Member of the SNC-Lavalin Group

Challonsleigh Farm Inert Landfill

Stability Risk Assessment Report

DDE (SW) Ltd.

January 2022

5149237.CFIL04

Notice

This document and its contents have been prepared and are intended solely as information for DDE (SW) Ltd. and use in relation to the environmental permit application for Challonsleigh Farm Inert Landfill.

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

This document has 30 pages including the cover.

Document history

Document title: Stability Risk Assessment Report

Document reference: 5149237.CFIL04

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Permit application	TSM	ATF	ATF	ATF	07/04/2021
Rev 2.0	Permit application	TSM	ATF	ATF	ATF	18/01/2022

Contents

Table	Details	Used
SRA1	A summary of the geotechnical investigations that have taken place at the site.	Yes
SRA2	The results of in-situ tests relevant to the Stability Risk Assessment.	No – see ESSD
SRA3	The results of laboratory tests relevant to the Stability Risk Assessment.	No – no see ESSD
SRA4	The proposed assessment scenarios, including the lifecycle phases, and the conceptualisation of these scenarios (i.e. how certain inputs may change with time).	No
SRA5	The derivation and justification of the range values for input parameters used in the analyses for each scenario.	Yes
SRA6	The derivation and justification of the factors of safety/performance criteria for each assessment scenario.	No
SRA7	The results of the geotechnical analyses (factors of safety), including results of sensitivity analyses on values of input parameters, carried out for each component of the model (e.g. basal stability, side slope liner integrity).	Yes
SRA8	The model validation exercise, which compares the output against any observed conditions.	No
SRA9	The overall modelling results adopting the preferred set of values for geotechnical parameters.	No
SRA10	The risk-based monitoring scheme, including proposals for the monitoring of pore fluid pressures and ground movement.	No

List of Drawings

Drawing	Title	Used
DSRA1	Conceptual Stability Site Model	Yes as DESSD5B & DESSD5c & DSRA1-2
DSRA2	Proposed Assessment Scenarios used in Modelling	Yes as DSRA1-2
DSRA3	Monitoring	No
DSRA4	Details of Monitoring Equipment	No

1. Introduction

Report Context

1.1. DDE (SW) Ltd. has commissioned Atkins Ltd to prepare the environmental permit application and associated supporting documentation and technical studies for a planned inert landfill at Challonsleigh Farm, Smithaleigh near Ivybridge, Devon, PL7 5AZ.

1.2. That follows grant of planning permission on 1st April 2020 by Devon County Council, ref. DCC/4038/2018, for a waste transfer building and associated infrastructure, and landraise operations for the importation inert waste material over a 10 year period requiring a change of use from agriculture and incorporating landscaping. However it is only the inert landfill site which is the subject of the bespoke permit application. The waste transfer building is within an existing waste management facility operated by DDE(SW) Ltd. to the south and west of the planned land raise area, and utilises the same private access road.

1.3. The landraise with inert waste entails filling on a total of approximately 13.53 ha split north and south of an unnamed intermittent ordinary watercourse which will remain open, and also includes filling over approximately 2.7 ha of previous landfill in the south which has scrub vegetation cover and is not used for agriculture. That previous landfill forms raised ground in the south of the planned landfill area and around and under an existing waste management facility.

1.4. A stability risk assessment for development of a landfill needs to consider the landfill's base, side slopes, lining system, waste mass and restoration, as applicable to the landfill configuration. The landfill configuration is outlined as the Conceptual Stability Site Model for which cross sections of the planned inert landfill waste thickness and slope profiles are provided in Appendix ASRA0.

1.5. This report has been prepared in general accordance with the Environment Agency's template for a Stability Risk Assessment Report and should be read in conjunction with the Environmental Setting & Site Design (ESSD) Report which details the findings of the following ground investigations:

Table 1-1 – TSRA1 Summary of Site Investigations

Date	Scope	Purpose
January 2017	Fifty shallow trial pits by YourEnvironment Ltd. Report included as Appendix AESSD1A.	Environmental shallow soil sampling for laboratory chemical analysis.
July and August 2020	Seven boreholes, twenty five trial pits, in-situ testing, soil and water sampling and analysis, carried out by Geotechnics Ltd. Report included as Appendix AESSD1B.	To install perimeter wells for groundwater and ground gas monitoring, for background monitoring data and hydrogeological assessment. In-situ testing to establish the infiltration and hydraulic conductivity characteristics of the subgrade geology. Geotechnical and environmental sampling and laboratory testing of soil samples including chemical analysis. Groundwater sampling and water sampling of the River Yealm and laboratory chemical analysis. Post well installation groundwater level and gas monitoring.

Conceptual Stability Site Model

1.6. Cross sections of the planned inert landfill waste thickness and slope profiles are provided in Appendix ASRA0.

Basal Sub-Grade Model

1.7. The basal sub-grade comprises natural ground under approximately 10.83 ha, with for the remaining approximately 2.7 ha in the south the basal sub-grade comprising restored former landfill.

1.8. The geological map shows the natural ground to be Middle Devonian Slate bedrock which underlies the whole site area including the historical landfill, with along and north east of the ordinary watercourse superficial deposits shown as ‘Head’ comprising clay, silt, sand and gravel, overlain with Alluvium (clay, silt, sand and gravel) in the east along the ordinary watercourse. However ground investigation exploratory hole logs refers to the shallow strata in those areas as residual soil which was found to primarily comprise sandy silt with gravel sized lithorelicts of weathered slate bedrock, which is largely as would be expected for the ‘Head’ material.

1.9. The slate bedrock strata is initially extremely weak to weak weathered such that it is recovered as gravel sized fragments, but becomes stronger and more competent with depth with its structure less weathered.

1.10. Groundwater levels follow the topography of the site, and in wet winter wet conditions are within 1m of ground surface near the unnamed ordinary watercourse. The unnamed ordinary watercourse is intermittent and dry in summer and dry periods except following heavy rainfall when it conveys surface water runoff to the River Yealm.

1.11. The majority of the existing ground surface, which the basal subgrade will broadly mirror, slopes at less than 1 in 10, with localised areas in the north west of Phase F, middle south of Phase F, and south west of Phase C at 1 in 10 to 1 in 6.

1.12. Exceptions to that occur in the area of the historical landfill, and in particular its northern boundary which is represented by a distinct 2-4m rise in ground elevation from north to south within less than 10m. That north facing slope aligns west to east and is slightly north of the historical landfill boundary shown by Environment Agency records. The slopes locally vary from 1 in 3 to 1 in 1.8, with a berm approximately 35m wide to the south which slopes down to the north to north east at generally less than 1 in 10 and locally up to 1 in 6.

1.13. The north facing sloping basal subgrade over which Phase H is to be formed is generally at 1 in 5 to 1 in 3, with localised areas steeper to 1 in 2. That area is required by the planning permission to be landfilled to form ground for tree planting to provide additional screening to the waste management facility which exists to its south.

1.14. The southern half of Phase B is on the historical landfill with has dense vegetation cover comprising small trees and scrub, and that basal subgrade has slopes which are mainly 1 in 6 to 1 in 4 over the top with the eastern basal subgrade sloping at 1 in 3 to 1 in 2 and locally potentially slightly steeper. The subgrade to the historical landfill will be the slate bedrock, and from historical maps that landraise is on ground which originally was at around 50mOD in the north which rose slightly to the south over a wide ridge with its axis west south west to east north east which also slope to the east north to the flood plain of the River Yealm. Inspection of a 1961 1:63,360 OS map indicates the historical landfill lies on a ridge of land above about 50mOD in the north and ≈61mOD (200’ contour) in the west at the access road, where the existing level is around 58mOD. That ridge sloped east towards the River Yealm to an elevation of around 46mOD (150’ contour) approximately 50m east of the river, indicating a sudden change of slope to the flood plain, where the current elevation is around 40-41mOD, compared to ≈100m to the north the historical 200’ contour is shown ≈250m west of the river and the flood plain is much wider. The implied difference in historical and existing ground levels may be due to scaling or the contour level accuracy or may imply locally lowered ground. The inferred base of the historical landfill from that information, which broadly accords with its thickness (6.1m) at BHL08, is shown on sections on drawing DSRA1-2 in Appendix ASRA0.

1.15. For that area of historical landfill there is no data on groundwater levels other than on the north side at BHL08 where groundwater elevations of 47.2-49.6mOD have been recorded, which are well above elevations of 40.3-41.7 recorded at BHL06 north east the historical landfill, with those elevations being around1.5-2.5m above the River Yealm. There may be perched water within the historical landfill, but seepage has not been observed from its northern or eastern side, and overall groundwater flow is likely to be to the south east towards the River Yealm.

Side Slopes Sub-Grade Model

1.16. As a landraise the planned inert landfill’s side slopes will be above the ground surface, rather than within an excavated area. Hence the side slope sub-grade is the same as the basal sub grade.

Basal Lining System Model

1.17. The planned inert landfill will have no geosynthetic basal liner, but will have an artificially established geological barrier which will be laid at not less than 0.5m thick with a permeability not more than $5x10^{-8}$ m/s equivalent to the minimum requirement for an inert landfill for a layer 1m thick with a permeability of less than or equal to $1x10^{-7}$ m/s. The artificially established geological barrier will also provide separation between the planned inert landfill and the former landfill area in the south, and will be used as a regulating layer to even out depressions or irregularities such as changes in the subgrade slope. Hence in localised areas the artificially established geological barrier may be slightly thicker than 0.5m.

1.18. The artificially established geological barrier will be formed in compliance with a Construction Quality Assurance Plan which includes criteria for the materials to be used and their compaction, essentially aligning with the Manual of Contract Documents for Highway Works Volume 1 Specification for Highway Works Series 600 Earthworks. The artificially established geological barrier will be formed site won soil (derived from the weathered Middle Devonian Slate bedrock), fines from the aggregate recycling plant, or incoming inert waste soil, or possibly a combination of those materials e.g. by excavation and compaction of one or two layers, to 0.15-0.4m below ground level, of the existing natural ground.

1.19. Against the northern slope of the historical landfill the artificially established geological barrier will be placed in lifts parallel to the northern slope adjacent the landfill operating area, with those lifts wider than 0.5m to enable placement using compaction plant. That wider zone will then be carefully trimmed back leaving not less than 0.5m wide against the northern slope, and the excavated material reused against the next section of the northern slope. The inert waste placed in horizontal lifts will buttress the artificially established geological barrier against the northern slope and the artificially established geological barrier will meet that within the Phase B and Phase C areas to the south.

1.20. The artificially established geological barrier will be placed at a shallow level following topsoil removal and hence there is no requirement for a groundwater drainage system, and as an inert landfill there is no requirement for a leachate drainage system.

1.21. There will be drainage to manage surface water runoff from the operational area of the planned inert landfill and restored areas.

Side Slope Lining System Model

1.22. The side slopes will be above the ground surface and as such will be formed as per the basal lining system model.

Waste Mass Model

1.23. The waste will be inert material in compliance with the Landfill Regulations, the environmental permit and the site's waste acceptance procedures. It is envisaged the inert waste is likely to be predominantly natural soil and stones and construction materials such as concrete and brick from earthworks or demolition at local development sites, but pre-treated by physical means prior to placement, such to remove material for recovery as secondary aggregate.

1.24. Incoming inert waste will be end tipped from the haulage vehicles into adjacent piles that will stand at the natural angle of repose of the material, typically 22-35° (1 in 2.5 to 1 in 1.5) for the envisaged inert waste materials. That end tipped material will be periodically levelled, forming horizontal lifts of 0.5-1m high, with the end tipping from haulage vehicles then recommencing over the levelled areas. Compaction will be mainly from trafficking of the mechanical excavation plant used to level the inert waste and from haulage vehicles. The filling will be carried out in sequence as per the phase numbering, with the inert waste lifted in horizontal layers to the restoration profile elevation less the anticipated topsoil/subsoil cover thickness.

1.25. The inert waste placed is likely to have low permeability which will limit infiltration, and with the restoration it is expected rainfall will be intercepted by the vegetation cover and also runoff overland and flow downslope through the shallow soils, draining to the perimeter surface water drainage system.

1.26. North of the ordinary watercourse a perched groundwater table above the natural groundwater elevation within the underlying subgrade is not expected to form within the inert waste during its placement or in the long term post restoration. The inert waste will be placed on the artificially established geological barrier but is likely to have similar low permeability, however if perched groundwater does form it is expected the flow direction would be downslope to the south and south east because the artificially established geological barrier will mirror the slope of the existing ground.

1.27. South of the ordinary watercourse the planned inert landfill will form a large mass up to ten metres thick adjacent to the former landfill buttressing against the former landfill to the south and over the former landfill, but separated by the artificially established geological barrier. Therefore if perched groundwater does form it is expected it will also flow in the direction of the existing ground over which the artificially established barrier has been placed.

Capping System Model

1.28. The planned inert landfill will not have an engineered cap.

1.29. The inert waste is likely to include local natural soils which are clayey being typically from weathered slate, and it is expected the inert waste mass will overall have a slow infiltration capability of circa $1x10^{-7}$m/s similar to the liner. The final surface will be formed by inert waste (fine soil material where possible) restored with the topsoil/subsoil stripped and stored from the existing ground while areas of the inert landfill are operated as per the phasing sequence. Over the eastern and southern area of Phase B where the planned inert landfill is over the historical landfill, the thickness becomes less than 1m over much of that area, and hence where less than 0.5m only the artificially established geological barrier material may be placed.

1.30. The majority of the restored area will be sown for grazing, with some hedgerow and tree planting. Once established the vegetation cover with the agricultural use will over time enhance the characteristics of the soil profile at the top of the waste. Infiltration will still be limited by the underlying inert waste, and so it is expected rainfall will runoff overland and flow downslope through the shallow soils and drain to the perimeter surface water drainage system, similar to the existing characteristics.

1.31. The site's restoration profile will mainly be at a slope of 1 in 6 up to 1 in 4, with localised areas within the middle of the site (i.e. not external facing) at up to 1 in 3 to 1 in 2.5 to provide undulation to the final form, and thereby adding some flow path attenuation to the surface water run off in addition to the vegetation cover. Due to the low permeability of the inert waste and general slope of the restoration profile a perched groundwater table or a high pore water pressure ratio within the surface restoration materials is not expected to occur. Where the restoration profile implies steeper slopes to 1 in 2, such as locally in the south east of Phase B and middle south side of Phase G, those slopes are not intended to be formed at steeper than 1 in 2.5 to 1 in 3.

1.32. The planning approved final restoration contours are shown on drawings DESSD5B and DESSD5C, in Appendix ASRA0.

2. STABILITY RISK ASSESSMENT

Risk Screening

2.1. The risk screening is provided in the following table, which considers for each landfill component whether a geotechnical issue is simple or complex, with justification for that assignment based on whether the stability or the landfill component is at significant risk or not and the principal reason for that conclusion. Although it is considered that there are no geotechnical issues for which the stability or integrity of a landfill component is at significant risk.

2.2. Within this section issues relating to stability or integrity are classified into simple or complex categories, with full justification for issues classified as simple, and only those falling within the complex category are subject to further detailed geotechnical analyses.

Table 2-1 – TSRA4 – Proposed assessment scenarios – stability risk screening of inert landfill components

Landfill component	Geotechnical issue	Classification of geotechnical issue	Justification		
			Is stability / integrity of landfill component at significant risk ?	Principal reason	Supporting analysis
Basal sub-grade	Compressibility of sub-grade (natural)	Simple	No	Slate bedrock sub-grade or 'head' derived from the slate bedrock, and no instability of existing ground has been observed.	No
	Compressibility of sub-grade (former landfill)	Complex	No but prudent to be cognisant of potential for long term settlement.	Estimated future settlement of former landfill and due to additional loading is likely to be limited for predominantly inert waste.	Yes
	Cavities in sub-grade (natural)	Simple	No	No natural cavities.	No
	Cavities in sub-grade (former landfill area)	Simple	No	No, cavities are not expected within the waste type.	No
	Basal heave	Simple	No	Landfill is proposed as a land raise and will be above the groundwater table.	No
	Slope stability over historical landfill	Complex	Not anticipated to be but prudent to check temporary and long term situation.	Inert waste will over artificially established geological barrier on historical landfill inert / historical landfill >18 years old, but will be placed in horizontal lifts in lifts 0.5-1m mainly against thereby buttressing existing slopes hence destabilisation of existing slopes is not likely.	Yes
Side slopes sub-grade	As a land raise the planned inert landfill's side slopes will be above the ground surface, rather than within an excavated area. Hence the side slope sub-grade screening is the same as the basal sub grade.				
Basal and side slope lining system	Slope stability of planned inert landfill over artificially established geological barrier.	Complex	Not anticipated to be for the shallow slopes but prudent to check temporary and long term situation.	Inert waste will be placed in horizontal lifts in lifts 0.5-1m with low height temporary slopes at natural angle of repose, but on an artificially established geological barrier on existing ground at shallow slope.	Yes
Waste mass	Stability of inert waste mass	Simple	Not anticipated to be for the shallow slopes but prudent to check temporary and long term situation.	Inert waste will be placed in horizontal lifts in lifts 0.5-1m with low height temporary slopes at natural angle of repose, and the final slopes will at shallow gradient slope inert waste mass expected to be adequately strong.	Yes

Landfill component	Geotechnical issue	Classification of geotechnical issue	Justification		
			Is stability / integrity of landfill component at significant risk ?	Principal reason	Supporting analysis
Capping system	Slope stability	Simple	No	Shallow gradient of 1V:<4H over most of restored landfill surface and perched water table or high pore pressure ratio within the near surface soils is unlikely. If a shallow slope failure occurred it would most likely be localised such as a slump perhaps brought about by prolonged rainfall causing saturated conditions. However the health and safety and environmental risk will be negligible with no structures or features that could be affected.	No
	Deformation due to landfill settlement	Simple	No	No engineered capping system, significant settlement not expected overall, and landform profile can tolerate localised deformation / undulation.	No

Lifecycle Phases

2.3. The planned inert landfill will be filled in phases broadly from south to north. That development of the inert landfill in phases has no specific lifecycle implications for stability, other than the filling in horizontal to sub-horizontal lifts from north to south within Phases B and C will buttress the northern slopes of the historical landfill.

2.4. Filling will be carried out by end tipping of the inert material from haulage vehicles to form 1-2m high adjacent piles of inert fill across the installation area, that material then being periodically levelled to form 0.5-1m high lifts. Specific compaction plant will not be utilised (except for the artificially established geological barrier) because the filling process is repeated such that each lift of fill material is effectively compacted to an adequate degree by vehicle and plant movements.

2.5. The inert landfill working areas and restoration will be as per the phasing sequencing to comply with the planning permission condition 31(a) which stipulates:

2.6. “no waste shall disposed of in any new phase of landraising until all practicable tipping has been completed in the previous phase and restoration has been completed in the phase before that”.

Data Summary

2.7. A geo-environmental ground investigation was carried out in July 2020 by Geotechnics Ltd. and reported its ‘Inert Landfill at Challonsleigh Farm Factual Report for Dorton Group’, project number PE201646, September 2020. That report is included within the permit application Environmental Setting and Site Design (ESSD) report.

2.8. Characteristic values are presented in the ESSD report based on the geotechnical data recorded on site and laboratory testing, and have been used as part of the geotechnical parameter selection process. Where deemed appropriate to complement site data or due to a lack of site-specific geotechnical data published or assumed values have been and the justification given. Uncertainty in the selected parameters is evaluated by sensitivity analysis to understand the potential stability risk.

Justification for Modelling Approach and Software

2.9. Compressibility of the basal subgrade where the proposed inert landfill is over the historical landfill has been modelled to assess the potential for settlement which may occur due to long term creep or biodegradation of the historical landfill, and compression due to loading by the planned inert landfill, and of long term creep or the planned inert landfill. That has been carried out using simple spreadsheet calculations considered suitable for the data and to appraise site situation and sensitivity to the material parameters.

2.10. The stability risk screening has indicated it is prudent to consider slope stability of the inert waste mass of the planned inert landfill which is to be placed over an artificially established geological, barrier and locally also over the historical landfill. For that appraisal selected slopes within the final profile sections on drawings DESSD5B and DESSD5C have been modelled with the additional detail shown on drawing DSRA1-2.

2.11. The slope stability analysis has been carried out using the SLOPE/W with GeoStudio 2019 version 10.0.1.17733, produced by GEOSLOPE International Ltd., which is a general software tool designed and developed for the stability analysis of earth structures. For this slope stability analysis Spencer's procedure has been utilised as an acceptable method under Eurocode 7 because it:

a. assumes the resultant side forces acting on each slice are parallel to each other
b. satisfies complete statics i.e. for moment equilibrium and for equilibrium, and
c. is adapted for calculating factor of safety and side-force inclination for circular and noncircular shear surface geometries.

Justification of Geotechnical Parameters Selected for Analyses

2.12. This section summarises the geotechnical material parameters that have been determined for use during stability analysis based on the ground investigation data included within the ESSD report or the specific references quoted.

Parameters Selected for Basal Sub-Grade Analyses

2.13. The parameters selected for the basal sub-grade compressibility analyses are detailed in the following table. For the basal sub-grade compressibility analyses, parameters for the artificially established geological barrier have been assumed to be the same as for the planned inert landfill, because that layer will comprise fine soil materials at ≥0.5m of similar weight density to the planned inert waste materials. Hence the assumption is considered justifiable for the estimate of loading due to the planned inert landfill and its potential settlement of that mass due to creep.

Table 2-2 – TSRA5a Parameters for Basal Sub-Grade Analyses

Parameter	Material	Design Value	Source	Comments
Creep factor	Historical inert / industrial landfill and planned inert landfill	0.003	BRE Building on fill: Geotechnical aspects, 2001, Table 10 Properties of refuse fills (after Watts and Charles 1999) assessed range 0.2-0.3 to 2%.	A low value is considered likely for the expected inert waste.
Bio-degradation factor	Historical inert / industrial waste	0.03	BRE Building on fill: Geotechnical aspects, 2001, Table 10 Properties of refuse fills (after Watts and Charles 1999) assessed range 2 to 6%.	A low value is considered likely for the expected inert waste.
	Planned inert landfill	n/a	Not applied as waste will be inert.	Adhering to regulations and site's waste acceptance procedures.
Period for creep or bio-degradation	Historical inert / industrial landfill and planned inert landfill	t2 = 30 years	Assumed period for most degradation, based on CIRIA C557 Remediation of closed landfills, 2001, para 2.4, states "as a general guide the long term settlement can be approximated to an exponential curve which could results in nearly all settlement taking place over 30 years, with a large proportion occurring in an initial five year period".	
Time since waste placement	Historical inert / industrial landfill	Two scenarios t1 = 25 yrs, and t2 = 20 years	Waste assumed to have been placed from start of licence in 1991 to planning permission for restoration in 2003.	Two scenarios for sensitivity analysis because 2021 is 30 years since start of licence, so t1=25 years is 1996 five years after start of licence, t2=20 years is 2001 ≈2 years before end of waste placement.
	Planned inert landfill	1	For inert waste placed in 2021.	Indicative start year.

Parameter	Material	Design Value	Source	Comments
Thickness	Historical inert / industrial landfill	3.15m - 13.46m	From drawing DESSD/5C cross sections B'B and F-F', and detailed on drawing DSRA1-2, at selected chainages ground level to base of historical waste inferred from original ground level on 1961 OS map which shows a wide ridge of land above about 50mOD in the north and 58-61mOD in the west which sloped east towards the River Yealm flood plain.	Chainages selected to evaluate variations in potential thicknesses of historical landfill and planned inert landfill.
	Planned inert landfill	1.7m – 6.3m	From drawing DESSD/5C cross sections B'B and F-F', detailed on drawing DSRA1-2 existing ground level and restoration profile at selected chainages.	Chainages selected to evaluate variations in potential thicknesses of historical landfill and planned inert landfill.
Weight density	Planned inert landfill	18 kN/m3	Assumed based on assessment of ground investigation data and literature including other publicly available stability studies for inert landfill.	
Secondary compression index	Historical inert / industrial landfill	Cc=0.3	Estimate for fine soils from Skempton (1944) Cc=0.007(LL-10) for average liquid limit LL=52% for shallow soils on historical landfill. Skempton conducted consolidation tests on remolded specimens of many different types of clays where the initial moisture content of the materials were at the liquid limit, and developed a relationship between Cc and LL.	For fine soils but will be conservative (upper estimate) and overall Cc likely to be lower because some waste materials will be incompressible e.g. rock, concrete. Hence sensitivity analysis carried out assuming lower Cc values of 0.2 and 0.1.
Porosity (void ratio) v stress	Historical inert / industrial landfill	e=0.82, 0.73, 0.64, 0.55, 0.52, 0.47 for stress 10, 20, 40, 80, 100, 150 kN/m2 respectively.	Estimated assuming clay with Cc=0.3 and initial void ratio of 0.82 at 1m, from the historical landfill shallow fine soils average moisture content ≈23.5%, assume bulk density p_b=1.835t/m3, particle density Gs=2.7, indicates void ratio = 0.82 (from (Gs / p_d)-1 where p_d is dry bulk density.	Some waste materials will be incompressible e.g. rock, concrete.

2.14. For parameters relating to slope stability analysis of the planned inert landfill over the artificially established geological barrier and historical landfill sub-grade refer to 'Parameters for Basal Liner Analyses'.

Parameters Selected for Side Slopes Sub-Grade Analyses

2.15. As for the basal subgrade analyses.

Parameters Selected for Basal Liner Analyses

2.16. The parameters selected for the basal liner slope stability analyses of the planned inert landfill over the artificially established geological barrier and historical landfill sub-grade are detailed in the following table:

Table 2-3 – TSRA5b Parameters for Basal Liner Analyses

Parameter	Material	Design Value	Source	Comments
Weight density	Weathered slate basal sub-grade	20 kN/m3	Assessed characteristic values from ground investigation data, e.g. material descriptions and SPT N values.	
Cu, (ϕ=0)		100 kN/m2		
c', ϕ'		5 kN/m2, 32°		
Weight density	Historical inert / industrial landfill sub-grade	18 kN/m2	Estimates, existing waste has consolidated >18 years since placement, it is expected to have a long term strength c' of 0-10kN/m2 and Ø of 20 to >30°, typically at least 25°, similar or maybe better than for the planned inert landfill.	Considered conservative, given likely consolidation, and granular materials would have higher phi'. Have assumed same parameters as for planned inert landfill.
Cu (ϕ=0)		75 kN/m2		
c', ϕ'		2 kN/m2, 25°		

Parameter	Material	Design Value	Source	Comments
Weight density	Artificially established geological barrier	18 kN/m3	Assessed characteristic values from ground investigation data, i.e. laboratory tests: compaction, triaxial tests and shear box.	
Cu, (ϕ=0)		100 kN/m2		
c', ϕ'		5 kN/m2, 28°		
Thickness		0.5m	Minimum value required.	Taken from 0.2m below existing ground level to account for topsoil / subsoil strip.
Weight density	Planned inert waste landfill	18 kN/m2	Estimates, similar to other publicly available stability studies for inert landfill. As the inert waste could comprise mixed soil (clay and sand) and stones, glass, concrete, bricks, tiles and ceramics that is effectively compacted from by vehicle movements, it is expected to have a long term strength c' of 0-10kN/m2 and Ø of 20 to >30°, typically at least 25°, those parameter values being based on a general assessment of information provide in Stability of Landfill Lining Systems: Report No. 1 Literature Review, EA R&D Technical Report P1-385/TR1 2003, Building on fill: geotechnical aspects, 2nd edition, BRE and DTLR, 2001; Earthworks: a guide, N. Trenter and Thomas Telford, 2001, Correlations of Soil Properties, M. Carter and S.P. Bentley.	Based on mainly fine soils, considered typical but could be higher with concrete/rock materials.
Cu, (ϕ=0)		75 kN/m2		Considered conservative, given likely compaction, and granular materials would have higher phi'.
c', ϕ'		2 kN/m2, 25°		

Parameters Selected for Side Slopes Liner Analyses

2.17. Refer to 'Basal Liner Analyses'.

Parameters Selected for Waste Analyses

2.18. Refer to 'Basal Liner Analyses'.:

Parameters Selected for Capping Analyses

2.19. Not applicable.

Selection of Appropriate Factors of Safety

Factor of Safety for Basal Sub-Grade

2.20. Calculation of a factor safety is not applicable to the assessment of compressibility of the basal sub-grade. Conservative parameters have been utilised and the sensitivity of the assessment results to those parameters is evaluated.

2.21. For factor of safety in relation to slope stability analysis for the planned inert landfill over the historical landfill sub-grade refer to 'Factors of Safety for Basal Lining System'.

Factor of Safety for Side Slopes Sub-Grade

2.22. As for the basal sub-grade.

Factor of Safety for Basal Lining System

2.23. The stability analyses have been carried out in accordance with Eurocode EC7 Geotechnical Design, for which the United Kingdom has adopted Design Approach 1 (DA1) Combination 1 & 2 (C 1 & 2) whereby partial factors are applied to either the material strength properties, actions or resistances in accordance with the EC7 limit state design approach. The software determines if an action is favourable or unfavourable, and the factored values are in turn used in the stability analysis to check if an ultimate limit state has been reached. The ultimate limit state is defined as a state associated with complete collapse or failure. In SLOPE/W the calculated factor of safety is interpreted as an over-design factor (ODF) when partial factors are applied, and an ODF of 1.0 is required.

2.24. The ODF is effectively the factor of safety after the partial factors have been applied, whereas SLOPE/W can also calculate the factor of safety without the application of partial factors. In that traditional approach the minimum acceptable factor of safety selected for slope stability analysis needs to take into account many factors, including the modelling approach, certainty of input parameters and the consequences of failure. Typically, acceptable factors of safety for slope analysis range from 1.1 to 1.3. Ground investigation and measurement of geotechnical parameters has been undertaken, and conservative parameters utilised based on that data, correlations or inference from published information, though the potential for localised variability of materials within the historical landfill will always be a source of uncertainty. Hence for the geotechnical stability and safety risks associated with the planned inert landfill development where no structures or infrastructure would be affected, it is considered a Factor of Safety (FoS) value of >1.2 would have be acceptable.

2.25. However the stability analysis has been carried out by the EC7 approach and only those results presented herein, and the FoS has not been evaluated other than to aide an understanding of the slope stability where the ODF is near to 1.

Factor of Safety for Side Slope Lining System

2.26. Refer to 'Factor of Safety for Basal Lining System'.

Factor of Safety for Waste Mass

2.27. Refer to 'Factor of Safety for Basal Lining System'.

Factor of Safety for Capping System

2.28. Not applicable.

Analyses

Basal Sub-Grade Analyses

2.29. To analyse the potential settlement of the basal sub-grade where that will be formed by the historical landfill, the following approach has been applied:

a. Potential settlement due to creep has been estimated as Ds = æc .H. (log t2/t1), where æc is the creep factor for the material, H is the height of the material, and t2 and t1 are taken from the start of load application.
b. Potential settlement due to biodegradation (historical landfill only) has been estimated as Db = æb .H. (log t2/t1), where æb is the biodegradation factor for the material, H is the height of the material, and t2 and t1 are taken from the start of load application.
c. Potential settlement of the historical landfill due to loading by the planned inert landfill has been estimated as Dc = Cc / (1 +e0) .H. log(δ'zf / δ'z0), where Cc is the secondary compression index for the material, e0 is the initial void ratio of the material, H is the height of the material, δ'zf is the final vertical stress, δ'z0 is the initial vertical stress. The initial void ratio e0 has been derived based on the Cc value, assuming e0=0.82 at 1m.

2.30. The parameters selected for the basal sub-grade 'compressibility' analysis have been outlined earlier and the results of the analyses and sensitivity analyses for selected parameters are provided in Appendix C.1 ASRA2a, and summarised in the following table.

Table 2-4 – TSRA7a Results of Basal Sub-Grade 'Compressibility' Analyses

Section and chainage	Existing waste thickness, m	Planned inert landfill thickness, m	Settlement of existing waste due to creep and bio-degradation	Settlement of existing waste, Cc=0.3, due to loading by planned inert landfill	Settlement of new waste due to creep over t2=30 years	Total estimated potential settlement	Sensitivity Analyses – total estimated potential settlement for:	
							Cc = 0.2	Cc=0.1
Existing waste age as t1=25 years, t2=30 years								
Section SB-SB'								
190	4.576	5.374	0.01	0.53	0.02	0.57	0.38	0.21
220	5.463	5.767	0.01	0.61	0.03	0.65	0.44	0.23
260	11.63	1.63	0.03	0.37	0.01	0.41	0.28	0.15
300	10.735	1.76	0.03	0.40	0.01	0.43	0.29	0.16
Section SF-SF'								
50	2.967	4.252	0.01	0.37	0.02	0.40	0.27	0.15
100	4.317	4.801	0.01	0.49	0.02	0.52	0.35	0.19
150	4.204	5.66	0.01	0.56	0.03	0.59	0.37	0.20
200	5.236	5.556	0.01	0.45	0.02	0.49	0.40	0.22
250	6.805	2.75	0.02	0.45	0.01	0.48	0.32	0.17
Existing waste age as t1=20 years, t2=30 years								
Section SB-SB'								
190	4.576	5.374	0.03	0.53	0.02	0.58	0.40	0.22
220	5.463	5.767	0.03	0.61	0.03	0.67	0.46	0.25
260	11.63	1.63	0.07	0.37	0.01	0.45	0.31	0.19
300	10.735	1.76	0.06	0.40	0.01	0.47	0.33	0.19
Section SF-SF'								
50	2.967	4.252	0.03	0.37	0.02	0.42	0.29	0.17
100	4.317	4.801	0.04	0.49	0.02	0.55	0.38	0.22
150	4.204	5.66	0.04	0.56	0.03	0.62	0.40	0.23
200	5.236	5.556	0.05	0.45	0.02	0.53	0.44	0.25
250	6.805	2.75	0.07	0.45	0.01	0.53	0.37	0.22

2.31. The results of slope stability analyses of the planned inert landfill over areas of historical landfill has are present under 'Basal Liner Analyses'.

Side Slopes Sub-Grade Analyses

2.32. Refer to 'Basal Sub-Grade Analyses'.

Basal Liner Analyses

2.33. The parameters selected for the slope stability analyses have been outlined earlier and the slope configuration models analysed are provided in Appendix C.2, with the results summarised in the following table which includes sensitivity analysis for selected parameters as indicated. The slope stability analysis has been carried out for selected slopes shown by the cross sections on drawings DESSD5B and DESSD5C, where the slopes are at the steepest planned. The slopes analysed are shown on drawing DSRA1-2.

Table 2-5 – TSRA7b Results of Basal Liner Slope Stability Analyses

Section	Scenario	Material	Total or Effective Stress Strength Parameters	ODF for DA1		Notes
				C1	C2	
Phases A1, F & G, section NB-NB' Ch 120-155	Piezometric line set to represent groundwater 0.5m below artificially established geological barrier.	All	Total, as per table TSRA5b	2.47	2.59	
		Artificially established geological barrier	Total, reduced Cu=40kN/m2	2.42	2.53	
		All	Effective, as per table TSRA5b	1.29	1.08	
		Artificially established geological barrier	Effective, reduced c'=2 kN/m2, ϕ'=25°	1.29	1.07	
		Artificially established geological barrier	Effective, reduced c'=1 kN/m2, ϕ'=25°	1.27	1.06	
		Artificially established geological barrier	Effective, reduced c'=1 kN/m2, ϕ'=20°	1.15	0.97	
	As above + leachate level at 1m to 0 above artificially established geological barrier from Ch 120 to toe of slope.	All	Effective, as per table TSRA5b	1.29	1.08	
	As above + leachate level at 1m to 0 above artificially established geological barrier from Ch 120 to toe of slope.	Artificially established geological barrier	Effective, reduced c'=1, kN/m2, ϕ'=25°	1.27	1.06	
	As above + leachate level at 4m to 0 above artificially established geological barrier from Ch 120 to toe of slope.	All	Effective, as per table TSRA5b	1.29	1.08	
	As above + leachate level at 6m to 0 above artificially established d geological barrier from Ch 120 to toe of slope.	All	Effective, as per table TSRA5b	1.29	1.08	
Phases B eastern side, section SF-SF' Ch 250-330	To check for shallow slides or destabilising of historical landfill which drops 3m at 1V:1.2H 12m east of the planned inert landfill, though that has a shallow restoration profile from 1:8.4 to 1:4.3 in the east.	All	Effective, as per table TSRA5b	1.77	1.49	Failure surface is wholly in historical landfill to the east of the planned inert landfill. No further assessment carried out, planned inert landfill slope is shallow with thickness 30m from perimeter only ≈2m thinning to zero at eastern edge.

Side Slopes Liner Analyses

2.34. Refer to 'Basal Liner Analyses'.

Waste Analyses

2.35. Slope stability has been assessed for failure modes wholly within the planned inert landfill waste body to inform the maximum safe height of temporary slope to be used during operation i.e. filling of the planned inert landfill. The cross sections shown on drawings DESSD5B and DESSD5C indicate the maximum heights of the planned inert landfill north and south of the ordinary watercourse, though filling in horizontal to horizontal lifts will avoid large temporary slopes, particularly south of the ordinary watercourse where with that filling method, the inert waste being placed would rise up and over the historical landfill.

2.36. Therefore waste analyses has been carried out for the maximum height of the planned inert landfill, which occurs along the north facing slope of Phase C north to south section line SB-SB' to a height of ≈10.0m above existing ground level at chainage 121. For comparison the north facing slope of Phase F on the north to south section line B-B' has a height of ≈7.6m above existing ground level at chainage 119.

2.37. To inform the safe working slope to be used during operation, slope stability analysis has been carried out assuming a temporary waste slope to the northern boundary of Phase C as shown on drawing DSRA1-2 in Appendix ASRA0, initially with a slope of 1 in 2 to 10m high to the south. Note the 'Basal Liner Analyses' also considers waste slope stability because the slip surface entry and exit range applied include for failure surfaces wholly within the inert waste (so a potential for failure would have been identified by an ODF<1 for a slip surface wholly within the inert waste).

2.38. The parameters selected for the slope stability analyses have been outlined earlier and the slope configuration models analysed are provided in Appendix C.3 with the results summarised in the following table which includes sensitivity analysis for selected parameters as indicated.

Table 2-6 – TSRA7c Results of Waste Slope Stability Analyses

Section	Scenario	Material	Total or Effective Stress Strength Parameters	ODF for DA1		Notes
				C1	C2	
SB-SB' Ch 95-135	Maximum waste height at chainage 121, 10.0m above existing ground level, 1:2 slope to the south, groundwater 0.5m below the artificially established geological barrier.	Inert waste	Total, as per table TSRA5b	2.28	2.29	Slip circle also passes through basal liner and basal sub-grade.
		Inert waste	Total, increased weight density to 23 kN/m3	1.8	1.8	Slip circle also passes through basal liner and basal sub-grade.
		Inert waste	Total, reduced Cu=50kN/m2	1.67	1.63	
		Inert waste	Total, reduced Cu=50kN/m2, and increased weight density to 23kN/m3	1.31	1.27	Can reduce the temporary slope height to reduce risk if inert waste of reduced strength and high weight density is likely to occur.
	As above + leachate level at 1m to 0 above artificially established geological barrier from Ch 110 to toe of slope respectively.	Inert waste	Total, reduced Cu=50kN/m2	1.67	1.63	
	As above + leachate level at 5m to 0 above artificially established geological barrier from Ch 110 to toe of slope respectively.	Inert waste	Total, reduced Cu=50kN/m2	1.67	1.63	A high leachate level within the temporary waste slope is considered unlikely.

Section	Scenario	Material	Total or Effective Stress Strength Parameters	ODF for DA1		Notes
				C1	C2	
	As above + leachate level at 5m to 0 above artificially established geological barrier from Ch 110 to toe of slope, + vertical variable surcharge load of 10kN/m2 from ch 100.94-106.	Inert waste	Total, reduced Cu=50kN/m2	1.67	1.62	A high leachate level within the temporary waste slope is considered unlikely.

Capping Analyses

2.39. Not applicable.

Assessment

Basal Sub-Grade Assessment

2.40. The compressibility of the basal sub-grade has been analysed for placement of the planned inert landfill over areas of historical landfill, for a combination of thicknesses for the existing waste and planned inert landfill. The potential settlement due to creep, biodegradation and secondary compression of the historical landfill, and creep of the planned inert landfill have been estimated.

2.41. That analyses indicates the potential settlement due to creep and biodegradation of the historical landfill and creep of the planned inert landfill is very small, and much less that the potential for settlement of the historical landfill. Sensitivity analysis has been carried out for two different ages of waste placement for the historical landfill i.e. 25 years and 20 years since waste placement, but the predicted creep and biodegradation settlement differences are small and not considered to be a concern. The potential effect of the historical waste having a lower secondary compression index has also been evaluated, and for those parameter variations the total estimated potential settlement is less.

2.42. It is unlikely the materials within the historical landfill have a higher secondary compression index, or that the secondary compression index or initial void ratio or void ratio profile with waste depth is the same over the whole historical landfill area. Rather localised variations may be present and some materials will not be compressible, e.g. rock or concrete, and the historical landfill has been consolidating under is self-weight for ≈18 years. However no notable adverse effects of variable surcharge loading due to the movement of plant, vehicles or stockpiles up to ≈6m high have been observed at the adjacent waste management facility which is on and surrounded by the historical landfill.

2.43. Therefore it is considered the higher settlement estimates are unlikely to be realised, with settlement more likely to align with the lowest estimates, and as the planned inert landfill will be placed in horizontal to sub-horizontal lifts with no voids, compacted by the movement of plant and vehicles, it is considered the estimated settlement, if it occurs, will not give a health and safety risk to the planned inert landfill. Therefore it is considered the actual settlement can be monitored by annual topographic surveys.

2.44. The potential slope stability implications of the planned inert landfill over areas of historical landfill has also been assessed and is discussed under ‘Basal Liner Assessment’.

Side Slopes Sub-Grade Assessment

2.45. Refer to ‘Basal Sub-Grade Assessment’.

Basal Liner Assessment

2.46. Slope stability analysis has been carried out for selected slope configurations to evaluate the potential for failure of the basal liner formed by the artificially established geological barrier, though the analysis of those slopes also includes slip surfaces wholly through the inert waste and also through the sub-grade, that being either the natural ground weathered slate or historical landfill.

2.47. The slope stability analysis has been carried out for selected slopes shown by the cross sections on drawings DESSD5B and DESSD5C, where the slopes are at the steepest planned. The analyses has shown that for the expected material parameters the planned external slopes will be stable in the short (temporary) and long term (external slopes not specifically analysed are shallower and hence will also be stable).

Side Slopes Liner Assessment

2.48. Refer to ‘Waste Assessment’.

Waste Assessment

2.49. The slope stability of a temporary waste face up to 10.0m height has been analysed with sensitivity analysis to appraise lower strength parameters, high leachate levels within the waste mass draining to the toe of the temporary slope, and a surcharge load at the top of the slope to represent mechanical plant during operation of the landfill, that action being variable.

2.50. The analysis indicates that the temporary waste slopes will be stable at 1:2 up to the 10.0m height, with a potential for slope failure if the shear strength of the inert waste is less than expected and the weight density higher than expected. Therefore in case exposed slopes are to be in place for longer than a temporary period, it is recommended that waste slopes at 1:2 are kept at less than 3m height, or if higher are made shallower overall, such as by the use of 1.5-3m wide berms every 3m in height.

Capping Assessment

2.51. Not applicable.

3. MONITORING

The Risk Based Monitoring Scheme

Basal Sub-Grade Monitoring

3.1. Basal sub-grade monitoring over areas with natural sub-grade strata is not required, but should be carried out over the historical landfill areas by annual topographic survey.

Side Slopes Sub-Grade Monitoring

3.2. As for the basal sub-grade.

Basal Lining System Monitoring

3.3. The basal lining system should be placed in accordance with the CQA Plan which should detail the quality assurance inspections and testing to be carried out, and records to be maintained. That data will be used to verify that the material(s) placed are in accordance with this assessment.

Side Slope Lining System Monitoring

3.4. As for the basal lining system.

Waste Mass Monitoring

3.5. Notable changes to the inert waste placed would be observed during normal operational activities at the inert landfill, assessed and acted upon appropriately.

3.6. Placement of the waste will be routinely monitored by the site manager in order to ensure that the waste is placed in ≈1m thick layers and is adequately compacted and that inert waste slopes are formed at appropriate gradients and remain stable. Records of inspections shall be recorded in the Site Diary.

3.7. As the filling progresses in-waste wells will be installed at 2-3 yearly intervals to provide 2 per hectare where the total depth of inert waste is 4 metres or more, for which indicative locations are shown on drawing DESSD7. Once installed groundwater levels within the waste will be monitored using those wells.

Capping System Monitoring

3.8. Monitoring of the inert landfill post restoration specifically for potential stability concern will be carried out by regular inspection for a period for at least three years, with topographic survey of the restored landfill surface undertaken at intervals in accordance with the environmental permit to monitor settlement.

3.9. However post restoration inspections of the inert landfill will also continue for a period likely to be up to five years, subject to agreement of the restoration scheme with the planning authority, for maintenance of the landscape planting.

3.10. The monitoring will include observation of the slope condition (e.g. slumping of restoration soils) and ground settlement and landscape planting, and notable changes which may give rise to an health and safety or environmental concern would be assessed and acted upon appropriately.

Appendices

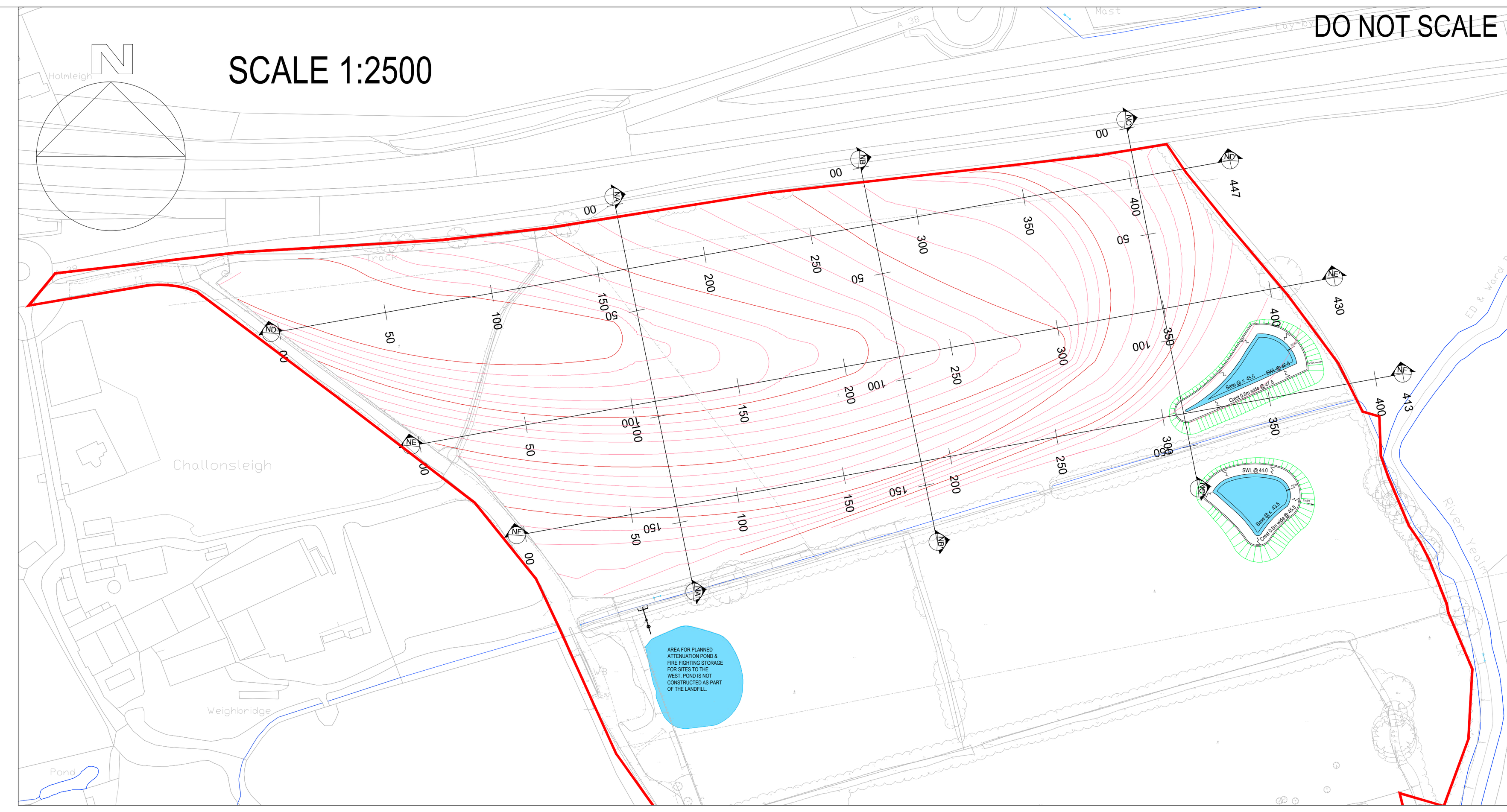
Appendix A. ASRA0 Drawings

A.1. Conceptual Stability Site Model – drawings DESSD5B and DESSD5C

A.2. Conceptual Stability Site Model and Proposed Assessment Scenarios used in Modelling – drawing DSRA1-2

0 10 MILLIMETRES 100

DO NOT SCALE



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS / RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

ITEM	HAZARD	RISK

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

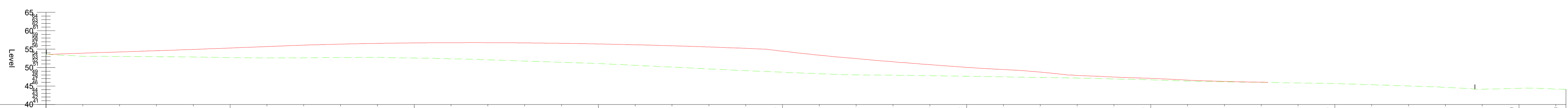
NOTES

1. DO NOT SCALE FROM THIS DRAWINGS
2. ALL MEASUREMENTS ARE IN METERS UNLESS STATED OTHERWISE

KEY

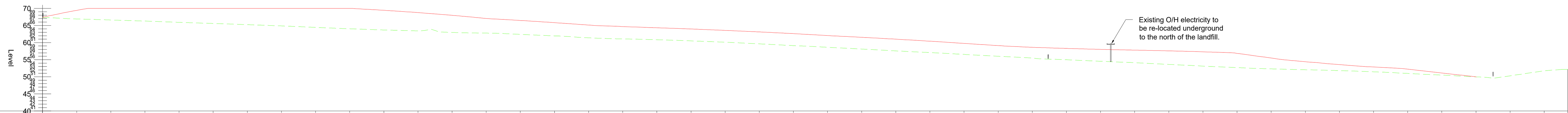
- CONTOURS INTERVAL 1.0m AND 5.0m
- EXISTING GROUND LEVEL
- PROPOSED LANDFILL LEVEL

CROSS SECTION NF-NF'
SCALE: H 1:500,V 1:500



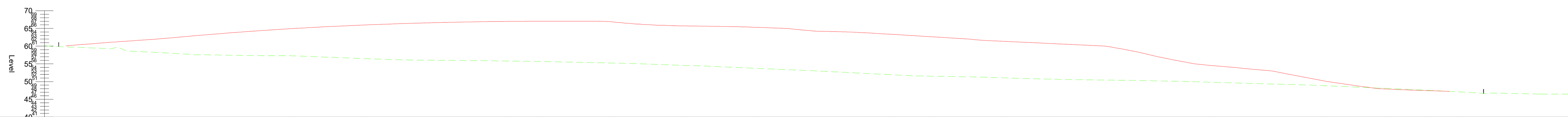
Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	53.612		
10.0	53.078	53.908	0.830
20.0	53.027	54.248	1.221
30.0	52.962	54.581	1.619
40.0	52.875	54.933	2.058
50.0	52.703	55.318	2.615
60.0	52.643	55.709	3.066
70.0	52.660	56.096	3.436
80.0	52.723	56.368	3.645
90.0	52.762	56.567	3.805
100.0	52.610	56.696	4.086
110.0	52.384	56.761	4.377
120.0	52.117	56.763	4.646
130.0	51.772	56.707	4.935
140.0	51.449	56.591	5.142
150.0	51.091	56.416	5.325
160.0	50.617	56.193	5.576
170.0	50.135	55.921	5.786
180.0	49.633	55.596	5.963
190.0	49.171	55.222	6.051
200.0	48.738	54.442	5.704
210.0	48.331	53.346	5.016
220.0	48.016	52.442	4.427
230.0	47.934	51.580	3.646
240.0	47.803	50.804	3.001
250.0	47.642	50.064	2.422
260.0	47.486	49.472	1.985
270.0	47.328	48.765	1.437
280.0	47.158	47.879	0.721
290.0	46.916	47.440	0.524
300.0	46.667	47.070	0.403
310.0	46.343	46.598	0.255
320.0	46.153	46.251	0.098
330.0	46.006	46.031	0.025
340.0	45.821		
350.0	45.668		
360.0	45.346		
370.0	45.019		
380.0	44.638		
390.0	44.119		
400.0	44.365		
410.0	44.184		

CROSS SECTION ND-ND'
SCALE: H 1:500,V 1:500



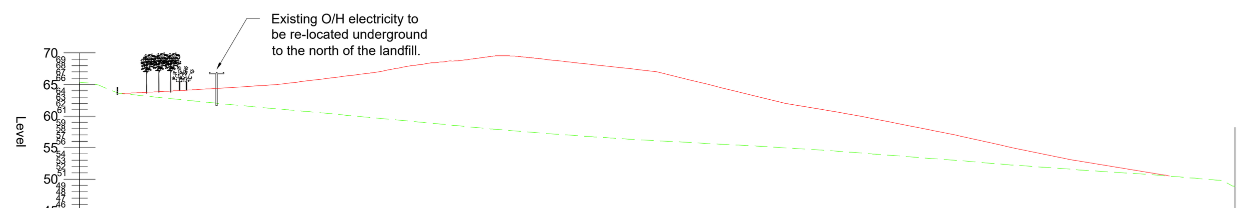
Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	67.373	67.380	0.007
10.0	66.904	69.424	2.520
20.0	66.609	70.000	3.391
30.0	66.284	69.942	3.658
40.0	65.917	69.364	3.447
50.0	65.588	68.824	3.237
60.0	65.242	68.925	3.683
70.0	64.873	67.775	2.902
80.0	64.450	67.163	2.713
90.0	64.041	66.572	2.531
100.0	63.682	66.003	2.321
110.0	63.442	65.562	2.120
120.0	62.971	65.034	2.062
130.0	62.770	64.462	1.691
140.0	62.404	63.867	1.463
150.0	61.960	63.156	1.196
160.0	61.396	62.384	0.988
170.0	61.077	61.856	0.779
180.0	60.832	61.394	0.562
190.0	60.498	60.870	0.371
200.0	60.114	60.299	0.185
210.0	59.633	59.637	0.003
220.0	59.115	59.118	0.003
230.0	58.629	58.629	0.001
240.0	58.109	58.112	0.003
250.0	57.570	57.589	0.019
260.0	57.083	57.088	0.005
270.0	56.545	56.558	0.014
280.0	56.009	56.013	0.003
290.0	55.490	55.469	-0.020
300.0	54.985	54.991	0.006
310.0	54.539	54.546	0.007
320.0	54.112	54.110	-0.002
330.0	53.624	53.638	0.014
340.0	53.128	53.139	0.011
350.0	52.696	52.703	0.007
360.0	52.322	52.336	0.014
370.0	52.054	52.156	0.102
380.0	51.806	52.175	0.368
390.0	51.463	52.100	0.637
400.0	50.978	51.869	0.891
410.0	50.507	51.654	1.147
420.0	49.977	51.426	1.449
430.0	50.284	49.965	-0.320
440.0	51.758	50.204	-1.554

CROSS SECTION NE-NE'
SCALE: H 1:500,V 1:500



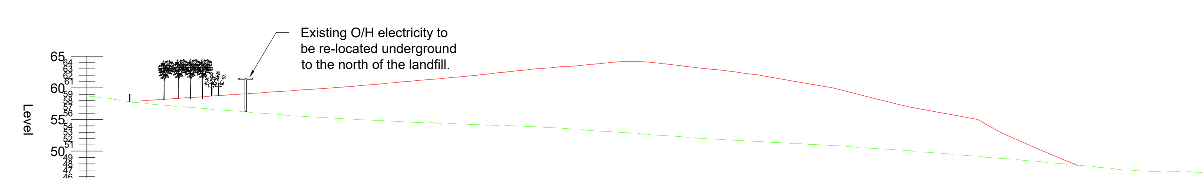
Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	60.099		
10.0	59.631	60.409	
20.0	59.584	61.182	
30.0	58.302	61.878	
40.0	57.757	62.727	
50.0	57.480	63.558	
60.0	57.329	64.306	
70.0	57.271	64.965	
80.0	56.888	65.511	
90.0	56.498	65.965	
100.0	56.167	66.332	
110.0	56.015	66.619	
120.0	55.920	66.833	
130.0	55.813	66.976	
140.0	55.673	67.022	
150.0	55.459	67.025	
160.0	55.229	66.855	
170.0	54.948	66.053	
180.0	54.593	65.719	
190.0	54.223	65.576	
200.0	53.771	65.346	
210.0	53.343	64.960	
220.0	52.897	64.174	
230.0	52.385	63.842	
240.0	51.886	63.283	
250.0	51.526	62.673	
260.0	51.350	62.048	
270.0	51.081	61.392	
280.0	50.781	60.917	
290.0	50.563	60.442	
300.0	50.414	59.892	
310.0	50.273	57.965	
320.0	50.071	55.842	
330.0	49.791	54.476	
340.0	49.500	53.572	
350.0	49.212	52.273	
360.0	48.894	50.378	
370.0	48.457	48.848	
380.0	48.011	47.838	
390.0	47.551	47.459	
400.0	47.041		
410.0	46.735		
420.0	46.525		
430.0			

CROSS SECTION NA-NA'
SCALE: H 1:500,V 1:500



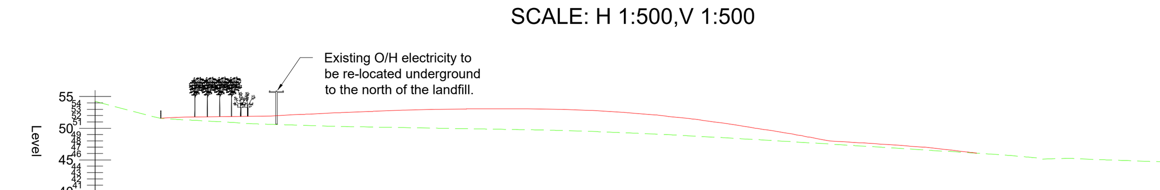
Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	65.339		
10.0	63.210	63.732	0.521
20.0	62.197	64.277	2.080
30.0	61.250	64.904	3.653
40.0	60.336	66.066	5.730
50.0	59.398	67.547	8.149
60.0	58.438	68.755	10.317
70.0	57.543	69.369	11.826
80.0	56.795	68.276	11.481
90.0	56.158	67.158	11.000
100.0	55.605	64.854	9.249
110.0	55.059	62.384	7.325
120.0	54.401	60.582	6.180
130.0	53.637	58.676	5.039
140.0	52.862	56.651	3.788
150.0	52.064	54.470	2.406
160.0	51.329	52.535	1.205
170.0	50.672	50.894	0.222
180.0	49.836		

CROSS SECTION NB-NB'
SCALE: H 1:500,V 1:500



Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	58.743		
10.0	57.459	58.044	
20.0	56.621	58.722	
30.0	55.825	59.400	
40.0	55.160	60.090	
50.0	54.655	60.953	
60.0	54.259	61.845	
70.0	53.884	62.898	
80.0	53.257	63.741	
90.0	52.561	63.951	
100.0	51.867	62.815	
110.0	51.306	61.372	
120.0	50.743	59.472	
130.0	50.044	56.985	
140.0	49.233	55.148	
150.0	48.381	50.500	
160.0	47.448		
170.0	46.824		

CROSS SECTION NC-NC'
SCALE: H 1:500,V 1:500



Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	54.243		
10.0	51.659		
20.0	51.014	51.845	
30.0	50.550	52.075	
40.0	50.262	52.504	
50.0	50.077	52.879	
60.0	49.904	53.056	
70.0	49.731	53.040	
80.0	49.433	52.718	
90.0	49.007	51.934	
100.0	48.458	50.704	
110.0	47.878	49.110	
120.0	47.257	47.762	
130.0	46.630	47.080	
140.0	46.011		
150.0	45.138		
160.0	44.994		

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

DRAWING STATUS: FOR INFORMATION
SUITABILITY: S2

ATKINS
Atkins Limited
The Octagon
Pynes Hill Court
Rydon Lane
Exeter, EX2 5AZ
England
Telephone +44(0)1392 352 900
Fax +44(0)1392 352 999
www.atkinsglobal.com

CLIENT:
DDE(SW) LIMITED

PROJECT:
Challonsleigh Farm,
Smithaleigh, nr Ivybridge, Plymouth, PL7 5AX
Inert Landfill

TITLE:
RESTORATION
POST SETTLEMENT CONTOURS
SHEET 1 OF 2

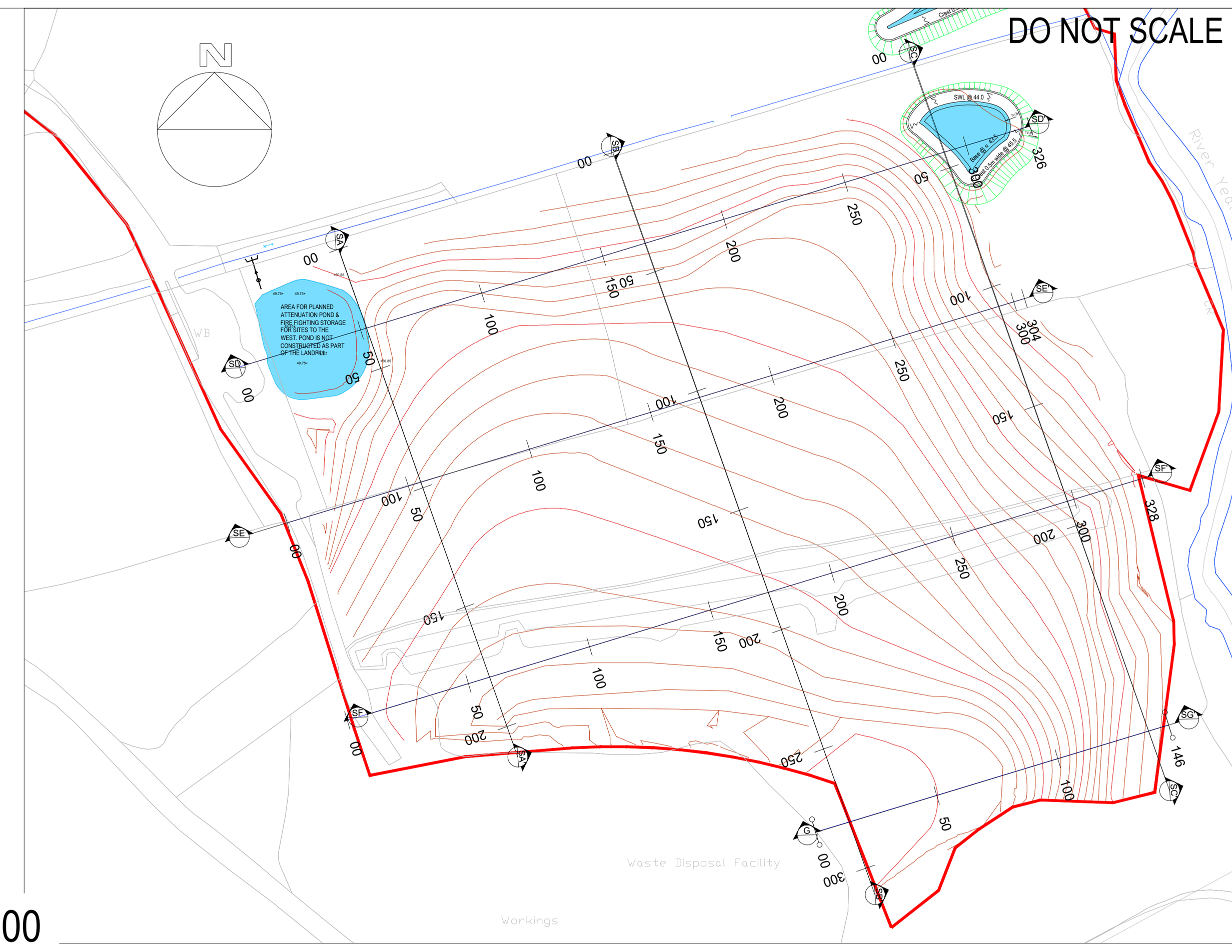
SCALE:	ORIGINAL SIZE: A1	DESIGNED: JDP	DRAWN: JDP	CHECKED: TSM	AUTHORISED: ATF
	OFFICE: EXETER	DATE: 20/07/2020	DATE: 20/07/2020	DATE: Mar 2021	DATE: 06/04/2021

DRAWING NUMBER: 5149237-ATK-DR-C-DESSD5B
REV: P01

0 10 MILLIMETRES 100

SG-SG' - CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0
Existing Levels	64.731	65.013	63.212	63.782	64.041	64.147	64.216	63.976	63.197	60.497	57.488	54.805	51.963	48.048	45.172
Proposed Levels			65.227	65.150	65.074	65.002	64.623	64.205	63.489	61.040	58.310	55.231	51.423	48.887	47.377
Level Difference			-2.015	-1.368	-1.033	-0.855	-0.407	-0.229	-0.292	-0.543	-0.822	-0.426	0.540	-0.838	-2.205



DO NOT SCALE

SCALE 1:2500

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS / RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

ITEM	HAZARD	RISK

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

NOTES

1. DO NOT SCALE FROM THIS DRAWINGS
2. ALL MEASUREMENTS ARE IN METERS UNLESS STATED OTHERWISE

SA-SA' CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	212.8
Existing Levels	49.441	48.979	48.626	48.303	48.035	48.012	48.041	48.106	48.302	48.570	49.127	50.003	51.145	52.243	53.254	54.203	57.495	60.034	58.588	58.701	58.980	59.460	59.573
Proposed Levels		49.468	50.685	50.924	51.325	51.823	53.230	54.669	55.689	56.582	57.443	58.178	58.834	59.524	60.161	60.794	61.451	62.063	62.723	63.540	62.848		
Level Difference		-0.489	-2.058	-2.622	-3.290	-3.811	-5.189	-6.564	-7.387	-8.012	-8.316	-8.175	-7.689	-7.281	-6.907	-6.591	-3.956	-2.029	-4.134	-4.839	-3.868		

SD-SD' - CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0	320.0	326.3
Existing Levels	50.594	50.158	48.899	48.680	48.490	48.252	48.045	47.757	47.473	47.223	46.991	46.811	46.584	46.353	46.111	46.019	45.922	45.707	45.523	45.335	45.204	45.048	44.878	44.671	44.499	44.367	44.207	44.025	43.877	43.818	43.731	43.612	43.550	43.515
Proposed Levels						50.485	52.852	53.569	53.919	53.680	52.956	52.119	51.430	50.999	50.810	50.620	50.430	50.240	50.117	50.323	50.562	50.839	51.170	51.193	50.757	50.583	49.467	47.464	45.409	43.400	43.400	43.400	43.528	
Level Difference						-2.233	-4.807	-5.812	-6.446	-6.457	-5.965	-5.308	-4.846	-4.646	-4.699	-4.601	-4.508	-4.534	-4.594	-4.988	-5.358	-5.791	-6.291	-6.522	-6.257	-6.216	-5.259	-3.439	-1.532	0.418	0.331	0.212	0.022	

KEY

- CONTOURS INTERVAL 1.0m AND 5.0m
- EXISTING GROUND LEVEL
- PROPOSED LANDFILL LEVEL

SB-SB' - CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0
Existing Levels	46.729	46.509	46.197	45.963	45.718	45.746	45.778	45.813	45.933	46.137	46.544	46.809	47.430	48.045	48.434	48.905	49.438	50.299	54.259	55.201	55.824	56.290	56.650	57.091	59.210	61.343	63.566	63.238	63.311	63.498	63.419	63.507
Proposed Levels			47.298	48.950	50.607	52.200	53.918	54.885	55.493	56.016	56.528	57.019	57.449	57.880	58.371	58.877	59.298	59.696	60.130	60.575	61.073	61.889	62.417	63.470	63.218	64.544	65.196	65.240				
Level Difference			-1.101	-2.987	-4.889	-6.454	-8.141	-9.071	-9.560	-9.879	-9.983	-10.211	-10.019	-9.835	-9.936	-9.972	-9.860	-9.397	-5.871	-5.374	-5.250	-5.599	-5.767	-6.380	-4.007	-3.201	-1.630	-2.003				

SE-SE' - CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	304.4
Existing Levels	51.075	51.109	49.772	49.608	49.504	49.131	48.659	48.650	48.335	48.150	47.923	47.809	47.683	47.420	47.237	46.993	46.879	46.663	46.501	46.323	45.985	45.700	45.459	45.175	44.882	44.565	44.204	43.952	43.731	43.480	43.296	43.135
Proposed Levels			52.108	54.529	55.778	56.780	57.652	58.248	58.567	58.743	58.790	58.712	58.513	58.104	57.741	57.401	57.058	56.668	56.285	55.922	55.589	55.252	54.916	54.566	54.087	53.046	51.317	49.087	47.022	45.159	43.663	43.078
Level Difference			-2.337	-4.921	-6.274	-7.649	-8.994	-9.598	-10.232	-10.593	-10.868	-10.903	-10.829	-10.684	-10.504	-10.408	-10.179	-10.005	-9.784	-9.599	-9.604	-9.552	-9.456	-9.391	-9.205	-8.481	-7.114	-5.135	-3.291	-1.680	-0.366	0.057

SC-SC' - CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	311.3	310.0
Existing Levels	45.604	45.083	44.759	44.353	43.967	43.491	43.125	43.003	42.968	43.020	43.287	43.418	43.368	43.849	44.300	44.718	45.469	46.438	47.428	49.467	51.085	51.219	50.898	49.627	48.581	48.491	48.076	47.759	47.087	45.346	45.884	45.529	45.554
Proposed Levels			43.904	43.400	43.400	43.576	44.234	44.290	44.115	43.898	44.158	44.701	45.480	46.198	46.843	47.428	47.993	48.697	49.494	50.396	51.206	51.462	51.123	49.942	49.784	49.808	49.753	48.863	48.182	47.505			
Level Difference			0.855	0.953	0.567	-0.085	-1.109	-1.287	-1.147	-0.878	-0.871	-1.284	-2.112	-2.349	-2.543	-2.711	-2.524	-2.259	-2.066	-0.929	-0.121	-0.243	-0.224	-0.315	-1.204	-1.317	-1.677	-1.105	-1.095	-2.159			

SF-SF' - CROSS SECTION
SCALE: H 1:500,V 1:500

Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0	320.0	328.2
Existing Levels	58.272	58.026	58.662	58.489	58.508	58.552	58.578	58.489	58.230	58.078	57.943	57.554	57.057	56.312	55.730	55.626	55.095	54.800	54.541	54.251	53.233	53.137	52.925	52.589	52.242	51.906	51.391	51.198	50.751	50.057	49.124	47.785	45.651	44.441
Proposed Levels			60.316	61.133	61.895	62.401	62.712	62.872	62.865	62.725	62.559	62.364	62.145	61.845	61.428	60.979	60.729	60.442	60.107	59.738	59.336	58.864	58.307	57.666	56.872	55.904	54.902	53.532	52.407	51.267	50.061	48.396	45.965	
Level Difference			-1.654	-2.644	-3.388	-3.849	-4.134	-4.384	-4.634	-4.647	-4.617	-4.810	-5.088	-5.533	-5.698	-5.353	-5.634	-5.642	-5.566	-5.488	-6.104	-5.727	-5.382	-5.077	-4.630	-3.998	-3.511	-2.334	-1.656	-1.210	-0.937	-0.611	-0.313	

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

DRAWING STATUS: FOR INFORMATION

SUITABILITY: S2

Atkins Limited
The Octagon
Pynes Hill Court
Rydon Lane
Exeter, EX2 5AZ
England

Telephone +44(0)1392 352 900
Fax +44(0)1392 352 999
www.atkinsglobal.com

CLIENT: DDE(SW) LIMITED

PROJECT: Challonsleigh Farm, Smithaleigh, nr Ivybridge, Plymouth, PL7 5AX Inert Landfill

TITLE: RESTORATION POST SETTLEMENT SECTIONS SHEET 2 OF 2

SCALE:	ORIGINAL SIZE:	DESIGNED:	DRAWN:	CHECKED:	AUTHORISED:
AS SHOWN	A1	JDP	JDP	ATF	ATF
	OFFICE: EXETER	DATE: 20.07.2020	DATE: 20.07.2020	DATE: 06/04/21	DATE: 06/04/21

DRAWING NUMBER: 5149237-ATK-DR-C-ESSD5C

REV: P01

DO NOT SCALE

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS / RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

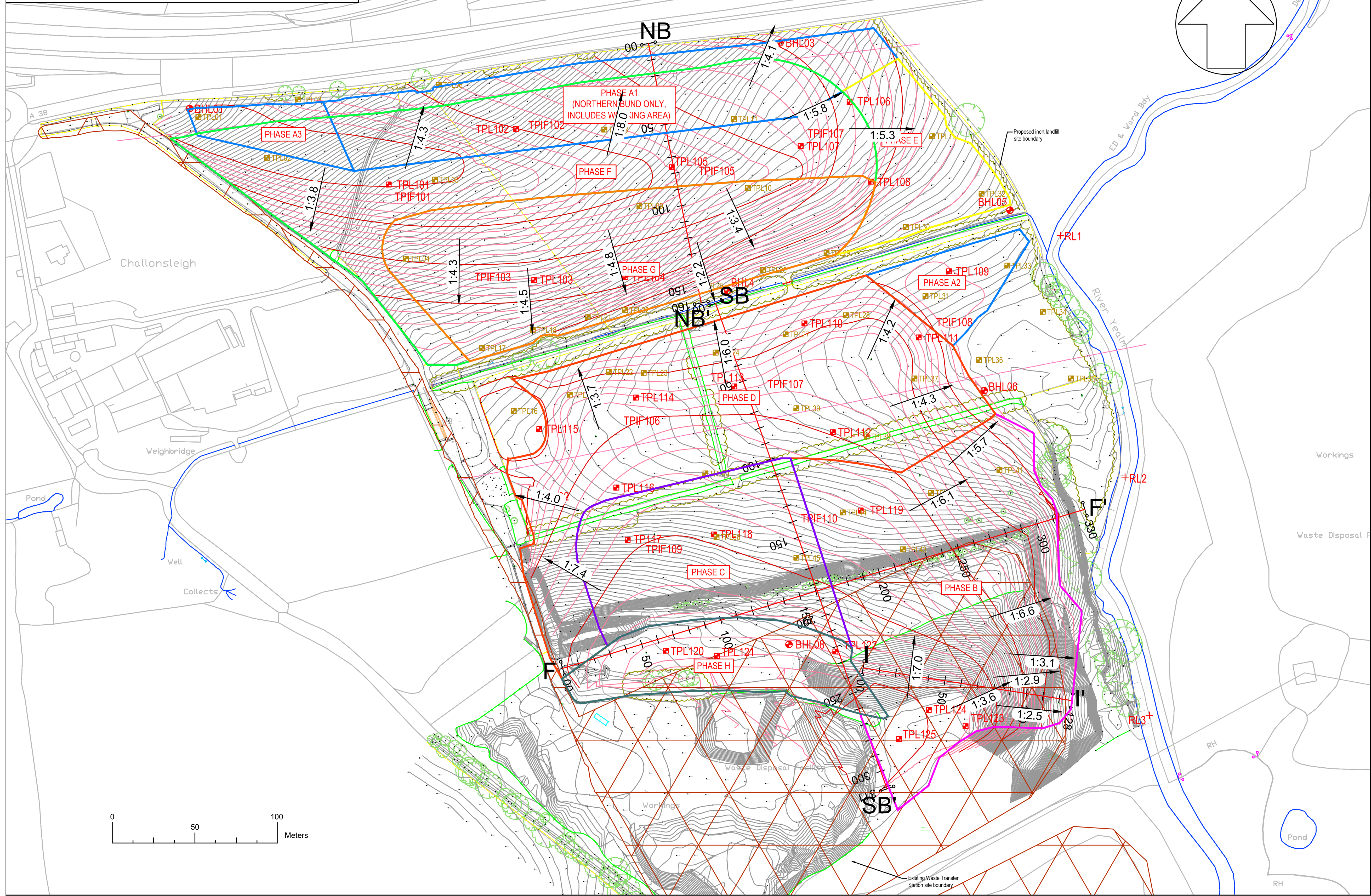
ITEM	HAZARD	RISK

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

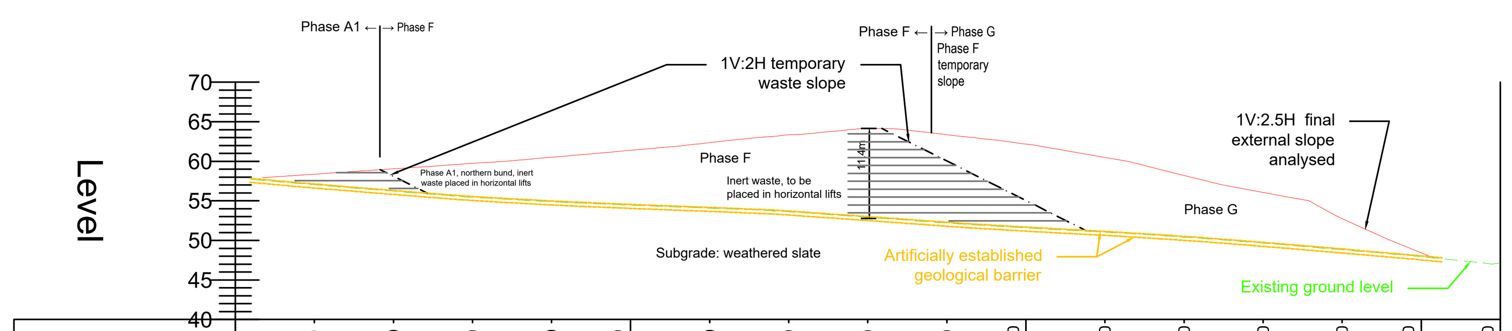
NOTES

1. DO NOT SCALE FROM THIS DRAWINGS
2. ALL MEASUREMENTS ARE IN METERS UNLESS STATED OTHERWISE
3. Refer to drawings DESSD5B and DESSD5C for planning approved cross sections of restoration profile.

Area shown as historic landfill by Environment Agency Historic Landfill dataset available from data.gov.uk

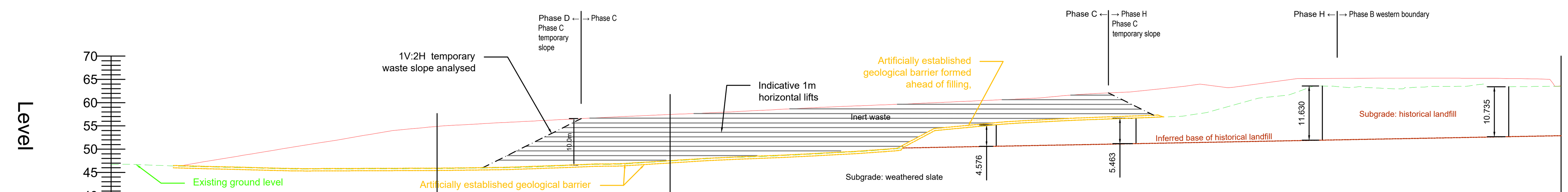


ALIGNMENT - PHASES A1 F & G SECTION NB-NB' (NORTH OF ORDINARY WATERCOURSE)
SCALE: H 1:500,V 1:500. DATUM: 40.000



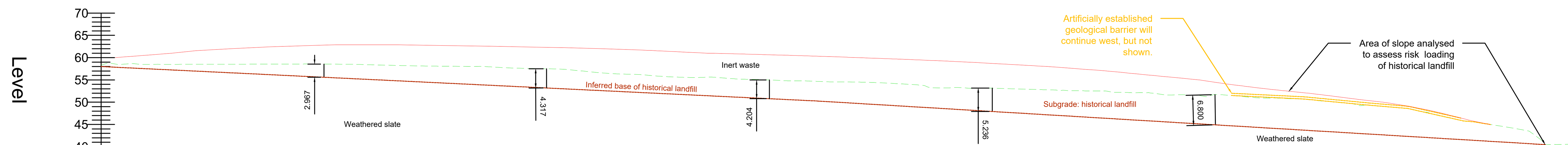
Chainage	Existing Levels	Proposed Levels	Level Difference
0.0			
10.0	57.025	58.373	1.348
20.0	56.214	59.052	2.838
30.0	55.443	59.738	4.295
40.0	54.882	60.510	5.627
50.0	54.449	61.388	6.939
60.0	54.071	62.368	8.297
70.0	53.613	63.348	9.735
80.0	52.915	64.156	11.241
90.0	52.189	63.366	11.178
100.0	51.576	62.186	10.610
110.0	51.037	60.503	9.467
120.0	50.410	58.219	7.809
130.0	49.656	56.065	6.409
140.0	48.810	52.738	3.928
150.0	47.943	48.435	0.492
160.0	47.024		

ALIGNMENT - PHASES D, C & H SECTION SB-SB' (SOUTH OF ORDINARY WATERCOURSE)
SCALE: H 1:500,V 1:500. DATUM: 40.000



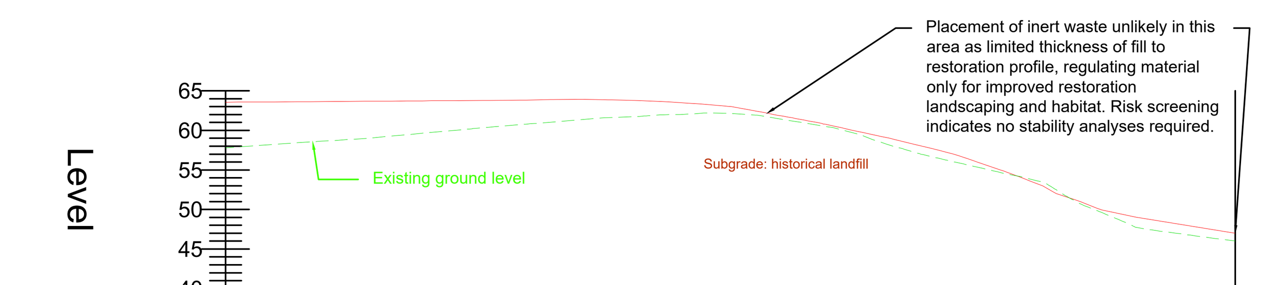
Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	46.729		
10.0	46.509		
20.0	46.197	47.298	1.101
30.0	45.963	48.950	2.987
40.0	45.718	50.607	4.889
50.0	45.746	52.200	6.454
60.0	45.778	53.918	8.141
70.0	45.813	54.885	9.071
80.0	45.933	55.493	9.560
90.0	46.137	56.016	9.879
100.0	46.544	56.528	9.983
110.0	46.809	57.019	10.211
120.0	47.430	57.449	10.019
130.0	48.045	57.880	9.835
140.0	48.434	58.371	9.936
150.0	48.905	58.877	9.972
160.0	49.438	59.298	9.860
170.0	50.299	59.696	9.397
180.0	54.259	60.130	5.871
190.0	55.201	60.575	5.374
200.0	55.824	61.073	5.250
210.0	56.290	61.889	5.599
220.0	56.650	62.417	5.767
230.0	57.091	63.470	6.380
240.0	59.210	63.218	4.007
250.0	61.343	64.544	3.201
260.0	63.566	65.196	1.630
270.0	63.238	65.240	2.003
280.0	63.311	65.273	1.961
290.0	63.498	65.254	1.755
300.0	63.419	65.179	1.760
310.0	63.507	[illegible]	[illegible]

ALIGNMENT - PHASES D, H, C & B SECTION F-F' (SOUTH OF ORDINARY WATERCOURSE)
SCALE: H 1:500,V 1:500. DATUM: 40.000



Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	58.300		
10.0	58.471	60.538	2.067
20.0	58.520	61.422	2.903
30.0	58.513	62.048	3.534
40.0	58.561	62.495	3.934
50.0	58.560	62.812	4.252
60.0	58.414	62.871	4.457
70.0	58.173	62.832	4.659
80.0	58.053	62.681	4.628
90.0	57.769	62.503	4.733
100.0	57.505	62.306	4.801
110.0	56.797	62.069	5.271
120.0	56.239	61.744	5.505
130.0	55.605	61.291	5.685
140.0	55.406	60.911	5.505
150.0	54.985	60.645	5.660
160.0	54.700	60.351	5.651
170.0	54.511	59.996	5.485
180.0	54.083	59.627	5.544
190.0	53.192	59.209	6.017
200.0	53.149	58.705	5.556
210.0	52.848	58.143	5.296
220.0	52.614	57.445	4.831
230.0	52.187	56.595	4.408
240.0	51.610	55.623	4.012
250.0	51.714	54.465	2.750
260.0	50.948	53.180	2.233
270.0	50.708	52.111	1.403
280.0	49.782	50.901	1.119
290.0	48.889	49.650	0.761
300.0	47.151	47.743	0.592
310.0	45.280	45.348	0.068
320.0	43.595		
330.0	40.571		

ALIGNMENT - PHASE B SECTION I-I' WNW TO ESE
SCALE: H 1:500,V 1:500. DATUM: 40.000



Chainage	Existing Levels	Proposed Levels	Level Difference
0.0	57.785	63.563	5.778
10.0	58.496	63.626	5.130
20.0	59.191	63.696	4.505
30.0	60.098	63.761	3.663
40.0	60.944	63.862	2.919
50.0	61.666	63.827	2.161
60.0	62.158	63.336	1.177
70.0	61.463	61.883	0.420
80.0	59.510	59.856	0.346
90.0	56.509	57.530	1.022
100.0	54.263	54.264	0.001
110.0	49.942	50.236	0.293
120.0	47.023	48.239	1.216
127.7	46.002	47.000	0.998

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH
P02	Phasing updated.	TSM	6/12/21	ATF	ATF

DRAWING STATUS: FOR INFORMATION
SUITABILITY: S2

Atkins Limited
The Octagon
Pynes Hill Court
Rydon Lane
Exeter, EX2 5AZ
England
Telephone +44(0)1392 352 900
Fax +44(0)1392 352 999
www.atkinsglobal.com

CLIENT:
DDE(SW) LIMITED

PROJECT:
Challonsleigh Farm,
Smithaleigh, nr Ivybridge, Plymouth, PL7 5AX
Inert Landfill

TITLE:
STABILITY RISK ASSESSMENT
CONCEPTUAL STABILITY SITE MODEL AND PROPOSED ASSESSMENT SCENARIOS USED IN MODELLING

SCALE:	ORIGINAL SIZE:	DESIGNED:	DRAWN:	CHECKED:	AUTHORISED:
As shown	A1	TSM	TSM	ATF	ATF
	OFFICE: EXETER	DATE: Mar 2021	DATE: Mar 2021	DATE: 06/04/2021	DATE: 06/04/2021

DRAWING NUMBER: 5149237-ATK-DR-C- DSRA1-2
REV: P02

Appendix B. ASRA1 Hard copies of the models and inputs used within the assessment – NOT USED

Appendix C. ASRA2 Results of all analyses carried out for the site (unless specified within the text), to include sub-sections for the various key components of the conceptual model (e.g. basal heave stability, side slope liner integrity)

C.1. Calculations for Basal Sub-Grade Settlement Analyses

Challonsleigh Farm Inert Landfill - Stability Risk Assessment Report - 5149237.CIFL04
Appendix C.1a Calculations for Basal Sub-Grade Settlement Analysis - Cc = 0.3

Section SB-SB' Ch	Historical landfill waste m	Planned inert waste m
190	4.576	5.374
220	5.463	5.767
260	11.63	1.63
300	10.735	1.76
Section SF-SF' Ch		
50	2.967	4.252
100	4.317	4.801
150	4.204	5.66
200	5.236	5.556
250	6.805	2.75

Creep settlement Ds = æc .h. (log t2/t1) measured from start of load application

Biodegradation settlement Db æb .h. (log t2/t1) measured from placement of waste

Waste placed 1991 - 2003 over a ridge of land above about 50mOD in the north and 55m in west,
which slopes towards the River Yealm flood plain.
Moret recent is conservative so assume from 1996 (t1=25) and conservative is 2001 (t1=20 years)

Assumed period for most degradation is in the order of 30 years (CIRIA Engineering Closed landfills Para 2.4)

BRE Building on fill: Geotechnical aspects, 2001, Table 10 Properties of refuse fill: æc = 0.2-0.3% to 2%
æb = 2% to 6%

If Creep taken from point of load application then t1 taken as one year
For t2 = 30yrs and t1 = 25 yrs for existing waste, t2 = 30 yrs and t1 = 1 yr for new inert waste, no biodegradation
Log 30/25 = 0.079181 for existing inert/industrial waste
Log 30/1 = 1.477121 for new inert waste

Section SB-SB' Ch	Old Waste m	Creep Factor 0.003	Biodegrade Factor 0.03	Creep sett	Bio Sett	Total self sett in old waste	New Waste thickness m	Creep factor 0.003	Creep sett	Total settlement
190	4.576	0.000238	0.0023754	0.001	0.011	0.012	5.374	0.004	0.024	0.036
220	5.463	0.000238	0.0023754	0.001	0.013	0.014	5.767	0.004	0.026	0.040
260	11.63	0.000238	0.0023754	0.003	0.028	0.030	1.63	0.004	0.007	0.038
300	10.735	0.000238	0.0023754	0.003	0.026	0.028	1.76	0.004	0.008	0.036
Section SF-SF' Ch										
50	2.967	0.000238	0.0023754	0.001	0.007	0.008	4.252	0.004	0.019	0.027
100	4.317	0.000238	0.0023754	0.001	0.010	0.011	4.801	0.004	0.021	0.033
150	4.204	0.000238	0.0023754	0.001	0.010	0.011	5.66	0.004	0.025	0.036
200	5.236	0.000238	0.0023754	0.001	0.012	0.014	5.556	0.004	0.025	0.038
250	6.805	0.000238	0.0023754	0.002	0.016	0.018	2.75	0.004	0.012	0.030

For t2 = 30yrs and t1 = 20 yrs for existing waste, t2 = 30 yrs and t1 = 1 yr for new inert waste with no biodegradation
Log30/20 = 0.176091
Log 30/1= 1.477121

Section SB-SB' Ch	Old Waste m	Creep Factor 0.003	Biodegrad Factor 0.03	Creep sett	Bio Sett	Total sett m	New Waste thickness m	Creep factor 0.003	Creep sett	Total settlement
190	4.576	0.000528	0.0052827	0.002	0.024	0.027	5.374	0.004	0.024	0.050
220	5.463	0.000528	0.0052827	0.003	0.029	0.032	5.767	0.004	0.026	0.057
260	11.63	0.000528	0.0052827	0.006	0.061	0.068	1.63	0.004	0.007	0.075
300	10.735	0.000528	0.0052827	0.006	0.057	0.062	1.76	0.004	0.008	0.070
Section SF-SF' Ch										
50	2.967	0.004431	0.0052827	0.013	0.016	0.029	4.252	0.004	0.019	0.048
100	4.317	0.004431	0.0052827	0.019	0.023	0.042	4.801	0.004	0.021	0.063
200	4.204	0.004431	0.0052827	0.019	0.022	0.041	5.66	0.004	0.025	0.066
200	5.236	0.004431	0.0052827	0.023	0.028	0.051	5.556	0.004	0.025	0.075
250	6.805	0.004431	0.0052827	0.030	0.036	0.066	2.75	0.004	0.012	0.078

Calculation of secondary compression in waste

Assumed waste density	18 kN/m^3	Compression index, Cc	0.3
Additional waste thickness	5.374 m		
Pressure increment at surface	96.732 kN/m^2		

Waste top depth m	Waste base depth m	Mean depth m	Initial p'$_0$ kN/m^2	Initial porosity %	Inital void ratio	Final p'$_1$ kN/m^2	Compression index, Cc	Settle-ment
0	1	0.5	9.0	45.5	0.83	105.732	0.3	0.175
1	2	1	18.0	42.6	0.74	114.732	0.3	0.138
2	3	2	36.0	39.5	0.65	132.732	0.3	0.103
3	4.576	3.788	68.2	36.3	0.57	164.9	0.3	0.115
								0.53

Assumed waste density	18 kN/m^3	Compression index, Cc	0.3
Additional waste thickness	5.767 m		
Pressure increment at surface	103.806 kN/m^2		

Waste top depth m	Waste base depth m	Mean depth m	Initial p'$_0$ kN/m^2	Initial porosity %	Inital void ratio	Final p'$_1$ kN/m^2	Compression index, Cc	Settle-ment
0	1.5	0.75	13.5	43.9	0.78	117.3	0.3	0.237
1.5	3	1.50	27.0	40.9	0.69	130.8	0.3	0.182
3	4.5	3.00	54.0	37.5	0.60	157.8	0.3	0.131
4.5	5.463	4.98	89.7	34.8	0.53	193.5	0.3	0.063
								0.61

Assumed waste density	18 kN/m^3	Compression index, Cc	0.3
Additional waste thickness	1.63 m		
Pressure increment at surface	29.34 kN/m^2		

Waste top depth m	Waste base depth m	Mean depth m	Initial p'$_0$ kN/m^2	Initial porosity %	Inital void ratio	Final p'$_1$ kN/m^2	Compression index, Cc	Settle-ment
0	3	1.50	27.0	40.9	0.69	56.3	0.3	0.170
3	6	3.00	54.0	37.5	0.60	83.3	0.3	0.106
6	9	6.00	108.0	33.8	0.51	137.3	0.3	0.062
9	11.63	10.32	185.7	30.6	0.44	215.0	0.3	0.035
								0.37

Assumed waste density	18 kN/m^3	Compression index, Cc	0.3
Additional waste thickness	1.76 m		
Pressure increment at surface	31.68 kN/m^2		

Waste top depth m	Waste base depth m	Mean depth m	Initial p'$_0$ kN/m^2	Initial porosity %	Inital void ratio	Final p'$_1$ kN/m^2	Compression index, Cc	Settle-ment
0	2	1.00	18.0	42.6	0.74	49.7	0.3	0.152
2	4	2.00	36.0	39.5	0.65	67.7	0.3	0.099
4	6	4.00	72.0	36.0	0.56	103.7	0.3	0.061
6	8	6.00	108.0	33.8	0.51	139.7	0.3	0.044
8	10.735	9.37	168.6	31.2	0.45	200.3	0.3	0.042
								0.40

Assumed waste density	18 kN/m^3	Compression index, Cc	0.3
Additional waste thickness	4.252 m		
Pressure increment at surface	76.536 kN/m^2		

Waste top depth m	Waste base depth m	Mean depth m	Initial p'$_0$ kN/m^2	Initial porosity %	Inital void ratio	Final p'$_1$ kN/m^2	Compression index, Cc	Settle-ment
0	1	0.50	9.0	45.5	0.83	85.5	0.3	0.160
1	2	1.00	18.0	42.6	0.74	94.5	0.3	0.124
2	2.967	2.00	36.0	39.5	0.65	112.5	0.3	0.087
								0.37

Assumed waste density	18 kN/m^3	Compression index, Cc	0.3
Additional waste thickness	4.801 m		
Pressure increment at surface	86.418 kN/m^2		

Waste top depth m	Waste base depth m	Mean depth m	Initial p'$_0$ kN/m^2	Initial porosity %	Inital void ratio	Final p'$_1$ kN/m^2	Compression index, Cc	Settle-ment
0	1	0.50	9.0	45.5	0.83	95.4	0.3	0.168
1	2	1.00	18.0	42.6	0.74	104.4	0.3	0.131
2	3	2.00	36.0	39.5	0.65	122.4	0.3	0.096
3	4.317	3.66	65.9	36.5	0.58	152.3	0.3	0.091
								0.49

Assumed waste density			18	kN/m^3	Compression index, Cc		0.3	
Additional waste thickness			5.66	m				
Pressure increment at surface			101.88	kN/m^2				
Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	45.5	0.83	109.0	0.3	0.177
1	2	1.00	18.0	42.6	0.74	118.0	0.3	0.141
2	3	2.00	36.0	39.5	0.65	136.0	0.3	0.105
3	4.204	3.60	64.8	36.6	0.58	164.8	0.3	0.093
								0.52

Assumed waste density			18	kN/m^3	Compression index, Cc		0.3	
Additional waste thickness			5.556	m				
Pressure increment at surface			100.008	kN/m^2				
Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	45.5	0.83	109.0	0.3	0.177
1.25	2.5	1.25	22.5	41.7	0.71	122.5	0.3	0.161
2.5	3.75	2.50	45.0	38.4	0.62	145.0	0.3	0.117
3.75	5.236	4.49	80.9	35.4	0.55	180.9	0.3	0.101
								0.56

Assumed waste density			18	kN/m^3	Compression index, Cc		0.3	
Additional waste thickness			2.75	m				
Pressure increment at surface			49.5	kN/m^2				
Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1.5	0.75	13.5	43.9	0.78	63.0	0.3	0.169
1.5	3	1.50	27.0	40.9	0.69	76.5	0.3	0.120
3	4.5	3.00	54.0	37.5	0.60	103.5	0.3	0.079
4.5	6	4.50	81.0	35.4	0.55	130.5	0.3	0.060
6	6.805	6.40	115.2	33.4	0.50	164.7	0.3	0.025
								0.45

Challonsleigh Farm Inert Landfill - Stability Risk Assessment Report - 5149237.CIFL04
Appendix C.1b Calculations for Basal Sub-Grade Settlement Analysis - Cc = 0.2

	Historical landfill waste	Planned inert waste
Section SB-SB'	m	m
Ch		
190	4.576	5.374
220	5.463	5.767
260	11.63	1.63
300	10.735	1.76
Section SF-SF'		
Ch		
50	2.967	4.252
100	4.317	4.801
150	4.204	5.66
200	5.236	5.556
250	6.805	2.75

Creep settlement Ds = æc .h. (log t2/t1) measured from start of load application

Biodegradation settlement Db æb .h. (log t2/t1) measured from placement of waste

Waste placed 1991 - 2003 over a ridge of land above about 50mOD in the north and 55m in west,
which slopes towards the River Yealm flood plain.
Moret recent is conservative so assume from 1996 (t1=25) and conservative is 2001 (t1=20 years)

Assumed period for most degradation is in the order of 30 years (CIRIA Engineering Closed landfills Para 2.4)

BRE Building on fill: Geotechnical aspects, 2001, Table 10 Properties of refuse fill: æc = 0.2-0.3% to 2%
æb = 2% to 6%

If Creep taken from point of load application then t1 taken as one year
For t2 = 30yrs and t1 = 25 yrs for existing waste, t2 = 30 yrs and t1 = 1 yr for new inert waste, no biodegradation
Log 30/25 = 0.079181 for existing inert/industrial waste
Log 30/1 = 1.477121 for new inert waste

	Old Waste	Creep Factor	Biodegrade Factor	Creep sett	Bio Sett	Total self sett in old waste	New Waste thickness	Creep factor	Creep sett	Total settlement
Section SB-SB'	m	0.003	0.03				m	0.003		
Ch										
190	4.576	0.000238	0.0023754	0.001	0.011	0.012	5.374	0.004	0.024	0.036
220	5.463	0.000238	0.0023754	0.001	0.013	0.014	5.767	0.004	0.026	0.040
260	11.63	0.000238	0.0023754	0.003	0.028	0.030	1.63	0.004	0.007	0.038
300	10.735	0.000238	0.0023754	0.003	0.026	0.028	1.76	0.004	0.008	0.036
Section SF-SF'										
Ch										
50	2.967	0.000238	0.0023754	0.001	0.007	0.008	4.252	0.004	0.019	0.027
100	4.317	0.000238	0.0023754	0.001	0.010	0.011	4.801	0.004	0.021	0.033
150	4.204	0.000238	0.0023754	0.001	0.010	0.011	5.66	0.004	0.025	0.036
200	5.236	0.000238	0.0023754	0.001	0.012	0.014	5.556	0.004	0.025	0.038
250	6.805	0.000238	0.0023754	0.002	0.016	0.018	2.75	0.004	0.012	0.030

For t2 = 30yrs and t1 = 20 yrs for existing waste, t2 = 30 yrs and t1 = 1 yr for new inert waste with no biodegradation
Log30/20 = 0.176091
Log 30/1= 1.477121

	Old Waste	Creep Factor	Biodegrad Factor	Creep sett	Bio Sett	Total sett	New Waste thickness	Creep factor	Creep sett	Total settlement
Section SB-SB'	m	0.003	0.03			m	m	0.003		
Ch										
190	4.576	0.000528	0.0052827	0.002	0.024	0.027	5.374	0.004	0.024	0.050
220	5.463	0.000528	0.0052827	0.003	0.029	0.032	5.767	0.004	0.026	0.057
260	11.63	0.000528	0.0052827	0.006	0.061	0.068	1.63	0.004	0.007	0.075
300	10.735	0.000528	0.0052827	0.006	0.057	0.062	1.76	0.004	0.008	0.070
Section SF-SF'										
Ch										
50	2.967	0.004431	0.0052827	0.013	0.016	0.029	4.252	0.004	0.019	0.048
100	4.317	0.004431	0.0052827	0.019	0.023	0.042	4.801	0.004	0.021	0.063
200	4.204	0.004431	0.0052827	0.019	0.022	0.041	5.66	0.004	0.025	0.066
200	5.236	0.004431	0.0052827	0.023	0.028	0.051	5.556	0.004	0.025	0.075
250	6.805	0.004431	0.0052827	0.030	0.036	0.066	2.75	0.004	0.012	0.078

Calculation of secondary compression in waste

Assumed waste density	18 kN/m^3	Compression index, Cc	0.2
Additional waste thickness	5.374 m		
Pressure increment at surface	96.732 kN/m^2		

Waste top depth	Waste base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.5	9.0	0.45	0.83	105.732	0.2	0.117
1	2	1	18.0	0.43	0.77	114.732	0.2	0.091
2	3	2	36.0	0.41	0.71	132.732	0.2	0.066
3	4.576	3.788	68.2	0.39	0.65	164.9	0.2	0.073
								0.35

Assumed waste density	18 kN/m^3	Compression index, Cc	0.2
Additional waste thickness	5.767 m		
Pressure increment at surface	103.806 kN/m^2		

Waste top depth	Waste base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1.5	0.75	13.5	0.44	0.79	117.3	0.2	0.157
1.5	3	1.50	27.0	0.42	0.73	130.8	0.2	0.119
3	4.5	3.00	54.0	0.40	0.67	157.8	0.2	0.084
4.5	5.463	4.98	89.7	0.39	0.63	193.5	0.2	0.040
								0.40

Assumed waste density	18 kN/m^3	Compression index, Cc	0.2
Additional waste thickness	1.63 m		
Pressure increment at surface	29.34 kN/m^2		

Waste top depth	Waste base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	3	1.50	27.0	0.42	0.73	56.3	0.2	0.111
3	6	3.00	54.0	0.40	0.67	83.3	0.2	0.068
6	9	6.00	108.0	0.38	0.61	137.3	0.2	0.039
9	11.63	10.32	185.7	0.36	0.57	215.0	0.2	0.021
								0.24

Assumed waste density	18 kN/m^3	Compression index, Cc	0.2
Additional waste thickness	1.76 m		
Pressure increment at surface	31.68 kN/m^2		

Waste top depth	base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	2	1.00	18.0	0.43	0.77	49.7	0.2	0.100
2	4	2.00	36.0	0.41	0.71	67.7	0.2	0.064
4	6	4.00	72.0	0.39	0.65	103.7	0.2	0.038
6	8	6.00	108.0	0.38	0.61	139.7	0.2	0.028
8	10.735	9.37	168.6	0.36	0.57	200.3	0.2	0.026
								0.26

Assumed waste density	18 kN/m^3	Compression index, Cc	0.2
Additional waste thickness	4.252 m		
Pressure increment at surface	76.536 kN/m^2		

Waste top depth	base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	85.5	0.2	0.107
1	2	1.00	18.0	0.43	0.77	94.5	0.2	0.081
2	2.967	2.00	36.0	0.41	0.71	112.5	0.2	0.056
								0.24

Assumed waste density	18 kN/m^3	Compression index, Cc	0.2
Additional waste thickness	4.801 m		
Pressure increment at surface	86.418 kN/m^2		

Waste top depth	base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	95.4	0.2	0.112
1	2	1.00	18.0	0.43	0.77	104.4	0.2	0.086
2	3	2.00	36.0	0.41	0.71	122.4	0.2	0.062
3	4.317	3.66	65.9	0.40	0.66	152.3	0.2	0.058
								0.32

Assumed waste density 18 kN/m^3 Compression index, Cc 0.2
Additional waste thickness 5.66 m
Pressure increment at surface 101.88 kN/m^2

Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	109.0	0.2	0.118
1	2	1.00	18.0	0.43	0.77	118.0	0.2	0.092
2	3	2.00	36.0	0.41	0.71	136.0	0.2	0.068
3	4.204	3.60	64.8	0.40	0.66	164.8	0.2	0.059
								0.34

Assumed waste density 18 kN/m^3 Compression index, Cc 0.2
Additional waste thickness 5.556 m
Pressure increment at surface 100.008 kN/m^2

Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	109.0	0.2	0.118
1.25	2.5	1.25	22.5	0.43	0.75	122.5	0.2	0.105
2.5	3.75	2.50	45.0	0.41	0.69	145.0	0.2	0.075
3.75	5.236	4.49	80.9	0.39	0.64	180.9	0.2	0.063
								0.36

Assumed waste density 18 kN/m^3 Compression index, Cc 0.2
Additional waste thickness 2.75 m
Pressure increment at surface 49.5 kN/m^2

Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1.5	0.75	13.5	0.44	0.79	63.0	0.2	0.112
1.5	3	1.50	27.0	0.42	0.73	76.5	0.2	0.078
3	4.5	3.00	54.0	0.40	0.67	103.5	0.2	0.051
4.5	6	4.50	81.0	0.39	0.64	130.5	0.2	0.038
6	6.805	6.40	115.2	0.38	0.61	164.7	0.2	0.016
								0.29

Challonsleigh Farm Inert Landfill - Stability Risk Assessment Report - 5149237.CIFL04
Appendix C.1c Calculations for Basal Sub-Grade Settlement Analysis - Cc = 0.1

Section SB-SB'	Historical landfill waste m	Planned inert waste m
Ch		
190	4.576	5.374
220	5.463	5.767
260	11.63	1.63
300	10.735	1.76
Section SF-SF'		
Ch		
50	2.967	4.252
100	4.317	4.801
150	4.204	5.66
200	5.236	5.556
250	6.805	2.75

Creep settlement Ds = æc .h. (log t2/t1) measured from start of load application

Biodegradation settlement Db æb .h. (log t2/t1) measured from placement of waste

Waste placed 1991 - 2003 over a ridge of land above about 50mOD in the north and 55m in west,
which slopes towards the River Yealm flood plain.
Moret recent is conservative so assume from 1996 (t1=25) and conservative is 2001 (t1=20 years)

Assumed period for most degradation is in the order of 30 years (CIRIA Engineering Closed landfills Para 2.4)

BRE Building on fill: Geotechnical aspects, 2001, Table 10 Properties of refuse fill: æc = 0.2-0.3% to 2%
æb = 2% to 6%

If Creep taken from point of load application then t1 taken as one year
For t2 = 30yrs and t1 = 25 yrs for existing waste, t2 = 30 yrs and t1 = 1 yr for new inert waste, no biodegradation
Log 30/25 = 0.079181 for existing inert/industrial waste
Log 30/1 = 1.477121 for new inert waste

Section SB-SB'	Old Waste m	Creep Factor 0.003	Biodegrade Factor 0.03	Creep sett	Bio Sett	Total self sett in old waste	New Waste thickness m	Creep factor 0.003	Creep sett	Total settlement
Ch										
190	4.576	0.000238	0.0023754	0.001	0.011	0.012	5.374	0.004	0.024	0.036
220	5.463	0.000238	0.0023754	0.001	0.013	0.014	5.767	0.004	0.026	0.040
260	11.63	0.000238	0.0023754	0.003	0.028	0.030	1.63	0.004	0.007	0.038
300	10.735	0.000238	0.0023754	0.003	0.026	0.028	1.76	0.004	0.008	0.036
Section SF-SF'										
Ch										
50	2.967	0.000238	0.0023754	0.001	0.007	0.008	4.252	0.004	0.019	0.027
100	4.317	0.000238	0.0023754	0.001	0.010	0.011	4.801	0.004	0.021	0.033
150	4.204	0.000238	0.0023754	0.001	0.010	0.011	5.66	0.004	0.025	0.036
200	5.236	0.000238	0.0023754	0.001	0.012	0.014	5.556	0.004	0.025	0.038
250	6.805	0.000238	0.0023754	0.002	0.016	0.018	2.75	0.004	0.012	0.030

For t2 = 30yrs and t1 = 20 yrs for existing waste, t2 = 30 yrs and t1 = 1 yr for new inert waste with no biodegradation
Log30/20 = 0.176091
Log 30/1= 1.477121

Section SB-SB'	Old Waste m	Creep Factor 0.003	Biodegrad Factor 0.03	Creep sett	Bio Sett	Total sett m	New Waste thickness m	Creep factor 0.003	Creep sett	Total settlement
Ch										
190	4.576	0.000528	0.0052827	0.002	0.024	0.027	5.374	0.004	0.024	0.050
220	5.463	0.000528	0.0052827	0.003	0.029	0.032	5.767	0.004	0.026	0.057
260	11.63	0.000528	0.0052827	0.006	0.061	0.068	1.63	0.004	0.007	0.075
300	10.735	0.000528	0.0052827	0.006	0.057	0.062	1.76	0.004	0.008	0.070
Section SF-SF'										
Ch										
50	2.967	0.004431	0.0052827	0.013	0.016	0.029	4.252	0.004	0.019	0.048
100	4.317	0.004431	0.0052827	0.019	0.023	0.042	4.801	0.004	0.021	0.063
200	4.204	0.004431	0.0052827	0.019	0.022	0.041	5.66	0.004	0.025	0.066
200	5.236	0.004431	0.0052827	0.023	0.028	0.051	5.556	0.004	0.025	0.075
250	6.805	0.004431	0.0052827	0.030	0.036	0.066	2.75	0.004	0.012	0.078

Calculation of secondary compression in waste

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1		
Additional waste thickness	5.374	m				
Pressure increment at surface	96.732	kN/m^2				

Waste top depth	Waste base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.5	9.0	0.45	0.83	105.732	0.1	0.059
1	2	1	18.0	0.44	0.80	114.732	0.1	0.045
2	3	2	36.0	0.43	0.77	132.732	0.1	0.032
3	4.576	3.788	68.2	0.42	0.74	164.9	0.1	0.035
								0.17

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1		
Additional waste thickness	5.767	m				
Pressure increment at surface	103.806	kN/m^2				

Waste top depth	Waste base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1.5	0.75	13.5	0.45	0.81	117.3	0.1	0.078
1.5	3	1.50	27.0	0.44	0.78	130.8	0.1	0.058
3	4.5	3.00	54.0	0.43	0.75	157.8	0.1	0.040
4.5	5.463	4.98	89.7	0.42	0.73	193.5	0.1	0.019
								0.19

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1		
Additional waste thickness	1.63	m				
Pressure increment at surface	29.34	kN/m^2				

Waste top depth	Waste base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	3	1.50	27.0	0.44	0.78	56.3	0.1	0.054
3	6	3.00	54.0	0.43	0.75	83.3	0.1	0.032
6	9	6.00	108.0	0.42	0.72	137.3	0.1	0.018
9	11.63	10.32	185.7	0.41	0.70	215.0	0.1	0.010
								0.11

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1		
Additional waste thickness	1.76	m				
Pressure increment at surface	31.68	kN/m^2				

Waste top depth	base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	2	1.00	18.0	0.44	0.80	49.7	0.1	0.049
2	4	2.00	36.0	0.43	0.77	67.7	0.1	0.031
4	6	4.00	72.0	0.42	0.74	103.7	0.1	0.018
6	8	6.00	108.0	0.42	0.72	139.7	0.1	0.013
8	10.735	9.37	168.6	0.41	0.70	200.3	0.1	0.012
								0.12

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1		
Additional waste thickness	4.252	m				
Pressure increment at surface	76.536	kN/m^2				

Waste top depth	base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	85.5	0.1	0.054
1	2	1.00	18.0	0.44	0.80	94.5	0.1	0.040
2	2.967	2.00	36.0	0.43	0.77	112.5	0.1	0.027
								0.12

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1		
Additional waste thickness	4.801	m				
Pressure increment at surface	86.418	kN/m^2				

Waste top depth	base depth	Mean depth	Initial p'$_0$	Initial porosity	Inital void ratio	Final p'$_1$	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	95.4	0.1	0.056
1	2	1.00	18.0	0.44	0.80	104.4	0.1	0.043
2	3	2.00	36.0	0.43	0.77	122.4	0.1	0.030
3	4.317	3.66	65.9	0.43	0.74	152.3	0.1	0.028
								0.16

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1	
Additional waste thickness	5.66	m			
Pressure increment at surface	101.88	kN/m^2			

Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	109.0	0.1	0.059
1	2	1.00	18.0	0.44	0.80	118.0	0.1	0.045
2	3	2.00	36.0	0.43	0.77	136.0	0.1	0.033
3	4.204	3.60	64.8	0.43	0.74	164.8	0.1	0.028
								0.17

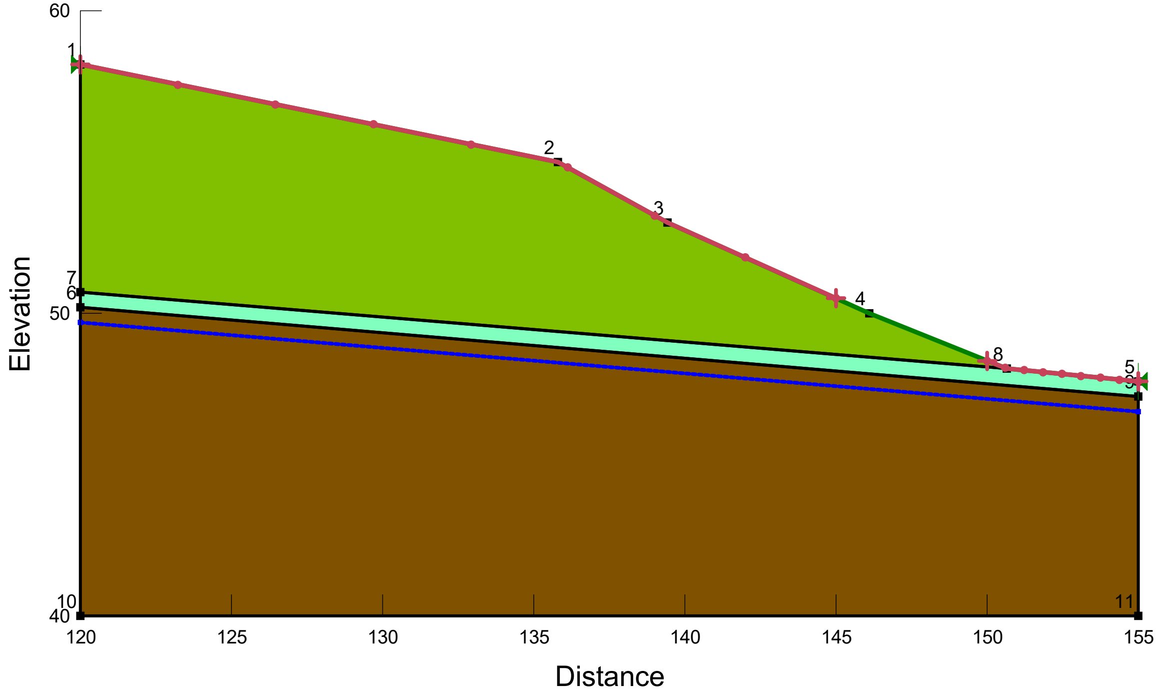
Assumed waste density	18	kN/m^3	Compression index, Cc	0.1	
Additional waste thickness	5.556	m			
Pressure increment at surface	100.008	kN/m^2			

Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	109.0	0.1	0.059
1.25	2.5	1.25	22.5	0.44	0.79	122.5	0.1	0.052
2.5	3.75	2.50	45.0	0.43	0.76	145.0	0.1	0.036
3.75	5.236	4.49	80.9	0.42	0.73	180.9	0.1	0.030
								0.18

Assumed waste density	18	kN/m^3	Compression index, Cc	0.1	
Additional waste thickness	2.75	m			
Pressure increment at surface	49.5	kN/m^2			

Waste top depth	base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1.5	0.75	13.5	0.45	0.81	63.0	0.1	0.056
1.5	3	1.50	27.0	0.44	0.78	76.5	0.1	0.038
3	4.5	3.00	54.0	0.43	0.75	103.5	0.1	0.024
4.5	6	4.50	81.0	0.42	0.73	130.5	0.1	0.018
6	6.805	6.40	115.2	0.42	0.72	164.7	0.1	0.007
								0.14

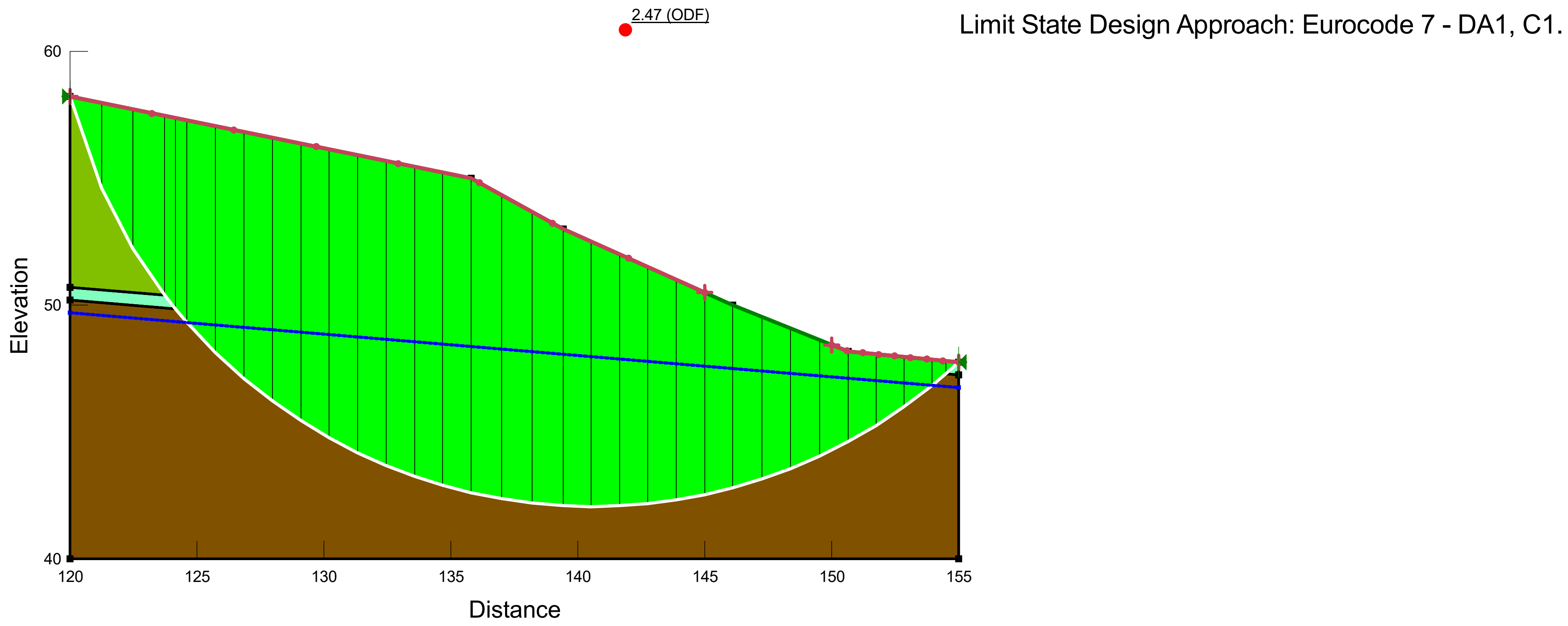
C.2. Slope Model for Basal Liner Analyses



Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

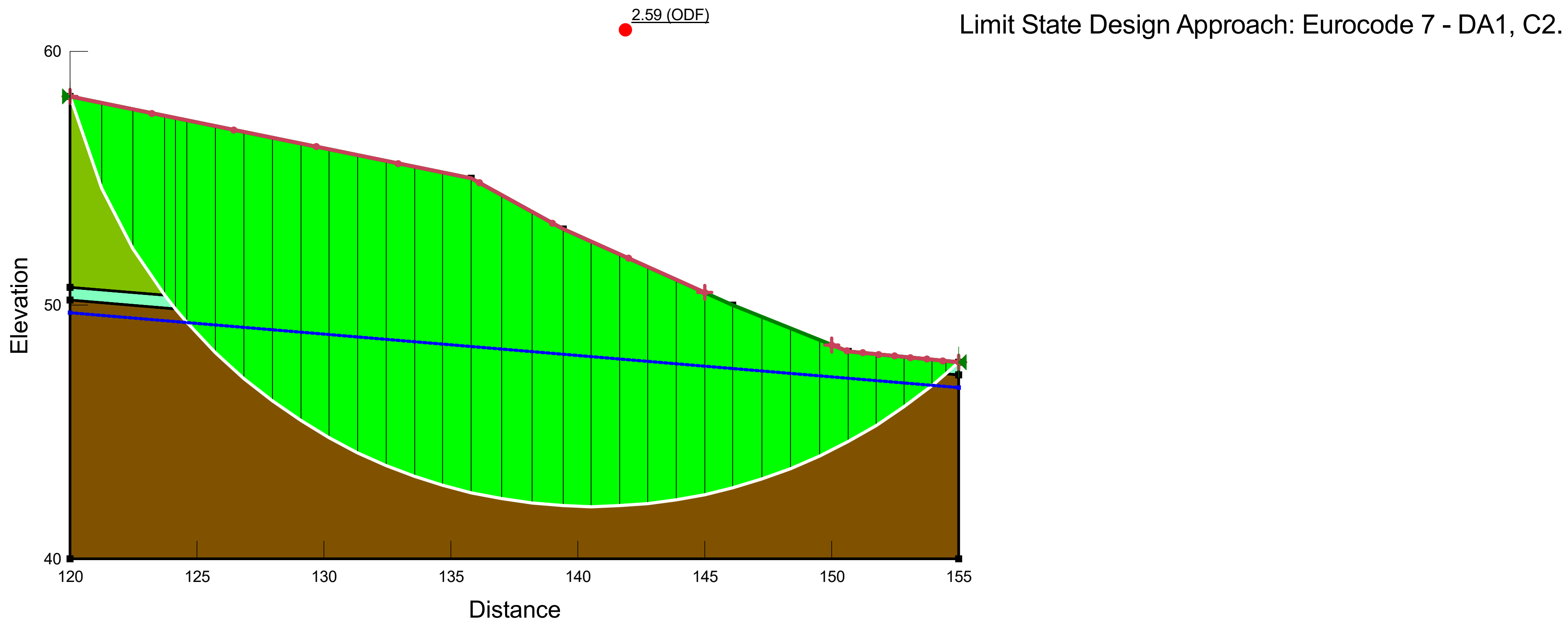
Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, total stress parameters	
(Challonsleighslopes.gsz)	1:250



Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, total stress parameters	
(Challonsleighslopes.gsz)	1:250

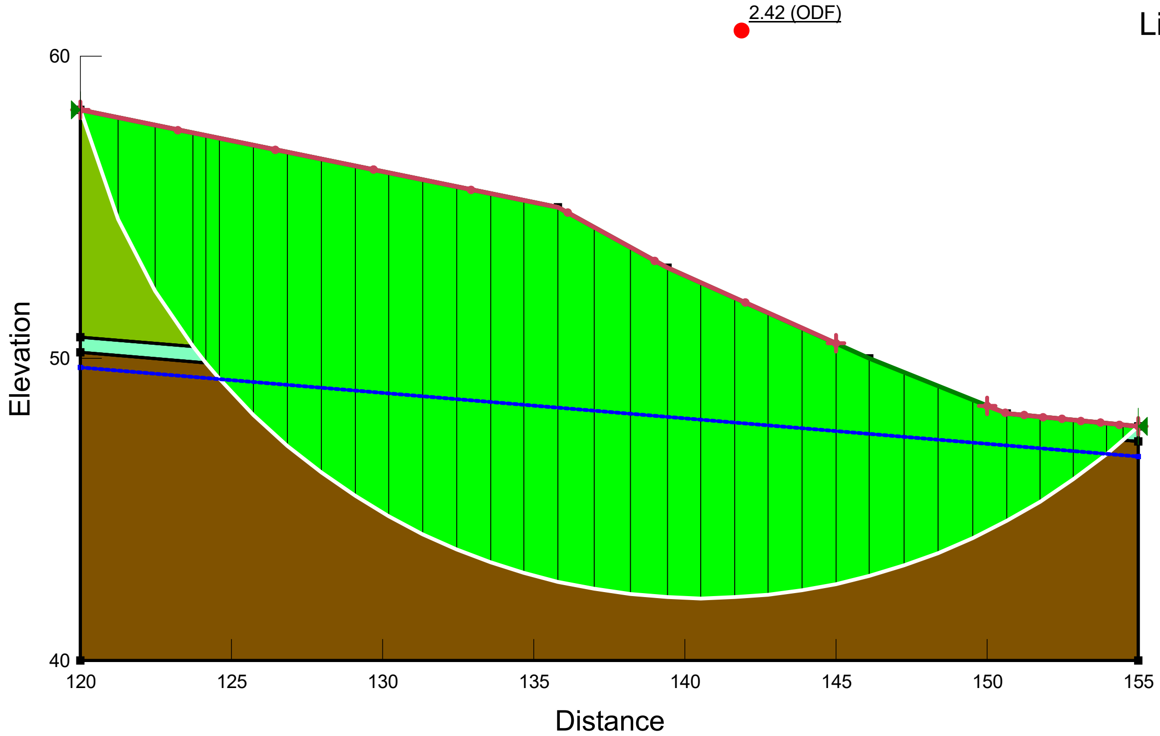


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, total stress parameters	
(Challonsleighslopes.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.



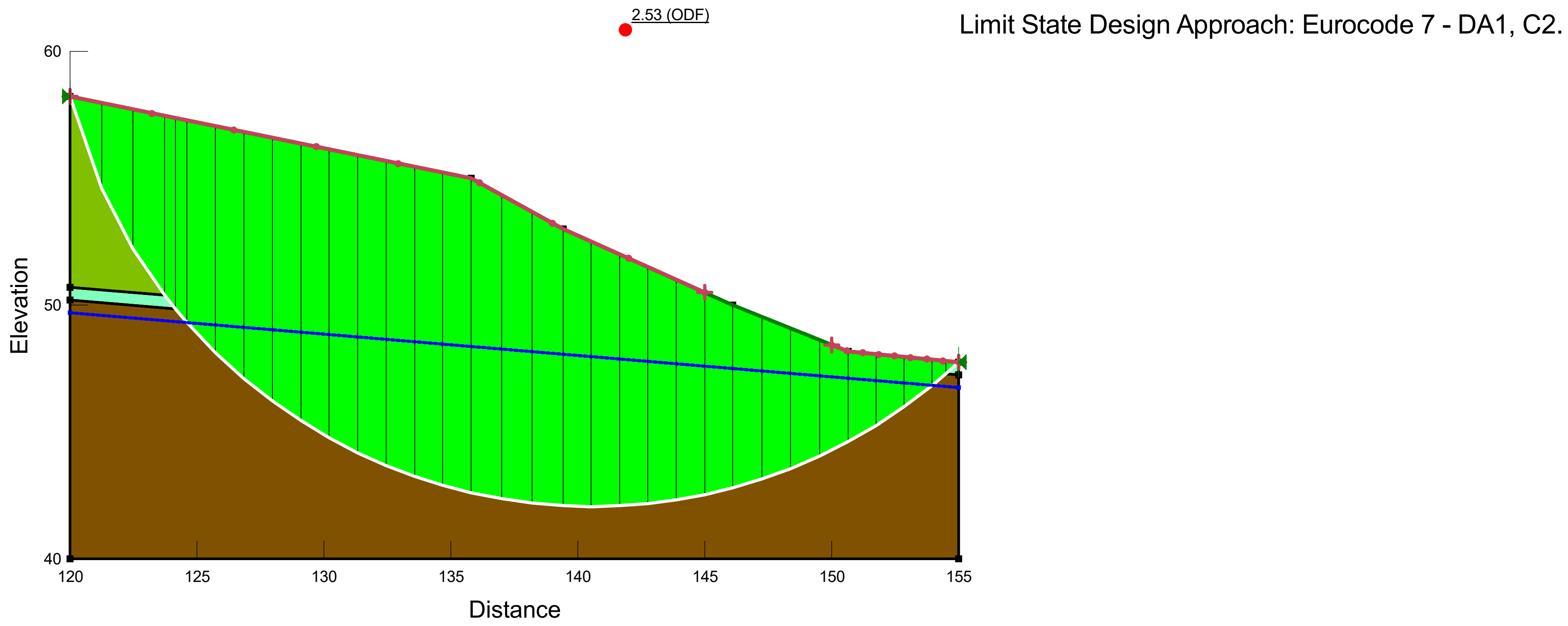
Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	40
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment

Section NB-NB' slope configuration, total stress parameters

(Challonsleighslopes.gsz) 1:250



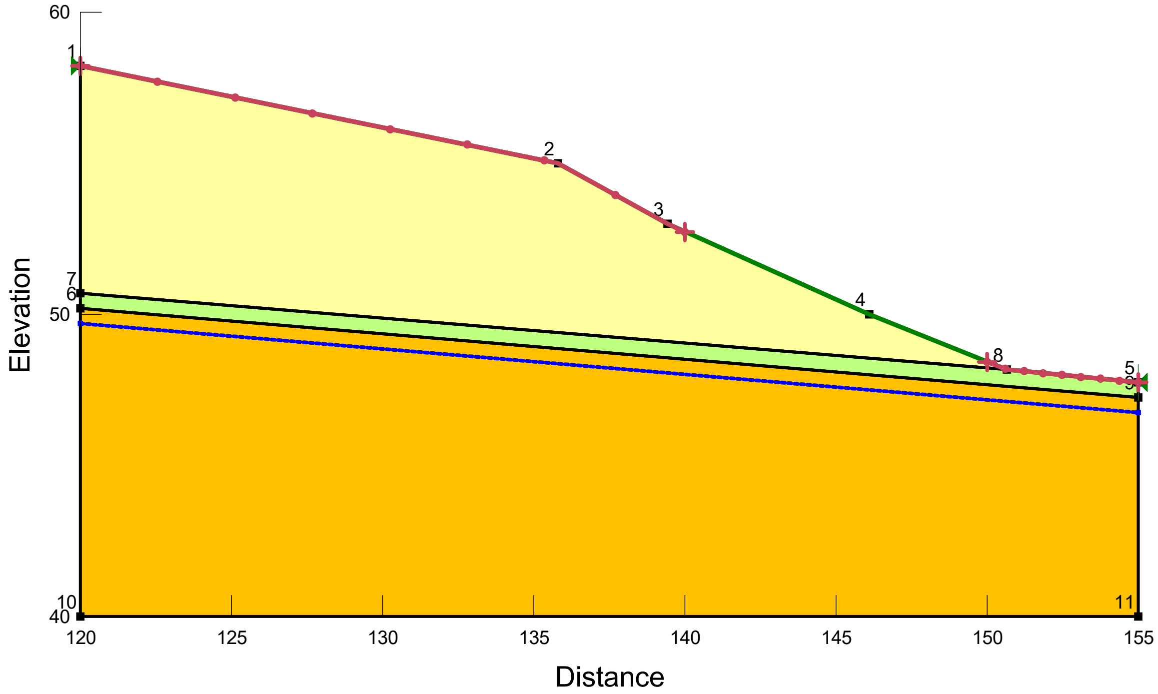
Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	40
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment

Section NB-NB' slope configuration, total stress parameters

(Challonsleighslopes.gsz) 1:250

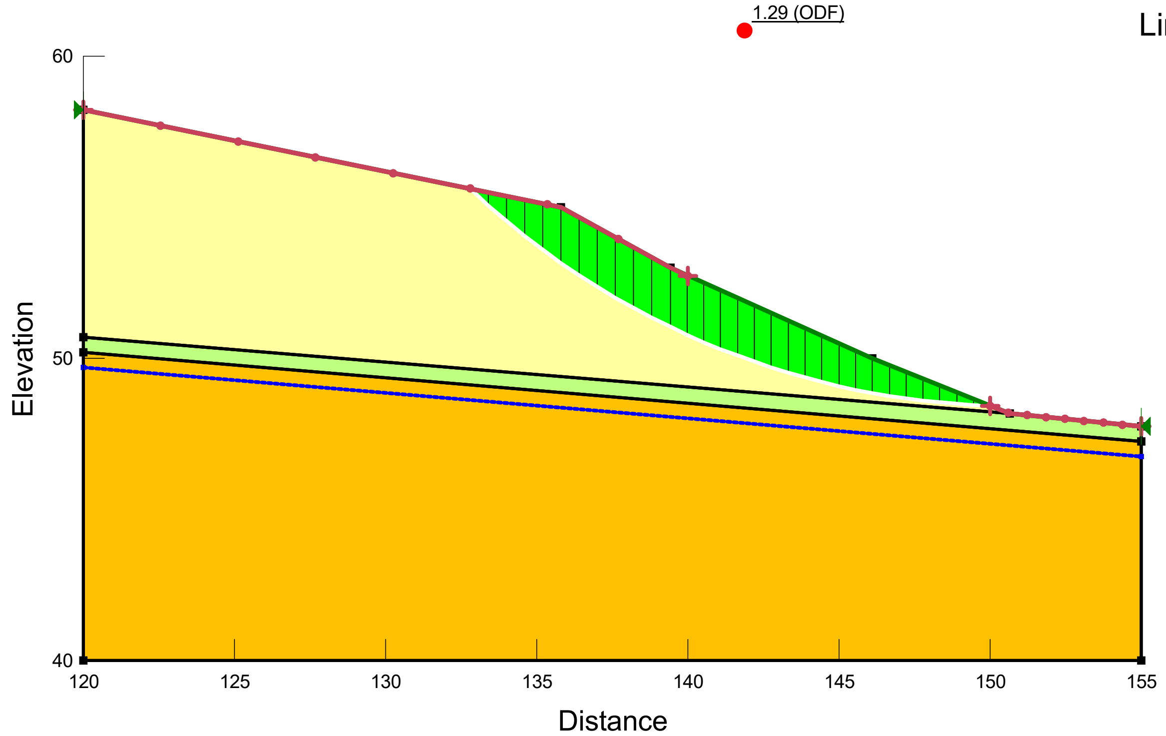


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

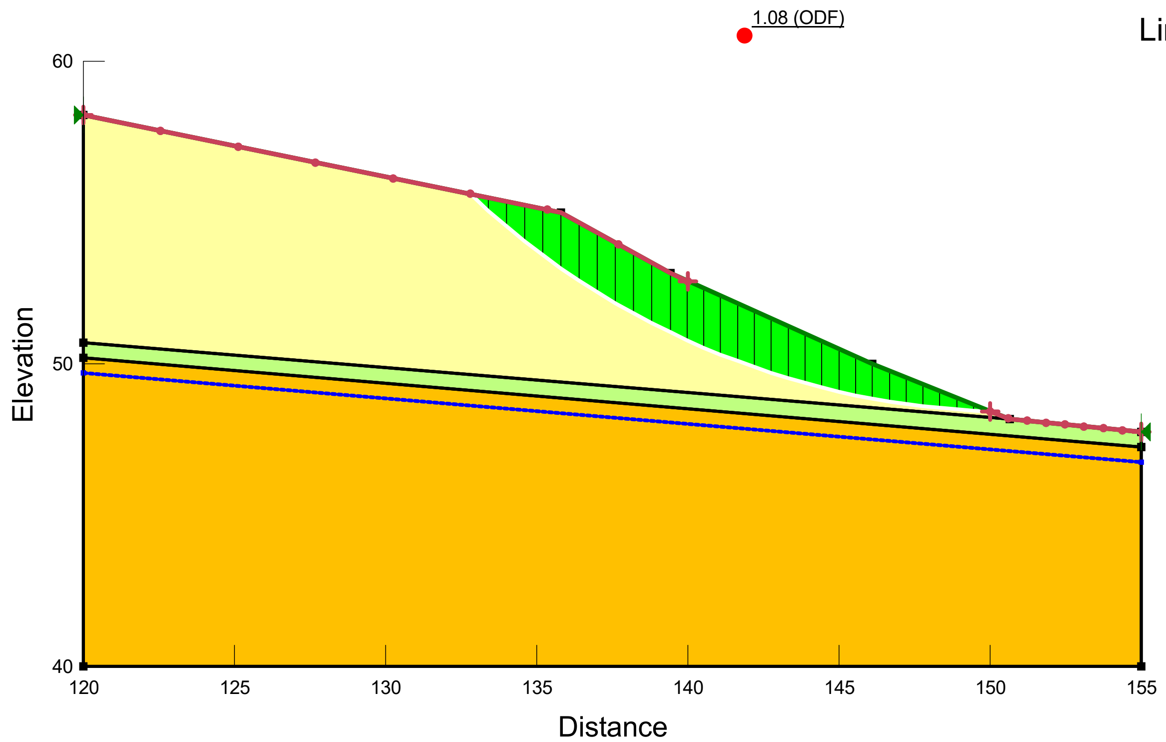


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

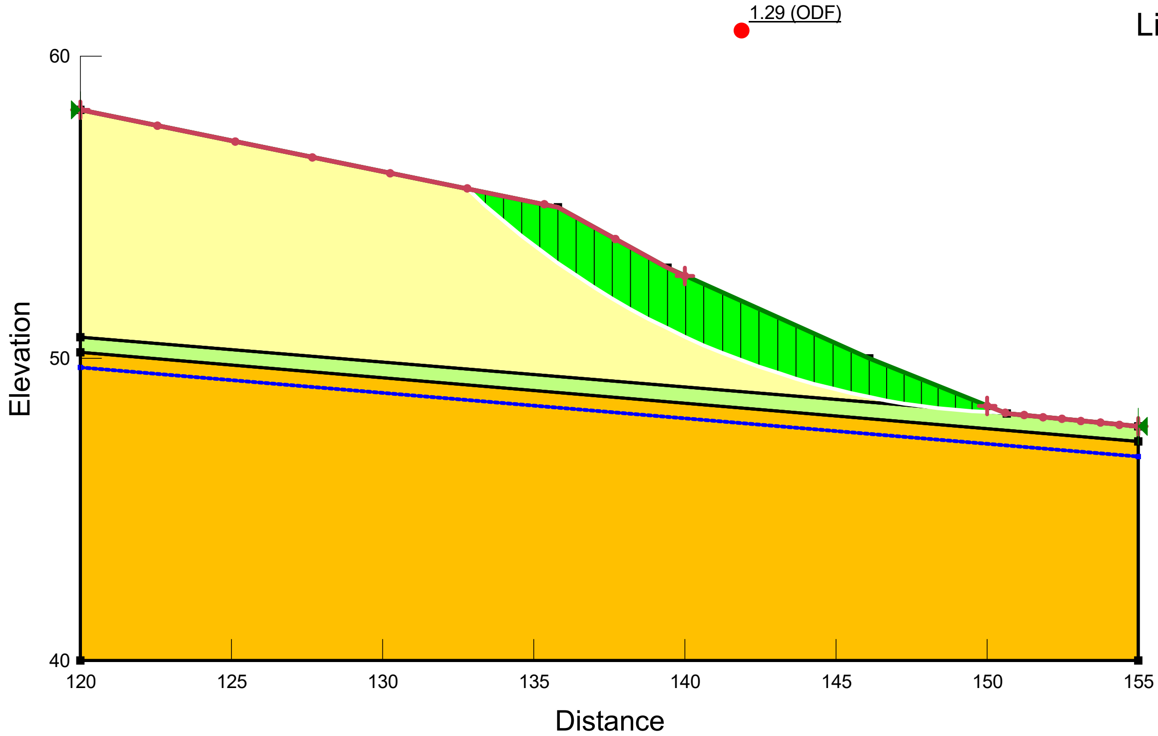
Limit State Design Approach: Eurocode 7 - DA1, C2.



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

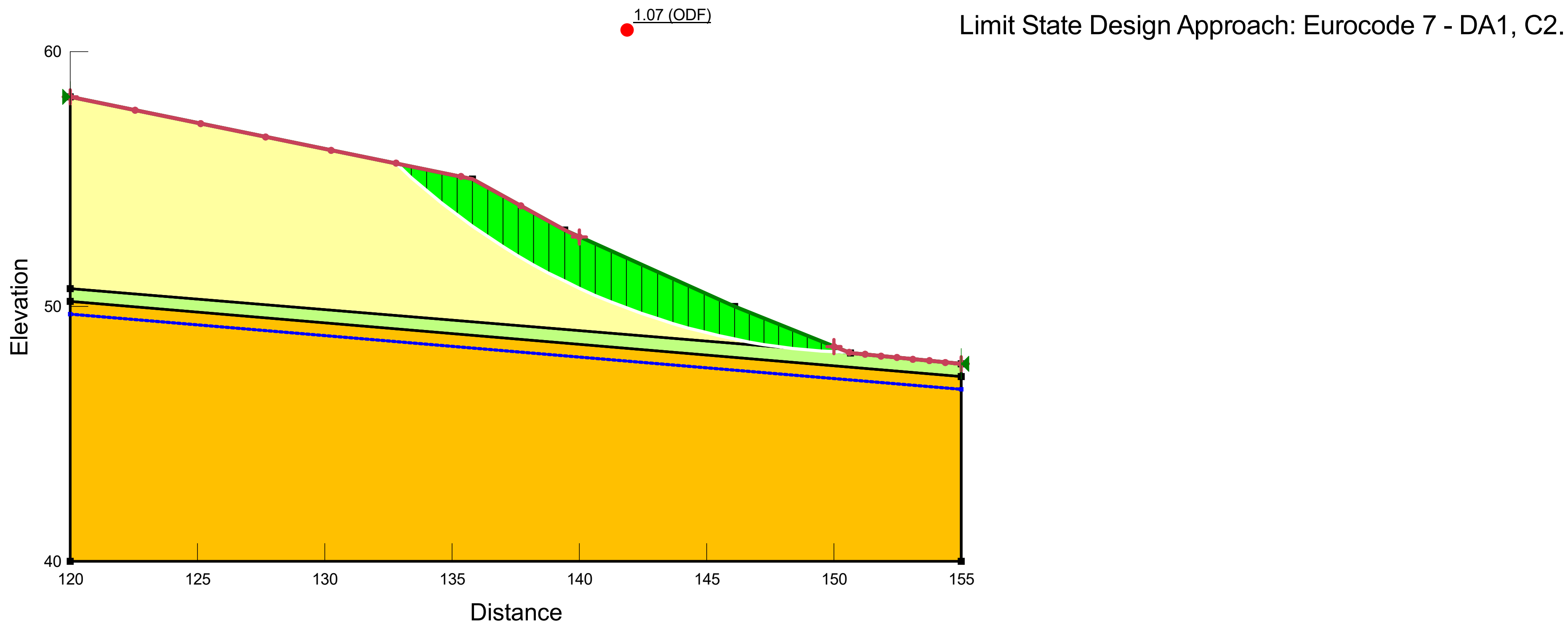


Limit State Design Approach: Eurocode 7 - DA1, C1.

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

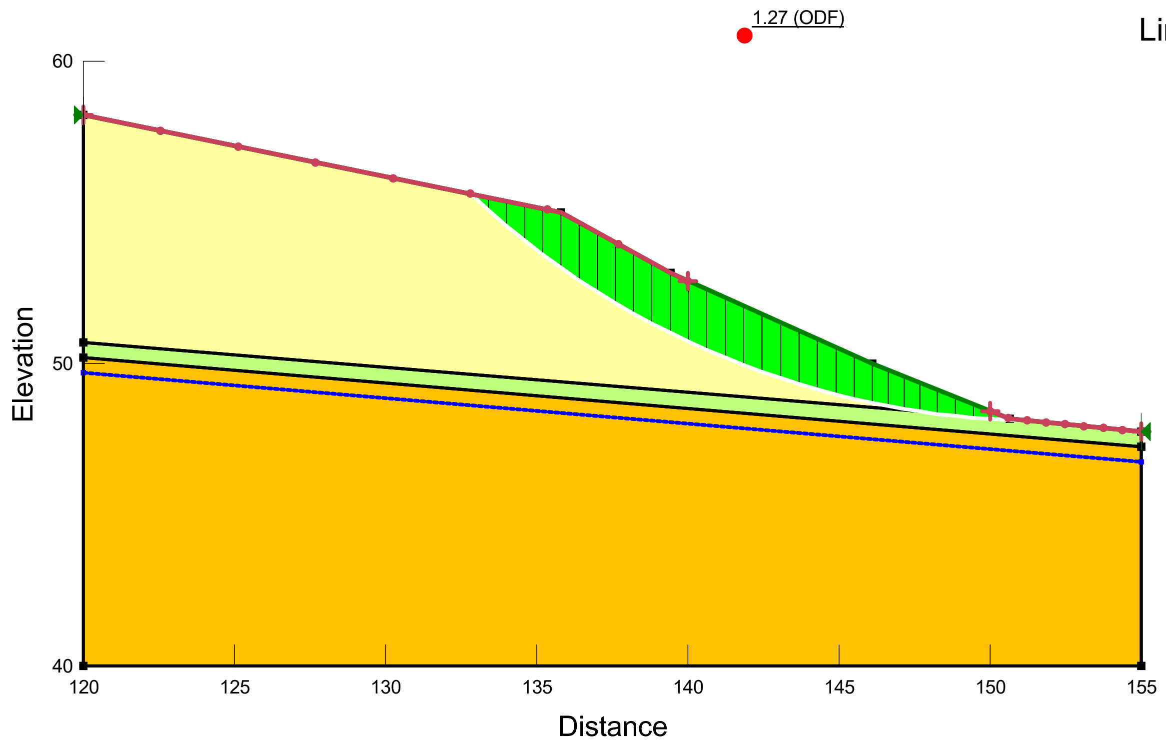


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

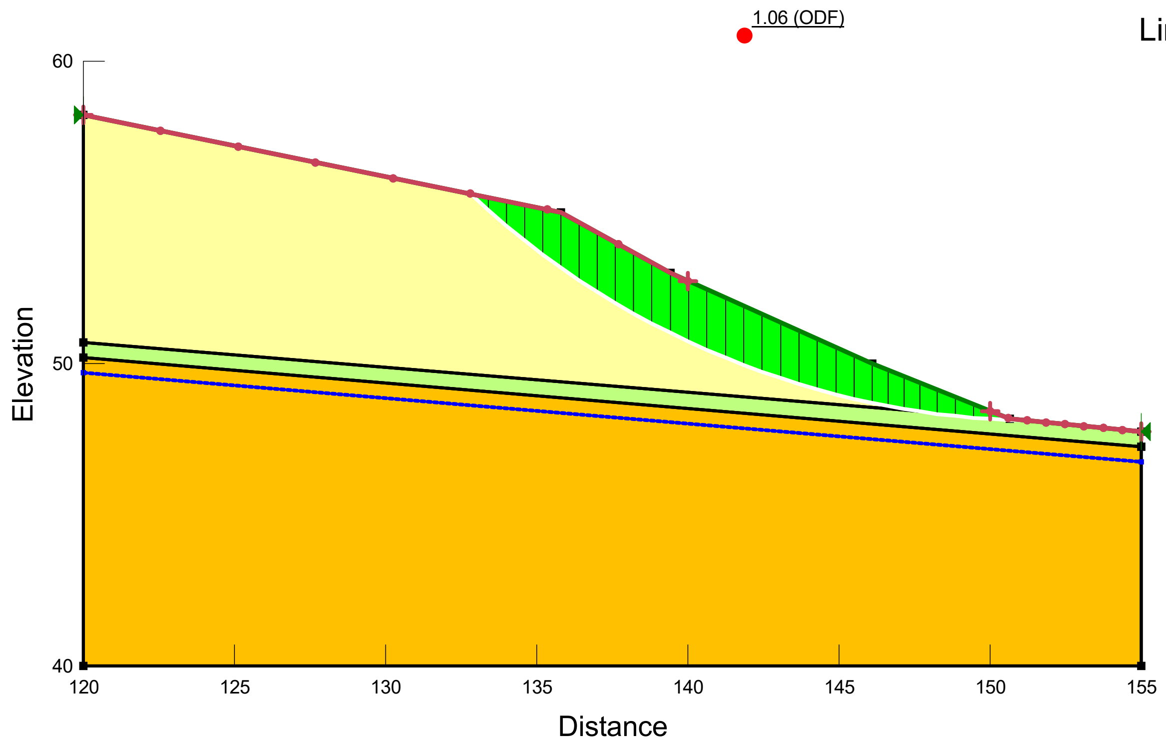
Limit State Design Approach: Eurocode 7 - DA1, C1.



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250



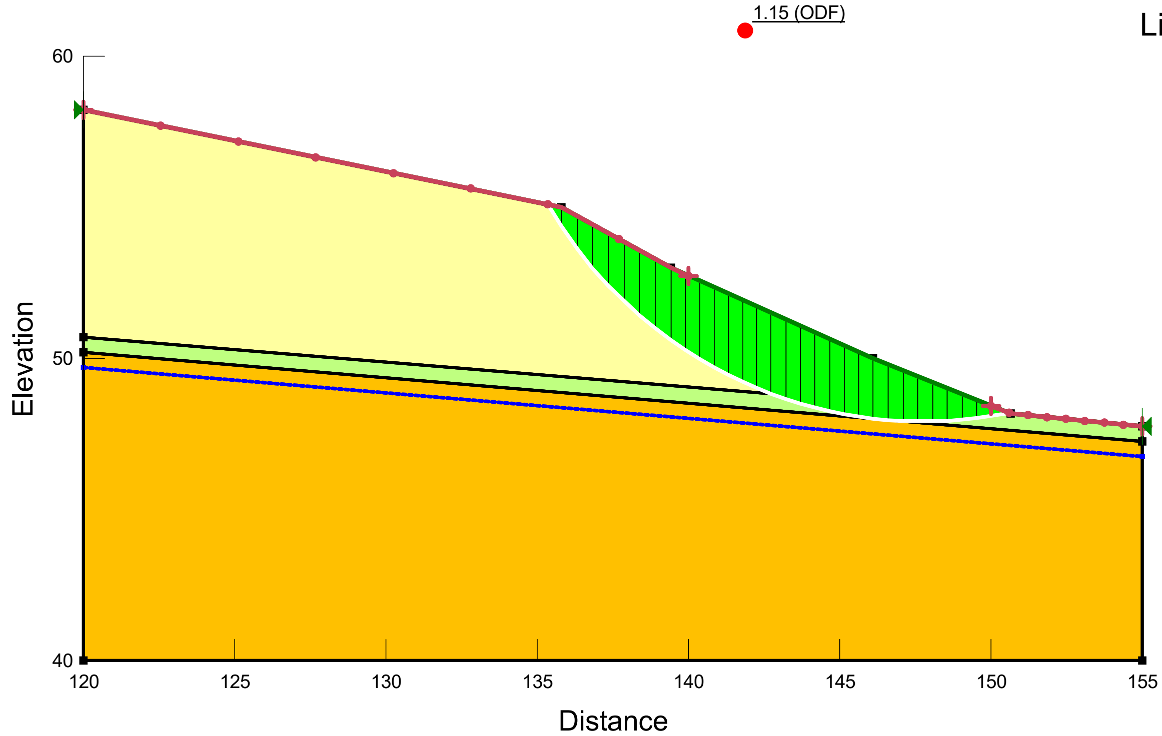
Limit State Design Approach: Eurocode 7 - DA1, C2.

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

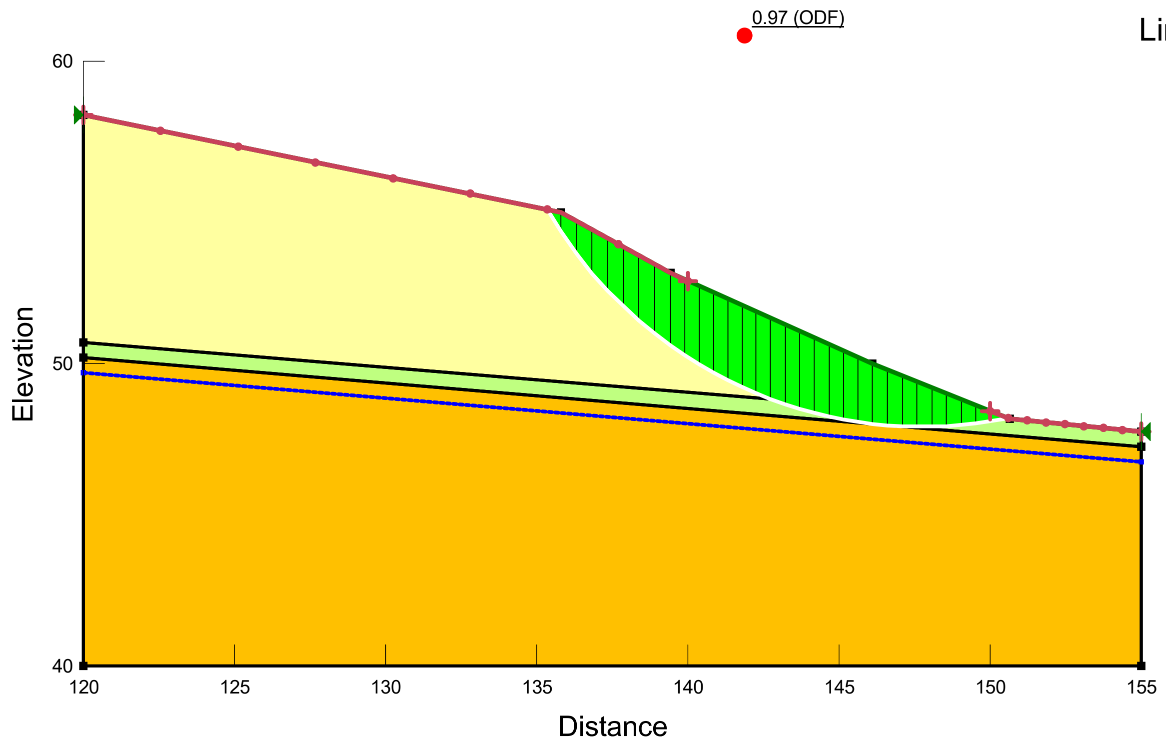


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	20
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

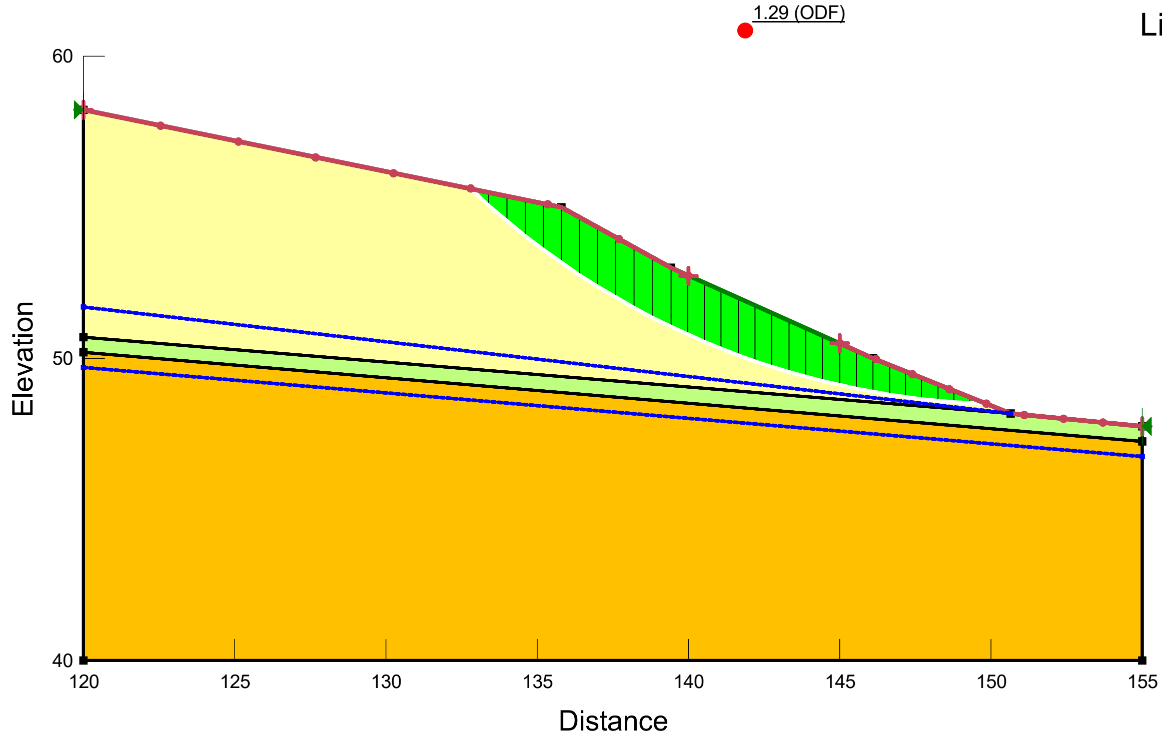


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
(light green)	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	20
(pale yellow)	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
(orange)	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

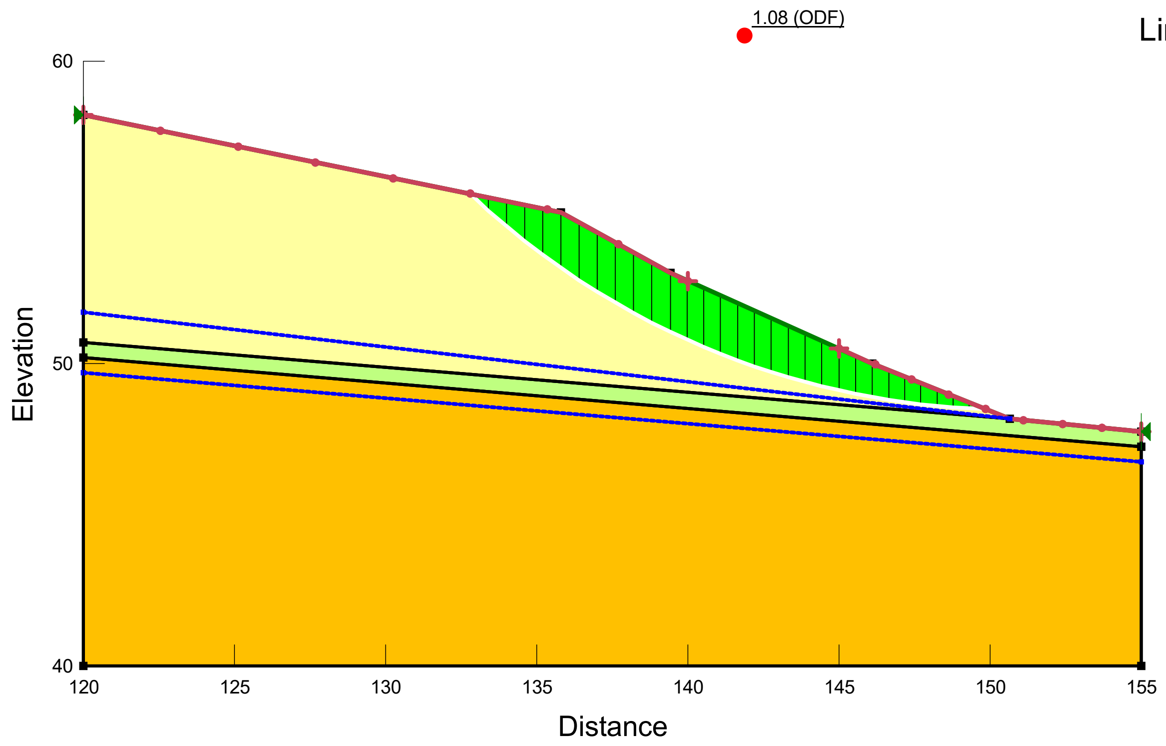


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

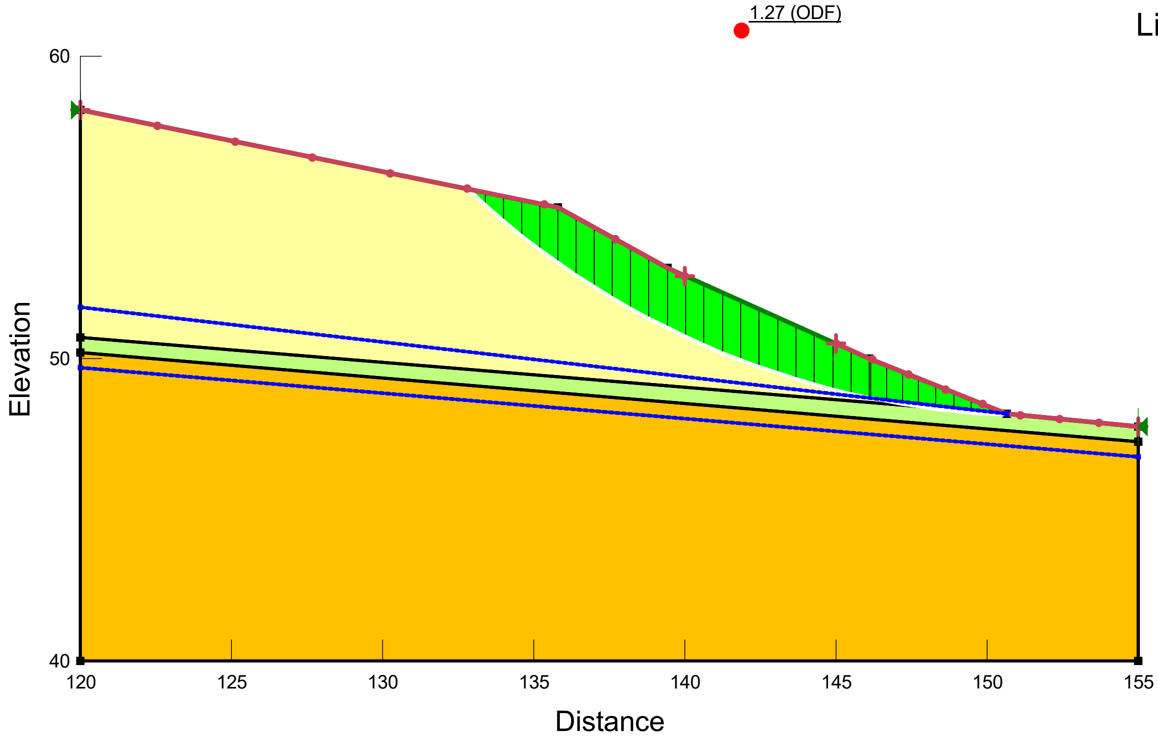


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

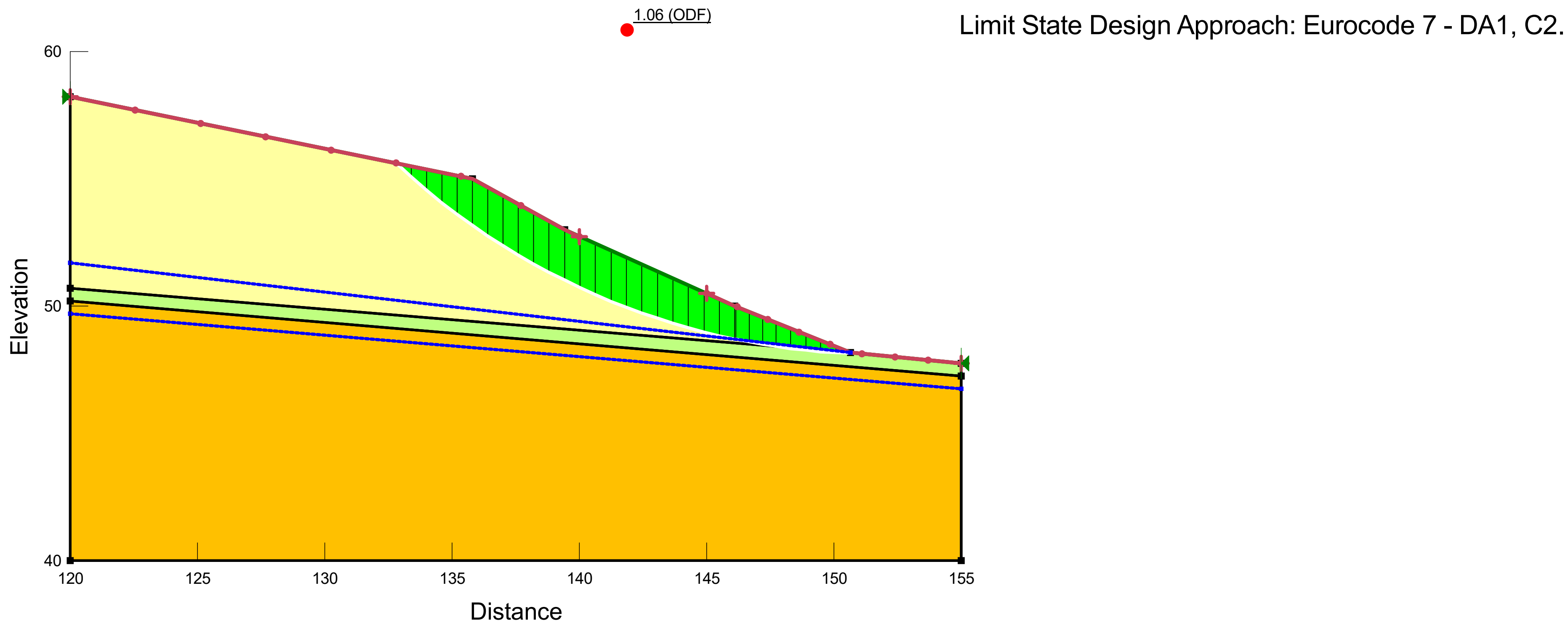
Limit State Design Approach: Eurocode 7 - DA1, C1.



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

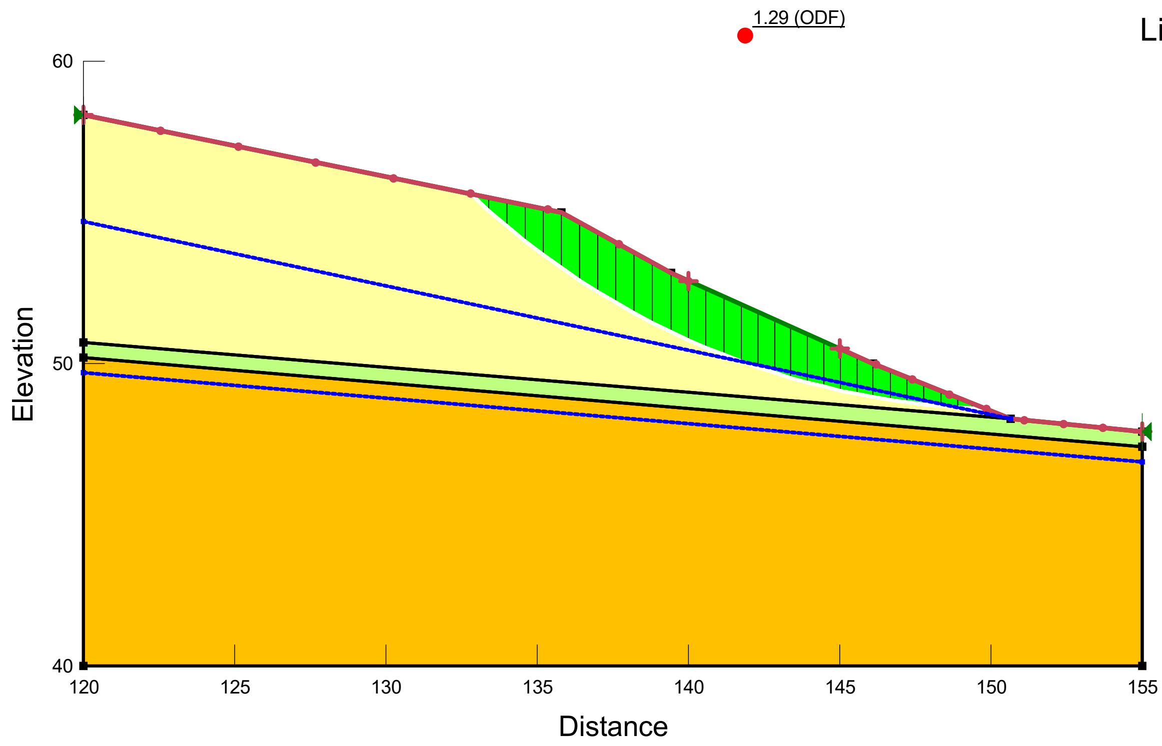


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

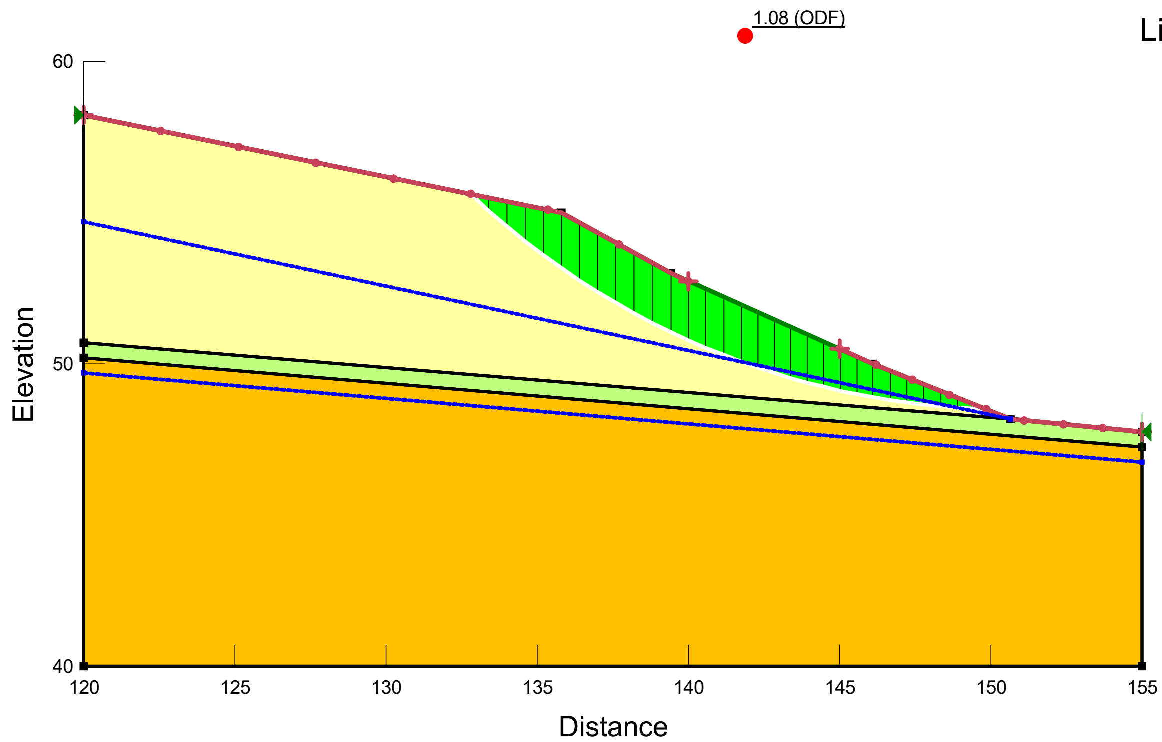


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
(light green)	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
(light yellow)	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
(orange)	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

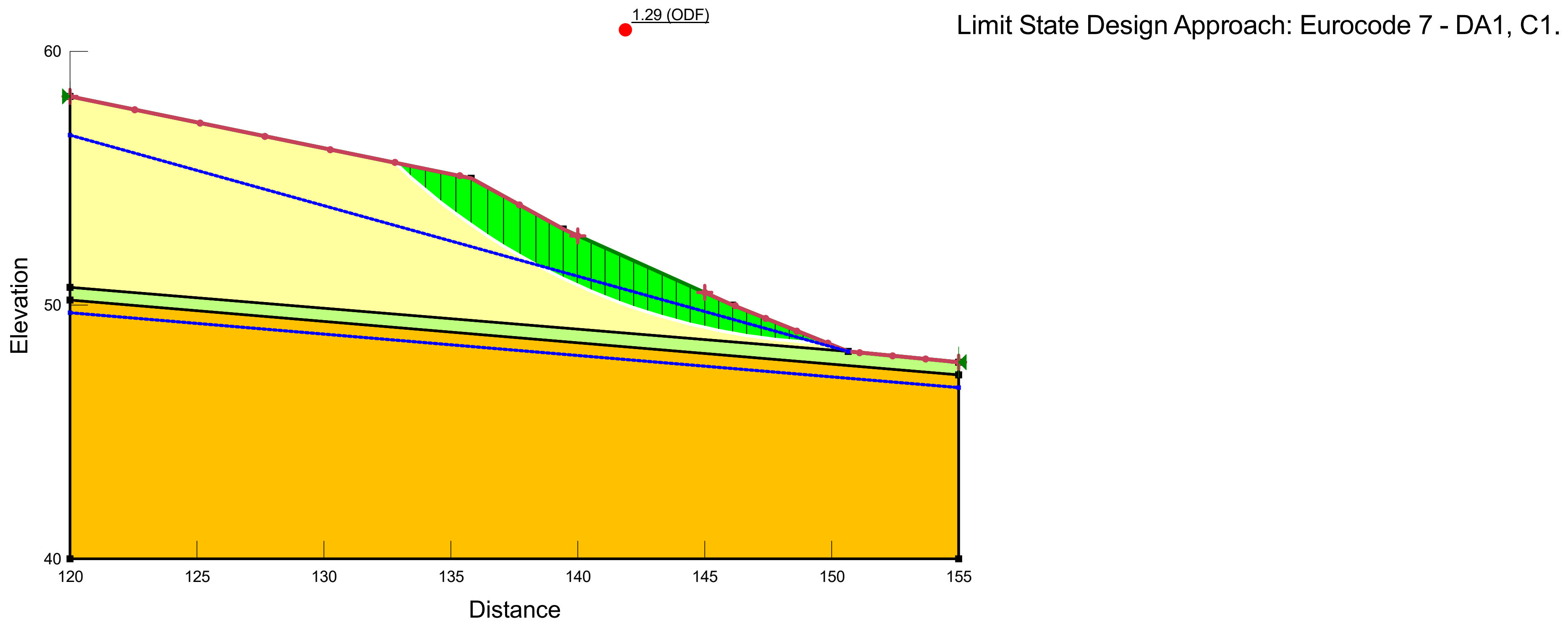
Limit State Design Approach: Eurocode 7 - DA1, C2.



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
(light green)	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
(light yellow)	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
(orange)	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section NB-NB' slope configuration, effective stress parameters
(Challonsleighslopes.gsz) 1:250

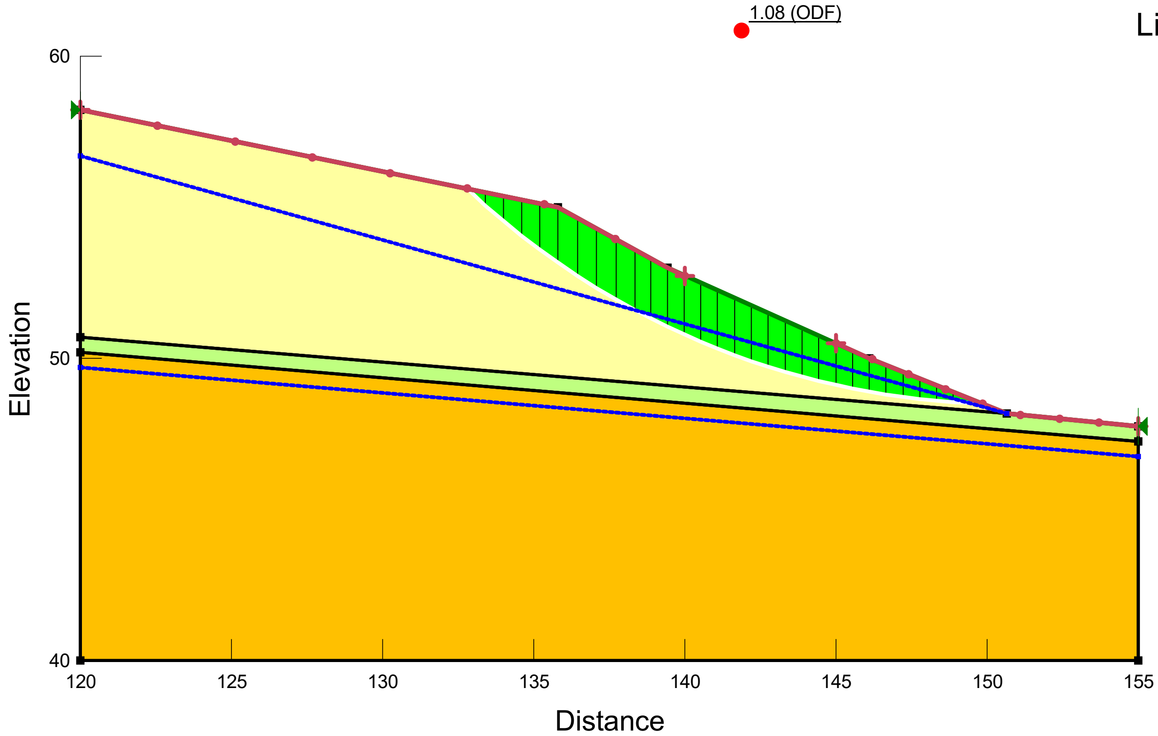


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250

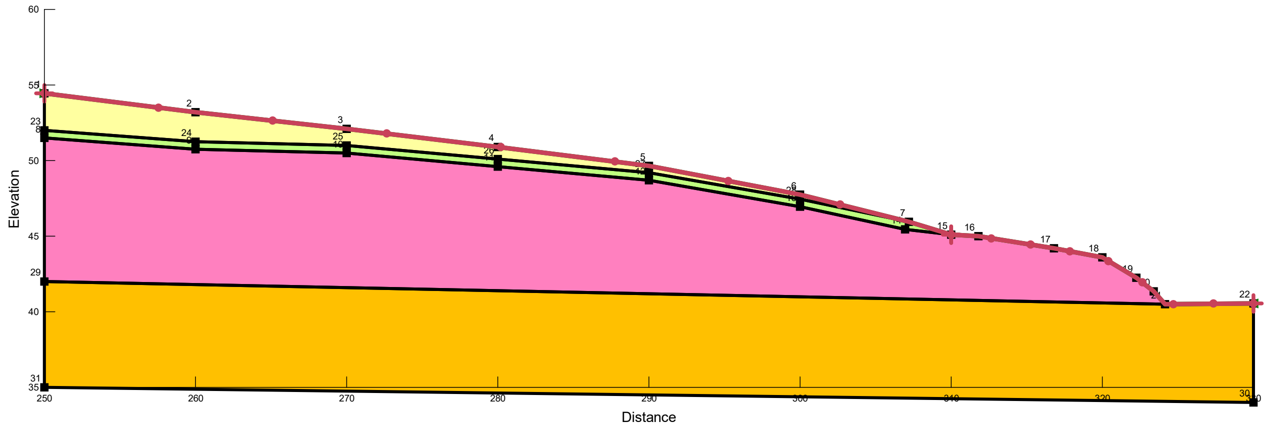
Limit State Design Approach: Eurocode 7 - DA1, C2.



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

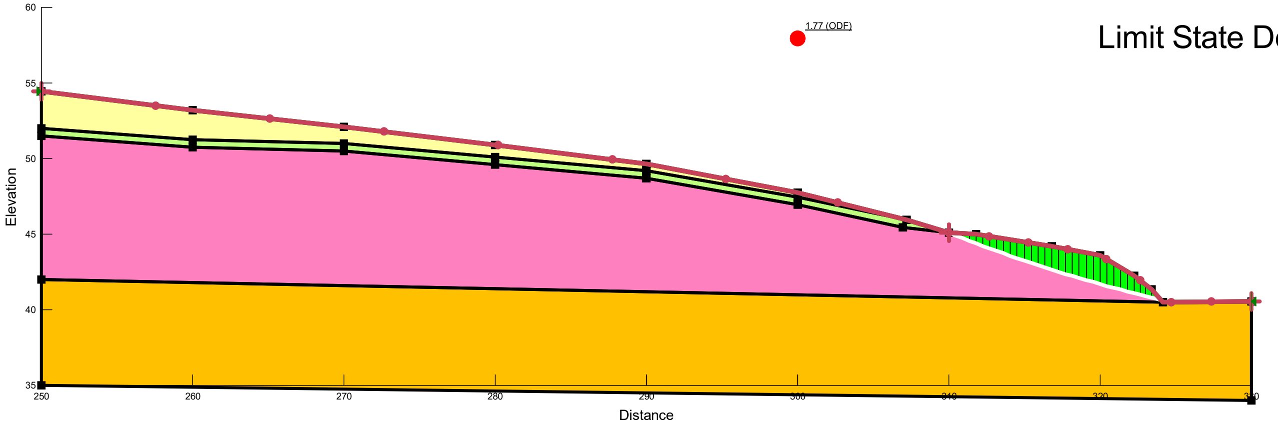
Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section NB-NB' slope configuration, effective stress parameters	
(Challonsleighslopes.gsz)	1:250



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Existing Landfill, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section SF-SF' slope configuration, effective stress parameters
(ChallonsleighslopesSFSF.gsz) 1:500



Limit State Design Approach: Eurocode 7 - DA1, C1.

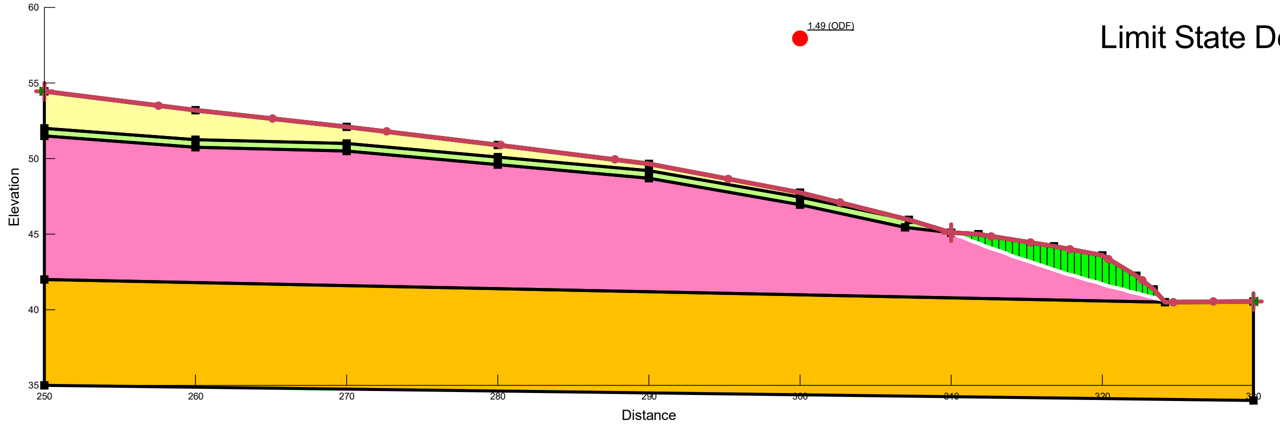
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Existing Landfill, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment

Section SF-SF' slope configuration, effective stress parameters

(ChallonsleighslopesSFSF.gsz) 1:500



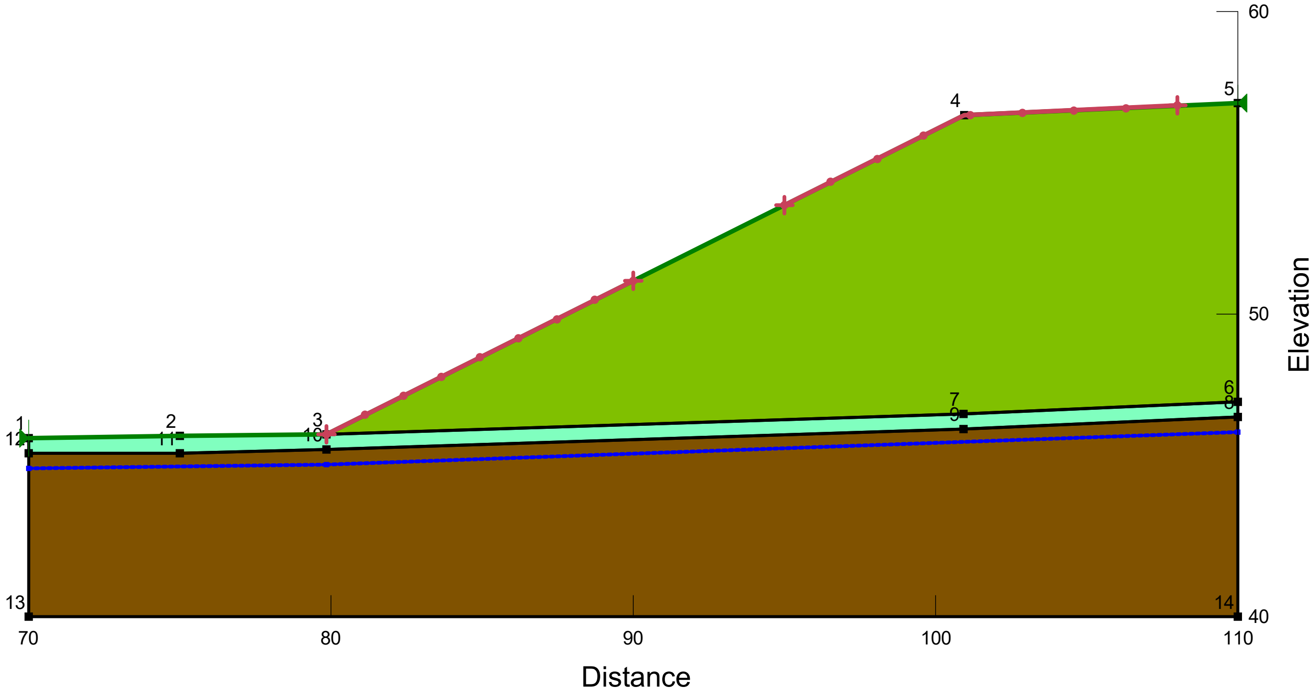
Limit State Design Approach: Eurocode 7 - DA1, C2.

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Existing Landfill, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section SF-SF' slope configuration, effective stress parameters
(ChallonsleighslopesSFSF.gsz) 1:500

C.3. Slope Model for Waste Analyses

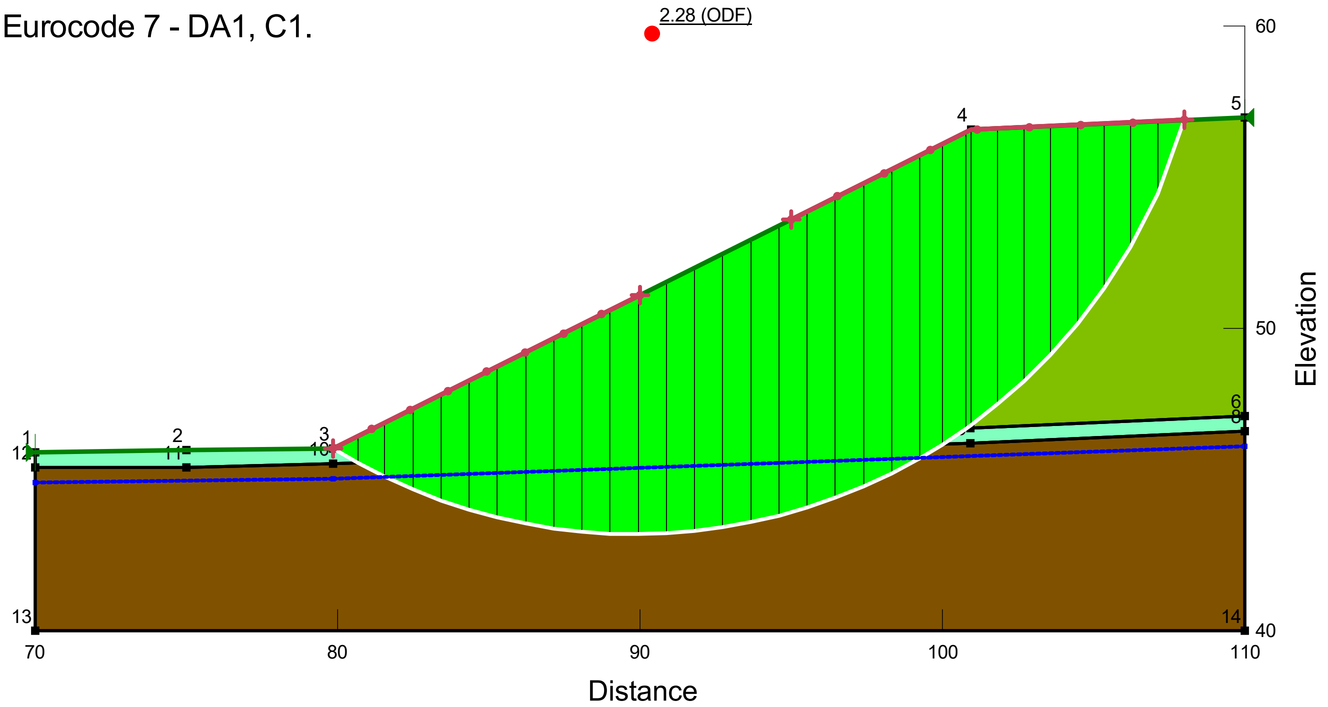


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

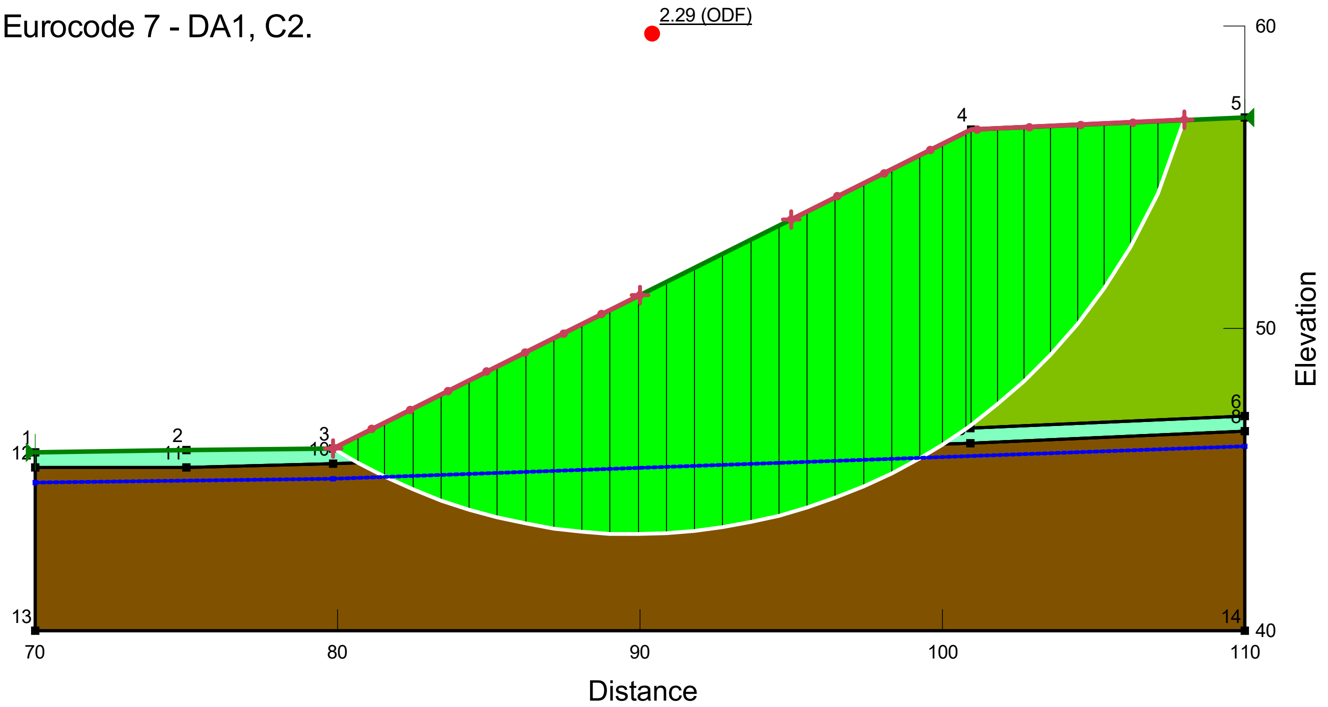


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

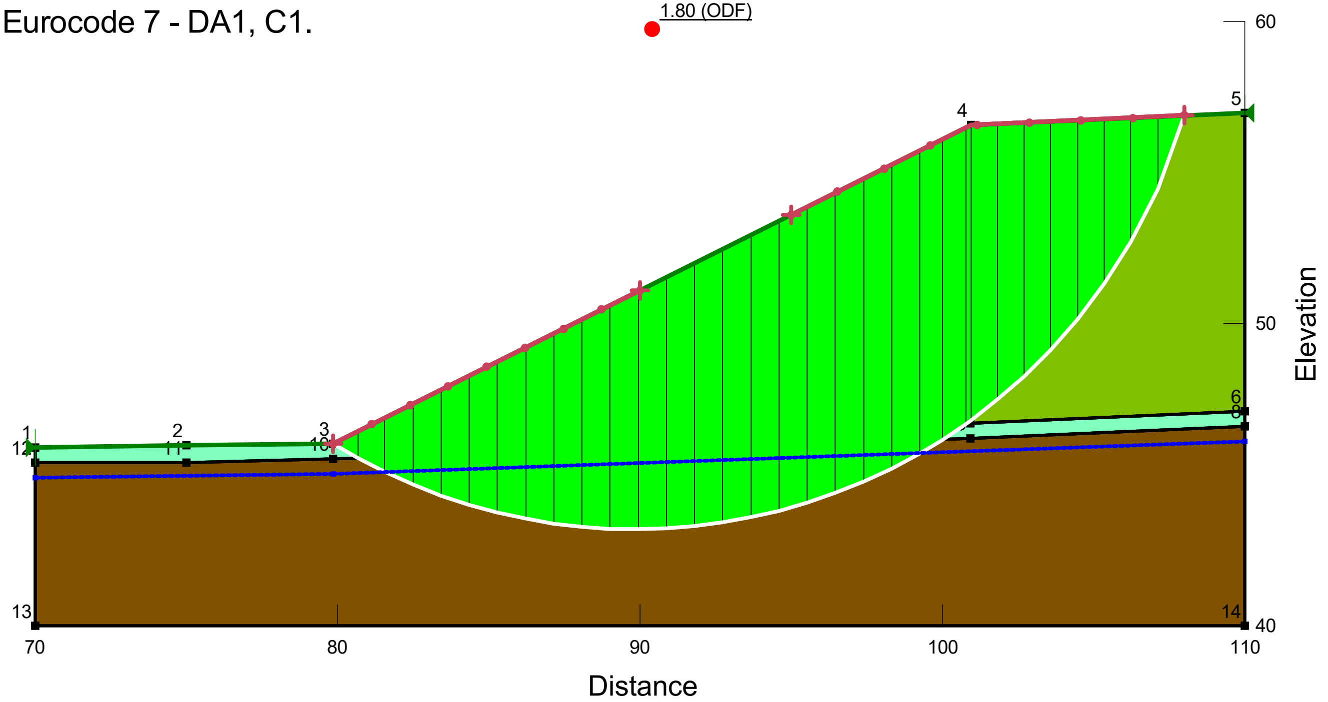


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

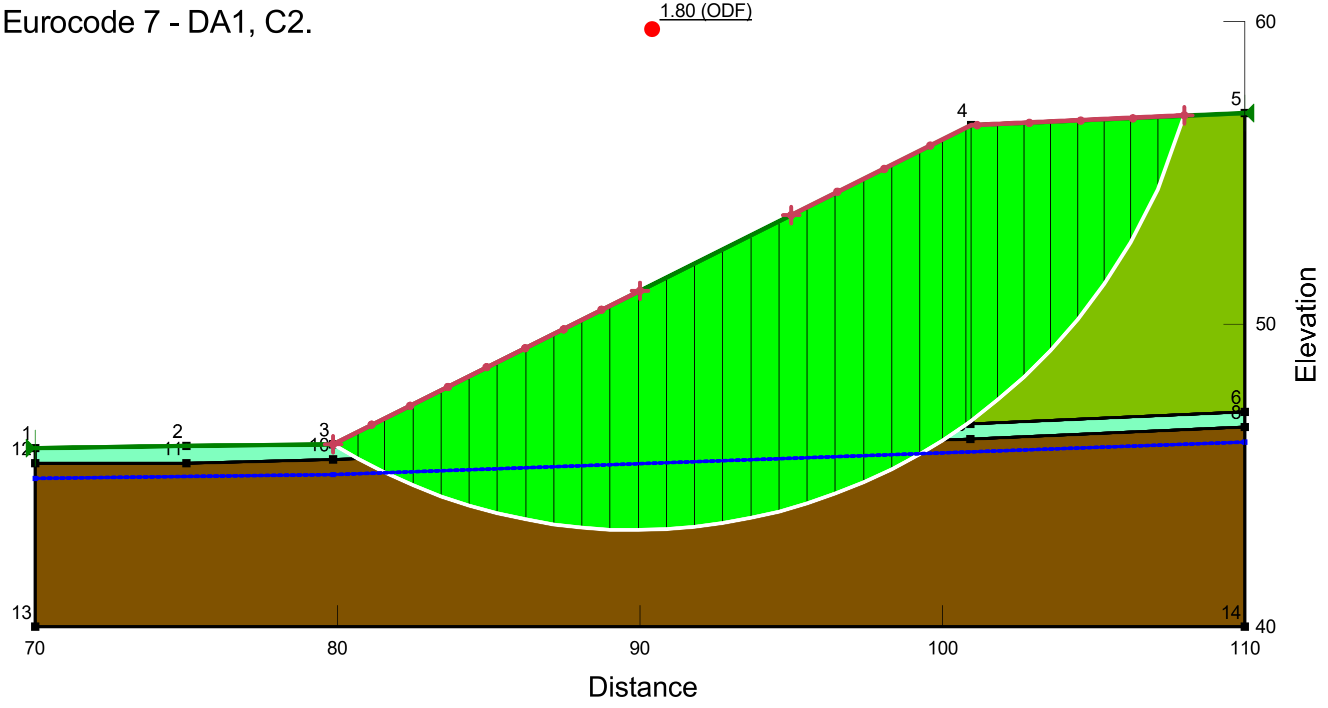


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

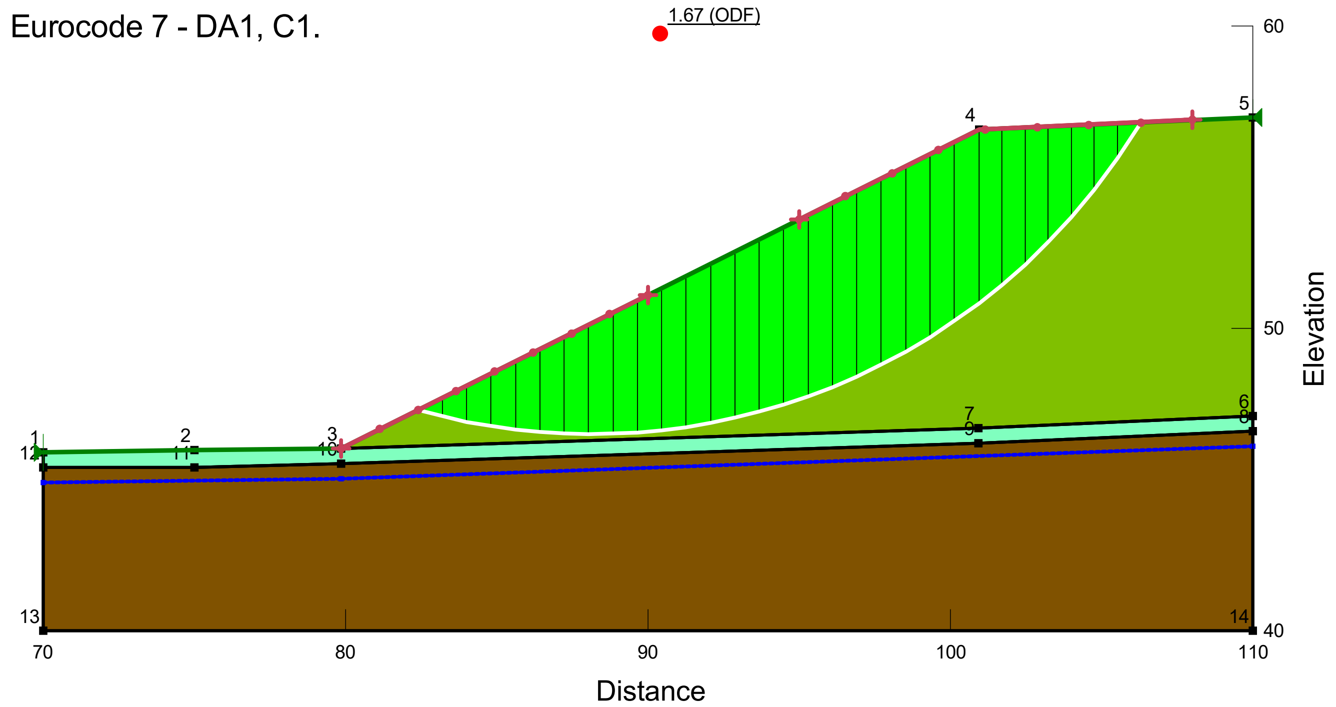


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

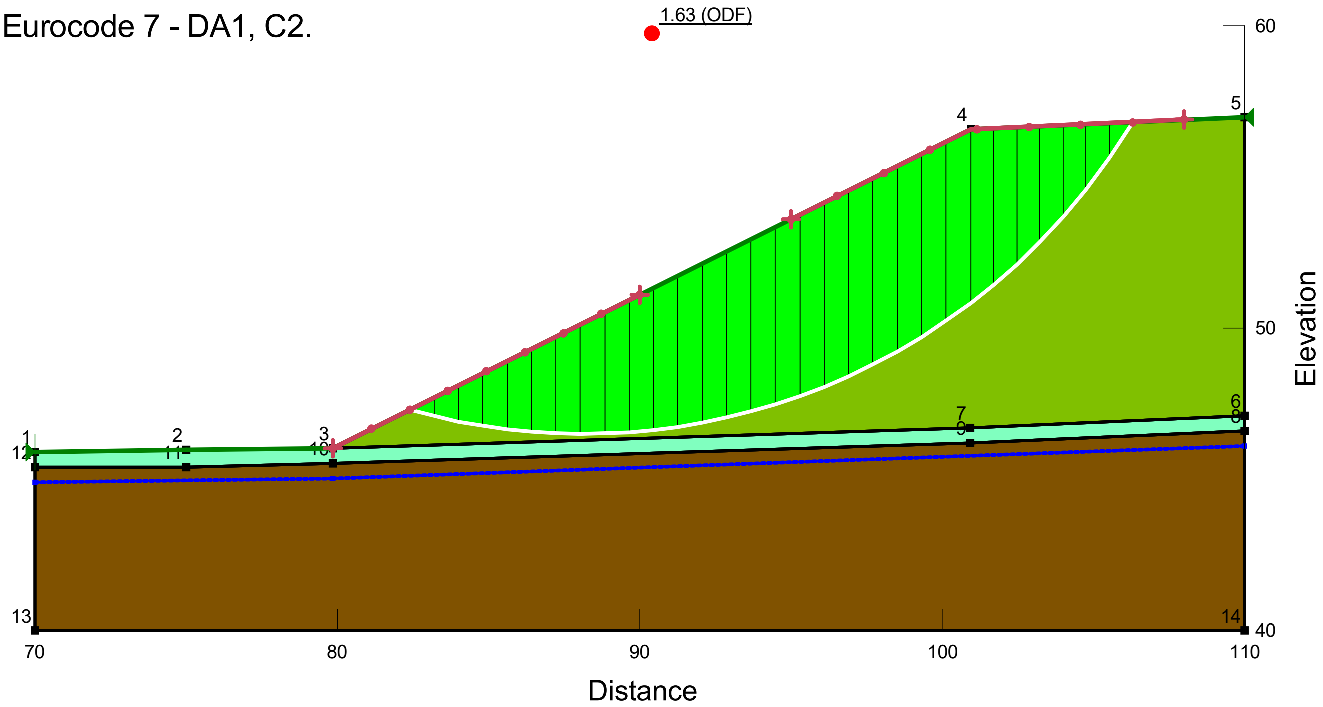


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

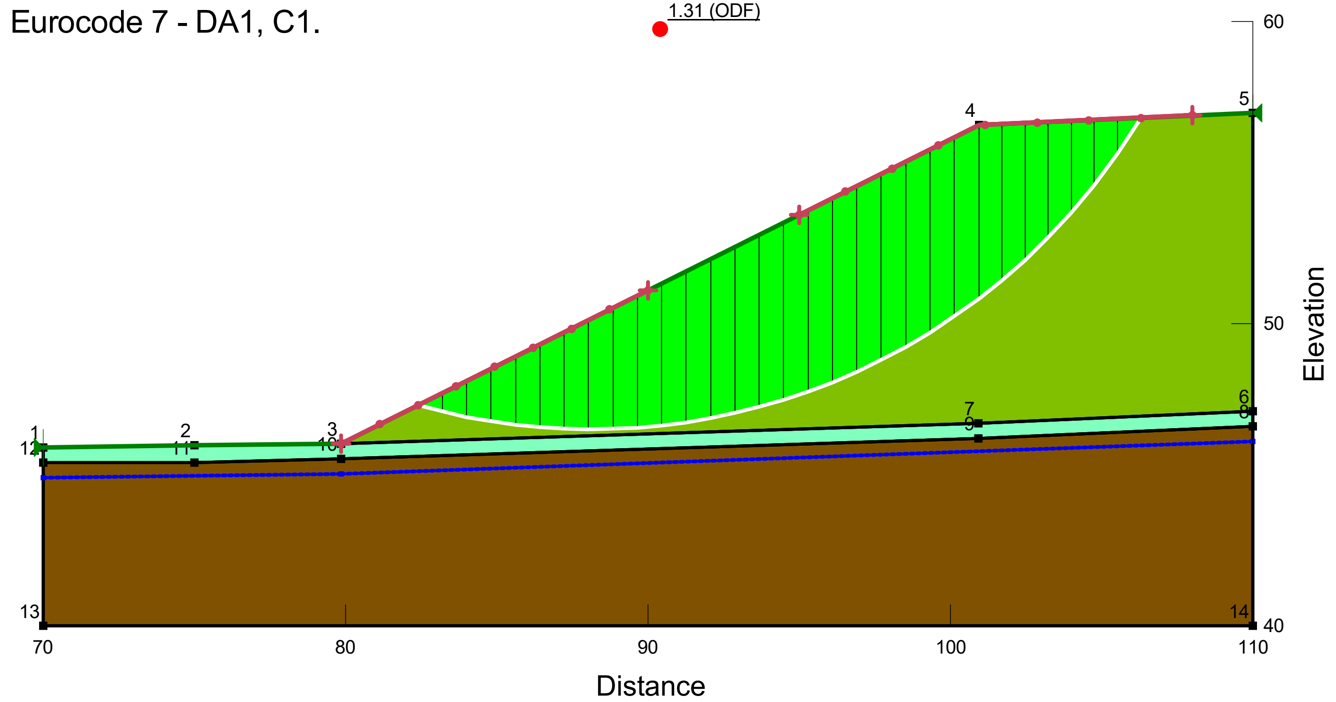


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

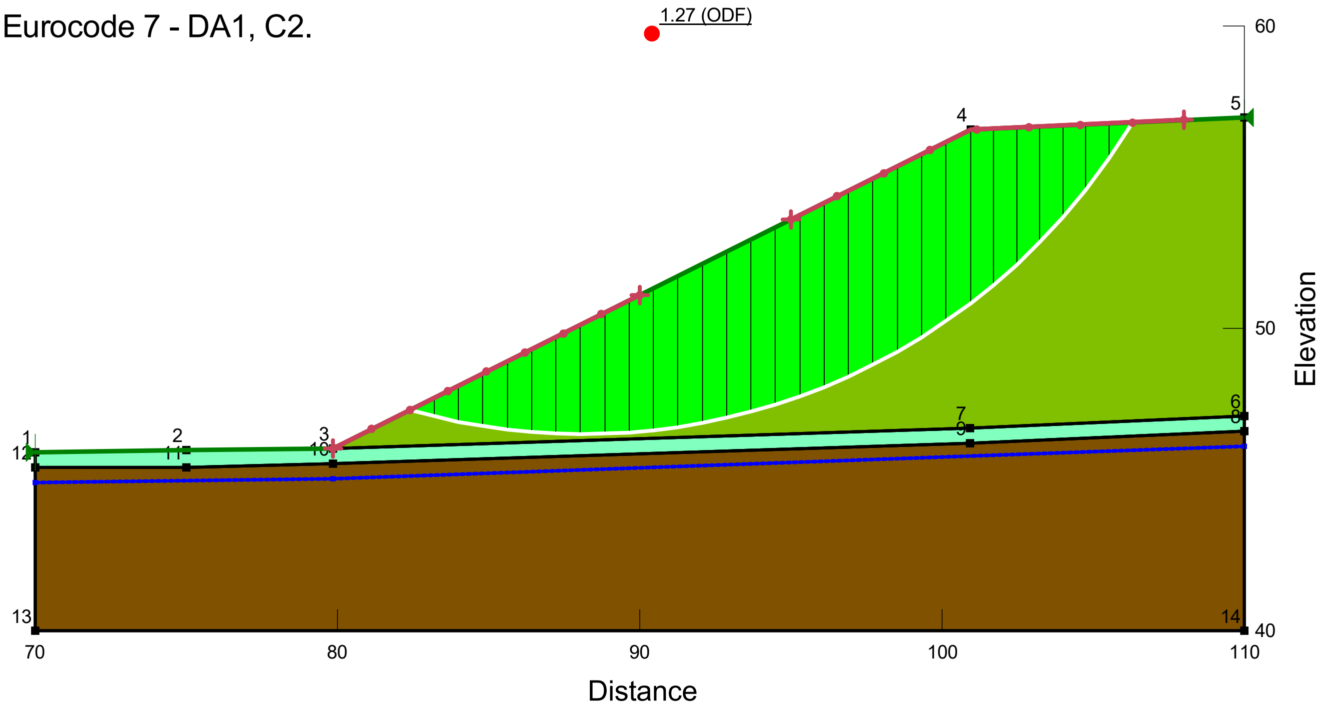


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

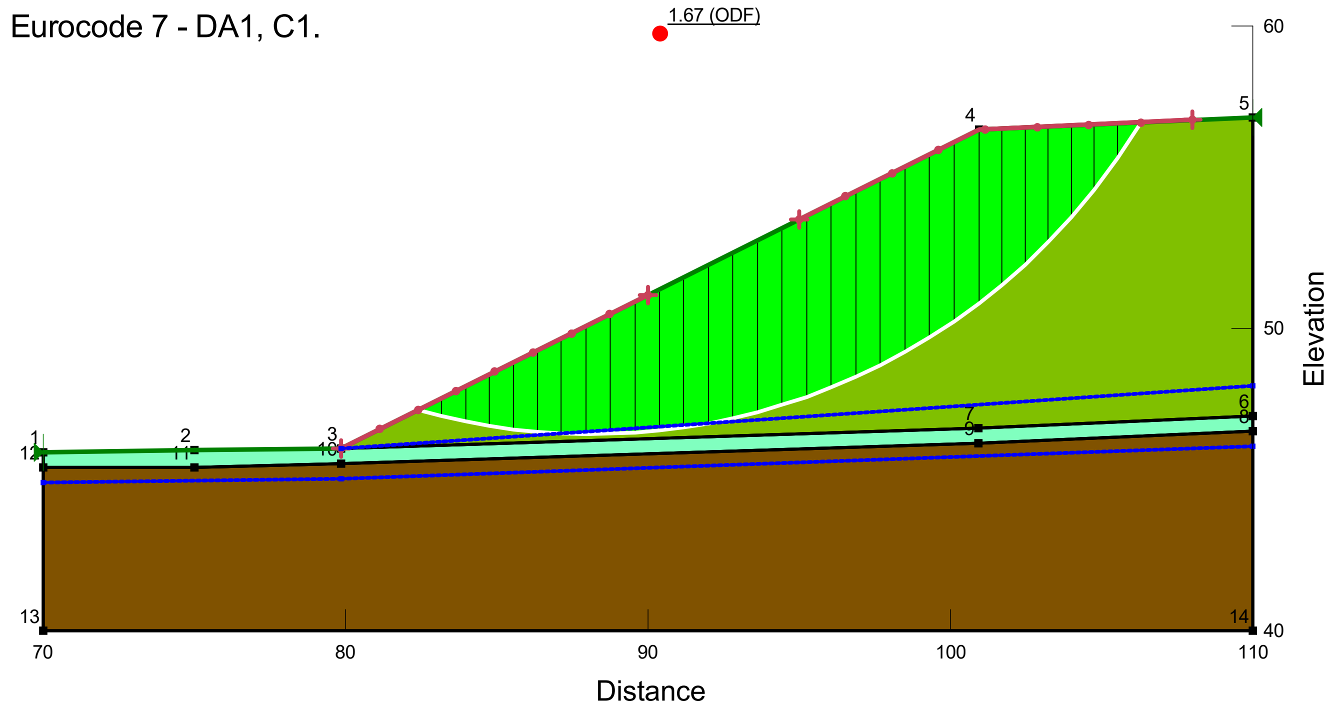


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

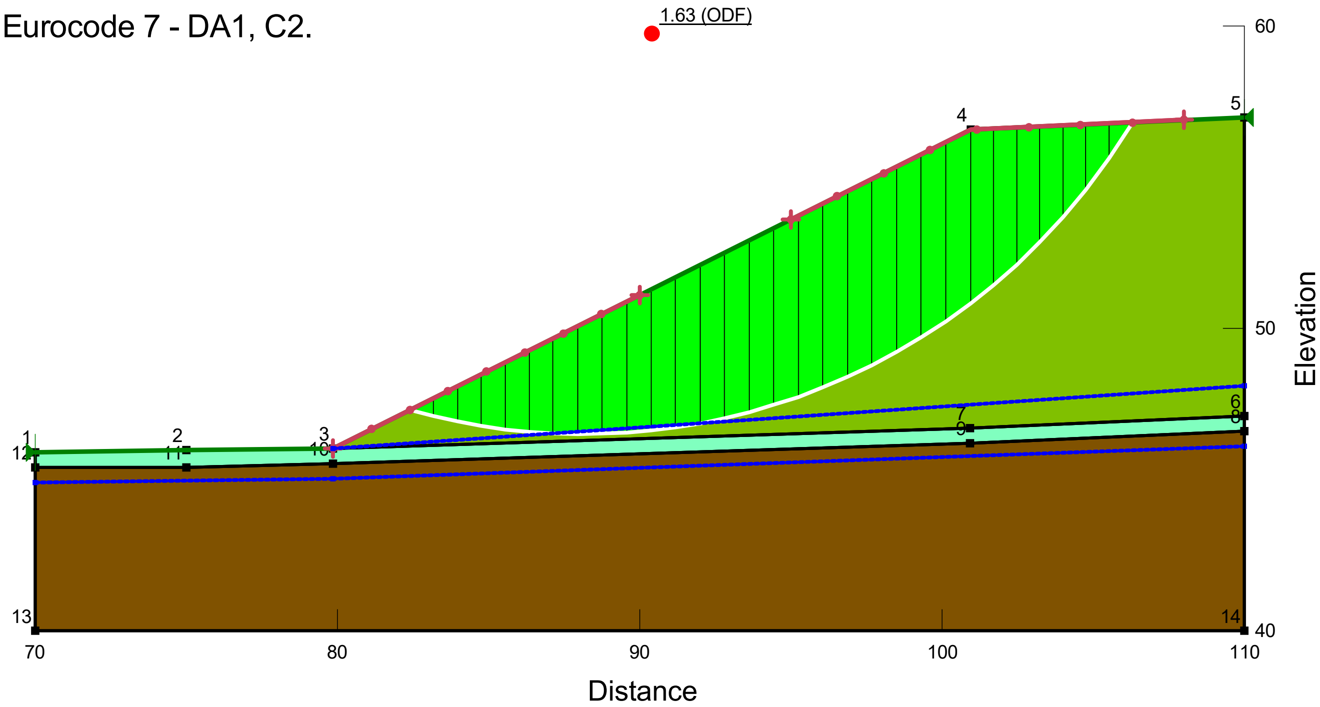


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

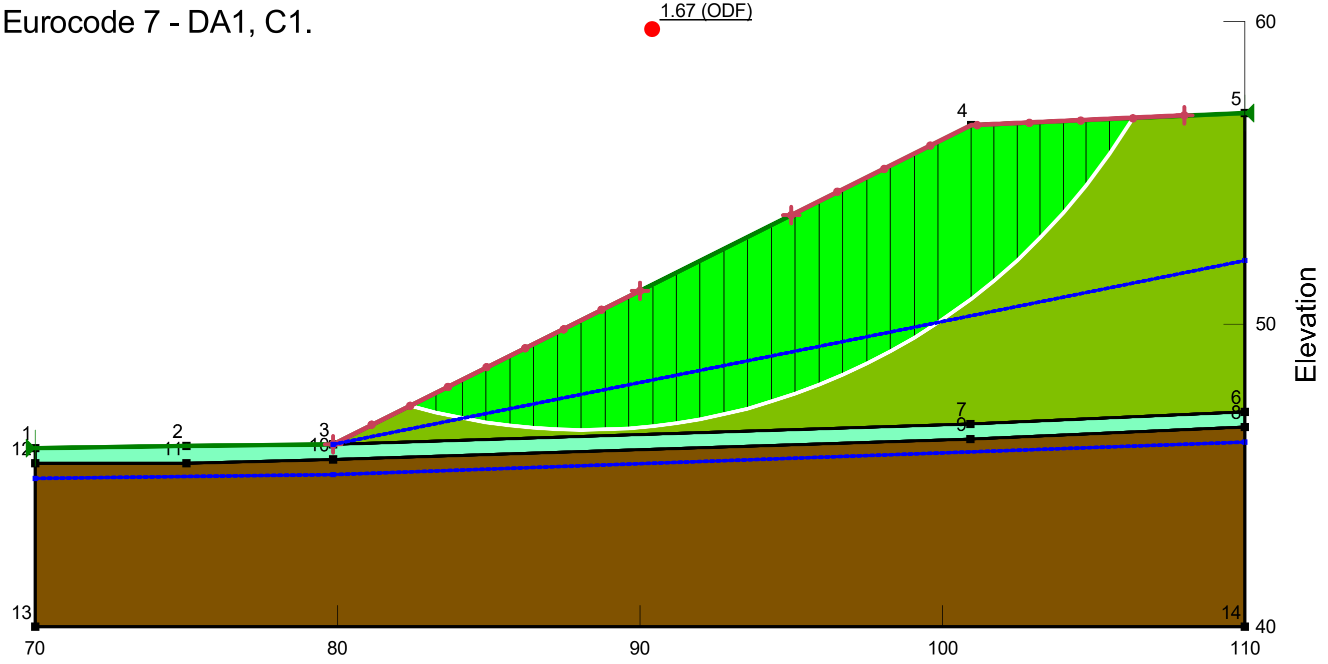


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

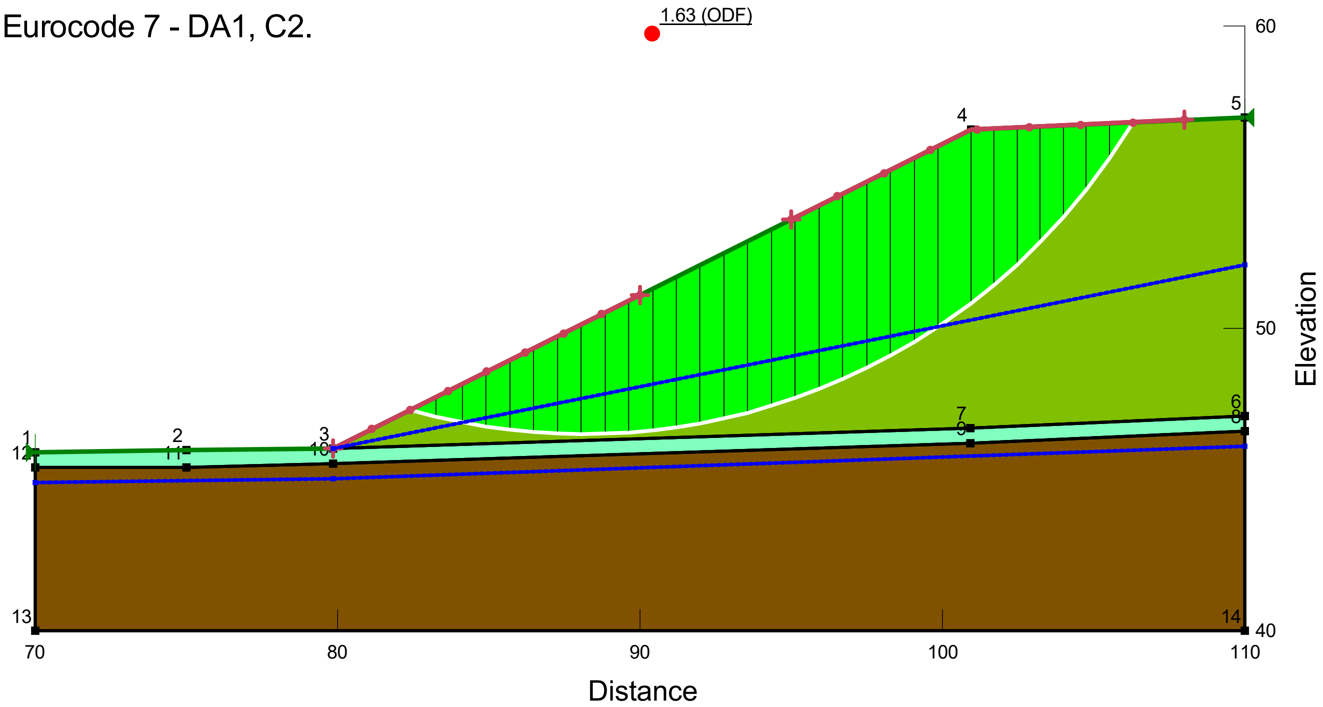


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.

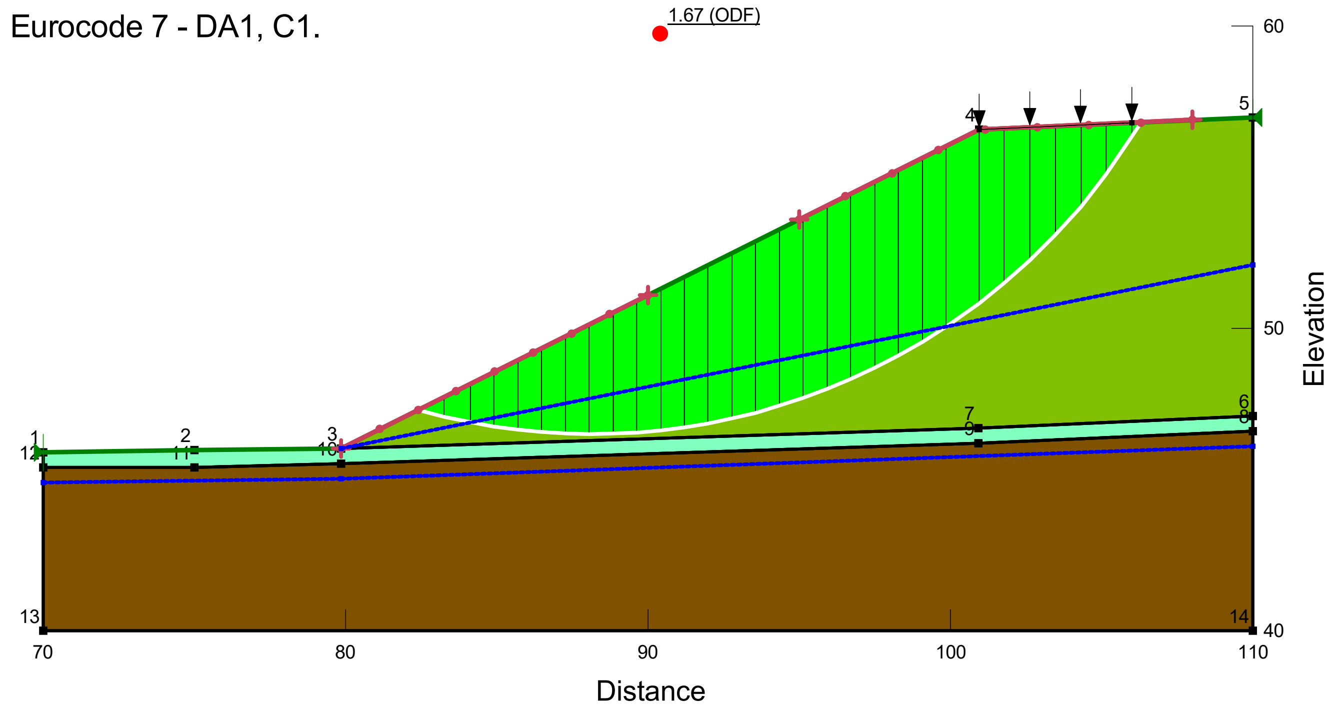


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C1.

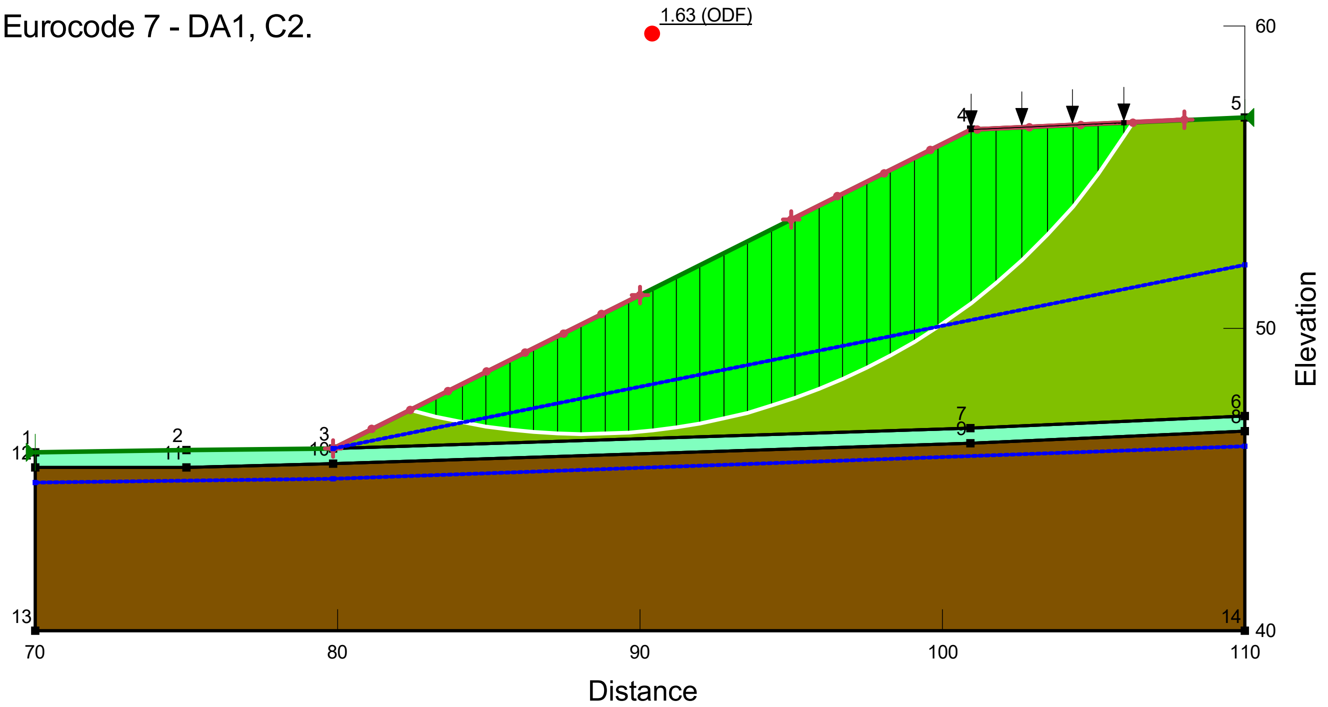


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Limit State Design Approach: Eurocode 7 - DA1, C2.



Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment	
Section SB-SB' slope configuration, total stress parameters	
(Challonsleighslopes1.gsz)	1:250

Appendix D. ASRA3 The proposed risk-based monitoring scheme equipment proposed for the landfill – NOT USED

Appendix E. ASRA4 The proposed monitoring equipment installation protocols – NOT USED

Atkins Limited
The Octagon
2nd floor, Pynes Hill Court
Rydon Lane
Exeter
EX2 5AZ

Tel: +44 (0)1392 352900
Fax: +44 (0)1392 352999