AtkinsRéalis

Stability Risk Assessment

DDE (SW) Ltd.

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CHALLONSLEIGH FARM INERT LANDFILL

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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 – 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 land raise operations for the importation of 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 land raise with inert waste entails filling on a total of approximately 10.76 ha split north and south of an unnamed intermittent ordinary watercourse which will remain open, and also includes filling over approximately 1.47 ha of previous historic fill which incorporates a former historic 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. The original planning permission showed the phasing north to south. The phasing has been revised from north to south to south to north.

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 A 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.
November 2024	One borehole and one trial pit. Report included as AESSD1C.	To install a perimeter well for groundwater and ground gas monitoring. In-situ testing to establish the infiltration and hydraulic conductivity characteristics of the subgrade geology. 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 9.36 ha. The remaining approximately 1.47 ha in the south, the basal sub-grade comprises restored former historic fill..

1.8. The BGS geological mapping 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 conditions are within 1 m 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 to 4 m rise in ground elevation from north to south within less than 10 m. 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 35 m 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.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 which has dense vegetation cover comprising small trees and scrub, and the 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 mapping, that land raise is on ground which originally was at around 50 m above Ordnance Datum (AOD) in the north which rose slightly to the south over a wide ridge. The ridge's axis is west south west to east north east which also slopes to the north east 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 50 m AOD in the north and ≈61 m AOD (200' contour) in the west at the access road, where the existing level is around 58 m AOD. That ridge sloped east towards the River Yealm to an elevation of around 46 m AOD (150' contour) approximately 50 m east of the river, indicating a sudden change of slope to the flood plain, where the current elevation is around 40 to 41 m AOD, compared to ≈100 m to the north the historical 200' contour is shown ≈250 m 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 (6.1 m) 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 and BHL09 where groundwater elevations of 47.2 to 49.6 m AOD have been recorded, which are well above elevations of 40.3 to 41.7 m AOD recorded at BHL06, north east of the historical landfill, with those elevations being around 1.5 to 2.5 m 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 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 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 0.5 m thick with a permeability not more than $5x10^{-8}$ m/s equivalent to the minimum requirement for an inert landfill for a layer 1 m 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 to 0.4 m 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 0.5 m to enable placement using compaction plant. That wider zone will then be carefully trimmed back leaving not less than 0.5 m 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 that 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 to 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 to 1 m 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 1x10-7m/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, 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 (historical 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 (historical 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 over artificially established geological barrier on inert / historical landfill >20 years old, but will be placed in horizontal lifts in lifts 0.5 to 1 m thereby buttressing existing slopes hence destabilisation of existing slopes is not likely.	Yes

Landfill component	Geotechnical issue	Classification of geotechnical issue	Justification		
			Is stability / integrity of landfill component at significant risk ?	Principal reason	Supporting analysis
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 to 1 m 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
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 liftswithin 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 to 2 m high adjacent piles of inert fill across the installation area, that material then being periodically levelled to form 0.5 to 1 m 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 be 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 of the planned inert landfill. That has been carried out using simple spreadsheet calculations considered suitable for the data and to appraise the 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 ≥ 0.5 m 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 yrs	Waste assumed to have been placed prior to the planning permission for restoration in 2003 to the extant permitted licence to the south of Phase B.	Two scenarios selected for sensitivity analysis because revised start year 2026 is 23 years since planning , so t1=25 year, t2=20 as age of landfill is assumed to be far greater years.

Parameter	Material	Design Value	Source	Comments
	Planned inert landfill	1	For inert waste placed in 2026.	Revised start year.
Thickness	Historical inert / industrial landfill	3.0 m – 6.8 m	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 50 m AOD in the north and 58 to 61 m AOD 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	1.7 m – 6.3 m	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/m^3	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/m^2 respectively.	Estimated assuming clay with Cc=0.3 and initial void ratio of 0.82 at 1 m, from the historical landfill shallow fine soils average moisture content ≈23.5%, assume bulk density p_b=1.835 t/m^3, 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/m^3	Assessed characteristic values from ground investigation data, e.g. material descriptions and SPT N values.	
Cu, (ϕ=0)		100 kN/m^2		
c', ϕ'		5 kN/m^2, 32°		
Weight density	Historical inert / industrial landfill sub-grade	18 kN/m^2	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/m^2		
c', ϕ'		2 kN/m^2, 25°		
Weight density	Artificially established geological barrier	18 kN/m^3	Assessed characteristic values from ground investigation data, i.e. laboratory tests: compaction, triaxial tests and shear box.	
Cu, (ϕ=0)		100 kN/m^2		
c', ϕ'		5 kN/m^2, 28°		
Thickness		0.5m	Minimum value required.	Taken from 0.2 m below existing ground level to account for topsoil / subsoil strip.
Weight density	Planned inert waste landfill	18 kN/m^2	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 0-10 kN/m^2 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/m^2		Considered conservative, given likely compaction, and granular materials would have higher phi'.
c', ϕ'		2 kN/m^2, 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 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 1 m.

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
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
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/m^2, ϕ'=25°	1.29	1.07	
		Artificially established geological barrier	Effective, reduced c'=1 kN/m^2, ϕ'=25°	1.27	1.06	
		Artificially established geological barrier	Effective, reduced c'=1 kN/m^2, ϕ'=20°	1.15	0.97	
	As above + leachate level at 1 m 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 1 m to 0 above artificially established geological barrier from Ch 120 to toe of slope.	Artificially established geological barrier	Effective, reduced c'=1, kN/m^2, ϕ'=25°	1.27	1.06	
	As above + leachate level at 4 m to 0 above artificially established geological barrier from Ch 120 to toe of slope.	All	Effective, as per table TSRA5b	1.29	1.08	

Section	Scenario	Material	Total or Effective Stress Strength Parameters	ODF for DA1		Notes
				C1	C2	
	As above + leachate level at 6 m to 0 above artificially established 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 250-300	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 sub-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 most critical section 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 ≈10.0 m above existing ground level at chainage 121.

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 80-135	Maximum waste height at chainage 121, 10.0 m above existing ground level, 1:2 slope to the south, groundwater 0.5 m 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/m^3	1.8	1.8	Slip circle also passes through basal liner and basal sub-grade.
		Inert waste	Total, reduced Cu=50 kN/m^2	1.67	1.63	
		Inert waste	Total, reduced Cu= 50k N/m^2, and increased weight density to 23 kN/m^3	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 1 m to 0 above artificially established geological barrier from Ch 110 to toe of slope respectively.	Inert waste	Total, reduced Cu=50 kN/m^2	1.67	1.63	
	As above + leachate level at 5 m to 0 above artificially established geological barrier from Ch 110 to toe of slope respectively.	Inert waste	Total, reduced Cu= 50kN/m^2	1.67	1.63	A high leachate level within the temporary waste slope is considered unlikely.
	As above + leachate level at 5 m to 0 above artificially established geological barrier from Ch 110 to toe of slope, + vertical variable surcharge load of 10 kN/m^2 from ch 100 to 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 analysis 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 than 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 greater than 20 years. However no notable adverse effects of variable surcharge loading due to the movement of plant, vehicles or stockpiles up to ≈6 m 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 10.0 m 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 10.0 m 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 3 m height, or if higher are made shallower overall, such as by the use of 1.5 to 3 m wide berms every 3 m 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 gas 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 a health and safety or environmental concern would be assessed and acted upon appropriately.

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APPENDICES

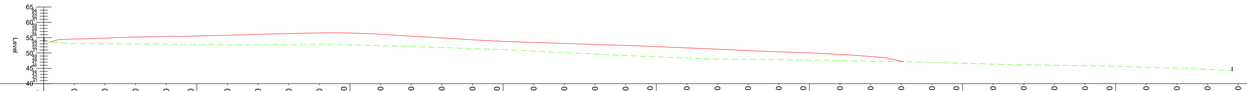
Appendix A. ASRA0 Drawings

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

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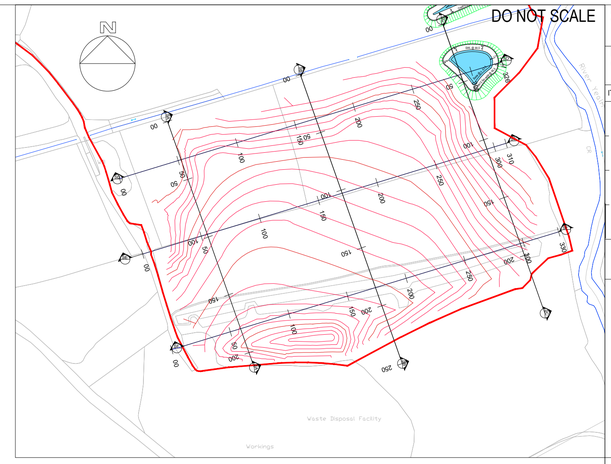
CROSS SECTION NF-NF'
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0 10 MILLIMETRES 100

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

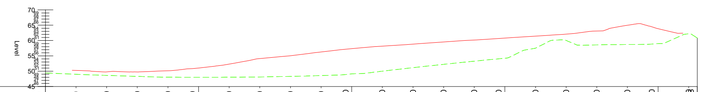
NOTES

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

KEY

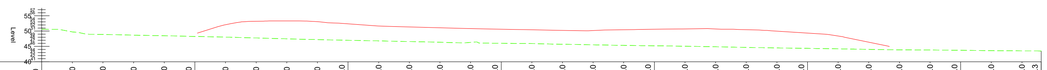
- PROPOSED LANDFILL BOUNDARY
- CONTOURS INTERVAL 1.0m AND 5.0m
- EXISTING GROUND LEVEL
- PROPOSED LANDFILL ELEVATION

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



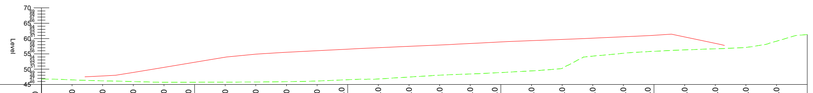
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Existing Levels	49.442	48.978	48.625	48.304	48.035	48.011	48.041	48.107	48.306	48.569	49.127	49.996	50.147	52.242	53.258	54.204	57.511	60.023	58.577	58.704	58.980	59.484
Proposed Levels		50.254	49.752	49.760	50.150	51.026	52.318	54.101	55.051	56.271	57.353	58.176	58.633	59.627	60.147	60.810	61.446	62.078	63.089	64.978	63.872	
Level Difference		1.276	1.128	1.455	2.115	3.014	4.276	5.994	6.745	7.702	8.226	8.180	7.686	7.385	6.890	6.606	3.936	2.055	4.512	6.274	4.892	

SD-SD' - CROSS SECTION
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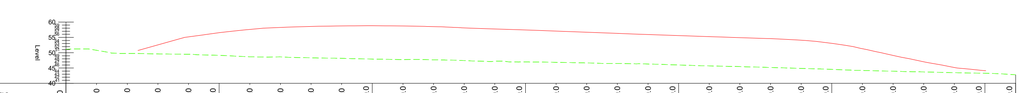
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Existing Levels	50.594	49.738	48.899	48.678	48.489	48.252	48.045	47.758	47.475	47.223	46.992	46.811	46.584	46.346	46.325	46.019	45.922	45.707	45.523	45.335	45.202	45.050	44.882	44.671	44.500	44.367	44.209	44.025	43.878	43.818	43.732	43.614	43.550	43.514
Proposed Levels							52.083	53.195	53.310	53.055	52.360	51.667	51.344	51.066	50.805	50.615	50.424	50.236	50.173	50.450	50.614	50.698	50.688	50.441	50.473	49.973	49.347	46.382						
Level Difference							4.038	5.437	5.836	5.832	5.369	4.856	4.760	4.720	4.480	4.596	4.502	4.529	4.650	5.115	5.412	5.648	5.807	5.770	5.473	4.980	4.169	2.358						

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



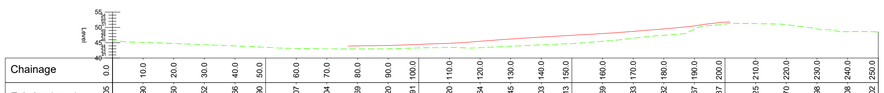
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Existing Levels	46.749	46.506	46.198	45.961	45.718	45.747	45.779	45.813	45.933	46.138	46.543	46.809	47.020	47.431	47.880	48.045	48.435	48.905	49.440	50.245	50.259	55.851	56.288	56.650	57.091	59.124								
Proposed Levels			47.788	48.950	50.600	52.252	53.921	54.911	55.502	56.016	56.928	57.020	57.449	57.880	58.369	58.878	59.299	59.605	60.122	60.579	61.048	60.534	60.534	58.432								
Level Difference			1.589	2.990	4.882	6.506	8.142	9.098	9.569	9.880	9.985	10.211	10.018	9.835	9.934	9.973	9.859	9.450	5.863	5.375	5.217	4.246	1.782											

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



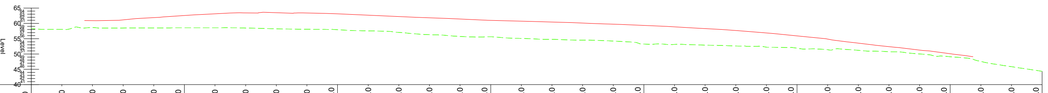
Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0
Existing Levels	51.090	50.775	49.767	49.608	49.504	49.131	48.659	48.648	48.335	48.153	47.922	47.761	47.687	47.420	47.221	46.992	46.847	46.663	46.500	46.315	45.985	45.704	45.461	45.176	44.884	44.559	44.205	43.961	43.731	43.489	43.296	42.812
Proposed Levels				52.566	55.187	56.534	57.395	58.238	58.566	58.740	58.787	58.712	58.510	58.099	57.743	57.401	57.058	56.671	56.291	55.922	55.589	55.251	54.914	54.581	54.085	53.046	51.301	50.760	50.023	49.124	47.033	45.181	44.138	
Level Difference				2.958	5.682	7.403	8.736	9.590	10.231	10.587	10.865	10.950	10.823	10.679	10.521	10.409	10.216	10.008	9.792	9.607	9.604	9.547	9.453	9.405	9.201	8.487	7.096	5.162	3.303	1.701	0.841			

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
Existing Levels	45.605	45.090	44.760	44.352	43.966	43.490	43.107	43.004	42.969	43.020	44.436	43.291	43.420	43.364	43.845	43.303	44.713	45.469	46.433	47.432	49.467	51.087				
Proposed Levels									43.975	44.082	44.436		44.806	45.479	46.203	46.849	47.427	47.998	48.700	49.482	50.490	51.701	51.225	50.870	49.498	48.608	46.502						
Level Difference									1.006	1.062	1.145		1.386	2.115	2.358	2.546	2.714	2.529	2.267	2.051	1.024	0.614											

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	330.0
Existing Levels	58.265	58.041	58.661	58.490	58.508	58.551	58.560	58.486	58.233	58.078	57.942	57.549	57.054	56.311	55.731	55.626	55.092	54.800	54.539	54.228	53.250	53.138	52.891	52.611	52.242	51.900	51.393	51.191	50.760	50.023	49.124	47.579	45.858	44.352
Proposed Levels			60.895	61.133	61.895	62.260	63.134	63.412	63.482	63.390	63.137	62.692	62.246	61.836	61.428	60.975	60.721	60.430	60.100	59.726	59.338	58.864	58.305	57.680	56.878	55.903	54.878	53.538	52.411	51.264	50.087	49.347			
Level Difference			2.234	2.643	3.388	3.710	4.574	4.926	5.249	5.312	5.195	5.143	5.192	5.525	5.698	5.349	5.629	5.630	5.561	5.498	6.088	5.726	5.414	5.069	4.406	4.004	3.485	2.348	1.650	1.262	0.963			

REV.	DESCRIPTION	BY	DATE	CHK'D	AUTH
P04	Revised landfill contours.	JDP	21/05/2025	ATF	PG
P03	Revised for updated inert landfill boundary and its contours.	TSM	16/09/2024	ATF	ATF
P02	Revised for updated inert landfill boundary and restoration contours.	TSM	1/12/2023	ATF	ATF

DRAWING STATUS: FOR INFORMATION

SUITABILITY: S2

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CLIENT: DDE(SW) LIMITED

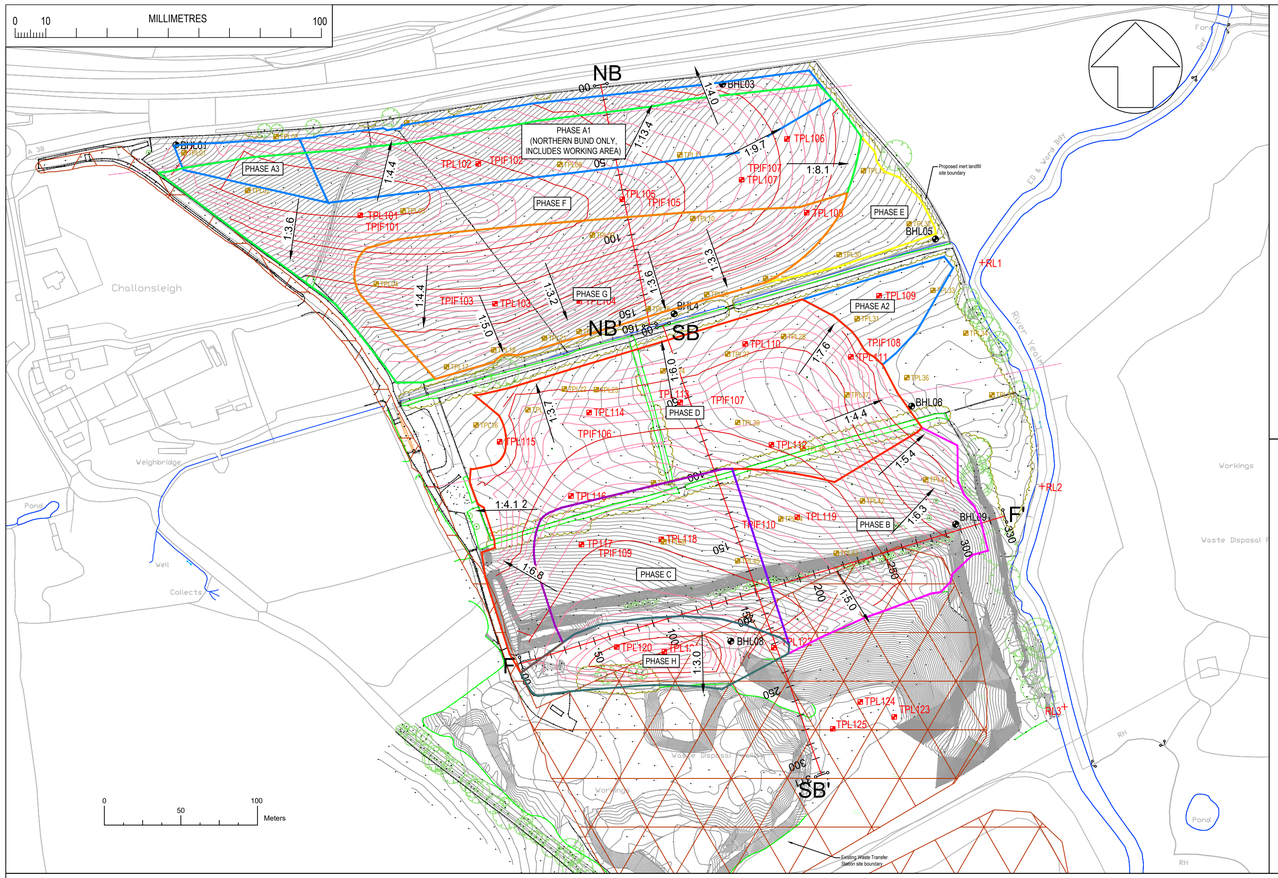
PROJECT:
Challonsleigh Farm,
Smithaleigh, nr Ivybridge, Plymouth, PL7 5AX
Inert Landfill

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

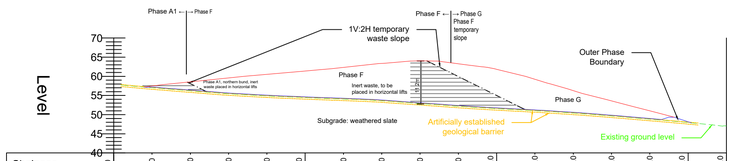
DRAWING NUMBER: 5149237-ATK-DR-C-ESSD5C

REV: P04



DO NOT SCALE

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



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
Existing Levels		57.025	56.214	55.443	54.882	54.449	54.071	53.613	52.915	52.189	51.576	51.037	50.410	49.666	48.810	47.943	47.024
Proposed Levels		57.470	58.561	59.591	60.519	61.360	62.340	63.383	64.007	63.281	61.834	59.243	56.275	53.593	50.996		
Level Difference		0.444	2.347	4.148	5.637	6.911	8.269	9.770	11.092	11.092	10.258	8.207	5.865	3.937	2.186		

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

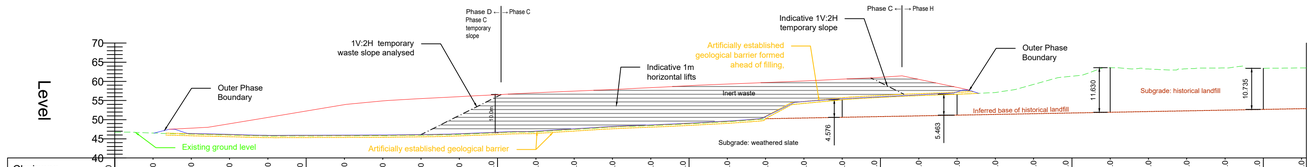
IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

NOTES

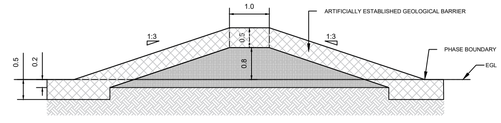
1. DO NOT SCALE FROM THIS DRAWINGS
2. ALL MEASUREMENTS ARE IN METERS UNLESS STATED OTHERWISE
3. Refer to drawings DESSD5B and DESSD5C for planning approved cross sections of restoration profile.

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

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

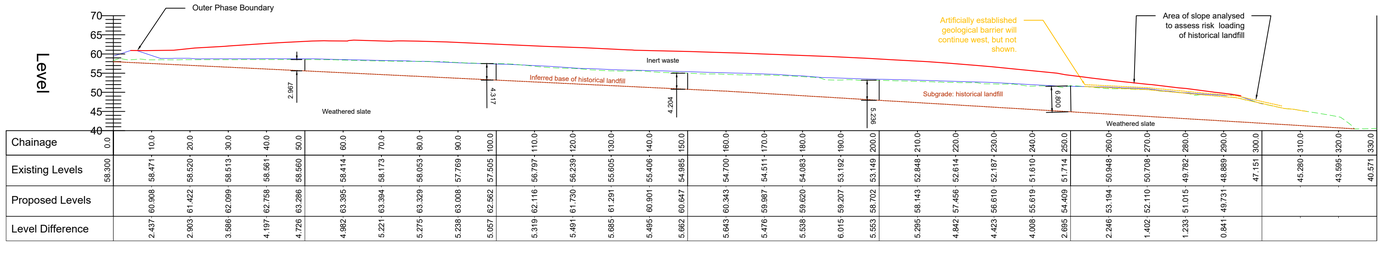


Chainage	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0	190.0	200.0	210.0	220.0	230.0	240.0	250.0	260.0	270.0	280.0	290.0	300.0	310.0
Existing Levels	46.729	46.509	46.197	45.963	45.718	45.746	45.778	45.813	45.933	46.137	46.544	46.809	47.430	48.045	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			47.788	48.950	50.600	52.252	54.911	55.502	56.016	56.528		57.020	57.449	57.880	58.369	58.878	59.299	59.695	60.122	60.579	61.048	60.534	58.432										
Level Difference			1.590	2.987	4.882	6.506	9.133	9.689	9.919	9.983		10.211	10.019	9.835	9.935	9.973	9.860	9.396	5.863	5.378	5.224	4.244	1.782										

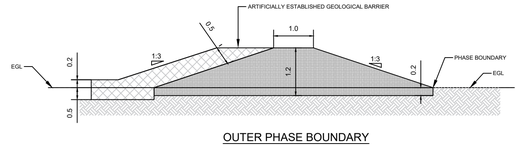


INTERMEDIATE PHASE BOUNDARY

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



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	330.0
Existing Levels	58.300	58.471	58.520	58.513	58.561	58.560	58.414	58.173	58.053	57.769	57.505	56.797	56.239	55.605	55.406	54.985	54.700	54.511	54.083	53.192	53.149	52.848	52.614	52.187	51.610	51.714	50.948	50.708	49.782	48.889	47.151	45.260	43.995	40.571
Proposed Levels		60.908	61.422	62.099	62.758	63.286	63.395	63.394	63.329	63.008	62.562	62.116	61.730	61.291	60.901	60.647	60.343	59.987	59.620	59.207	58.702	58.143	57.456	56.610	55.619	54.409	53.194	52.110	51.015	49.731				
Level Difference		2.437	2.903	3.586	4.197	4.726	4.982	5.221	5.275	5.238	5.057	5.319	5.491	5.685	5.495	5.662	5.643	5.476	5.538	6.015	5.553	5.295	4.842	4.423	4.008	2.695	2.246	1.402	1.293	0.841				



OUTER PHASE BOUNDARY

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH
P04	Updated to revised proposed inert landfill extent and restoration contours.	JDP	21/05/2025	ATF	ATF
P03	Updated to revised proposed inert landfill extent and restoration contours.	TSM	4/12/2023	ATF	ATF
P02	Phasing updated.	TSM	6/12/2021	ATF	ATF

DRAWING STATUS: FOR INFORMATION
SUITABILITY: S2

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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: P04

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 V02
Appendix C.1a Calculations for Basal Sub-Grade Settlement Analysis - Cc = 0.3

Section SB-SB' Ch	Historical landfill waste m	inert waste landfill m
190	4.576	5.374
220	5.463	5.767
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 fi 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
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
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	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	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	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	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			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	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	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	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 v 2
Appendix C.1b Calculations for Basal Sub-Grade Settlement Analysis - Cc = 0.2

Section SB-SB' Ch	Historical landfill waste m	inert waste landfill m
190	4.576	5.374
220	5.463	5.767
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 fi 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
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
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 4.252 m
Pressure increment at surface 76.536 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	0.50	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	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	0.50	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

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Appendix C.1c Calculations for Basal Sub-Grade Settlement Analysis - Cc = 0.1

Section SB-SB' Ch	Historical landfill waste m	inert waste landfill m
190	4.576	5.374
220	5.463	5.767
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 fi 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
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
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 4.252 m
Pressure increment at surface 76.536 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	0.50	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

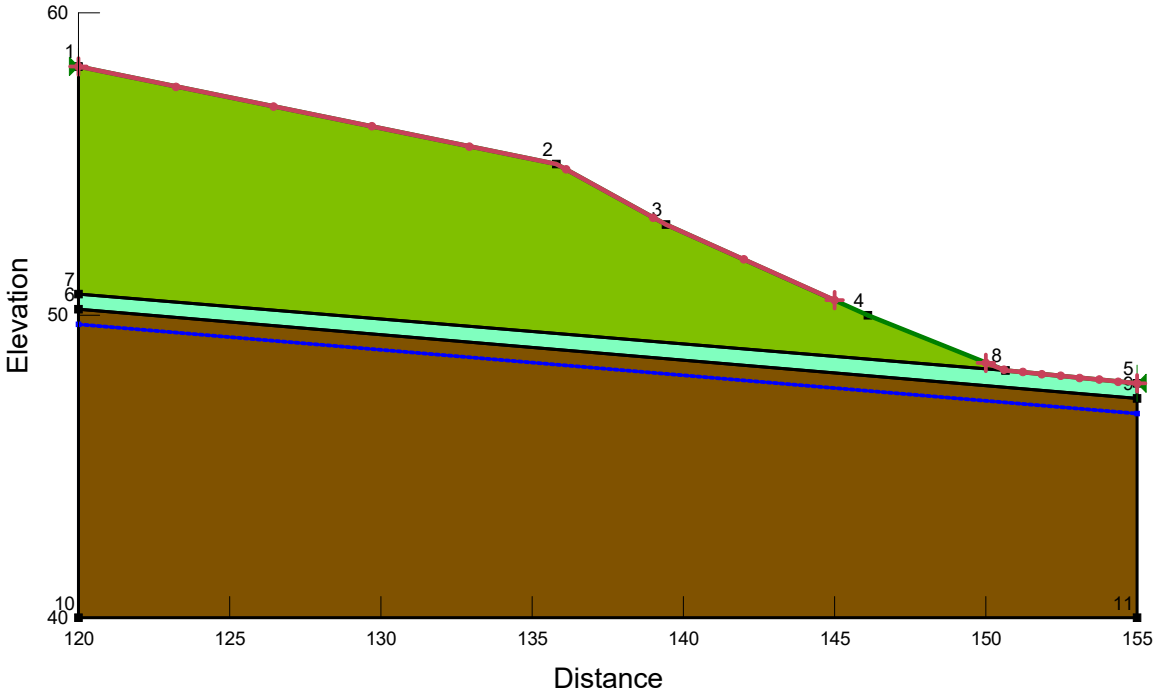
Waste top depth	Waste base depth	Mean depth	Initial p'_0	Initial porosity	Inital void ratio	Final p'_1	Compression index, Cc	Settle-ment
m	m	m	kN/m^2	%		kN/m^2		
0	1	0.50	9.0	0.45	0.83	95.4	0.1	0.056
1	2	1.00	18.0	0.44	0.80	104.4	0.1	0.043
2	3	2.00	36.0	0.43	0.77	122.4	0.1	0.030
3	4.317	3.66	65.9	0.43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



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

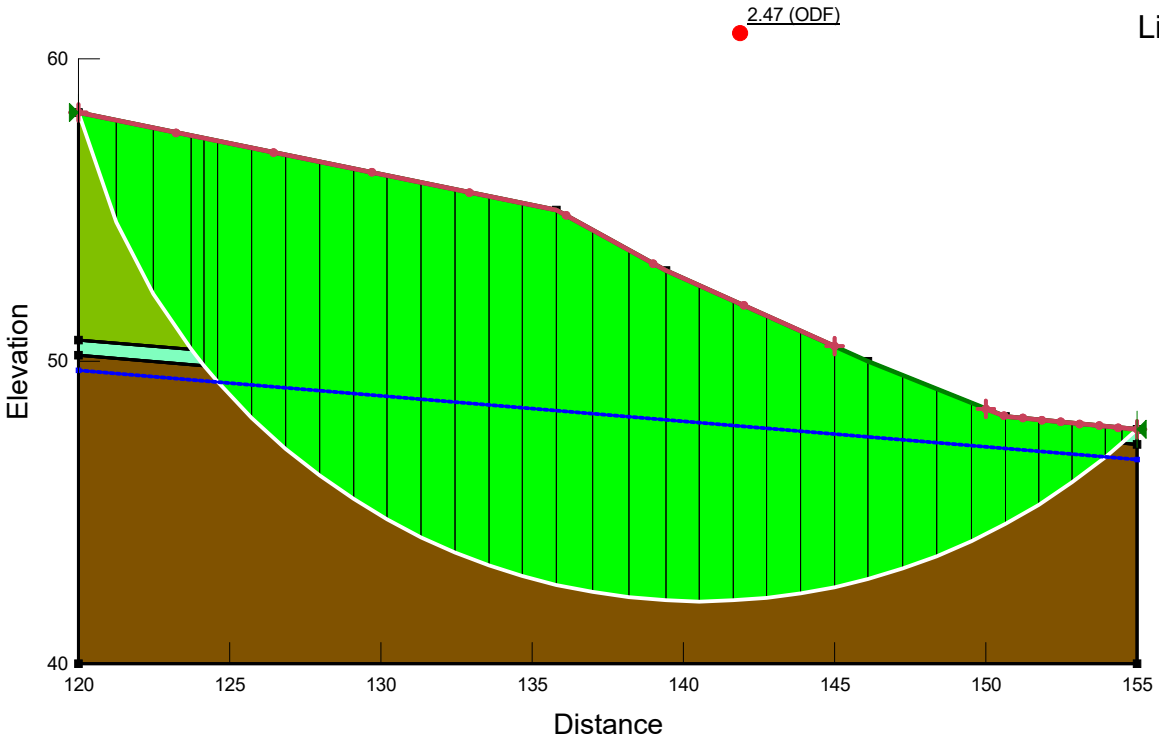
Red lines define the slip circle entry exit range to be used by SLOPE/W.

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.

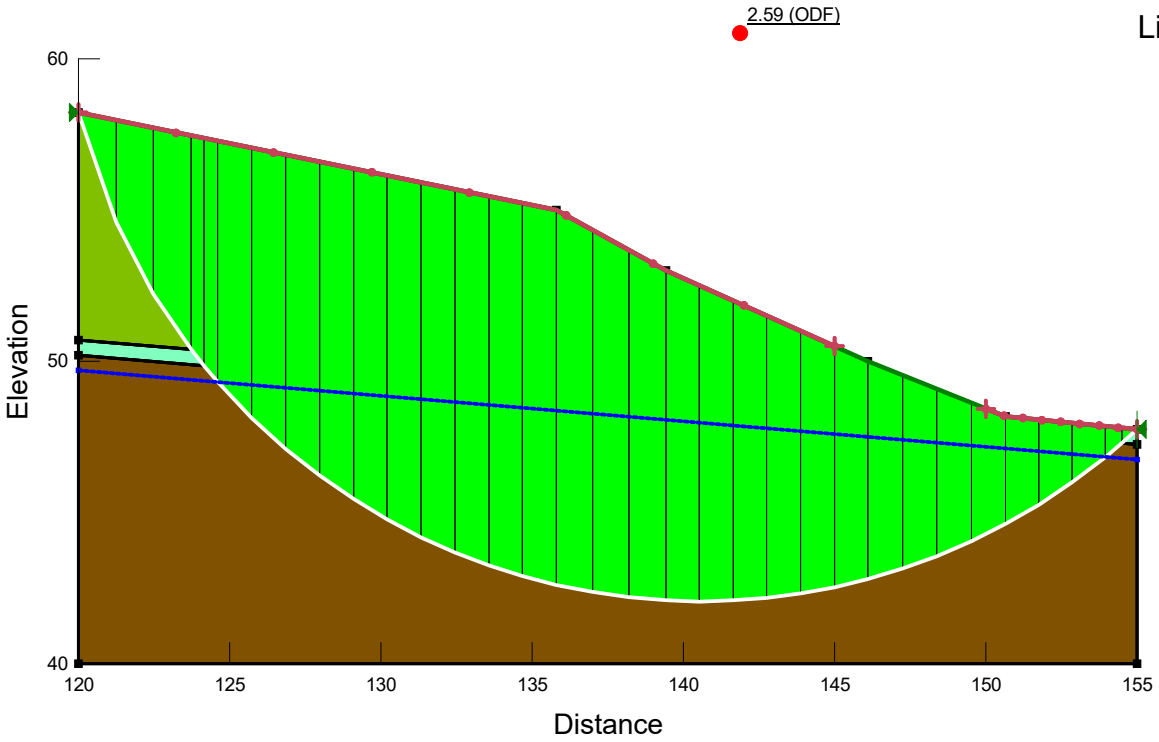


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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, C2.

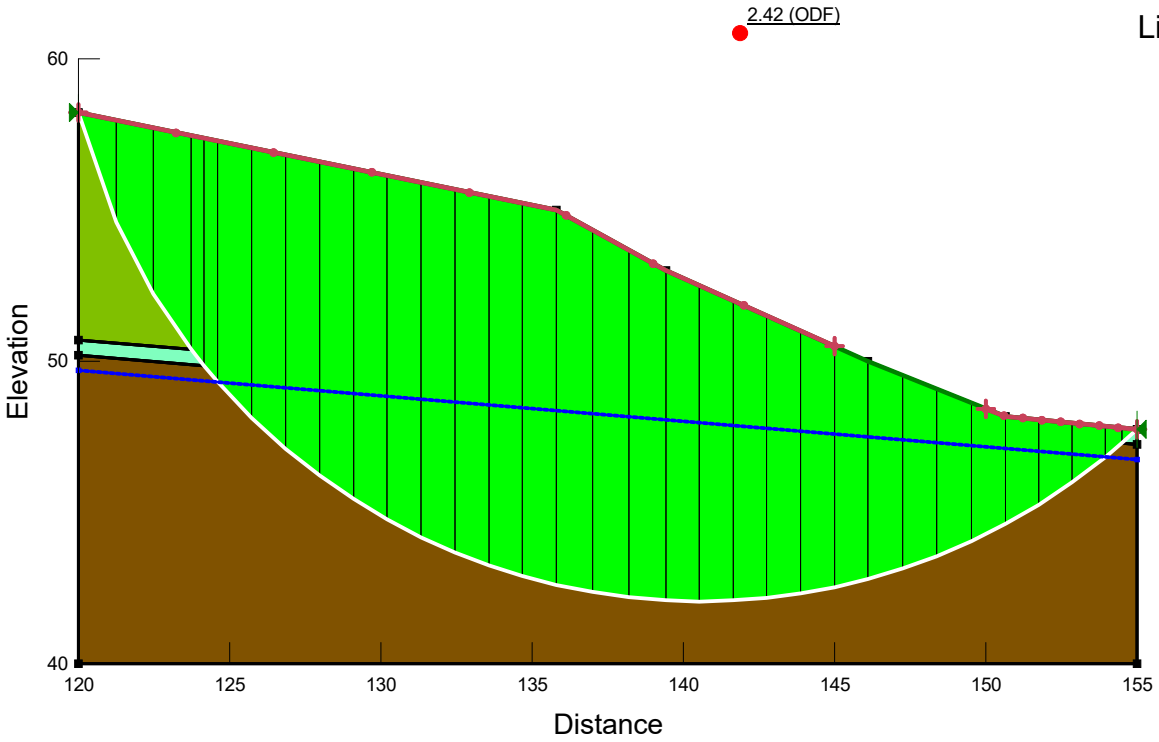


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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

Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section 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

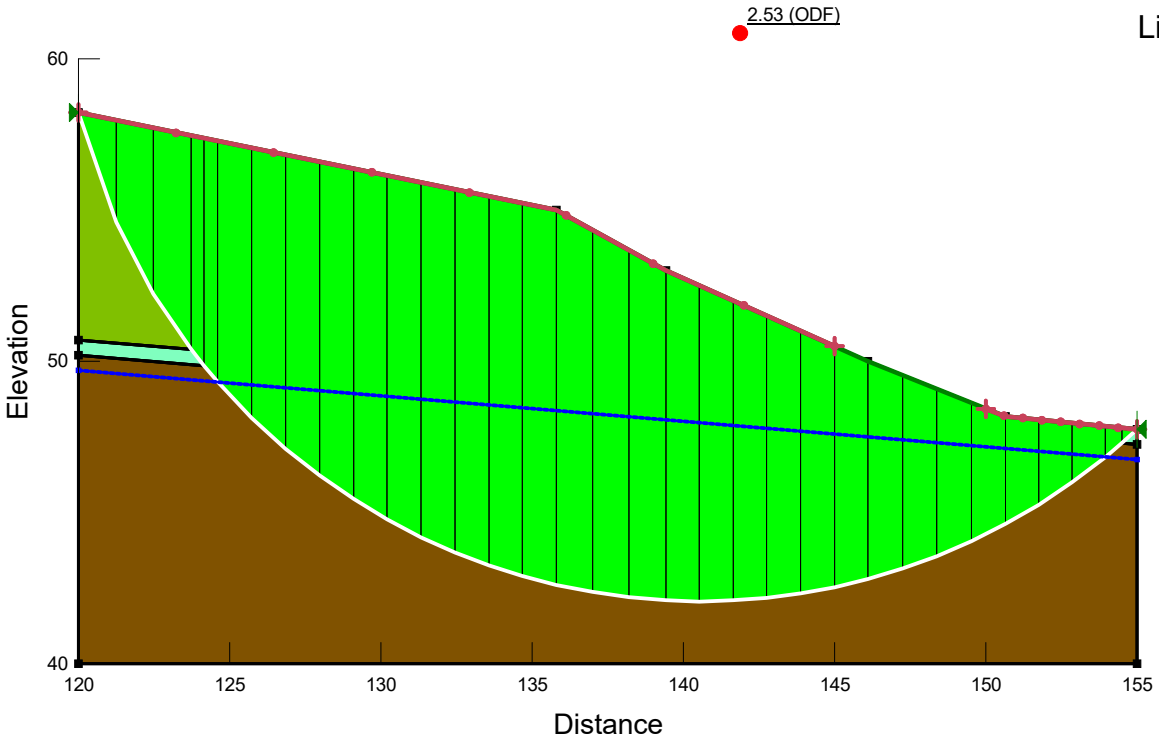
Red lines define the slip circle entry exit range to be used by SLOPE/W.

Challonsleigh Farm Inert Landfill - Stability Risk Assessment

Section NB-NB' slope configuration, total stress parameters

(Challonsleighslopes.gsz) 1:250

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



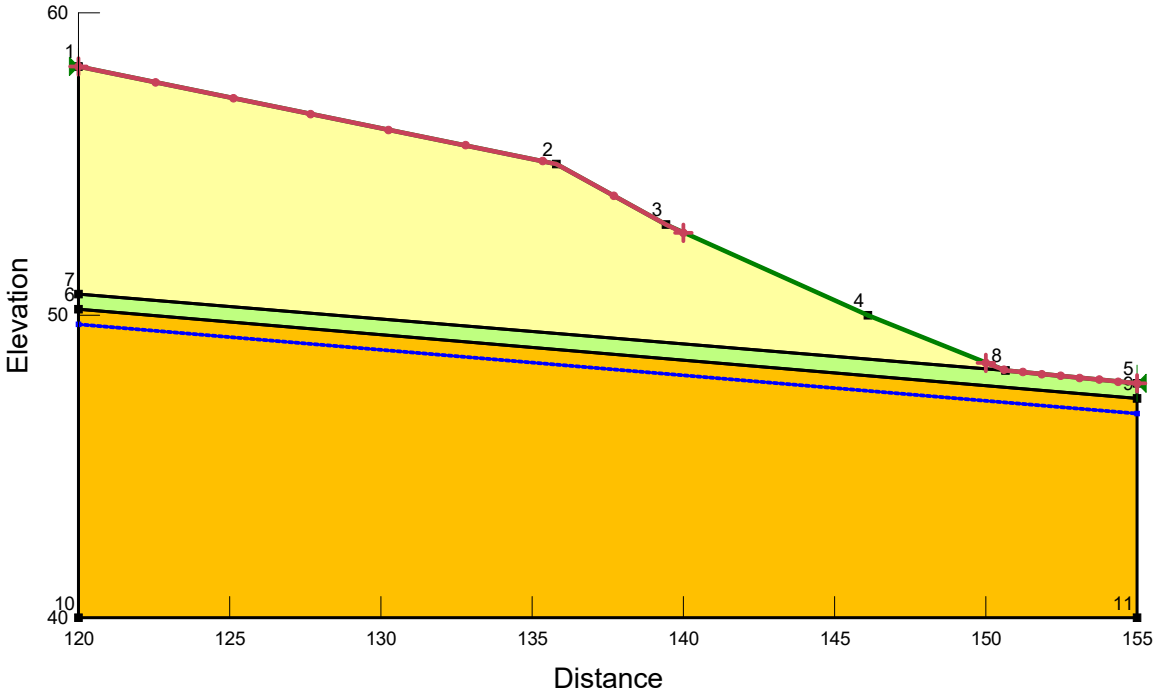
Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	40
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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

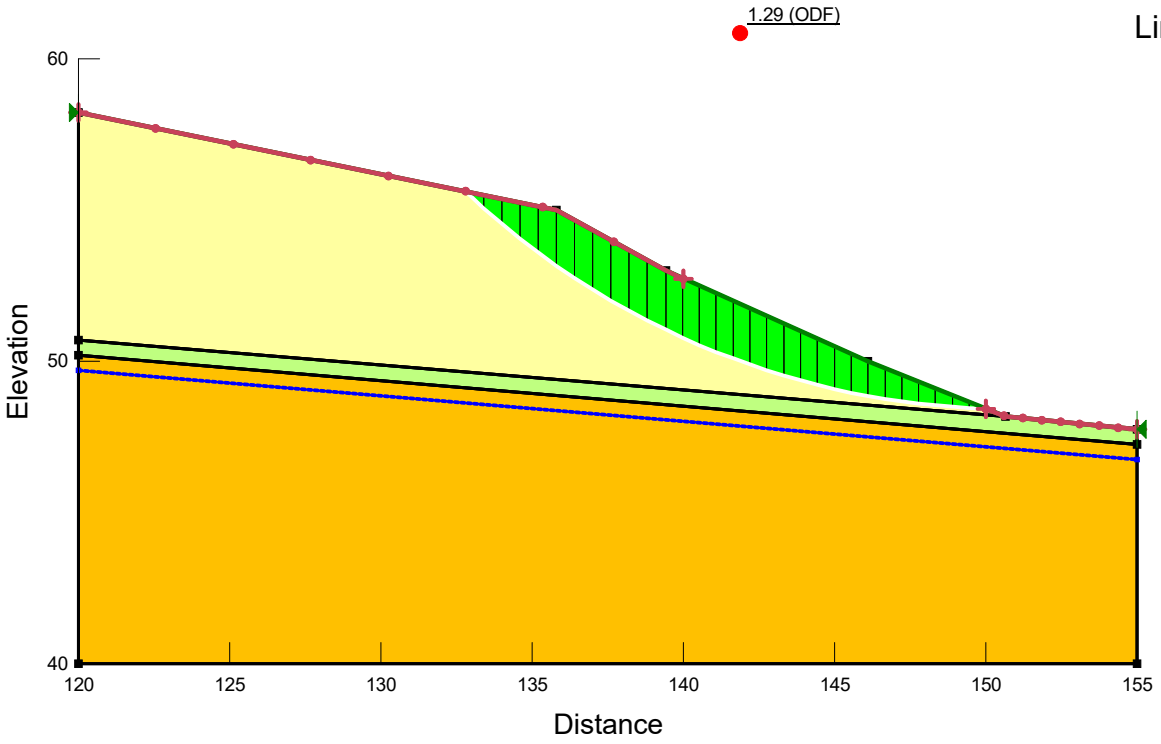
Red lines define the slip circle entry exit range to be used by SLOPE/W.

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.

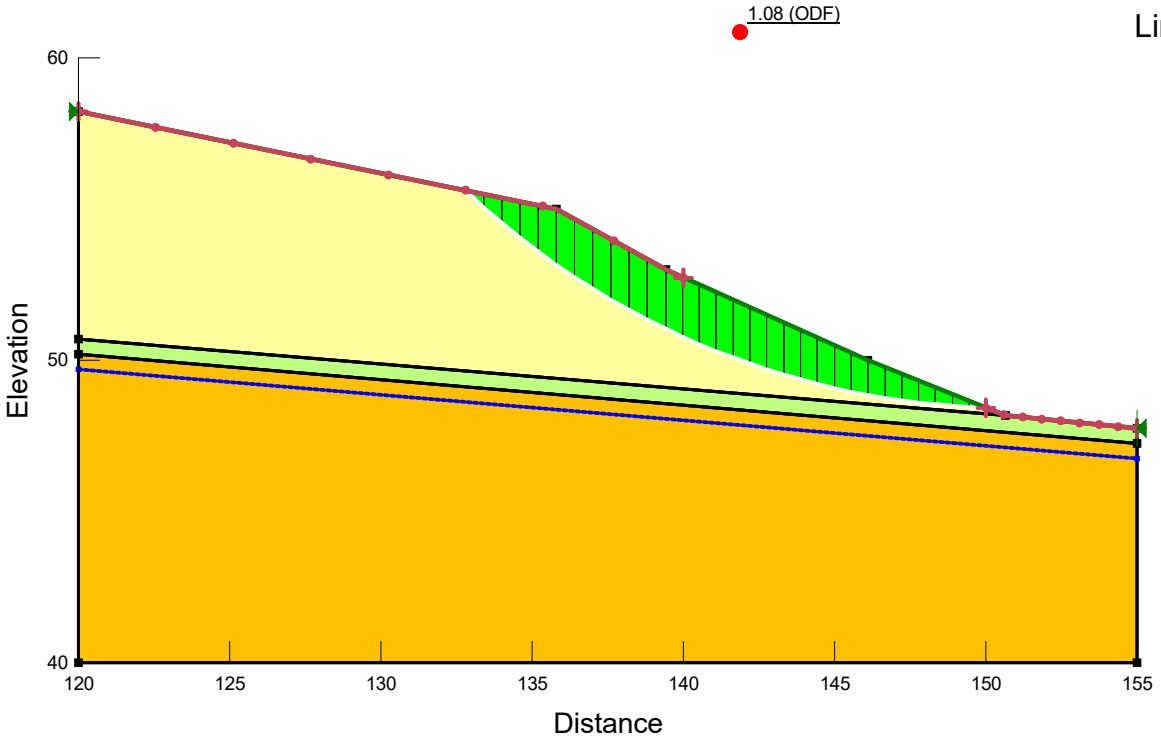


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

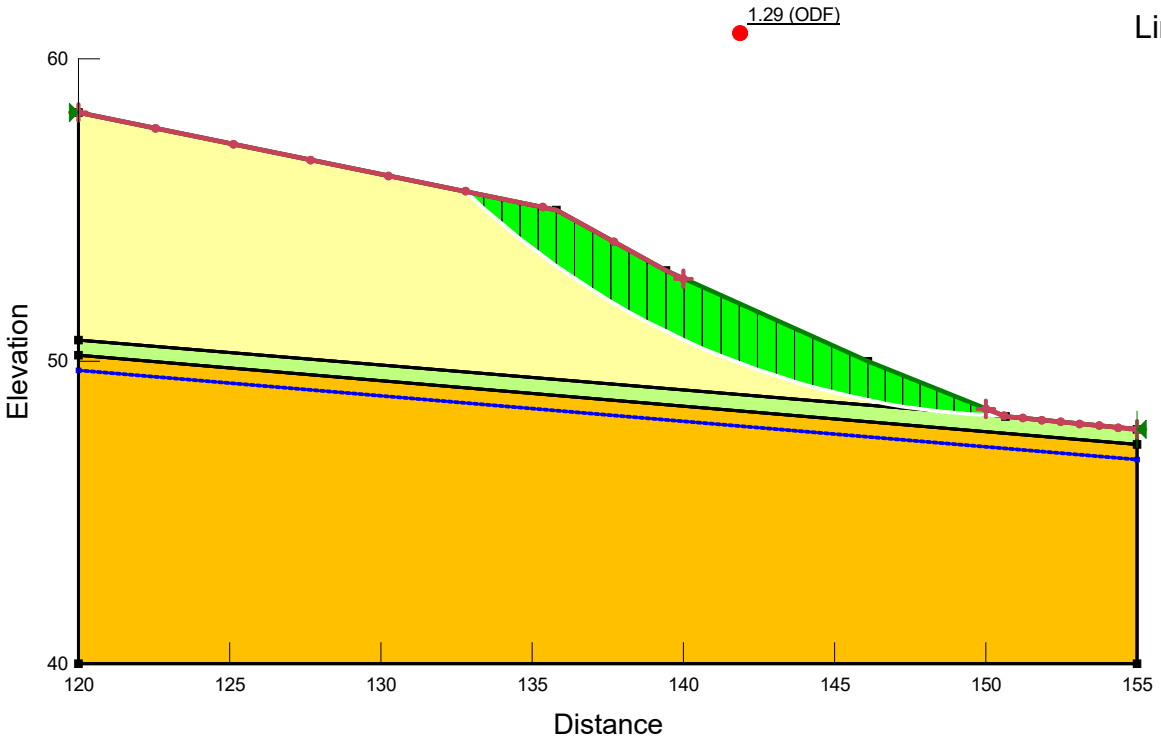


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

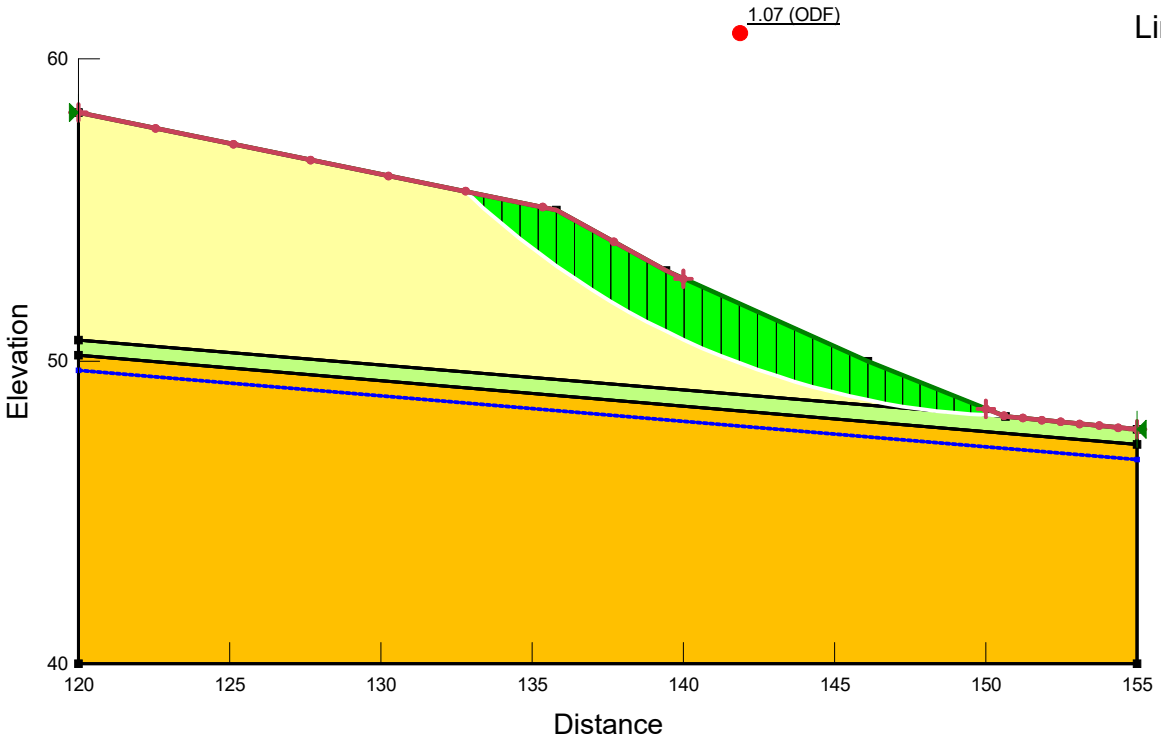


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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

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

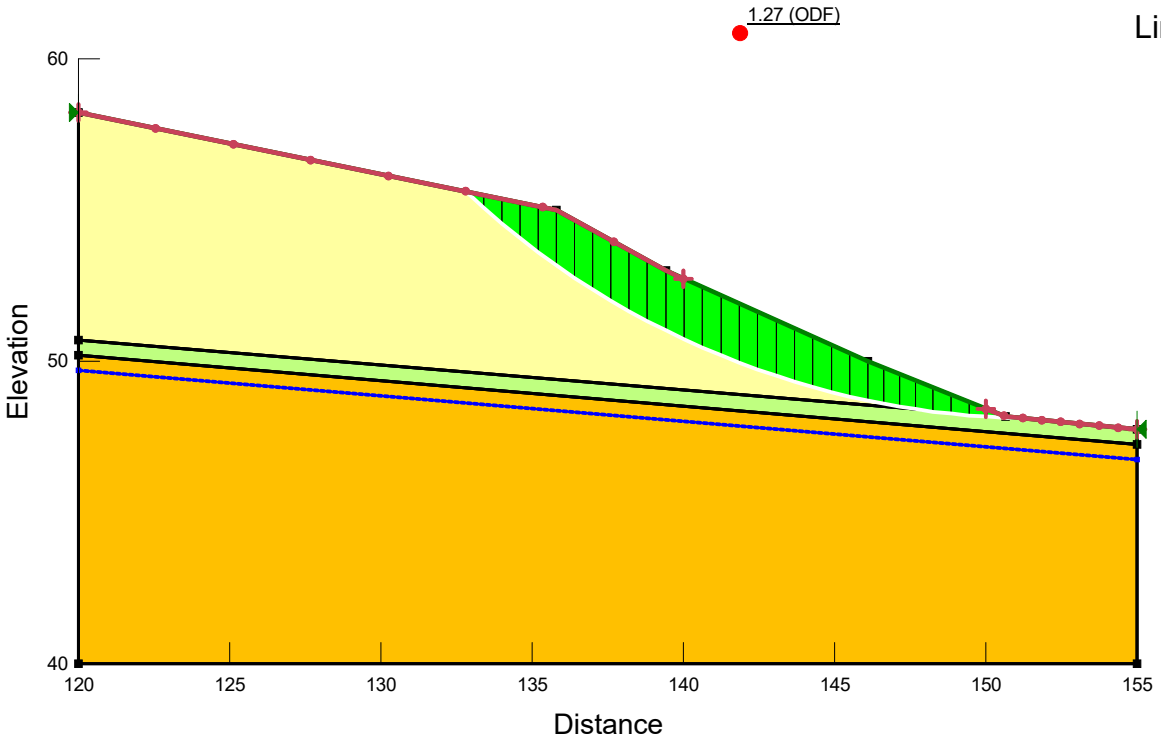


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

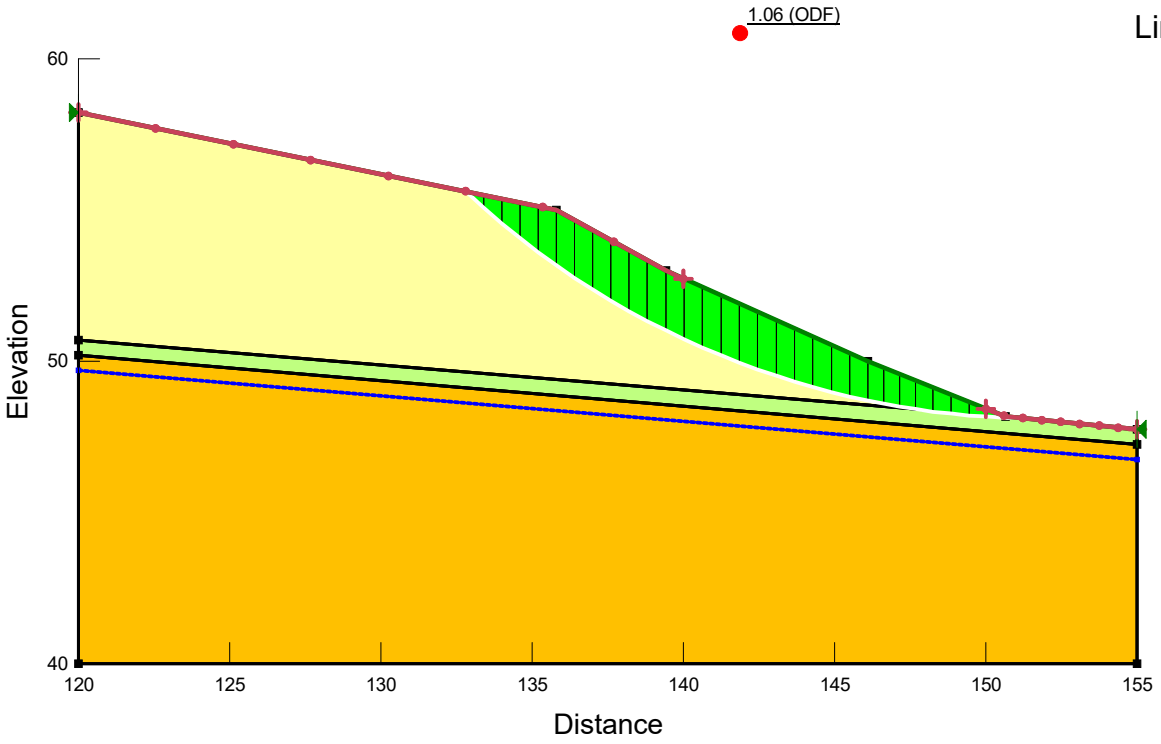


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

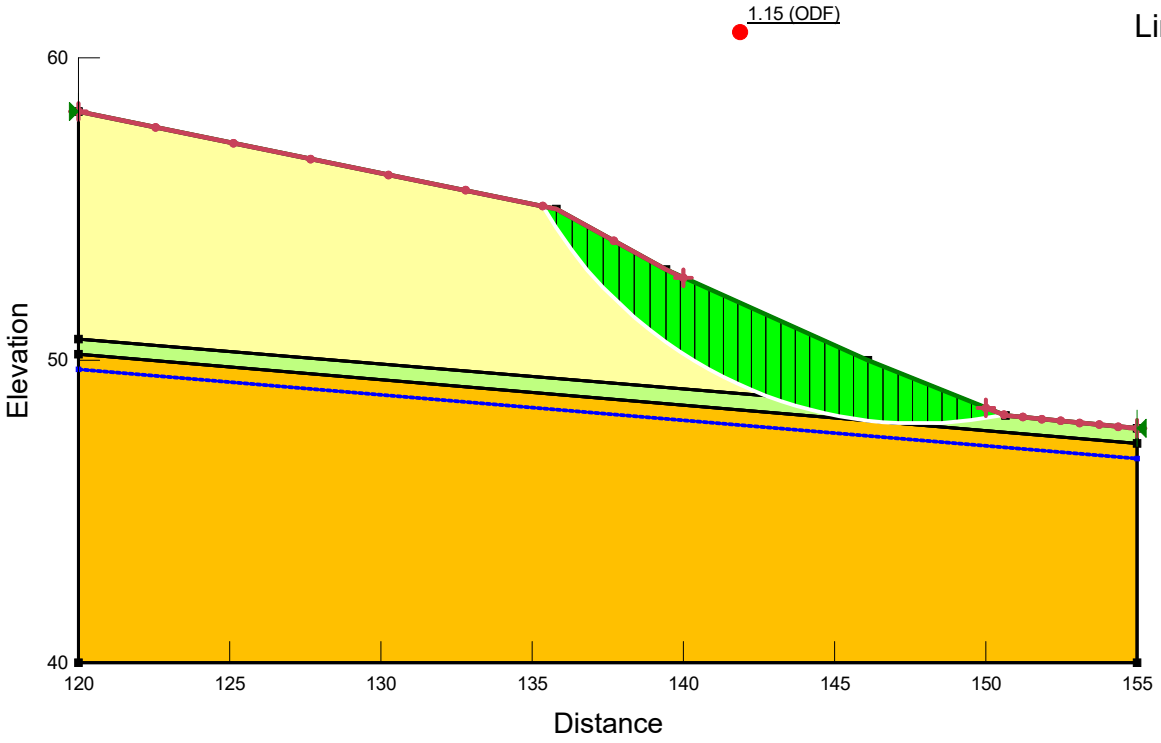


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

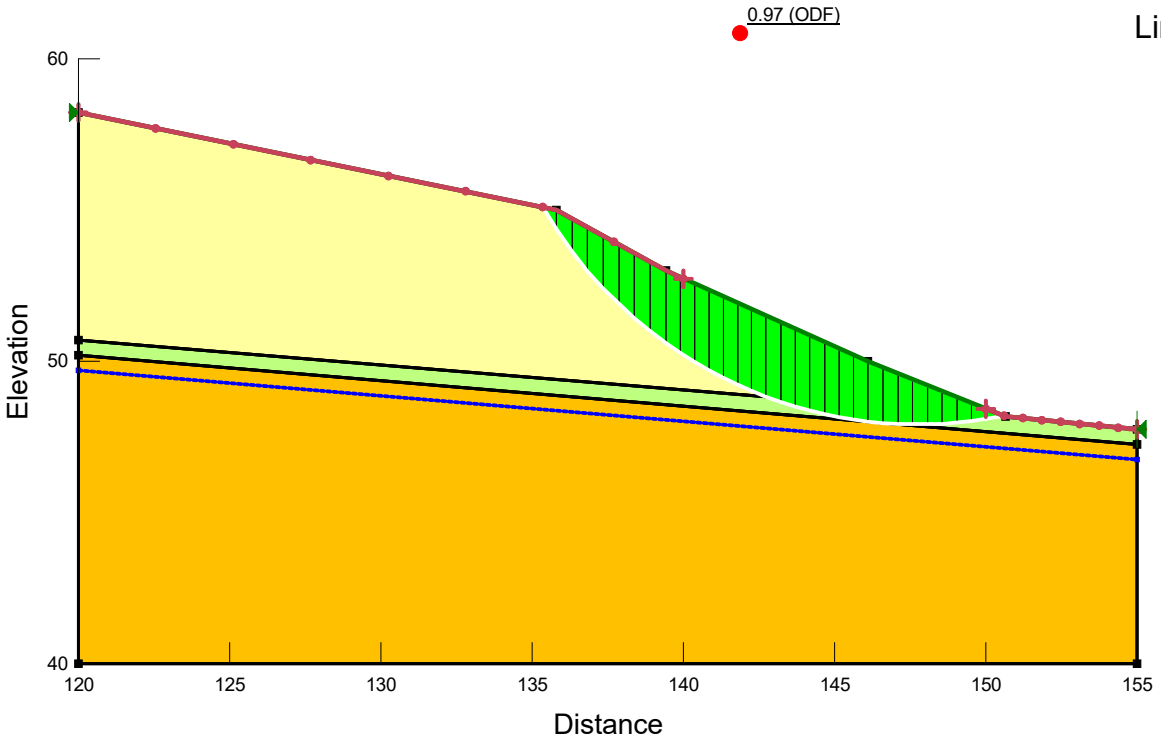


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	20
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

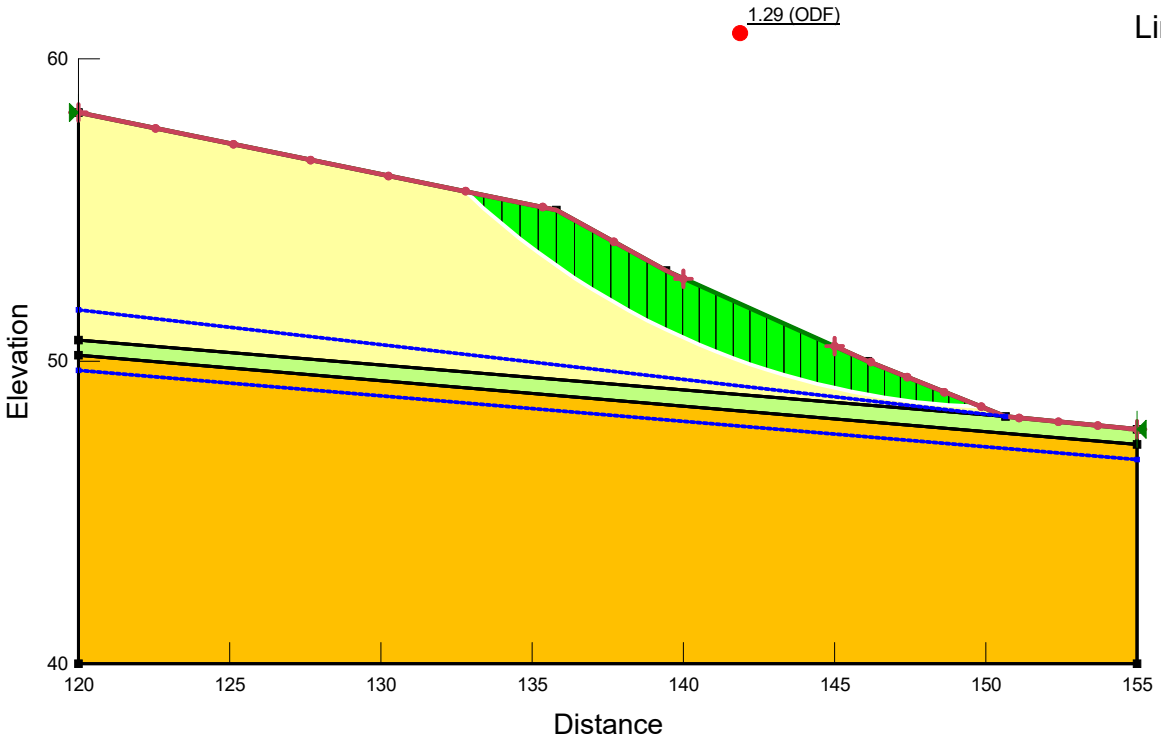


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	20
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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, C1.

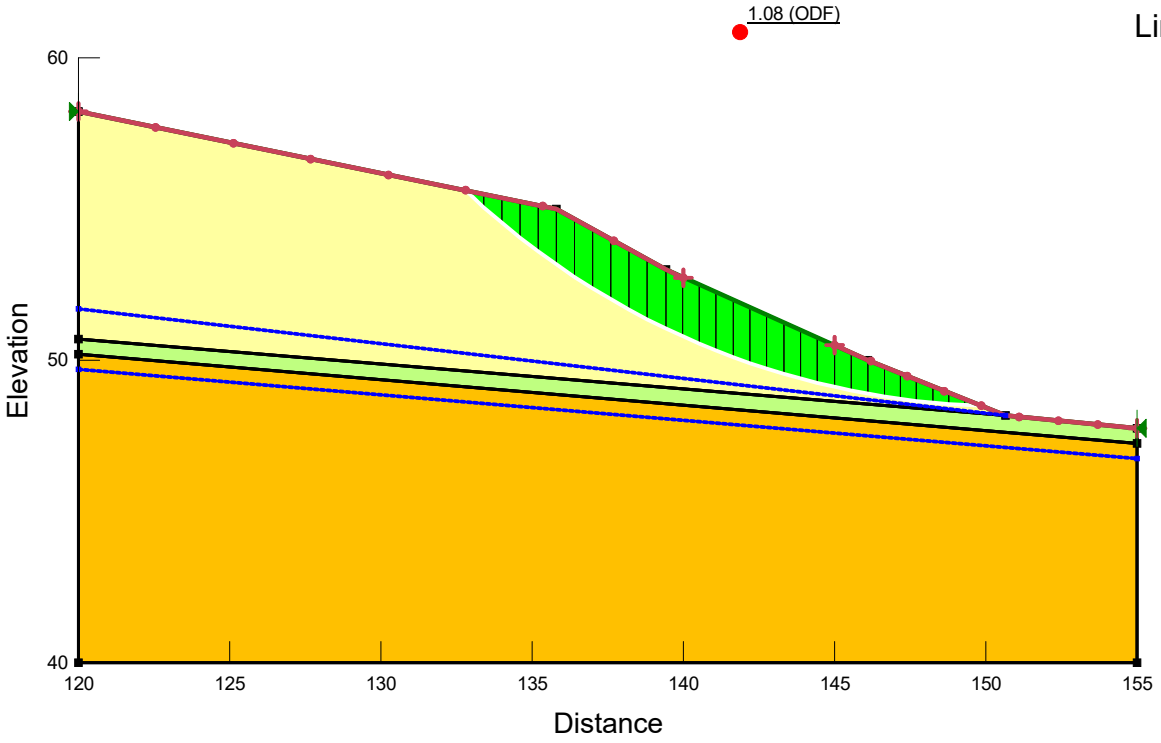


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

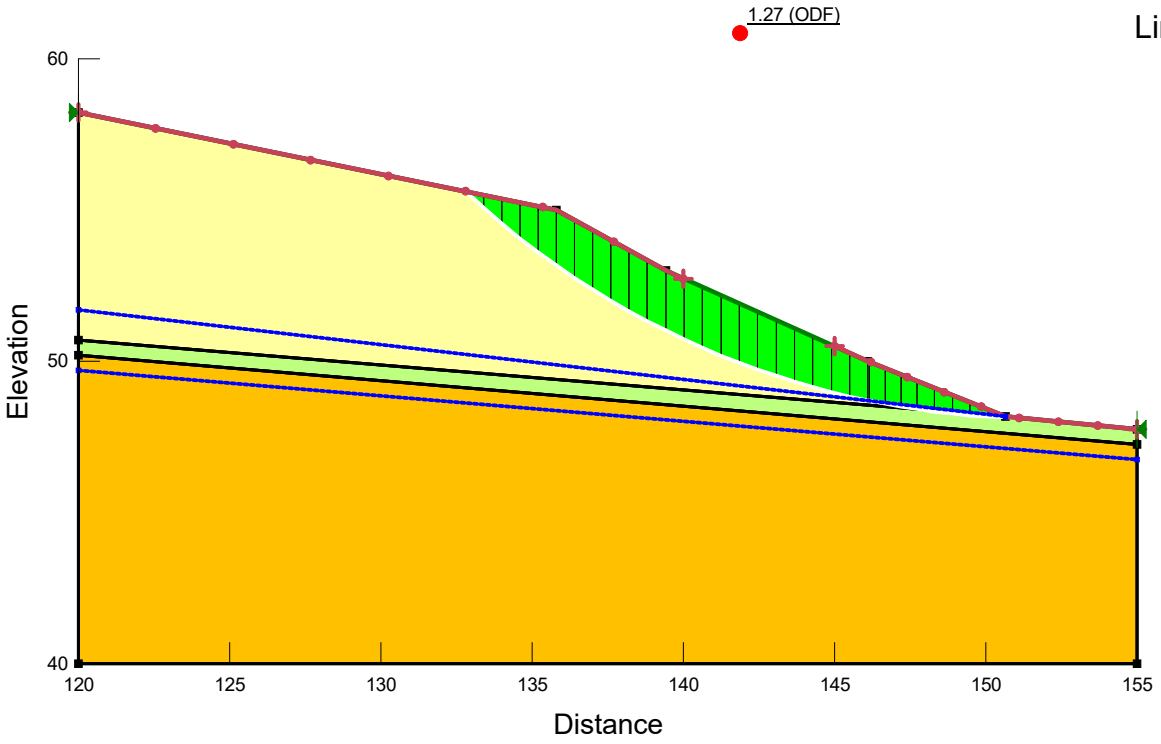


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

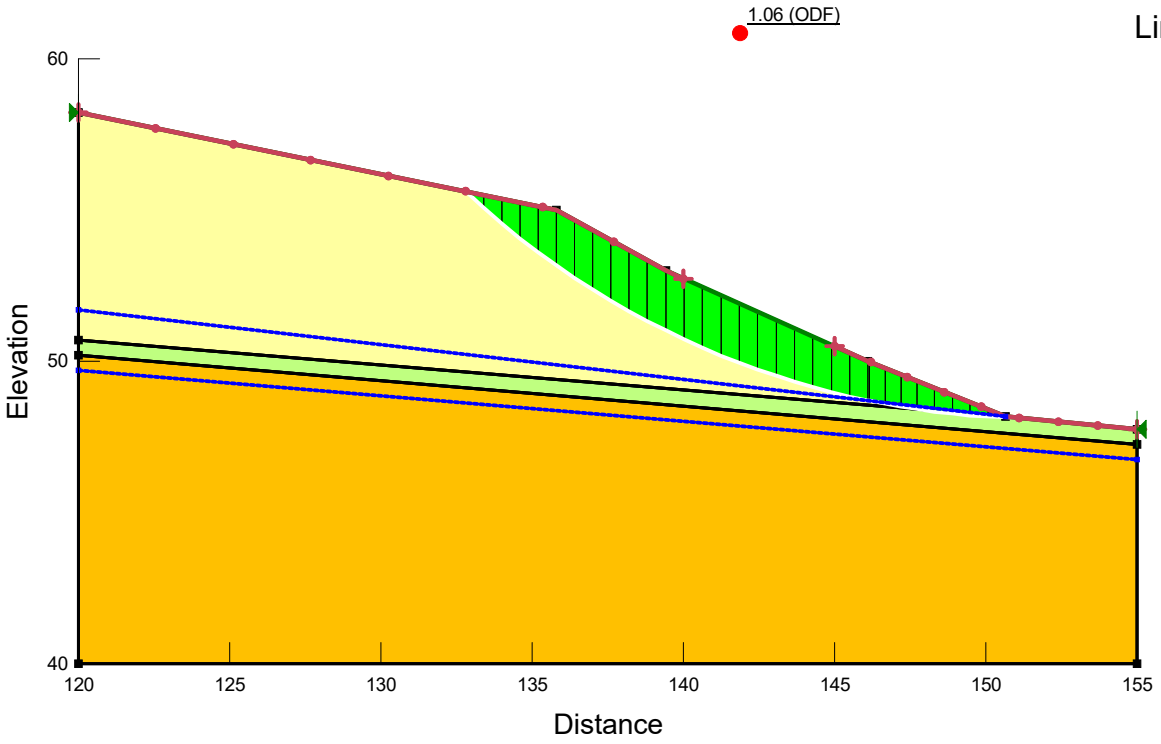


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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

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

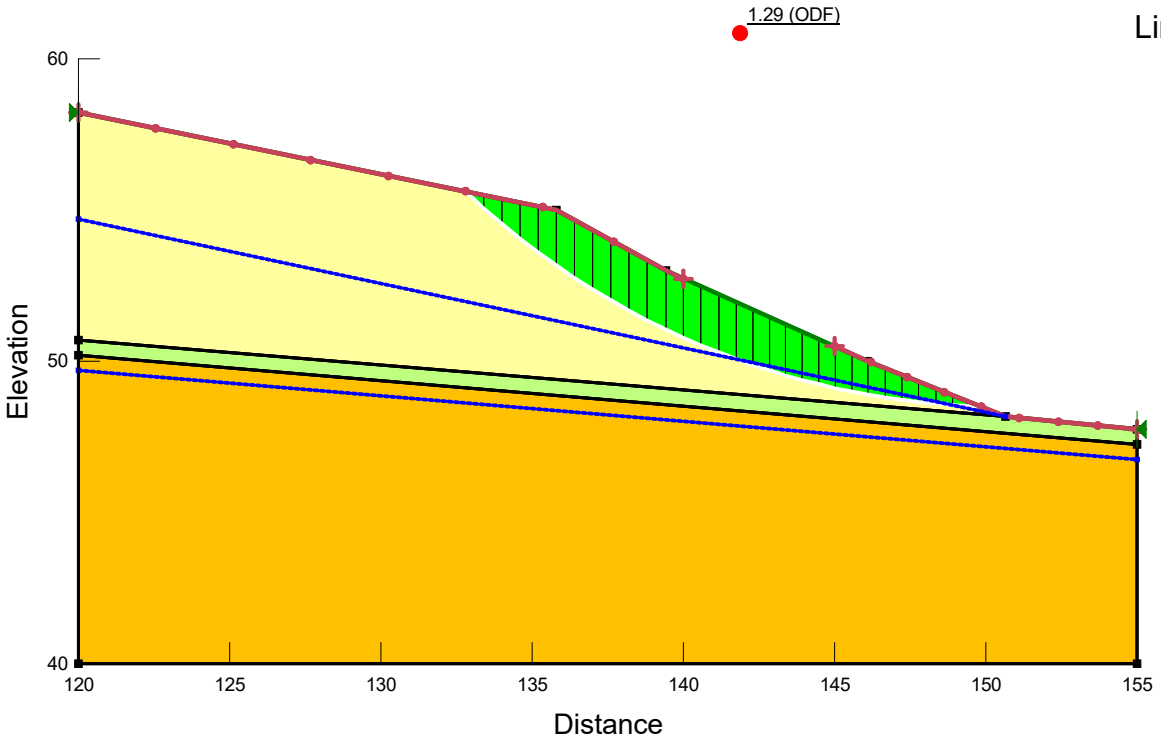


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	1	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

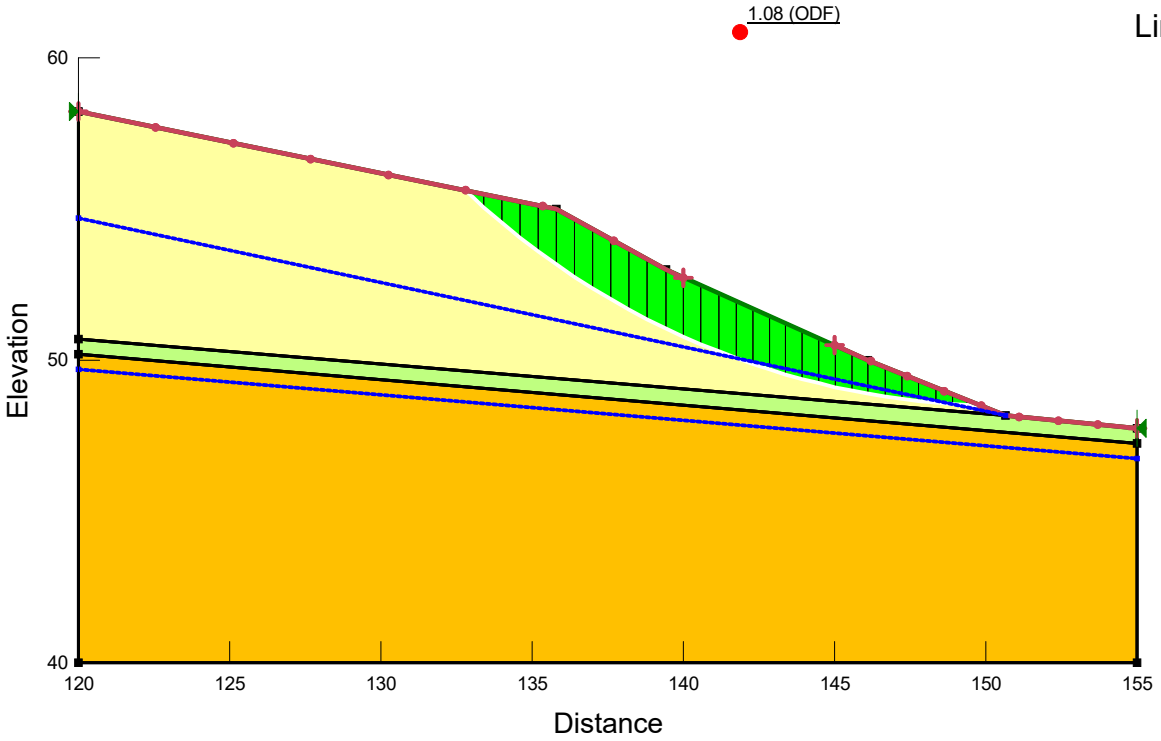


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

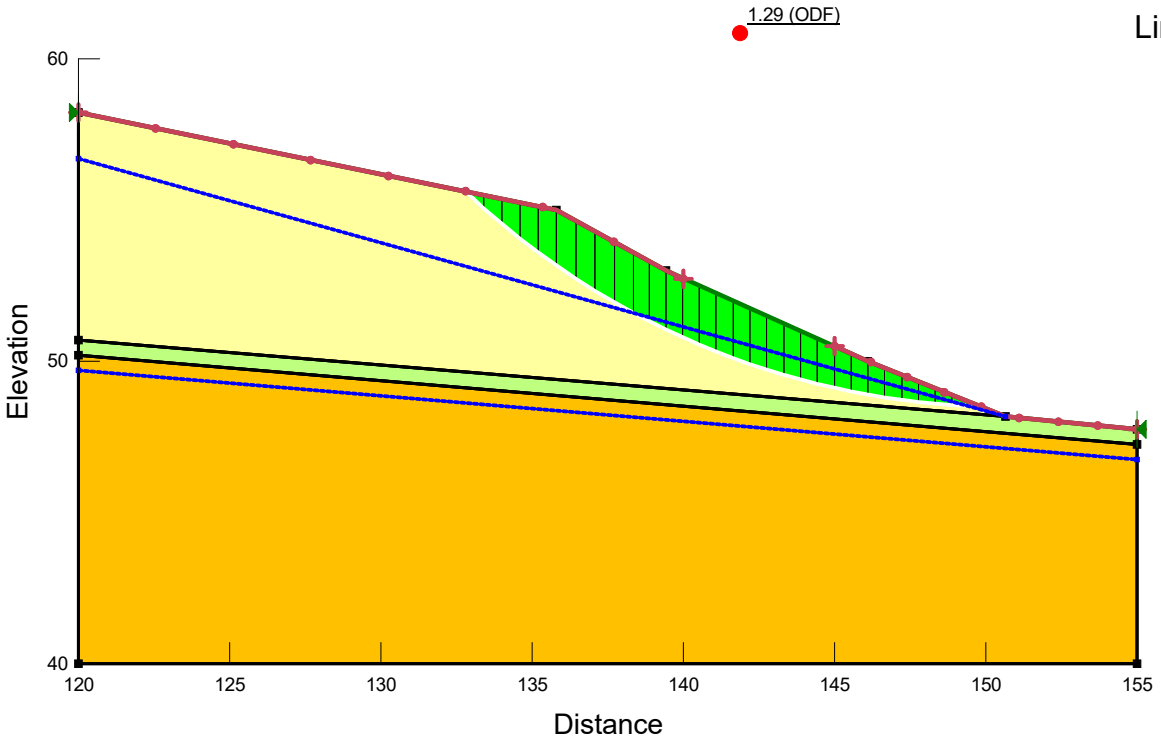


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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.

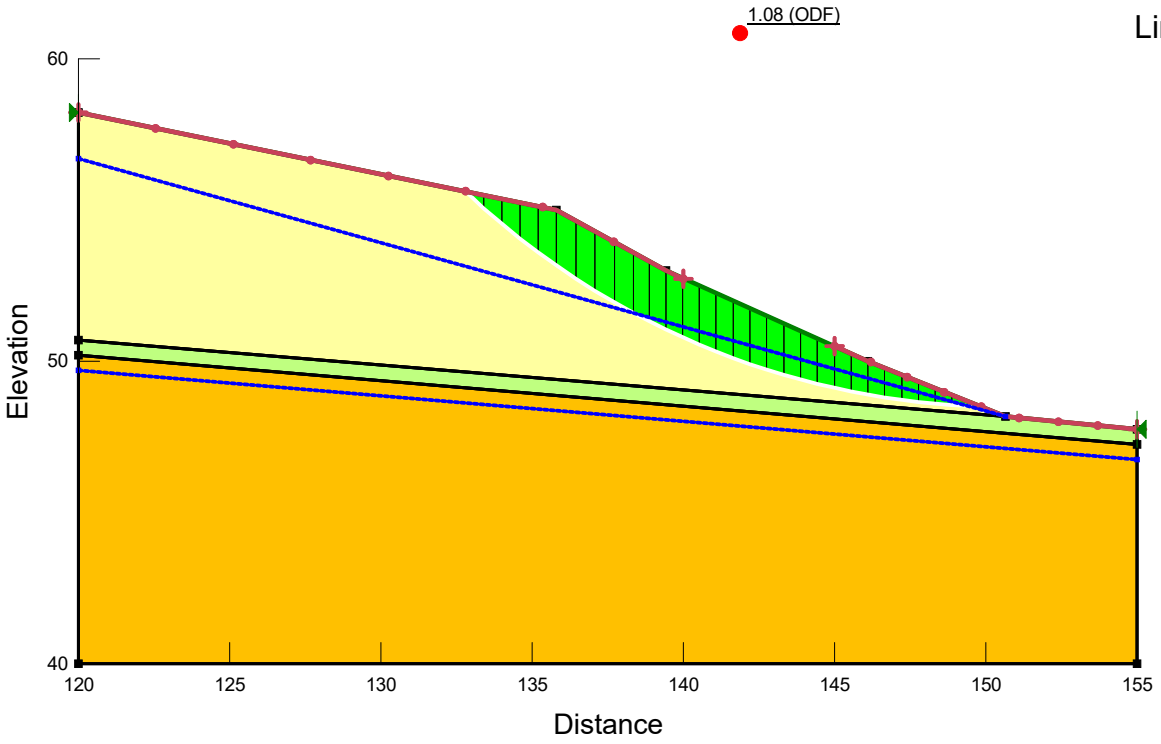


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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

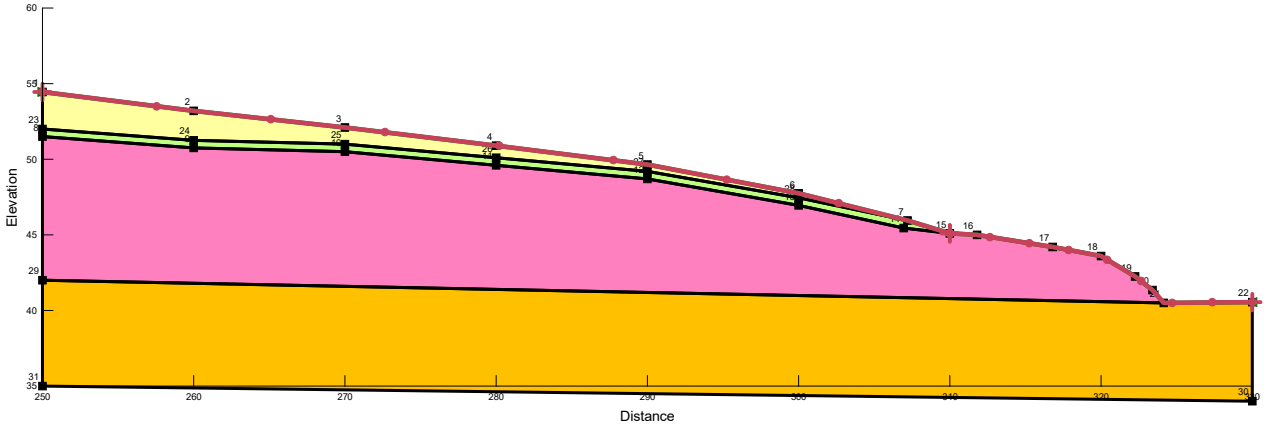
Limit State Design Approach: Eurocode 7 - DA1, C2.



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



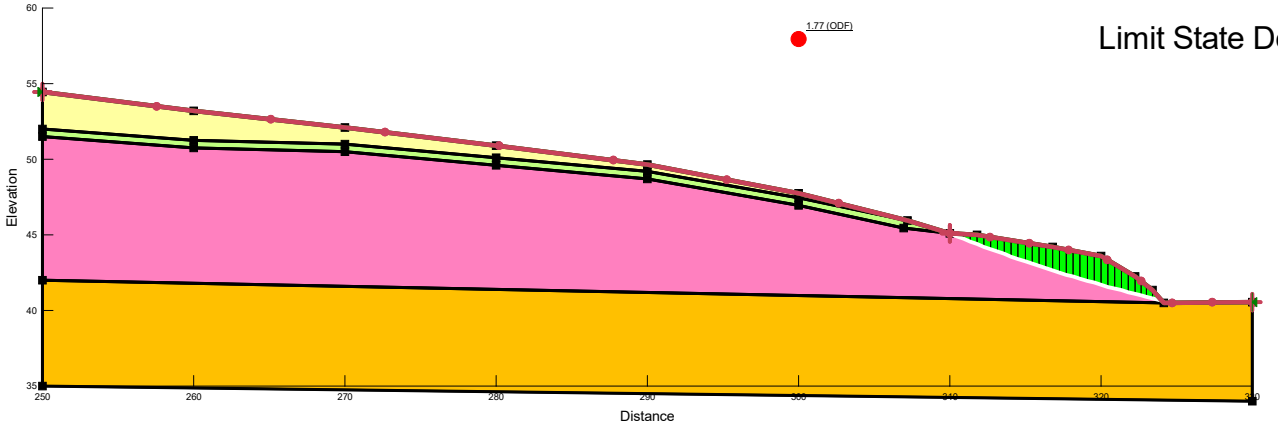
Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Artificially Established Geological Barrier, Mohr-Coulomb	Mohr-Coulomb	18	5	28
	Existing Landfill, Mohr-Coulomb	Mohr-Coulomb	18	2	25
	Inert Waste, Mohr Coulomb	Mohr-Coulomb	18	2	25
	Weathered slate, Mohr-Coulomb	Mohr-Coulomb	20	5	32

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

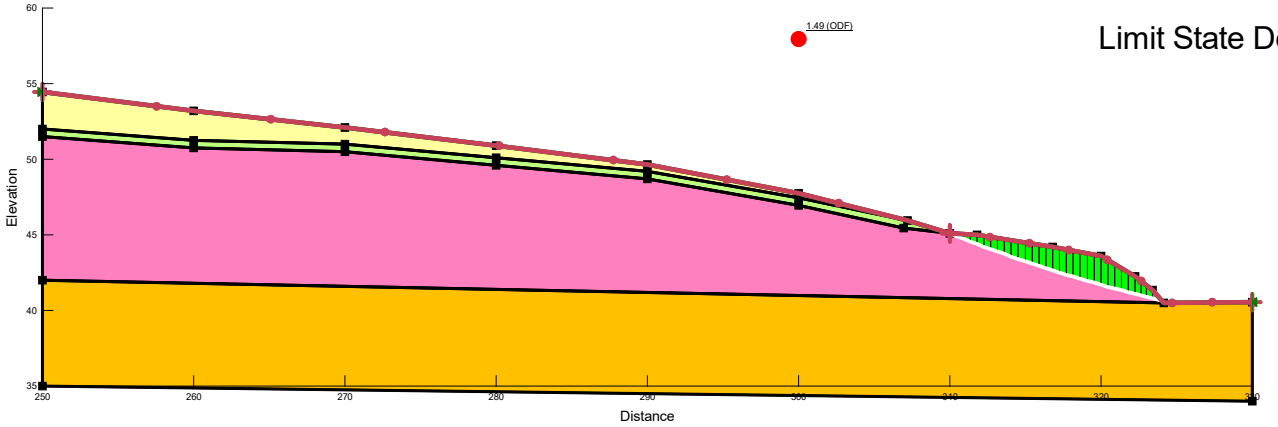


Limit State Design Approach: Eurocode 7 - DA1, C1.

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



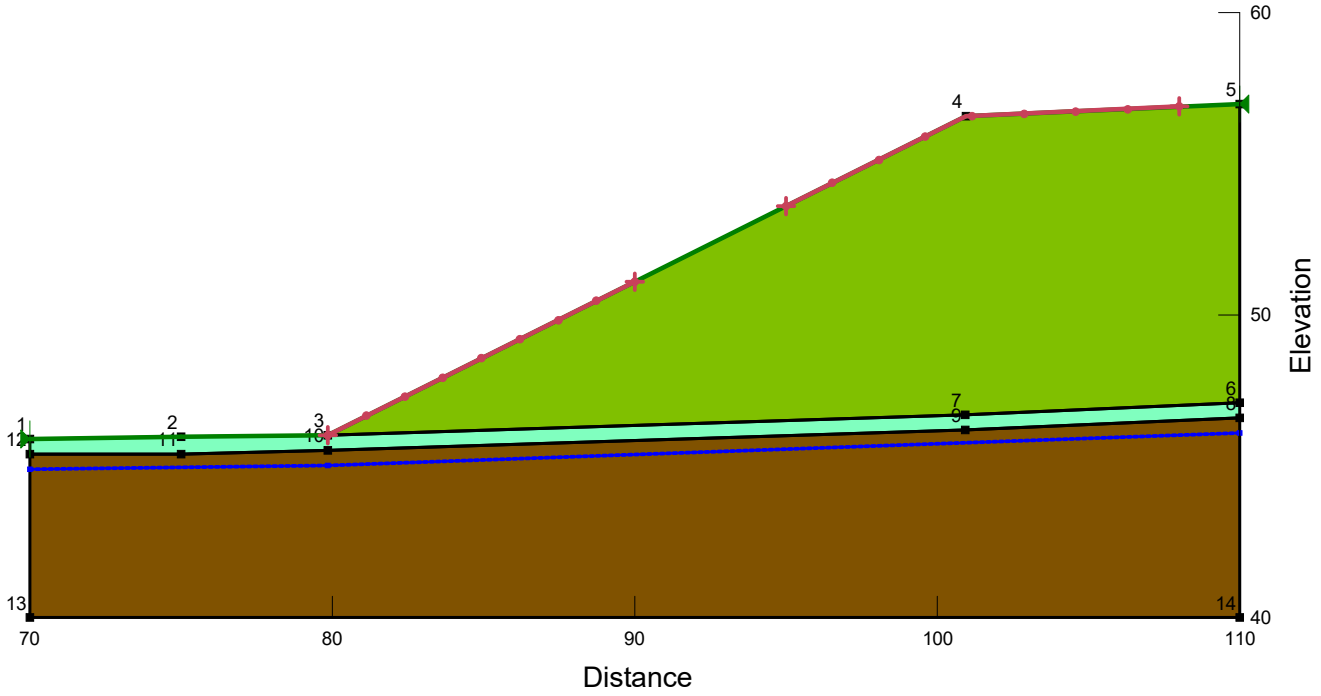
Limit State Design Approach: Eurocode 7 - DA1, C2.

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 Analysis



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.

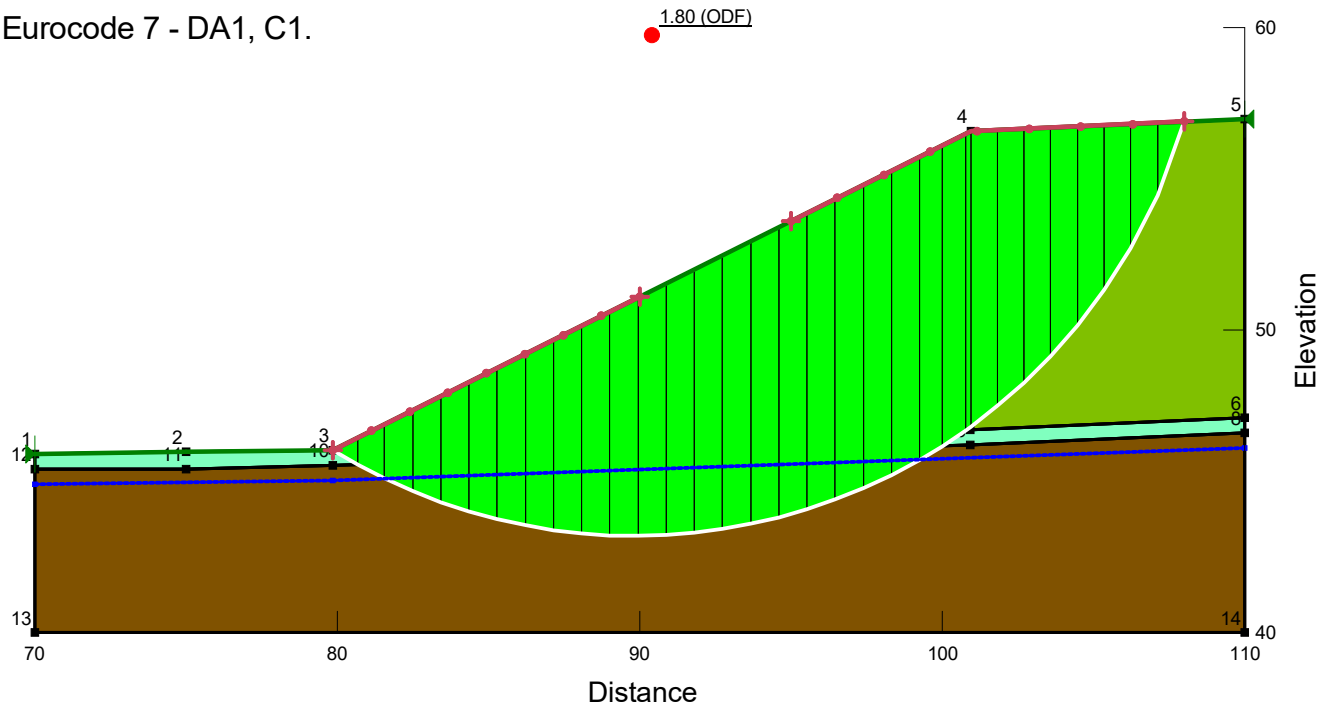


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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.

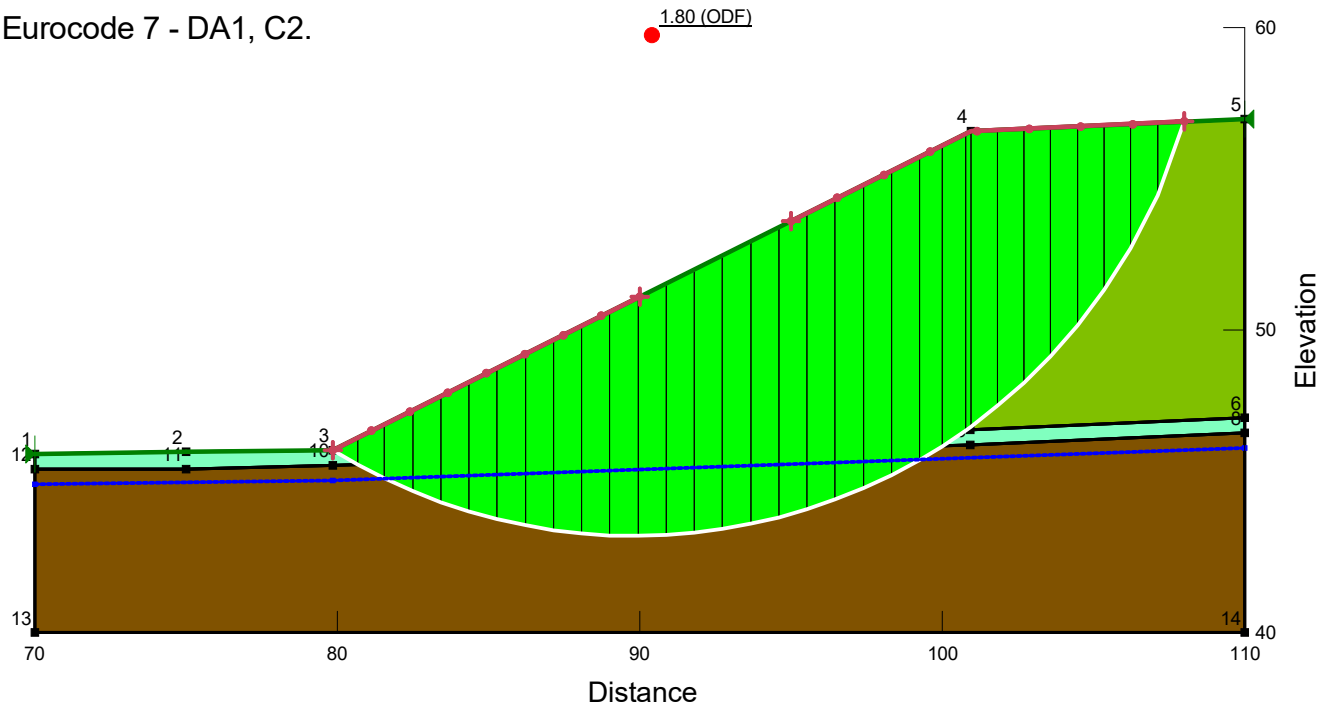


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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.

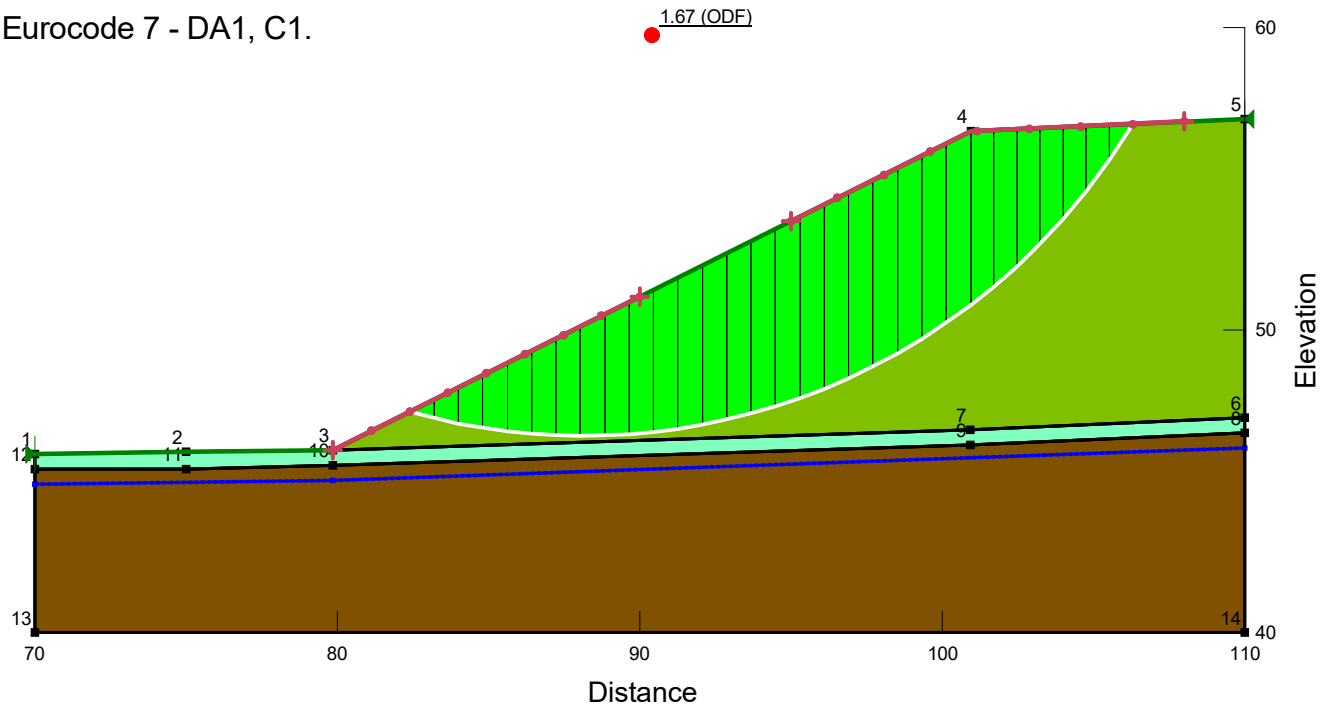


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	75
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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.

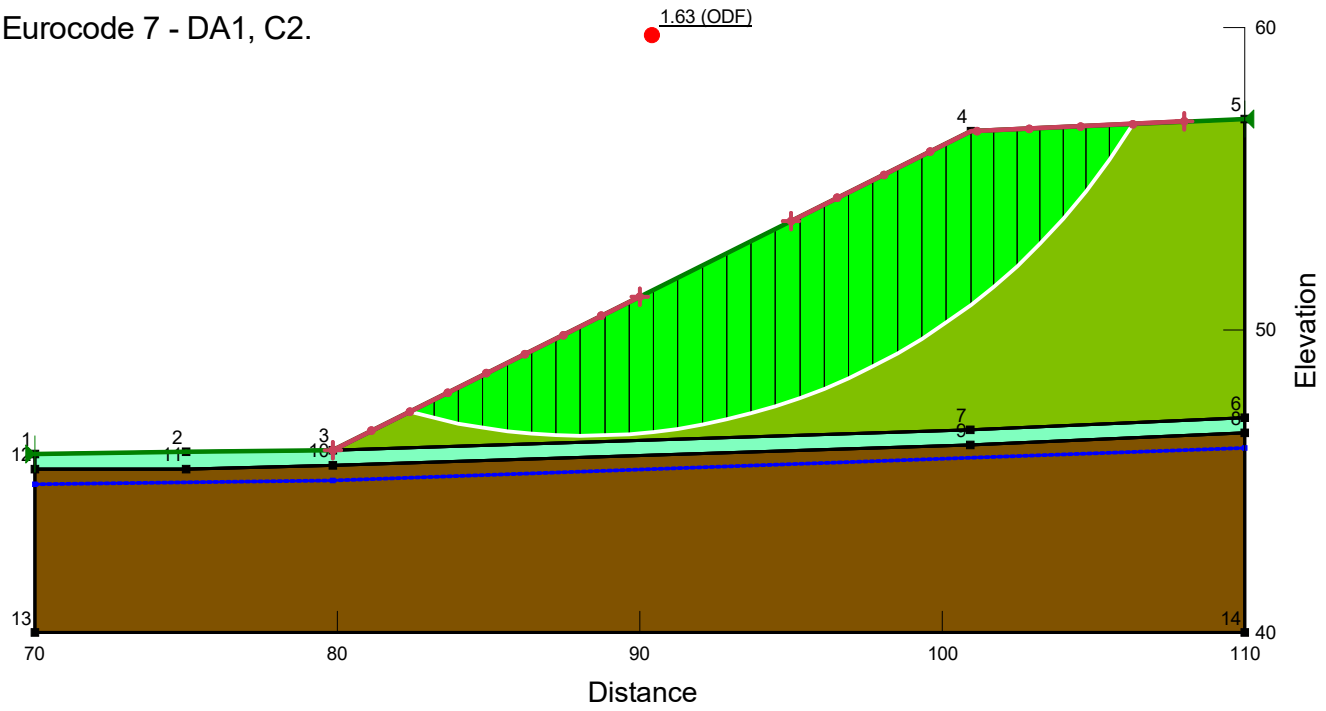


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	18	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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.

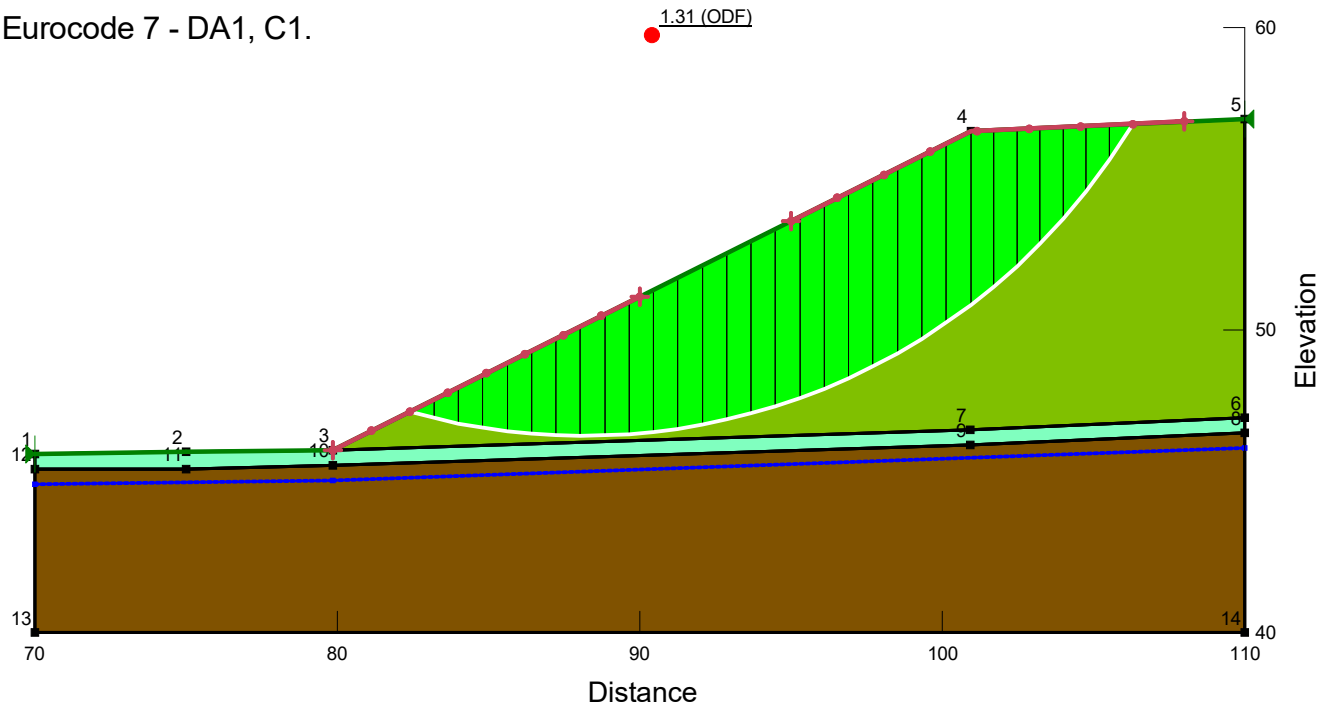


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	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
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Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

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

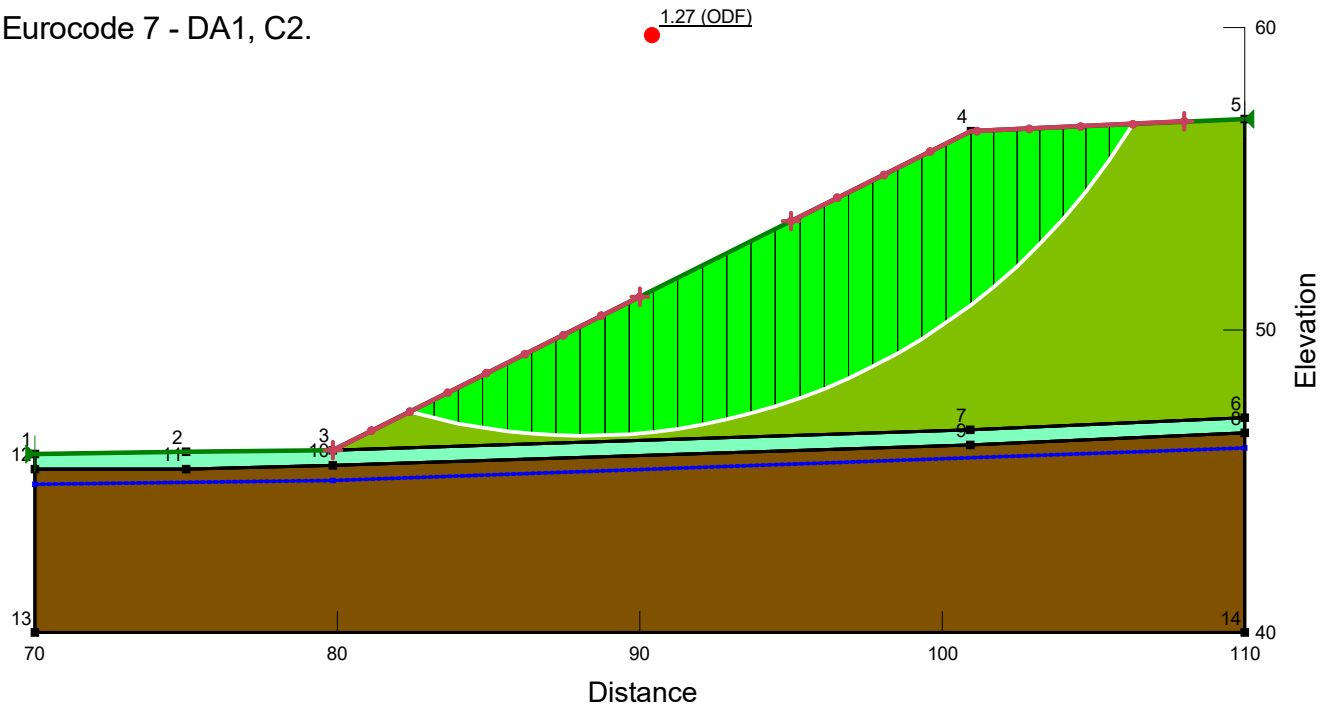


Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)
	Artificially Established Geological Barrier, Undrained	Undrained (Phi=0)	18	100
	Inert Waste, Undrained	Undrained (Phi=0)	23	50
	Weathered slate, Undrained	Undrained (Phi=0)	20	100

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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.

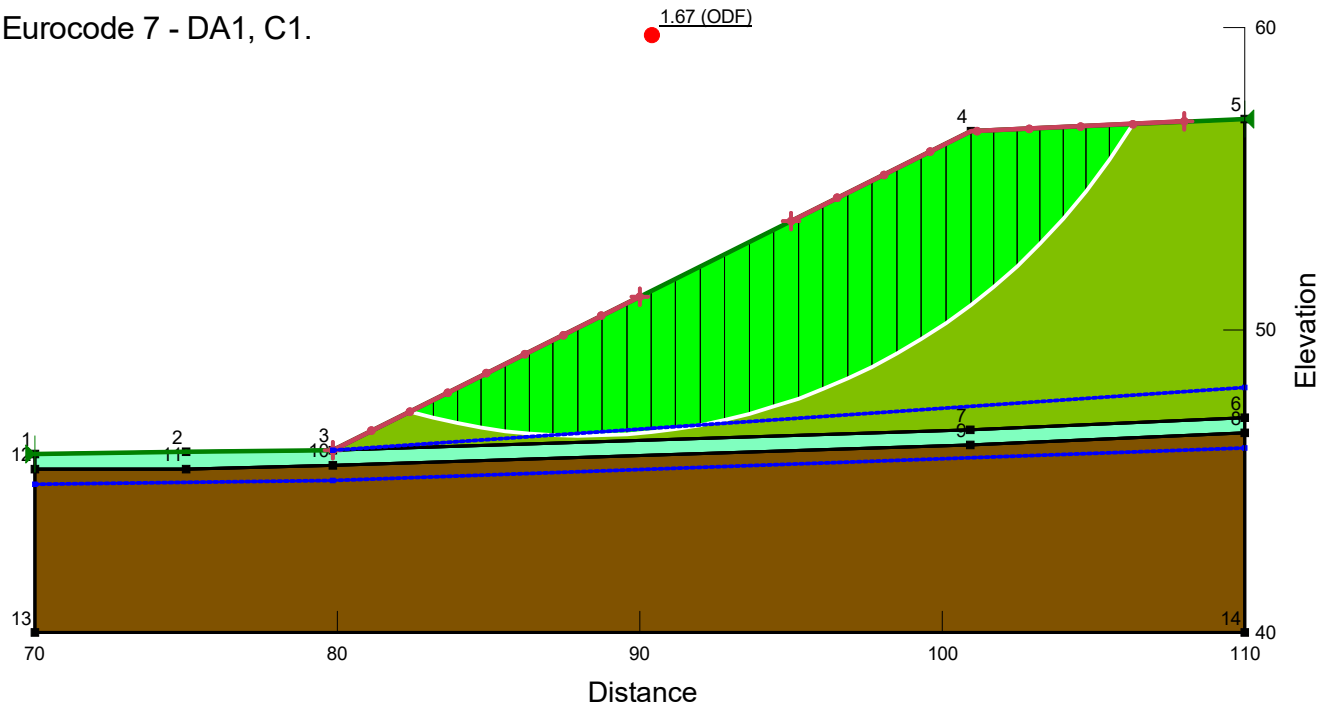


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Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

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

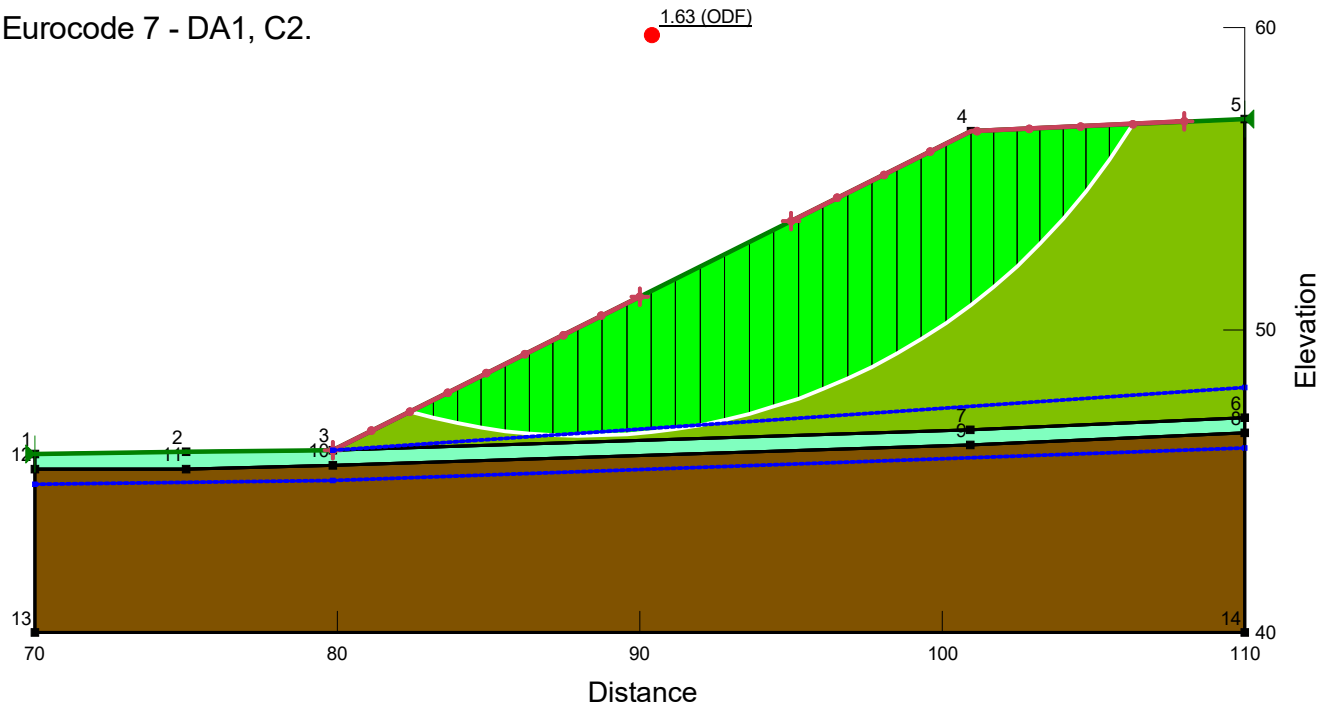


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Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

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

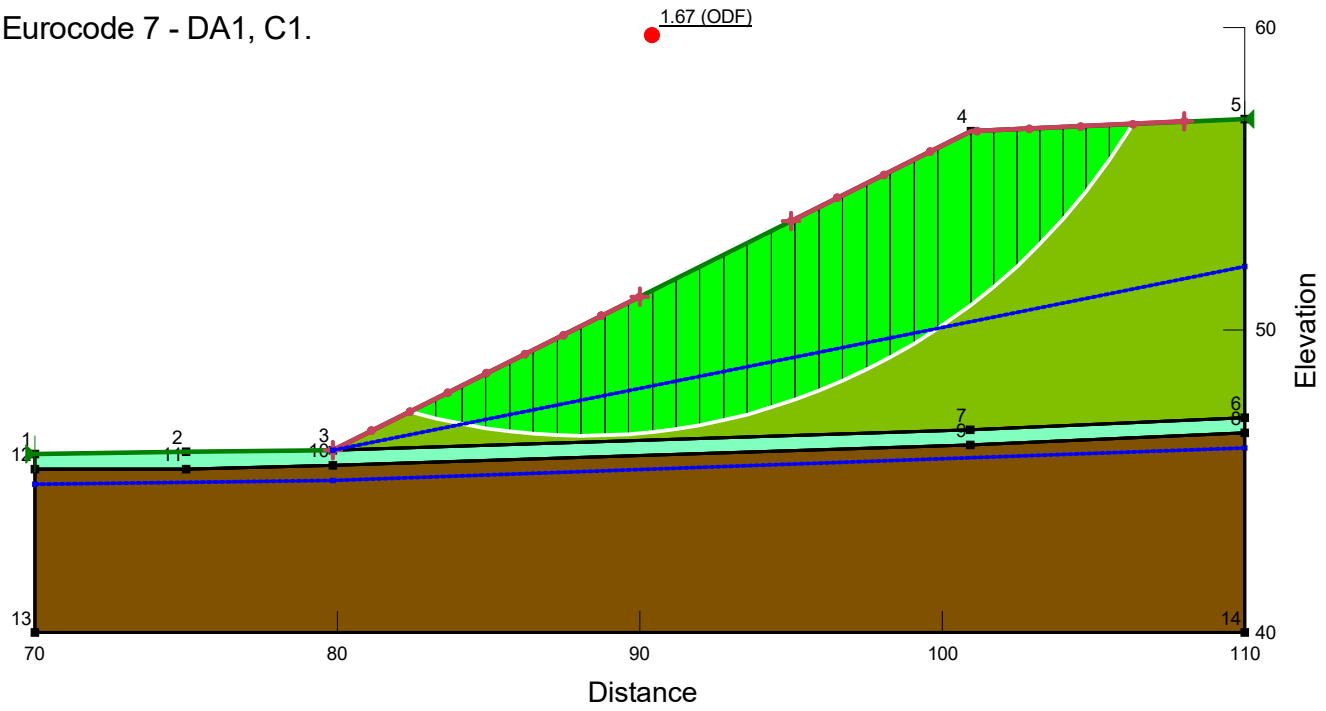


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Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

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

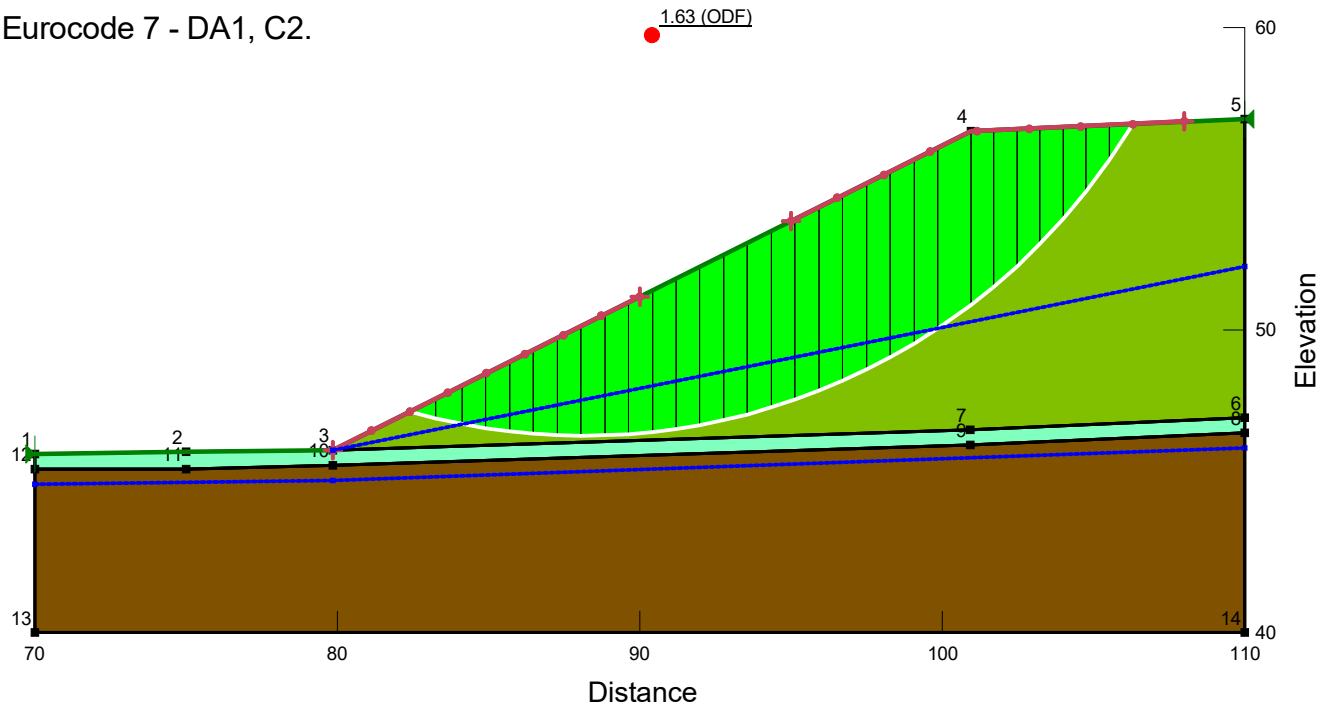


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Section SB-SB' slope configuration, total stress parameters
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Limit State Design Approach: Eurocode 7 - DA1, C2.

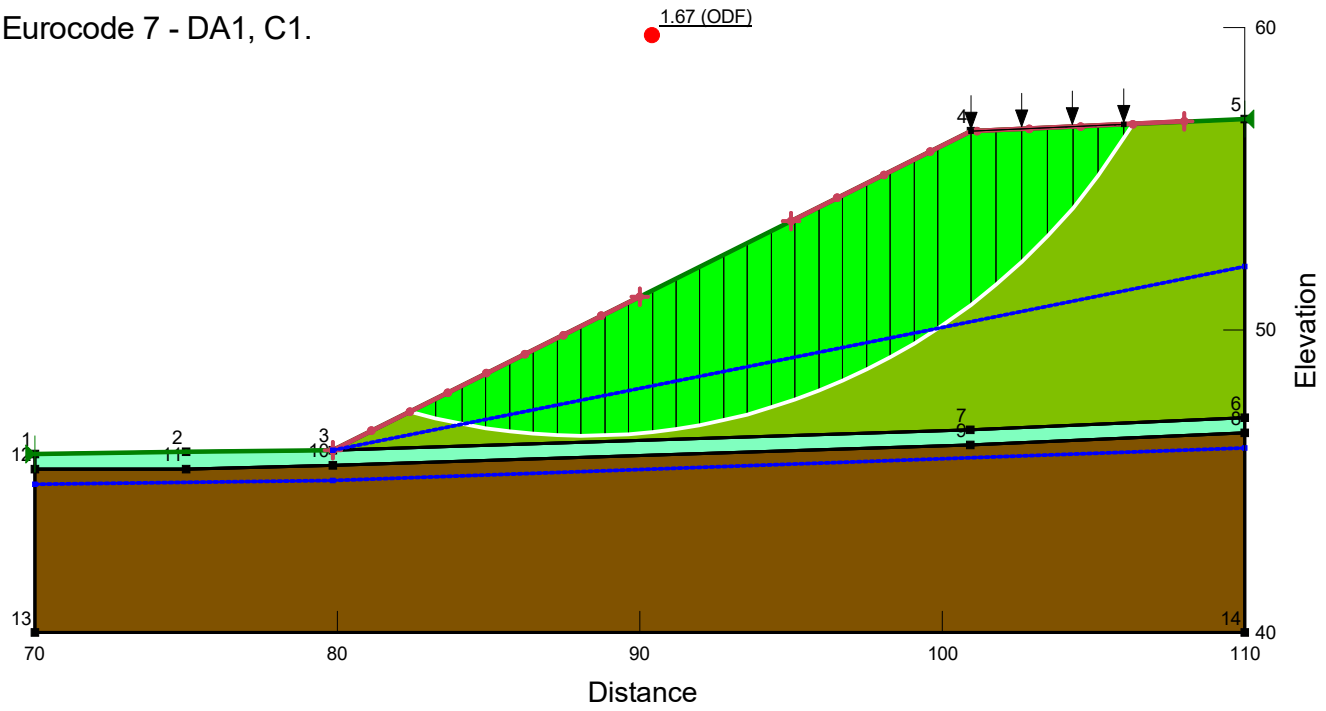


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Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

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

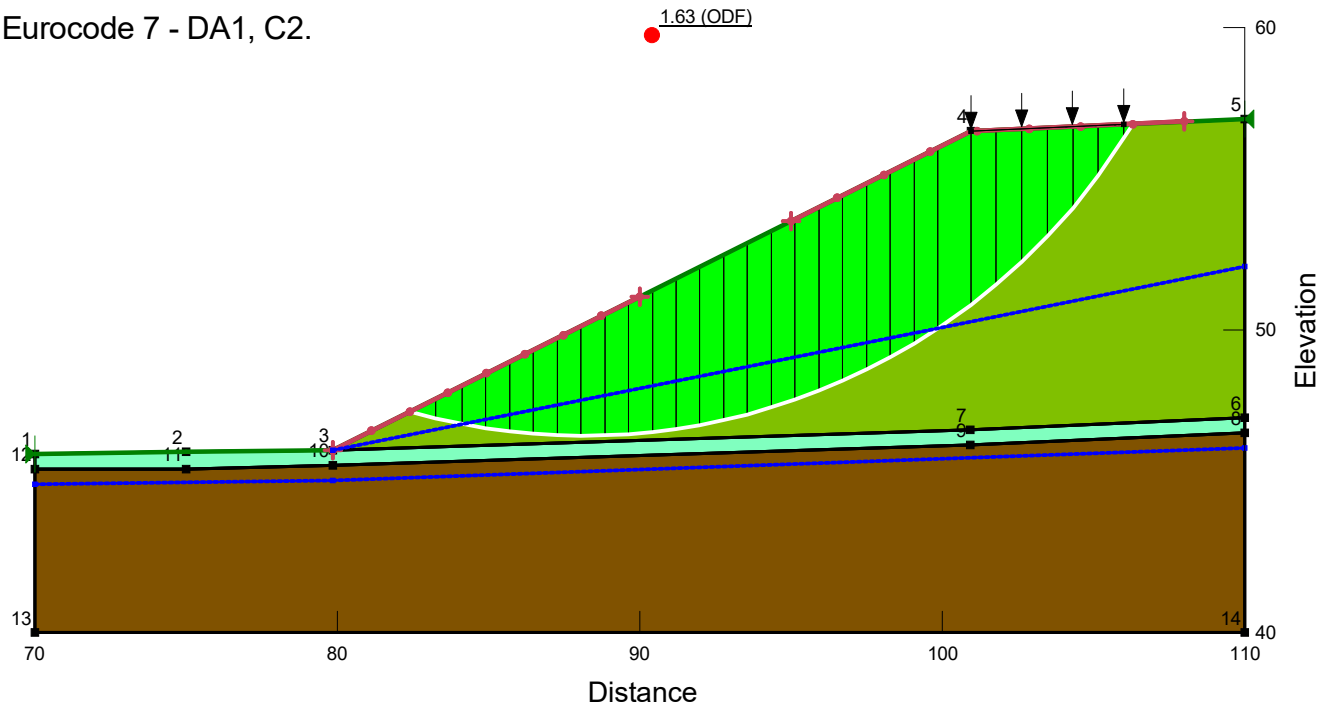


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Challonsleigh Farm Inert Landfill - Stability Risk Assessment
Section SB-SB' slope configuration, total stress parameters
(Challonsleighslopes1.gsz) 1:250

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

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