land
Existing Vegetation
Awaiting Restoration
Conveyor
Spur Conveyor
Phase Sequence

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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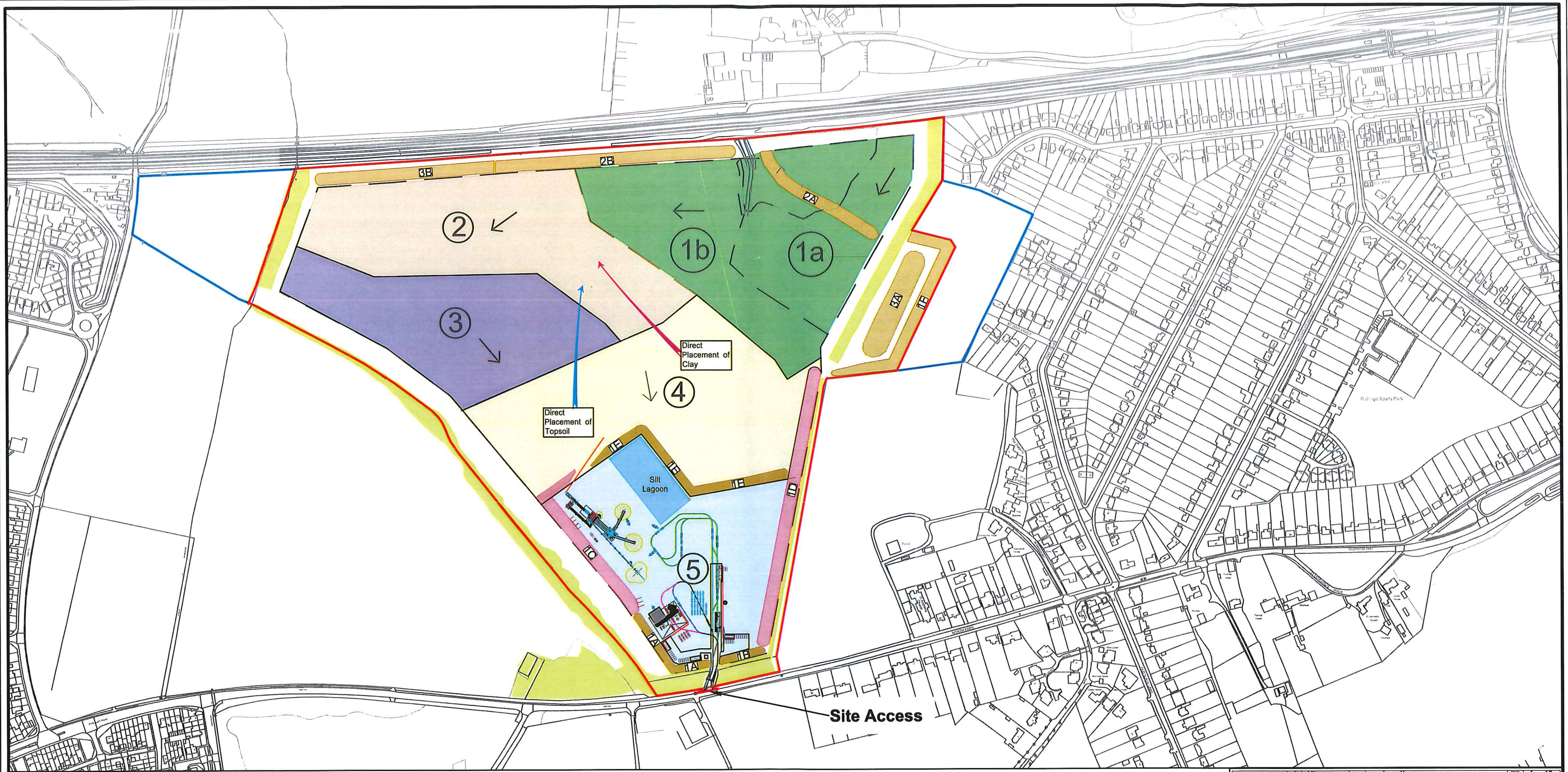
Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases Phase 3 (Year 2 Month11-Year 3 Month8)
OS Ref:	Dwg No: P1/739/4B Phase 3



Application Boundary	Overburden Bund	Plant Site Operation Area	Restored Land	
Other Company's Controlled Land	Topsoil Bund	Silt Lagoon	Existing Vegetation	
Extraction Boundary	Overburden Soil Movement	Mineral Extraction	Awaiting Restoration	
Direction of Working	Topsoil Movement	Infilling	Conveyor	
			Spur Conveyor	
			Phase Sequence	

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases Phase 4 (Year 3 Month9-Year4 Month12)
OS Ref:	Dwg No: P1/739/4B Phase 4

Application Boundary
Other Company's Controlled Land
Extraction Boundary
Direction of Working
Overburden Bund
Topsoil Bund
Overburden Soil Movement
Topsoil Movement
Plant Site Operation Area
Silt Lagoon
Mineral Extraction
Infilling
Restored Land
Existing Vegetation
Awaiting Restoration
Conveyor
Spur Conveyor
Phase Sequence

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Date: June 2017	Site: Land off North Park road, Richings Park
Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases Phase 5 (Year5 Month1-Year6 Month1)
OS Ref:	Dwg No: P1/739/4B Phase 5

Application Boundary	Overburden Bund	Plant Site Operation Area	Restored Land
Other Company's Controlled Land	Topsoil Bund	Silt Lagoon	Existing Vegetation
Extraction Boundary	Overburden Soil Movement	Mineral Extraction	Awaiting Restoration
Direction of Working	Topsoil Movement	Infilling	Conveyor
			Spur Conveyor
			Phase Sequence

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases (Year 6 Month2-Year8 Month5)
OS Ref:	Dwg No: P1/739/4B Restoration of Phase 4

	Application Boundary
	Other Company's Controlled Land
	Extraction Boundary
	Direction of Working
	Overburden Bund
	Topsoil Bund
	Overburden Soil Movement
	Topsoil Movement
	Plant Site Operation Area
	Silt Lagoon
	Mineral Extraction
	Infilling
	Restored Land
	Existing Vegetation
	Awaiting Restoration
	Conveyor
	Spur Conveyor
	Phase Sequence

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases (Year 8 Month6-Year 9 Month7)
OS Ref:	Dwg No: P1/739/4B Restoration of Phase 5

Application Boundary

Other Company's Controlled Land

Extraction Boundary

Restored Land

Existing Vegetation

Revisions				
	A	Minor amendment on phase1's arrows	TP	Aug 16
	B	Phasing layout has been amended requested by Helen and Tom	TP	June 17

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Date: June 2017	Site: Land off North Park road, Richings Park
Scale: 1:5000 @ A3	Project: Mineral Extraction
Chkd:	Title: Method of Working and Restoration Phases Final Restoration Configuration For precise restoration refer to plan P1/739/5C
OS Ref:	Dwg No: P1/739/4B Final Restoration