Stability Risk Assessment Report

STABILITY RISK ASSESSMENT

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DRAWINGS

The numbering and content of the drawings presented within this report will alter according to site-specific circumstances. However, typical examples of drawings that could be included are presented below.

Drawing SRA1. Conceptual Stability Site Model
A plan which identifies all of the site specific situations upon which the modelling scenarios are

APPENDIX

Appendix A: GeoSlope Models for Outer Quarry Slopes
Appendix B: Justifications for stability input values

1.0 INTRODUCTION

1.1 Report Context

To include details relating to the following :

- The operator of the proposed installation. M V Kelly Ltd
- The Agent who completed this report. Enviroarm Ltd
- An outline of the proposed installation and how it relates to historically operated areas of landfill (if appropriate).New site, inert. Quarry walls stable. Install geological barrier as waste is built up in Christmas tree so always supported by inert fill
- Cross reference to appropriate Environmental Setting and Installation Design (ESID) Reports. See Pinches/ESID.

1.2 Conceptual Stability Site Model

Primary Components

The following sub-sections present a summary of the natural geological, geosynthetic or fill materials (the latter to include engineered fill and waste) of the site model, relating to 6 components identified from and from the guidance contained within the Environment Agency R&D Technical Report P1-385/TR2.

- The basal sub-grade.
- The side slopes sub-grade.
- The basal lining system.
- The side slope lining system.
- The waste mass.
- The capping system.

Pore fluid conditions

The pore fluid conditions relevant to each of these components are considered in each sub-section. Such conditions include the following.

- Groundwater pressures acting from below the base and outside the side slopes of the model (Cross Ref to ESID series Drawings).
- Leachate pressures acting on top of the base of the model.
- Leachate pressures acting behind side slopes of the model (e.g. where leachate recirculation is undertaken in previous landfill cells).
- Landfill gas pressures acting on lining components or within the waste mass itself.
- Excess pore water pressures generated as a result of filling (either engineered fill or waste).
- Negative pore water pressures generated as a result of excavation.

The stability conceptual model is largely developed from the information contained in the ESID report.

1.2.1 Basal Sub-Grade Model

To include an outline of the following.

- The geology of the basal sub-grade (e.g. types of soils, cohesive, non-cohesive, soft rock, hard rock). Sherwood Sandstone, medium to hard to excavate, 8.5,13.5,18.5 metres unsaturated zone
- The pore fluid pressures which could act on the sub-grade. 0

1.2.2 Side Slopes Sub-Grade Model

To include an outline of the following.

- The geology of the side slopes sub-grade (e.g. types of soils, cohesive, non-cohesive, soft rock, hard rock and their structure).Sherwood Sandstone, cuts in quarry to the north have remained stable for in excess of ten years
- The range of inclinations of the slopes. Quarry slopes range from 1:1.5.Side slopes modelled, see Appendix A
- The general form of the sub-grade (e.g. areas of rock/soil cut/fill). Medium to hard sandstone
- The pore fluid pressures which could act on the sub-grade.0

1.2.3 Basal Lining System Model

- The proposed mineral and geosynthetic lining elements. Not applicable
- The proposed groundwater and leachate drainage elements. Not applicable
- The pore fluid pressures which could act on the basal lining system. Not applicable

1.2.4 Side Slope Lining System Model

To include an outline of the following.

- The proposed mineral and any geosynthetic lining elements and their interface with the waste. Not applicable.
- The proposed groundwater and leachate drainage elements. Not applicable
- The pore fluid pressures which could act on the basal lining system. Not applicable

1.2.5 Waste Mass Model

- The type of waste to be deposited, its heterogeneity and physical form. Inert compacted soils effective peak angles between18 and 45kPa.Friction angles between 20-36kPa. Soils tipped in a dry state
- The type and distribution of soils used for cover. All the same
- The site will be restored to a profile incorporating gradients
- The pore fluid pressures which could act within the waste.0

1.2.6 Capping System Model

To include an outline of the following.

- The proposed mineral and/or geosynthetic lining elements. Not applicable
- The proposed restoration cover elements, including drainage. 1 metres of sub and top soils
- The general and maximum slopes of the capping surface for pre-settlement and post settlement conditions and will be a field with slopes of 14.3 to 17.6.
- The gas pressure that could act on the underside of the system. Not applicable
- The pore fluid pressure which could act within the capping system.0

2.0 STABILITY RISK ASSESSMENT

2.1 Risk Screening

Classify all issues relating to stability or integrity into simple and complex categories. Only those falling within the complex category should be subject to further detailed geotechnical analyses.

- Provision of full justification for issues classified as simple (e.g. sound bedrock forming a sub-grade) and therefore not requiring detailed geotechnical analyses.
- Summary of the reasons for classifying other issues as complex, identifying the governing geotechnical principals behind the decisions.

2.1.1 Basal Sub-Grade Screening

A summary of whether this component is considered to be an issue requiring analytical assessment or an issue which requires no further consideration (full justification given for the latter).

Not considered as part of the assessment, due to the unsaturated zone beneath the site and no lining system in place.

2.1.2 Side Slopes Sub-Grade Screening

A summary of whether this component is considered to be an issue requiring analytical assessment or an issue which requires no further consideration (full justification given for the latter).

No side slope lining required; .If as geological barrier is required in the later engineered phase this will be brought up at the same time as the waste mass .Quarry slopes are stable as per Appendix A

2.1.3 Basal Lining System Screening

A summary of whether this component is considered to be an issue requiring analytical assessment or an issue which requires no further consideration (full justification given for the latter).

Geological barrier on base will be stable due to slope of 1:100 to perfectly flat. There is therefore no slide. Unsaturated zone so no basal heave. No subsidence as no historical mining.

2.1.4 Side Slope Lining System Screening

A summary of whether this component is considered to be an issue requiring analytical assessment or an issue which requires no further consideration (full justification given for the latter).

No requirement

2.1.5 Waste Mass Screening

A summary of whether this component is considered to be an issue requiring analytical assessment or an issue which requires no further consideration (full justification given for the latter). No consideration needed. The site will be an inert landfill site accepting solid inert wastes. The soil is laid in horizontal layers no greater than 2 metres in thickness and compacted.

2.1.6 Capping System Screening

A summary of whether this component is considered to be an issue requiring analytical assessment or an issue which requires no further consideration (full justification given for the latter).

The site will be restored to a profile incorporating gradients between of 14.3 to 17.6

2.2 Lifecycle Phases

Identification of critical phases during the development of the landfill. In order to ensure that the Stability Risk Assessment fully addresses the key issues throughout the life of the landfill, the following operational factors should be taken into consideration.

- Phasing of Subgrade Slopes. Not applicable
- Phasing of engineered fill and waste placement (rate of construction). Not applicable
- Waste mass geometry (height/outer slope inclination/crest width) vs. time. Not applicable
- Leachate management. Not applicable
- Landfill gas management. Not applicable
- Daily cover characteristics. Not applicable
- Temporary capping characteristics. Not applicable

2.3 Data Summary

Provision of a summary of geotechnical data as follows.

- Site specific data.
- Published data with justification for its use.
- Assumed data with justification for its use.
- Uncertainties in the data to be used and proposals for addressing those uncertainties (e.g. sensitivity analyses).

The geotechnical data used as input for detailed analyses to include the following (where appropriate).

- Material unit weight.1.50-2.00Mg/m^3
- Soil characterisation data (particle size distribution/plasticity index/natural moisture content).Inert soils, generally have a moisture content of between 10% and 20%
- Drained shear strength of soils and rocks.25-40kPa
- Undrained shear strength of cohesive soils.+100kPa
- Shear strength of interfaces.
- Groundwater pressures.0

- Leachate pressures.0
- Potential landfill gas pressures.0
- Excess pore water pressure dissipation characteristics of cohesive soils.
- Consolidation characteristics of soils and waste. Low less than 2%
  Permeability characteristics of soils and waste . Hydraulic conductivity measurements have been made on a variety of scales on the Permo-Triassic sandstones. The distribution of core hydraulic conductivities of the Wildmoor Sandstone Formation and its local lateral equivalents, has a range of values locally from, from 2.02 x 10^{-6}m/s to 8.8 x10^{-6}m/s and a pronounced negative skew, due to the presence of more low hydraulic conductivity values than high, most likely the result of lithological control. The lowest hydraulic conductivities occur in the strongly cemented horizons, fluid flow in these is most likely to occur in fractures. Medium-grained strata have intermediate hydraulic conductivities. Horizontal hydraulic conductivity values are higher than vertical value, which gives an anisotropy ratio. Test locations are shown at Appendix ESID 3.
- Discontinuity characteristics of rock masses. Not applicable
- Geotechnical parameters for any ground improvement methods adopted (e.g. soil reinforcement).Not required
- Stiffness characteristics of soil and waste.

In situ horizontal stresses in waste.

2.4 Justification for Modelling Approach and Software

- Quarry walls modelled using GeoSlope. The site is stable with the slopes constructed and complies with the Quarries Regulations 1999.

2.5 Justification of Geotechnical Parameters Selected for Analyses

To include the following.

- Assessment of the quality and relevance of site-specific data. See Appendix B
- Assessment of the relevance/applicability of non site-specific data. See Appendix B
- Methodology/reasoning adopted for the derivation of parameters (e.g. statistical analysis, conservative estimates). Geo Slope

2.5.1 Parameters Selected for Basal Sub-Grade Analyses

A summary of data used in the analysis of this component. Not applicable

2.5.2 Parameters Selected for Side Slopes Sub-Grade Analyses

A summary of data used in the analysis of this component. BGS data, G Walton

2.5.3 Parameters Selected for Basal Liner Analyses

A summary of data used in the analysis of this component. Not applicable

2.5.4 Parameters Selected for Side Slope Liner Analyses

A summary of data used in the analysis of this component. Ass the liner is built up in small lifts at 2 metres at a time and then landfilled directly behind no slope is exposed for a long period. The internal deposited soils will have minimal consolidation.

2.5.5 Parameters Selected for Waste Analyses

A summary of data used in the analysis of this component. Not applicable

2.5.6 Parameters Selected for Capping Analyses

A summary of data used in the analysis of this component. Wedge analysis on final profiles assessed

2.6 Selection of Appropriate Factors of Safety

The factor of safety is the numerical expression of the degree of confidence that exists, for a given set of conditions, against a particular failure mechanism occurring. It also represents the confidence in the input parameters used and analysis method used. It is commonly expressed as the ratio of the load or action which would cause failure against the actual load or actions likely to be applied during service. This is readily determined for some types of analysis (e.g. limit equilibrium slope stability analyses). However, greater consideration must be given to analyses which do not report factors of safety directly. For example, a finite difference analysis of shear strains within a steep side slope lining system would not usually indicate overall ‘failure’ of the model even though the strains could be high enough to indicate a failure of the *integrity* of the lining system. In such cases, it is necessary to define an upper limit for shear strains and to express the factor of safety as the ratio of allowable strain to actual strain.

Prior to determining appropriate factors of safety for the various components of the model, it is necessary to identify key ‘receptors’ and evaluate the consequences in the event of a failure (relating to both stability and integrity). Consideration of the following receptors is required.

- Groundwater. Not applicable
- Other environmental receptors.None
- Property - relating to site infrastructure, third party property. No third property within vicinity
- Human beings (i.e. direct risk).

The Factor of Safety adopted for each component of the model would be related to the consequences of a failure.

2.6.1 Factor of Safety for Basal Sub-Grade

A description of the relevant factors involved in the selection of the factor of safety for this component. Not applicable

2.6.2 Factor of Safety for Side Slopes Sub-Grade

A description of the relevant factors involved in the selection of the factor of safety for this component 1.3

2.6.3 Factor of Safety for Basal Lining System

A description of the relevant factors involved in the selection of the factor of safety for this component. Not applicable

2.6.4 Factor of Safety for Side Slope Lining System

A description of the relevant factors involved in the selection of the factor of safety for this component. Not applicable

2.6.5 Factor of Safety for Waste Mass

A description of the relevant factors involved in the selection of the factor of safety for this component. 1.3

2.6.6 Factor of Safety for Capping System

A description of the relevant factors involved in the selection of the factor of safety for this component.1.3

2.7 Analyses

To include details relating to the following.

- The completion of a sufficient sensitivity analysis, which may include the use of multiple model runs to simulate different justifiable ranges of input parameter values.

2.7.1 Basal Sub-Grade Analyses

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.7.2 Side Slopes Sub-Grade Analyses

Presentation of the approach to and the results of the analyses undertaken for this component. See Appendix A

2.7.3 Basal Liner Analyses

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.7.4 Side Slopes Liner Analyses

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.7.5 Waste Analyses

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.7.6 Capping Analyses

Presentation of the approach to and the results of the analyses undertaken for this component.

2.8 Assessment

To comprise a reasoned review of the results of the analyses, and to include the following.

- The consideration of analytical limitations, the assessment of uncertainties and the potential effects on Factors of Safety.
- An overall assessment of risk for each component.

2.8.1 Basal Sub-Grade Assessment

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.8.2 Side Slopes Sub-Grade Assessment

Presentation of the approach to and the results of the analyses undertaken for this component. See Appendix A, slopes stable.

2.8.3 Basal Liner Assessment

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.8.4 Side Slopes Liner Assessment

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.8.5 Waste Assessment

Presentation of the approach to and the results of the analyses undertaken for this component. Not applicable

2.8.6 Capping Assessment

Presentation of the approach to and the results of the analyses undertaken for this component.

3.0 MONITORING

3.1 The Risk Based Monitoring Scheme

Monitoring may need to be undertaken. For example, this could take the form of basal settlement monitoring, pore water pressure monitoring or slope movement monitoring.

The Stability Risk Assessment should be used to develop risk-based monitoring objectives and schedules. Consequently, this section must provide the technical rationalisation for the design of a monitoring programme, to focus monitoring effort on actual risks.

Where geotechnical monitoring is adopted, appropriate assessment and performance criteria must be specified within each of the appropriate sections. Full justification and a clear audit trial must be provided for each proposed criterion.

3.1.1 Basal Sub-Grade Monitoring

Provide details of the proposed monitoring scheme. Not applicable

3.1.2 Side Slopes Sub-Grade Monitoring

Provide details of the proposed monitoring scheme. Visual inspection

3.1.3 Basal Lining System Monitoring

Provide details of the proposed monitoring scheme. Not applicable

3.1.4 Side Slope Lining System Monitoring

Provide details of the proposed monitoring scheme. Visual inspection. Shear vane testing and soil pentration strength tests

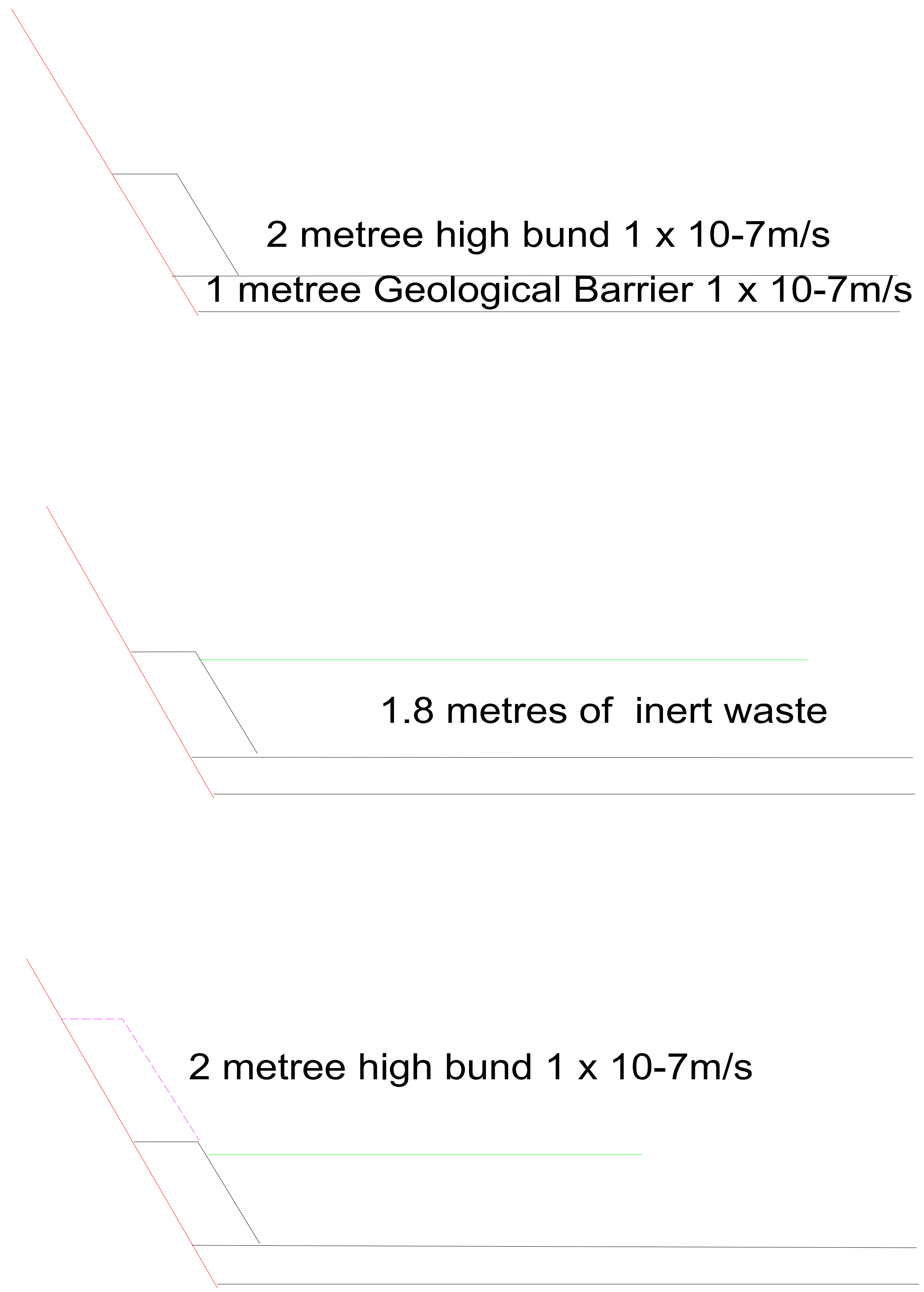
3.1.5 Waste Mass Monitoring

Provide details of the proposed monitoring scheme. Visual inspection

3.1.6 Capping System Monitoring

Provide details of the proposed monitoring scheme. Visual inspection

DRAWING



The Contractor is to check and verify all building and site dimensions, levels and sewer invert levels at connection points prior to the commencement of works.

This drawing must be read with and checked against any structural or other specialist drawings provided by the client.

The Contractor is to comply in all respects with the current Building Regulations and CDM regulations whether or not specifically stated on these drawings.

This drawing is not intended to show details of foundations, ground conditions or ground contaminants. Each area of ground relied upon to support the proposed works, including drainage, depicted must be investigated by the contractor, suitable methods of foundation be provided and any suspect contaminents on or within the ground covered by the works be further investigated by a suitable expert.

Notes

ENVIROARM LIMITED

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Client: Chadwich Lane Quarry Ltd

Project: Chadwich Lane Quarry Landfill

Title: Geological Barrier

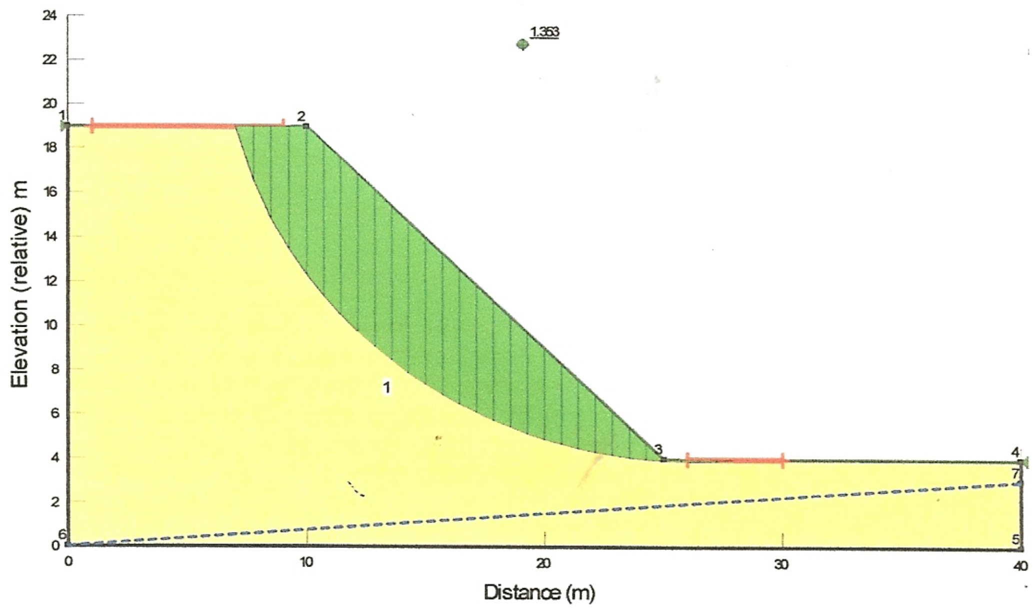
Date : NOV 2022	Scales:		
Drawn: ARM	Project No. SRA	Drg No. 1	Rev.
Checked:			

APPENDIX A:

GeoSlope Models for Outer Quarry Slopes

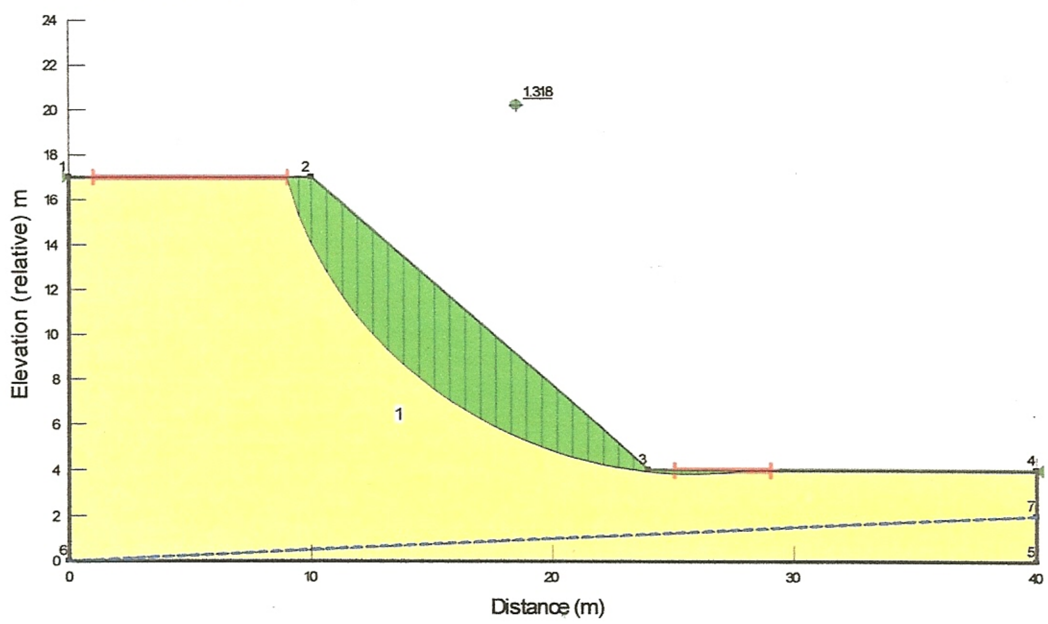
SLOPE1

Material #: 1
Description:
Model: MohrCoulomb
Wt: 2
Cohesion: 0
Phi: 42
Piezometric Line: 1



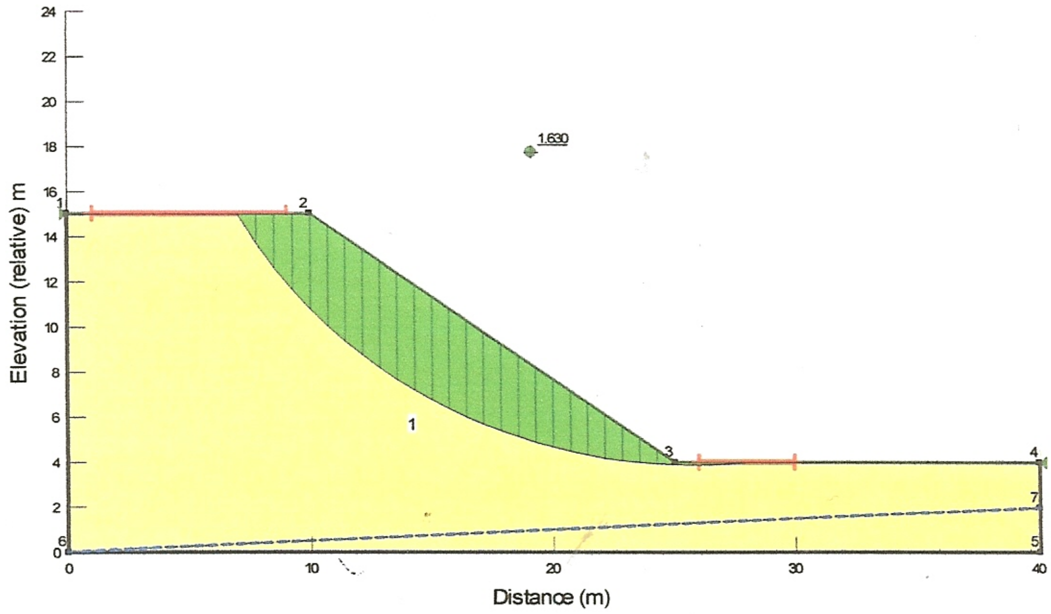
SLOPE 2

Material #: 1
Description:
Model: MohrCoulomb
Wt: 2
Cohesion: 0
Phi: 42
Piezometric Line: 1



SLOPE 3

Material #: 1
Description:
Model: MohrCoulomb
Wt: 2
Cohesion: 0
Phi: 42
Piezometric Line: 1

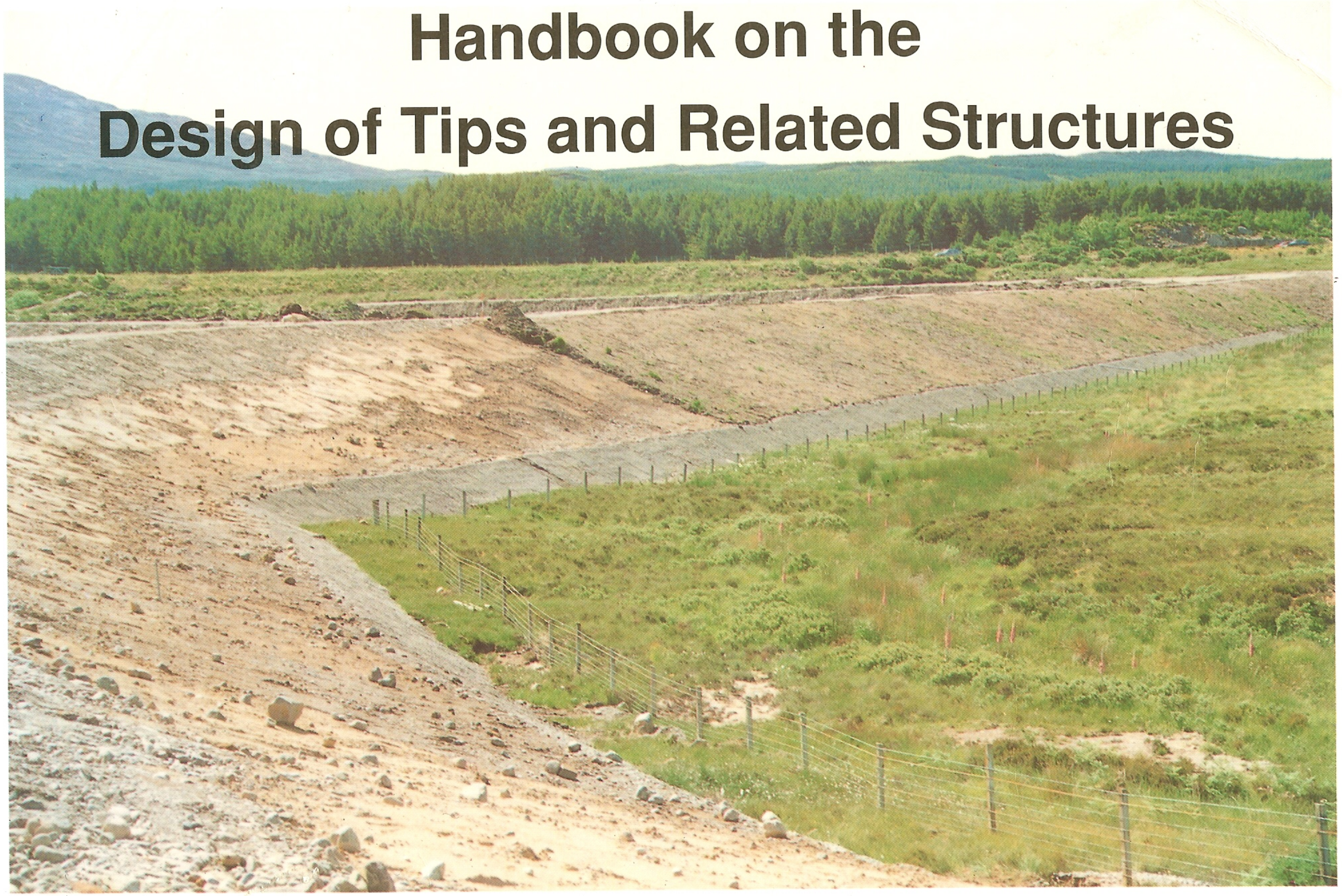


APPENDIX B:

Justification for stability input values

Department of the Environment

Handbook on the Design of Tips and Related Structures



HMSO

Material	Specific Gravity	Bulk Density	Dry Density Mg/m3	Natural Moisture Mg/m3	Void Ratio Content %	Liquid Limit	Plastic Limit %	Plasticity Index %	Cohesion (effective peak) %	Friction (effective peak) kPa	Friction (effective residual) Degrees
Gravel	2.50-2.80	1.45-2.30	1.40-2.10	-	-	NP	NP	NP	0	35-45	32-36
Sand	2.60-2.70	1.40-2.15	1.35-1.90	-	-	-	-	-	0	32-42	30-34
Silt (Non plastic)	-	-	-	-	-	NP	NP	NP	-	28-34	26-30
Silt	2.64-2.66	1.82-2.15	1.45-1.95	-	0.35-0.85	24-35	14-25	-	75	32-36	-
Clay	2.55-2.75	1.50-2.15	1.20-1.75	-	0.42-0.96	>25	>20	-	20-200	-	-
Peat	1.30-1.70	0.91-1.05	0.07-0.11	650-1100	12.7-14.9	-	-	-	20	5	
Keuper Marl I, II (i)	2.30-2.50	1.90-2.40	5-15	25-35	-	17-25	10-15	10-35	40	23-32	-
Keuper Marl II (ii)	2.10-2.30	1.80-2.10	10-12	25-40	-	17-27	10-18	10-35	32-42	22-29	
Keuper Marl IV (iii)	1.80-2.20	1.40-1.80	18-35	35-60	-	17-33	17-35	30-50	25-32	18-24	-
Basal/lodgement	2.50-2.90	1.80-2.40	-	8-25	-	20-45	12-26	9-23	0-55	24-35	23-32
till (iv)									(10)	(32)	(30)
Meltout till (iv)	2.50-2.90	1.60-2.20	-	6-22	-	15-35	8-21	8-20	0-5	31-46	-
										(0)	(36)
Flow till (iv)	2.50-2.90	1.50-1.95	-	8-30	-	18-48	12-30	10-25	0-10	30-36	-
										(0)	(34)
clays (iv)											
									(20)	(20)	(13)
Fluvioglacial	2.50-2.80	1.85-2.00	-	5-20	-	NF-30	NP-18	NP-15	0-5	32-46	
sediments (iv)									(0)	(37)	(36)
Head (iv)	2.30-2.90	1.70-2.20	-	10-35	-	NP-40	NP-20	NP-25	0-27	28-39	-
										(27)	(35)
Collivium (iv)											
										(10)	(35)

Table 3.6 Typical Range of Material Properties for Cohesive and Cohesionless Materials (after [24], [25], [26], [38], [45], [48] and [91])

(**) typical values