wardell-armstrong.com

ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
INFRASTRUCTURE AND UTILITIES
LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

TARMAC LIMITED

Old Quarrington and Cold Knuckle Quarry

Stability Risk Assessment

October 2021

wardell armstrong

Wardell Armstrong LLP
City Quadrant, 11 Waterloo Square, Newcastle upon Tyne, NE1 4DP, United Kingdom
Telephone: +44 (0)191 232 0943 www.wardell-armstrong.com

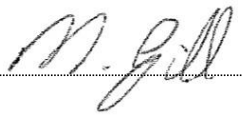
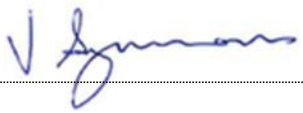
DATE ISSUED:	**October 2021**
JOB NUMBER:	**NT14345**
REPORT NUMBER:	**0001**
VERSION:	**V1.0**
STATUS:	**Final**

TARMAC LIMITED

Old Quarrington and Cold Knuckle Quarry

Stability Risk Assessment

October 2021

PREPARED BY:		
Michael Gill	Associate Director	
REVIEWED BY:		
Michael Milner	Technical Director	
APPROVED BY:		
Julian Symmons	Technical Director	

CONTENTS

TABLES

APPENDICES

DRAWINGS

1 INTRODUCTION

1.1.1 Wardell Armstrong (WA) has been commissioned by Tarmac Limited (the Client) to produce a Stability Risk Assessment (SRA) for the proposed extension of landfilling at Old Quarrington and Cold Knuckle Quarry (the Site), near Bowburn, Co Durham at National Grid Reference (NGR) NZ 33140 37820.

1.1.2 The site is operated by Tarmac Ltd under the Environmental Permit Number EPR/BB3007CA as an inert landfill facility. Following an extension of quarrying operations, it is proposed to vary the permit to create an additional landfill volume capacity of approximately 400,000m^3.

1.1.3 The SRA has been produced to support an Environmental Permit Variation for the inert landfill operations, undertaken as part of infilling and restoration of the quarry.

1.1.4 The report broadly follows the Environment Agency Guidance Template for landfill stability risk assessment, although adapted and simplified to take account of the inert waste only input at the site. The main design elements to be considered are as follows:

- stability of the landfill subgrade;
- stability of the lining system;
- stability of the waste mass; and
- stability of landfill capping system.

1.1.5 The report is set out to review each of the above elements of design having regard to the geological setting of the site, the method of working at the quarry and the waste inputs into the landfill facility.

2 SOURCES OF INFORMATION

2.1.1 The report is based upon the following:

- Published information provided by the British Geological Survey (Sheet NZ33SE);
- Topographic Survey provided by the client (January 2021);
- Phasing and Restoration plans provided by the client;
- Groundwater monitoring information provided by the client;
- Coal Authority information and datasets (accessed through http://www.gov.uk/);
- Landfills for inert waste guidance and Stability Risk Assessment Report Template (March 2010) (accessed through http://www.gov.uk/).

3 SITE DESCRIPTION

3.1 Location and Current Activities

3.1.1 The site is located approximately 300m north-west of Quarrington Hill and 7km south-east of the City of Durham, County Durham. The site is centred at National Grid Reference NZ 33140 37820 and is accessed via the A688 to the west.

3.1.2 The site boundary and proposed extension area is shown on Drawing No. Q003-00197-48. The site area encompasses part of the existing Cold Knuckle Quarry void and the remaining area of the limestone escarpment separating it from Old Quarrington Quarry.

3.1.3 The topography of the site is shown on Drawing No. Q003-00197-48. The remaining limestone within the site forms a ridge with an east-west running crest at approximately 170m AOD. The base of Cold Knuckle Quarry lies between 150m AOD in the east and 136m AOD in the centre of the site. The existing excavations of Old Quarrington Quarry lie to the north and west.

3.1.4 The existing quarry void comprises a floor level at close to 140m AOD. The quarry floor is slightly undulating due to the irregular interface between the Permian Sand and underlying Coal Measures. Existing rock faces at the quarry are up to 30m in height, although in the extension area, which forms the leading edge of the escarpment, the faces have now largely been removed.

3.2 Geology

3.2.1 The site comprises strata of the Raisby Formation, a Magnesian limestone (Dolostone) of the Permian Period. The limestone is underlain by Yellow Sands representing the base of the Permian Succession. The sands are an Aolian or Dune deposit and as such can vary significantly in thickness over a relatively short distance. All Limestone and Yellow Sands shall be removed as part of the quarrying works. The base of quarry is formed from an extensive sequence of mudstones, siltstones, and sandstones, with occasional coal seams belonging to the Coal Measures of the Carboniferous Period.

3.2.2 There is little to no superficial cover overlying the limestone, comprising top and subsoil underlain directly by the limestone.

3.3 Mining

3.3.1 The site is directly underlain by underground mine workings in four coal seams at depths of between 100m and 270m bgl, namely the Main, Yard, Tilley, and Busty

seams. The last date of working in this area was 1981. All effects of ground subsidence associated with these workings would by now have ceased.

3.4 Groundwater

3.4.1 The quarry has always been worked dry and the existing groundwater table, as proven in the site monitoring boreholes, is below the base of quarry. No problems are anticipated with regard to groundwater at the site.

4 LANDFILL STABILITY ASSESSMENT

4.1 Proposed Excavation Works and Landfilling

4.1.1 The existing landfill permit covers the whole of the existing quarry excavation and extends to 30Ha, the area covered by the proposed permit extension is 2.6Ha. The application area measures approximately 550m by 80m (Drawing Q003-00197-48).

4.1.2 It is proposed to extract the remaining reserves of rock, prior to the commencement of landfilling operations. The infill works will comprise the placement of waste in layers, working up from the base of excavation, to produce the restoration profile.

4.1.3 The maximum depth of landfill within the extension area will be 20m, although the full restoration profile will extend up to 30m height in total, as part of the wider site area. A typical cross section through the site is shown on Drawing Q003-00197-48. The cross section shows the former profile of the limestone escarpment, the existing permit boundary, the proposed permit extension area, and restoration profile. The waste thickness grades out to zero along the southern boundary of the site. The final restoration profile is that of a south facing slope with an overall gradient of 1 vertical to 3 horizontal (approx. 18°) as shown on Drawing Q003-00197-00.

4.2 Basal Sub-grade Screening

4.2.1 The landfill basal subgrade comprises Coal Measures bed rock. There are former worked coal seams at a depth of 100m below the site. The limestone strata at the site is characterised by fissuring as a consequence of past mining operations; however, within the area of landfilling, all limestone has been removed by quarrying. All effects of subsidence associated with past mining should by now have long since ceased and the potential for movement in the basal subgrade at the site is considered to be negligible. No further analysis or consideration of this aspect, in respect to the proposed extension of landfilling operations, is considered necessary.

4.3 Side Slope Subgrade Screening

4.3.1 The rock strata at the quarry are worked through a combination of blasting and mechanical extraction (hydraulic excavator). From inspection, quarry faces both in the limestone and underlying sand are formed close to the vertical. Prior to landfill lining, the quarry faces shall be re-profiled with waste rock forming batter slopes of up to 1 in 2.5 to allow for safe tracking and compaction of the attenuation layer material.

4.3.2 The extension area will be formed largely within the base of excavation and there are no anticipated problems of instability associated with the side slope subgrade profile.

4.4 Stability of the Basal Lining System Screening

4.4.1 The landfill facility shall be constructed with a 1m thick basal attenuation layer (geological barrier), comprising crushed and screened dolomite fines. The attenuation layer shall be continuous across the base and up the sides of the excavation, split into five phasing areas as shown on Drawing Q003-00197-48. The lining will extend up the quarry side slopes in the form of a 1 in 2.5 batter, with any steeper quarry faces being lined contemporaneously with waste emplacement, '*Christmas Tree*' fashion using a series of overlapping horizontally placed bunds, typically 2m to 3m in height.

4.4.2 The integrity of the geological barrier in maintaining a permeability of 1x10-7m/s (as required by the EA landfill guidance for inert sites) shall be maintained by the proposed construction techniques. The proposed inert waste stream (see below) shall not affect the integrity of the lining system. This form of liner construction follows the standard approach for inert waste sites. Stability of the basal and side slope lining system is not considered to be an issue at the site.

4.5 Stability of the Waste Mass Screening

4.5.1 The waste mass will comprise inert material consisting predominantly of clay and subsoil type materials with occasional hardcore. The waste is placed in the base of quarry, in horizontal layers not exceeding 2 to 3m in thickness. A restoration slope profile will be formed at no greater than 1 in 3 (approx. 18°).

4.5.2 Given the proposed dimensions, the stability of the overall restoration profile is considered to warrant further assessment (Section 6 below).

4.5.3 The effects of waste mass settlement have been assessed. Unlike other forms of biodegradable wastes where settlement can be as much as 20%, it is likely that there shall be no appreciable settlement of the subsoils and clays making up the inert wastes

mass at this site. Providing that waste materials are adequately layered and tracked in by dozer, the estimated total settlement will typically be less than 5% (i.e. 100mm for a 2m layer thickness). The majority of the waste settlement (estimated at around 75-90%) will occur over a short term (i.e. prior to completion of infilling) through the effects of self-weight settlement and consolidation of the waste material.

4.5.4 Any localised areas of increased settlement resulting from variations in waste type can usually be addressed at the time of restoration. It is considered that there is no requirement to form a pre-settlement waste profile at the site.

4.5.5 The effect of waste mass settlement on the integrity of the lining system is considered to be minimal and does not require further consideration.

4.6 Stability of Capping System Screening

4.6.1 There will be no landfill capping system at the site other than restoration with soil materials. As such, there are no stability issues associated with the capping of the site.

5 LIFECYCLE PHASES

5.1.1 Given the inert composition of the waste, there will be no degradation and breakdown of the waste mass constituents, in addition there will be no requirement for leachate and/or gas management at the site and no need for the application of daily cover. Stability considerations associated with the above life cycle operations and the breakdown of waste are not considered to be applicable at this facility.

6 STABILITY ASSESSMENT

6.1.1 The risk screening process indicates there are no overriding stability issues associated with the proposed inert landfilling operations at the site, with the risk status being assessed as low. However, there is a requirement to confirm that the design 1 in 3 restoration profile forming the southern slope will remain stable.

6.1.2 Stability calculations have been undertaken adopting anticipated geotechnical parameters for inert waste, with varying pore water conditions and a slope gradient of 1 in 3 (i.e. the steepest proposed profile).

6.1.3 Slope stability has been assessed in accordance with British Standard BS EN 1997-1, and BS 6031. Analysis was undertaken using the '*Slope*' analysis package (V12.05 Revision A18.B14.R58) developed by Geosolve.

6.1.4 In line with BS EN 1997-1 both ultimate and serviceability limit states have been assessed. The ultimate limit state has been assessed through the use of Design

Approach 1 Combinations 1 and 2, and the Partial Factors recommended by BS EN 1997-1 and confirmed in BS 6031.

6.1.5 Stability was also assessed for the loaded (temporary) and unloaded (permanent) slope profiles. A generalised ground model, based on the available data for the site was utilised, assuming waste deposits overlying a 1m thick attenuation layer with coal measure strata below.

6.1.6 The results of the analyses (presented in Table 1 with detailed results in Appendix 1) indicate that a restoration slope profile of 1 in 3 is stable up to a typical slope height of 30m (i.e. has an overdesign factor (factor of safety) in excess of 1.0) in both temporary and permanent conditions.

6.1.7 Sensitivity checks were undertaken to assess:

- The impact of a steeper 1V:2.5 restoration profile;
- The effect of potential increase in pore water pressures in the waste material; and,
- The effect of plant loading on slope crests at maximum slope height.

6.1.8 The minimum reported factor of safety for transient condition states relating to pore water pressure and surcharge loading, both remain in excess of 1.0 and therefore demonstrate stability. The factor of safety of a steeper 1 in 2.5 restoration slope profile shows an unstable permanent condition with a factor of safety of 0.96.

6.1.9 Shallow failure surfaces, which were not considered to represent global failures of the slopes, were excluded by setting a minimum slipped mass and equating to removing failure surfaces less than approx. 1.0m depth.

Table 1 : Summary Stability Calculation Results

Output	Slope Ref	Slope Gradient	Surcharge (10kN/m², 5m length)	Pore Water Pressure (Ru)	Factor of Safety
1	1 in 3 waste Ru=0	1 in 3.0	No	0.0	1.13
2	1 in 3 waste Ru=0.2	1 in 3.0	No	0.2	1.10*
3	1 in 2.5 slope Ru=0	1 in 2.5	No	0.0	0.96**
4	1 in 3 waste Ru=0 surcharge	1 in 3.0	Yes	0.0	1.08

* For Serviceability Limit State, no partial factors are applied to actions on material parameters. FoS for transient state therefore similar to Ultimate state.

** Factor of Safety of less than one indicating an unstable ultimate condition state for a slope profile of 1:2.5 (steeper than the design profile of 1:3)

6.1.10 The stability assessment shows that the risk of failure of the waste deposits when formed at the design gradient of 1 in 3 is low. The risk of failure increases with added pore water pressure, and the application of temporary surcharge loading. However, these are considered transient cases, a safe FoS of above unity in the serviceability limit state is still maintained at assumed worst case conditions.

7 MONITORING

7.1.1 Construction stage monitoring is a crucial element of the risk assessment process.

- It allows for validation of the risk assessment
- It can confirm whether risk management options are meeting their aims
- It provides a warning mechanism if adverse impacts are found

7.1.2 It is proposed to undertake annual monitoring and recording of the landfill structure including obtaining records relating to:

- The landform surface occupied by waste;
- The volume and composition of the waste;
- The time and duration of depositing waste; and
- An annual landform survey of the landfill during its operation and calculation of remaining capacity.

8 CONCLUSIONS

8.1 Summary

8.1.1 Old Quarrington is an active quarry for the extraction of limestone and sand, the void area is backfilled and restored with inert waste. This Stability Risk Assessment has reviewed the proposals for extending the waste-filling operations southwards, following the removal of remaining reserves making up the escarpment and the former Cold Knuckle Quarry.

8.1.2 The Stability Risk Assessment has reviewed the proposals for waste infilling. These works are required to ensure the long-term stability of the restoration profile.

8.1.3 The report provides an assessment of potential instability of the waste deposits. The waste import will be restricted to inert wastes only and there is no landfill capping requirement at the site. The assessment shows that for the restoration slope batters of the landfill, a design slope profile of up to 1 vertical to 3 horizontal will give an

adequate factor of safety to ensure long term stability of the waste mass and as such present a low risk in terms of overall stability at the site.

8.2 Recommendations

8.2.1 It is recommended that the conclusions reached in this report are reviewed by the Quarry Manager to ensure compatibility with the Geotechnical Assessment (Quarry Regulations 1999) for the quarry.

Appendix 1 Slope Stability Calculations

Units: kN,m

INPUT DATA

PROFILE DATA

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Stratum	Y-Coordinates							
1(GL)	178.00	178.00	178.00	176.38	173.32	173.27	172.70	171.86
2	178.00	178.00	177.00	169.00	153.27	153.00	153.00	153.00
3	178.00	178.00	176.00	168.18	152.00	152.00	152.00	152.00
4	142.70	141.50	141.00	141.00	140.00	139.98	139.79	139.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	243.00	246.04	273.00
Stratum	Y-Coordinates							
1(GL)	168.95	163.38	159.89	159.39	158.70	141.70	141.06	138.50
2	141.00	141.00	141.44	141.50	142.00	141.70	141.05	138.50
3	140.00	140.00	140.44	140.50	141.00	140.52	141.00	138.50
4	139.80	140.00	140.44	140.50	140.90	140.52	140.32	138.50

SOIL PROPERTIES

----- S t r a t u m -----		Bulk unit wt.		-------Strength parameters-------			
No.	Description	below GWL	above GWL	C	Phi	dC/dY	Datum for C
		kN/m3	kN/m3	kN/m2	(deg)	kN/m2/m	
1	Inert Waste	18.00	18.00	0.00	25.00		
2	Liner	20.00	20.00	0.00	30.00		
3	Old Waste	15.00	15.00	0.00	25.00		
4	Coal Measures	25.00	25.00	0.00	45.00		

GROUND WATER CONDITIONS

Unit wt. of water = 10.00 kN/m3

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	243.00	246.04	273.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

CIRCULAR SLIP SURFACE DATA

Grid of centres:	X	Y
Corner of grid	220.00	190.00
Grid increment	5.00	5.00
No. of grid lines	10	10

The grid of centres will be extended automatically
until a minimum factor of safety has been found.

Common point(s):	X	Y
Coordinates of (first) point	190.00	146.00
Increment between points	5.00	0.00

Number of points = 8

ANALYSIS OPTIONS

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength
Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on soil weight = 1.000
Partial factor of safety on surcharge loads = 1.300
Minimum number of slices = 10

Units: kN,m

Brief results for selected circles through common point no.1

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
220.00	255.00	113.05	1.526	13325	363351	554652	13.21
				(-0)	(7)	(0)	(4)
220.00	250.00	108.24	1.529	13149	346437	529590	15.50
				(-0)	(-13)	(0)	(4)
220.00	260.00	117.88	1.540	13512	380607	586240	15.51
				(0)	(-13)	(0)	(4)
220.00	265.00	122.72	1.555	13743	399068	620562	15.26
				(0)	(-12)	(0)	(4)
220.00	245.00	103.45	1.556	12986	329865	513260	13.06
				(0)	(10)	(0)	(4)
225.00	290.00	148.19	1.562	14720	512389	800289	15.10
				(0)	(-10)	(0)	(4)
220.00	270.00	127.58	1.571	13926	416085	653494	15.06
				(0)	(-12)	(0)	(4)
220.00	240.00	98.67	1.578	12838	313654	495102	13.02
				(0)	(12)	(0)	(4)
220.00	235.00	93.92	1.584	12711	297772	471633	13.12
				(0)	(13)	(0)	(4)
225.00	285.00	143.34	1.585	14568	495265	784768	11.60
				(0)	(13)	(0)	(4)
220.00	275.00	132.44	1.585	14141	434516	688835	14.95
				(0)	(-11)	(0)	(4)
225.00	280.00	138.50	1.586	14402	477198	756901	12.53
				(0)	(8)	(0)	(4)
225.00	275.00	133.66	1.589	14245	459473	730049	12.55
				(0)	(9)	(0)	(4)
225.00	265.00	124.04	1.591	13943	424500	675318	12.77
				(0)	(10)	(0)	(4)
225.00	260.00	119.25	1.591	13827	407954	649080	12.85
				(0)	(11)	(0)	(4)
225.00	270.00	128.84	1.592	14071	441387	702523	12.69
				(0)	(10)	(0)	(4)
220.00	230.00	89.20	1.593	12602	282229	449493	15.15
				(0)	(-10)	(0)	(4)
220.00	280.00	137.32	1.600	14363	453293	725320	14.84
				(-0)	(-11)	(0)	(4)
220.00	285.00	142.20	1.615	14590	472418	762944	14.73
				(0)	(-11)	(0)	(4)
220.00	290.00	147.09	1.630	14822	491890	801704	14.62
				(0)	(-10)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.2

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
220.00	220.00	78.11	1.418	9863	200600	284423	14.28
				(0)	(8)	(0)	(4)
220.00	225.00	82.86	1.426	10042	215075	306781	14.19
				(-0)	(7)	(0)	(4)
225.00	250.00	108.24	1.430	11169	309877	443085	13.87
				(0)	(6)	(0)	(4)
220.00	230.00	87.64	1.437	10231	229821	330241	14.12
				(0)	(7)	(0)	(4)
225.00	255.00	113.05	1.443	11342	325574	469813	16.30
				(0)	(-11)	(0)	(4)
220.00	235.00	92.44	1.449	10459	245604	355758	13.80
				(0)	(7)	(0)	(4)
225.00	260.00	117.88	1.457	11524	341603	497639	16.17
				(0)	(-11)	(0)	(4)
220.00	240.00	97.27	1.462	10675	261217	381835	13.67
				(0)	(6)	(0)	(4)
225.00	245.00	103.45	1.468	11011	294520	432375	13.57
				(0)	(8)	(0)	(4)
220.00	215.00	73.39	1.469	9726	186958	274618	14.77
				(0)	(5)	(0)	(4)
225.00	265.00	122.72	1.471	11714	357963	526551	16.04
				(0)	(-10)	(0)	(4)
220.00	245.00	102.11	1.476	10899	277166	409059	13.55
				(0)	(6)	(0)	(4)
225.00	240.00	98.67	1.477	10850	278975	411970	13.75
				(0)	(10)	(0)	(4)
230.00	290.00	148.19	1.483	12589	459692	681809	15.90
				(0)	(-9)	(0)	(4)
225.00	270.00	127.58	1.485	11911	374654	556542	15.91
				(0)	(-10)	(0)	(4)
225.00	235.00	93.92	1.488	10730	264452	393496	13.77
				(0)	(11)	(0)	(4)
230.00	285.00	143.34	1.488	12420	442716	658929	12.33
				(0)	(10)	(0)	(4)
220.00	250.00	106.96	1.491	11130	293451	437418	13.43
				(0)	(6)	(0)	(4)
230.00	280.00	138.50	1.497	12260	426079	638042	12.14
				(0)	(12)	(0)	(4)
230.00	275.00	133.66	1.498	12111	409783	613694	13.13
				(0)	(7)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.3

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
225.00	220.00	78.11	1.344	8058	171853	230960	15.09
				(0)	(6)	(0)	(4)
225.00	225.00	82.86	1.349	8233	185343	250019	14.93
				(0)	(6)	(0)	(4)
230.00	250.00	108.24	1.355	9187	267592	362533	14.59
				(0)	(5)	(0)	(4)
225.00	230.00	87.64	1.357	8422	199169	270245	14.77
				(0)	(5)	(0)	(4)
230.00	255.00	113.05	1.367	9352	281983	385411	17.16
				(0)	(-9)	(0)	(4)
225.00	235.00	92.44	1.367	8599	212671	290812	14.56
				(0)	(5)	(0)	(4)
220.00	205.00	62.30	1.373	7252	121641	167024	14.92
				(0)	(7)	(0)	(4)
220.00	200.00	57.58	1.374	7067	109824	150851	14.90
				(0)	(7)	(0)	(4)
220.00	210.00	67.05	1.375	7461	134172	184542	14.92
				(0)	(6)	(0)	(4)
220.00	195.00	52.92	1.378	6909	98702	136033	14.88
				(0)	(8)	(0)	(4)
225.00	240.00	97.27	1.379	8805	227066	313184	14.44
				(0)	(5)	(0)	(4)
220.00	215.00	71.84	1.379	7698	147643	203651	14.80
				(0)	(6)	(0)	(4)
230.00	260.00	117.88	1.380	9541	297124	409975	16.91
				(0)	(-8)	(0)	(4)
225.00	215.00	73.39	1.380	7919	159292	219850	15.31
				(0)	(4)	(0)	(4)
230.00	245.00	103.45	1.384	9057	254256	351912	14.28
				(0)	(7)	(0)	(4)
220.00	220.00	76.66	1.387	7933	161188	223570	14.53
				(0)	(6)	(0)	(4)
225.00	245.00	102.11	1.392	9016	241739	336574	14.33
				(0)	(5)	(0)	(4)
230.00	265.00	122.72	1.393	9727	312283	435143	16.75
				(0)	(-8)	(0)	(4)
230.00	240.00	98.67	1.394	8920	240473	335288	14.29
				(-0)	(8)	(0)	(4)
220.00	225.00	81.49	1.397	8192	175472	245215	14.38
				(0)	(5)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.4

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
230.00	220.00	78.11	1.280	6299	140119	179326	15.50
				(0)	(4)	(0)	(4)
230.00	225.00	82.86	1.285	6442	151225	194380	15.43
				(0)	(4)	(0)	(4)
235.00	250.00	108.24	1.290	7258	220856	284918	18.11
				(0)	(-7)	(0)	(4)
230.00	230.00	87.64	1.292	6603	162984	210612	15.37
				(0)	(4)	(0)	(4)
225.00	200.00	57.58	1.299	5518	89922	116854	15.61
				(-0)	(5)	(0)	(4)
235.00	255.00	113.05	1.300	7424	234197	304375	17.95
				(0)	(-6)	(0)	(4)
225.00	205.00	62.30	1.300	5668	99671	129554	15.63
				(0)	(5)	(0)	(4)
230.00	235.00	92.44	1.300	6781	175408	228035	15.32
				(0)	(4)	(0)	(4)
225.00	210.00	67.05	1.302	5841	110114	143384	15.34
				(0)	(5)	(0)	(4)
225.00	195.00	52.92	1.304	5392	80700	105270	15.64
				(-0)	(6)	(0)	(4)
235.00	245.00	103.45	1.307	7107	207943	271800	15.00
				(0)	(4)	(0)	(4)
225.00	215.00	71.84	1.308	6040	121333	158671	15.28
				(0)	(4)	(0)	(4)
230.00	240.00	97.27	1.309	6979	188641	246857	15.19
				(0)	(4)	(0)	(4)
235.00	260.00	117.88	1.311	7598	247838	324814	17.79
				(0)	(-6)	(0)	(4)
225.00	220.00	76.66	1.315	6256	133224	175177	15.23
				(0)	(4)	(0)	(4)
230.00	215.00	73.39	1.319	6188	129828	171208	15.25
				(0)	(6)	(0)	(4)
230.00	245.00	102.11	1.319	7188	202320	266861	17.76
				(0)	(-7)	(0)	(4)
235.00	265.00	122.72	1.323	7778	261773	346214	17.63
				(0)	(-6)	(0)	(4)
225.00	225.00	81.49	1.323	6485	145804	192916	15.18
				(0)	(4)	(0)	(4)
235.00	240.00	98.67	1.328	6980	195824	260072	14.71
				(0)	(6)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.5

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of (Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
235.00	220.00	78.11	1.223	4627	107004	130881	16.19
				(0)	(3)	(0)	(4)
235.00	225.00	82.86	1.227	4748	115996	142360	16.10
				(-0)	(3)	(0)	(4)
235.00	230.00	87.64	1.233	4884	125532	154834	16.03
				(0)	(2)	(0)	(4)
240.00	250.00	108.24	1.236	5382	170032	210128	18.72
				(0)	(-4)	(0)	(4)
230.00	205.00	62.30	1.238	4141	75853	93888	16.23
				(0)	(3)	(0)	(4)
230.00	210.00	67.05	1.238	4294	84495	104636	16.09
				(0)	(3)	(0)	(4)
235.00	235.00	92.44	1.241	5031	135492	168137	18.68
				(0)	(-5)	(0)	(4)
230.00	200.00	57.58	1.242	4026	68127	84593	16.38
				(0)	(3)	(0)	(4)
235.00	215.00	73.39	1.242	4528	98565	122454	15.94
				(0)	(4)	(0)	(4)
230.00	215.00	71.84	1.243	4464	93700	116434	15.98
				(0)	(3)	(0)	(4)
240.00	255.00	113.05	1.244	5528	181185	225449	18.61
				(0)	(-4)	(0)	(4)
240.00	245.00	103.45	1.246	5259	159758	199078	15.62
				(0)	(3)	(0)	(4)
230.00	220.00	76.66	1.249	4647	103450	129254	15.91
				(0)	(3)	(0)	(4)
235.00	240.00	97.27	1.250	5202	146373	182904	18.56
				(0)	(-5)	(0)	(4)
230.00	195.00	52.92	1.252	3927	60733	76045	16.41
				(0)	(3)	(0)	(4)
240.00	260.00	117.88	1.253	5687	192967	241853	18.51
				(0)	(-4)	(0)	(4)
240.00	240.00	98.67	1.256	5156	150077	188521	15.47
				(0)	(3)	(0)	(4)
230.00	225.00	81.49	1.258	4841	113734	143037	15.63
				(0)	(3)	(0)	(4)
235.00	245.00	102.11	1.259	5385	157884	198770	18.45
				(0)	(-5)	(0)	(4)
225.00	200.00	56.04	1.261	3974	64551	81372	15.94
				(0)	(3)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.6

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
240.00	225.00	82.86	1.182	3156	79590	94054	19.76
				(0)	(-3)	(0)	(4)
240.00	220.00	78.11	1.183	3054	72561	85856	19.80
				(0)	(-3)	(0)	(4)
240.00	230.00	87.64	1.184	3264	86864	102821	19.64
				(0)	(-3)	(0)	(4)
245.00	245.00	103.45	1.185	3531	111002	131583	15.34
				(0)	(3)	(0)	(4)
245.00	250.00	108.24	1.185	3645	119361	141497	19.49
				(0)	(-2)	(0)	(4)
240.00	235.00	92.44	1.188	3400	95067	112954	19.51
				(0)	(-3)	(0)	(4)
235.00	215.00	71.84	1.192	2978	64717	77141	16.74
				(0)	(2)	(0)	(4)
245.00	255.00	113.05	1.193	3772	128302	153002	19.36
				(0)	(-2)	(0)	(4)
235.00	220.00	76.66	1.194	3127	72314	86350	19.52
				(0)	(-3)	(0)	(4)
235.00	210.00	67.05	1.194	2834	57424	68587	16.82
				(0)	(2)	(0)	(4)
240.00	240.00	97.27	1.195	3549	103833	124051	19.37
				(0)	(-3)	(0)	(4)
245.00	240.00	98.67	1.195	3435	103239	123365	15.06
				(0)	(3)	(0)	(4)
235.00	225.00	81.49	1.199	3301	80796	96897	19.37
				(0)	(-3)	(0)	(4)
235.00	205.00	62.30	1.200	2719	51008	61224	16.79
				(0)	(2)	(0)	(4)
245.00	260.00	117.88	1.201	3911	137777	165424	19.25
				(0)	(-2)	(0)	(4)
250.00	270.00	128.84	1.203	3985	154224	185485	14.92
				(0)	(2)	(0)	(4)
240.00	245.00	102.11	1.203	3709	113140	136092	19.23
				(0)	(-3)	(0)	(4)
250.00	275.00	133.66	1.204	4100	163721	197143	15.05
				(0)	(2)	(0)	(4)
250.00	265.00	124.04	1.205	3882	145274	175008	14.74
				(0)	(3)	(0)	(4)
240.00	215.00	73.39	1.207	2980	66316	80037	16.30
				(0)	(2)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.7

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
255.00	270.00	128.84	1.150	2295	91691	105423	13.79
				(0)	(2)	(0)	(4)
250.00	250.00	108.24	1.150	2060	69170	79570	20.18
				(0)	(-1)	(0)	(4)
255.00	265.00	124.04	1.151	2199	84711	97518	13.61
				(0)	(2)	(0)	(4)
250.00	245.00	103.45	1.151	1966	63050	72590	20.18
				(0)	(-1)	(0)	(4)
250.00	255.00	113.05	1.151	2172	76116	87635	13.83
				(0)	(2)	(0)	(4)
255.00	275.00	133.66	1.154	2397	98951	114232	13.65
				(0)	(2)	(0)	(4)
250.00	260.00	117.88	1.155	2295	83583	96540	13.72
				(0)	(2)	(0)	(4)
245.00	240.00	97.27	1.155	2037	61305	70814	20.12
				(0)	(-1)	(0)	(4)
245.00	235.00	92.44	1.156	1915	54733	63271	20.12
				(0)	(-1)	(0)	(4)
250.00	240.00	98.67	1.157	1894	57875	66939	19.90
				(0)	(-1)	(0)	(4)
245.00	245.00	102.11	1.157	2176	68604	79381	20.03
				(0)	(-1)	(0)	(4)
245.00	230.00	87.64	1.157	1814	49105	56831	20.11
				(-0)	(-1)	(0)	(4)
260.00	290.00	149.45	1.159	2504	115423	133738	13.40
				(-0)	(2)	(0)	(4)
245.00	225.00	82.86	1.159	1733	44322	51374	20.09
				(-0)	(-1)	(0)	(4)
255.00	260.00	119.25	1.159	2117	78298	90772	15.58
				(0)	(1)	(0)	(4)
260.00	285.00	144.64	1.160	2412	107884	125151	13.23
				(0)	(2)	(0)	(4)
255.00	280.00	138.50	1.161	2516	107101	124306	13.51
				(0)	(2)	(0)	(4)
250.00	265.00	122.72	1.161	2419	91301	105991	13.56
				(0)	(2)	(0)	(4)
245.00	220.00	78.11	1.161	1675	40321	46832	20.06
				(0)	(-1)	(0)	(4)
240.00	230.00	86.35	1.162	2046	54422	63235	20.02
				(0)	(-1)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.8

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
265.00	285.00	144.64	1.131	919	41703	47181	26.36
				(0)	(-1)	(0)	(4)
265.00	280.00	139.84	1.131	861	37785	42750	26.36
				(0)	(-1)	(0)	(4)
265.00	290.00	149.45	1.131	989	46394	52491	26.36
				(0)	(-1)	(0)	(4)
265.00	275.00	135.06	1.132	816	34585	39134	26.35
				(0)	(-1)	(0)	(4)
260.00	270.00	128.84	1.133	878	35481	40200	26.34
				(0)	(-1)	(0)	(4)
260.00	265.00	124.04	1.133	817	31777	36004	26.34
				(0)	(-1)	(0)	(4)
260.00	275.00	133.66	1.133	953	39935	45250	26.34
				(0)	(-1)	(0)	(4)
260.00	260.00	119.25	1.133	769	28762	32593	26.34
				(0)	(-1)	(0)	(4)
260.00	280.00	138.50	1.133	1041	45203	51225	26.34
				(0)	(-1)	(0)	(4)
260.00	285.00	143.34	1.133	1143	51353	58207	26.34
				(0)	(-1)	(0)	(4)
260.00	255.00	114.48	1.134	735	26384	29908	26.34
				(0)	(-1)	(0)	(4)
260.00	290.00	148.19	1.135	1259	58418	66291	26.27
				(0)	(-1)	(0)	(4)
255.00	255.00	113.05	1.135	836	29605	33605	13.99
				(0)	(0)	(0)	(4)
255.00	250.00	108.24	1.135	771	26125	29657	13.99
				(0)	(0)	(0)	(4)
255.00	260.00	117.88	1.135	916	33808	38379	13.99
				(0)	(0)	(0)	(4)
255.00	265.00	122.72	1.135	1010	38803	44056	13.99
				(0)	(1)	(0)	(4)
255.00	245.00	103.45	1.135	720	23308	26464	13.99
				(0)	(0)	(0)	(4)
255.00	270.00	127.58	1.136	1118	44660	50719	13.99
				(0)	(1)	(0)	(4)
255.00	240.00	98.67	1.136	683	21096	23963	13.99
				(0)	(0)	(0)	(4)
255.00	275.00	132.44	1.136	1242	51476	58489	13.96
				(0)	(1)	(0)	(4)

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

Exclusion options

The summary results and selected results for each exit point exclude:
All slip surfaces where the interlock value in any slice is less than 0.1000
All slip surfaces where the slipped mass is less than 500 kN/m run

Critical Factor of Safety for each Common Point

Common point		Critical circle				
Point no.	X coord	Y coord	Centre X	Centre Y	Radius	Factor of safety	
1	190.00	146.00	220.00	255.00	113.05	1.526	
2	195.00	146.00	220.00	220.00	78.11	1.418	
3	200.00	146.00	225.00	220.00	78.11	1.344	
4	205.00	146.00	230.00	220.00	78.11	1.280	
5	210.00	146.00	235.00	220.00	78.11	1.223	
6	215.00	146.00	240.00	225.00	82.86	1.182	
7	220.00	146.00	255.00	270.00	128.84	1.150	
8	**225.00**	**146.00**	**265.00**	**285.00**	**144.64**	**1.131**	**<---**

FACTORS OF SAFETY AT CENTRES OF CIRCLES

Y-coord \ X-coordinates	220.00	230.00	240.00	250.00	260.00	270.00
290.00	1.592	1.502	1.419	1.345	1.284	1.234	1.190	1.155	1.135	1.131	1.200
285.00	1.573	1.483	1.401	1.328	1.269	1.221	1.178	1.146	1.133	1.131	1.416
280.00	1.554	1.464	1.382	1.311	1.255	1.207	1.166	1.140	1.133	1.131	1.786
275.00	1.535	1.444	1.363	1.295	1.242	1.194	1.156	1.136	1.133	1.132	.
270.00	1.515	1.425	1.345	1.280	1.227	1.181	1.148	1.136	1.133	1.137	.
265.00	1.495	1.406	1.328	1.266	1.213	1.169	1.141	1.135	1.133	1.227	.
260.00	1.475	1.386	1.311	1.251	1.199	1.158	1.139	1.135	1.133	1.470	.
255.00	1.455	1.368	1.296	1.237	1.186	1.150	1.139	1.135	1.134	1.891	.
250.00	1.435	1.349	1.280	1.222	1.173	1.144	1.138	1.135	1.139	2.349	.
245.00	1.415	1.333	1.265	1.207	1.162	1.143	1.138	1.135	1.189	2.837	.
240.00	1.397	1.317	1.250	1.193	1.154	1.143	1.138	1.136	1.273	.	.
235.00	1.378	1.302	1.235	1.180	1.150	1.142	1.138	1.137	1.644	.	.
230.00	1.361	1.287	1.220	1.169	1.149	1.142	1.138	1.141	2.155	.	.
225.00	1.346	1.272	1.205	1.162	1.149	1.142	1.139	1.174	2.661	.	.
220.00	1.332	1.256	1.192	1.160	1.149	1.142	1.140	1.251	3.149	.	.
215.00	1.318	1.242	1.182	1.159	1.149	1.143	1.142	1.536	3.627	.	.
210.00	1.304	1.228	1.177	1.159	1.149	1.144	1.147	2.068	.	.	.
205.00	1.291	1.216	1.177	1.159	1.149	1.146	1.186	2.624	.	.	.
200.00	1.278	1.209	1.178	1.159	1.150	1.148	1.264	3.167	.	.	.
195.00	1.268	1.209	1.179	1.160	1.185	1.153	1.620	3.702	.	.	.
190.00	1.263	1.213	1.180	1.161	1.204	1.159	2.210	4.206	.	.	.

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

DETAILED RESULTS FOR CRITICAL CIRCLE

Factor of safety = 1.131

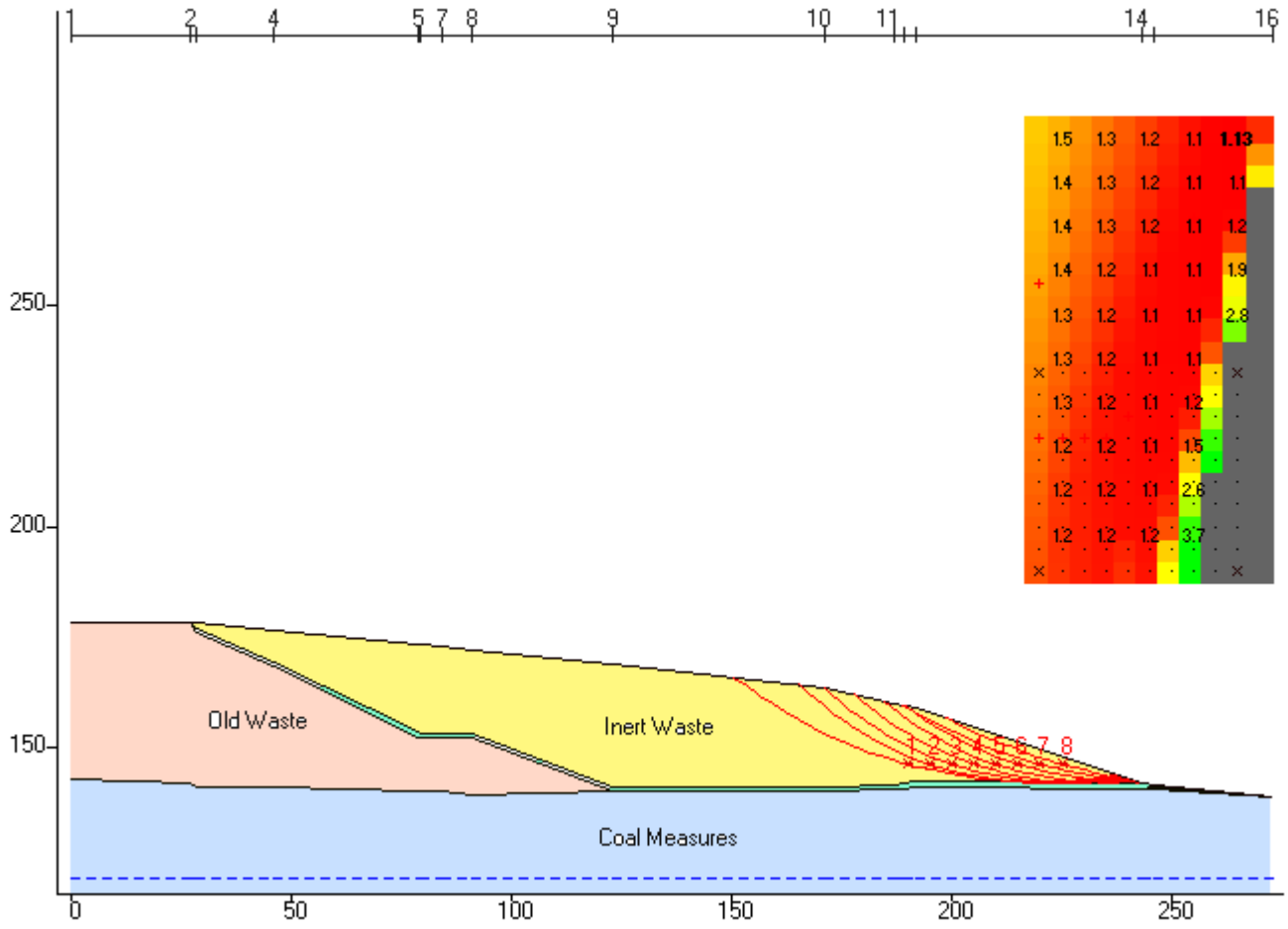
Slipped mass = 919 kN/m Out of balance vertical force = 0 kN/m
Delta =26.4deg. Out of balance horizontal force = -1 kN/m
Centre of circle: X = 265.00 Y = 285.00 Radius = 144.64
Overturning moment = 41703 kN.m/m Restoring moment = 47181 kN.m/m

Slip surface coordinates			Piezometric	Interslice forces		
			elevation	horizontal		vertical
No.	X	Y	Y(w)	E(total)	E'(effective)	Q
				kN/m	kN/m	kN/m
1	198.60	156.50	120.00	0	0	0
2	203.64	154.02	120.00	5	5	2
3	208.76	151.74	120.00	14	14	7
4	213.97	149.66	120.00	23	23	12
5	219.26	147.78	120.00	27	27	13
6	224.62	146.11	120.00	24	24	12
7	230.03	144.65	120.00	15	15	8
8	235.50	143.40	120.00	5	5	3
9	241.02	142.36	120.00	-1	-1	0

Slice	Cohesion	Tan(phi)	Pore	Weight	Forces on base of slice		
No.			pressure	of slice	normal		shear
	(avge)	(avge)	(avge)	W	P	P'	S
	kN/m2		kN/m2	kN/m	kN/m	kN/m	kN/m
1	0.00	0.3730	0.00	36	32	32	11
2	0.00	0.3730	0.00	100	91	91	30
3	0.00	0.3730	0.00	145	134	134	44
4	0.00	0.3730	0.00	169	159	159	52
5	0.00	0.3730	0.00	171	164	164	54
6	0.00	0.3730	0.00	151	147	147	49
7	0.00	0.3730	0.00	107	107	107	35
8	0.00	0.3730	0.00	40	41	41	13

WARDELL ARMSTRONG | Sheet No.
Program: SLOPE Version 12R.05 Revision A18.B14.R58 |
Licensed from GEOSOLVE | Job No. NT14345
Run ID. 1-in-3-waste-Ru0 | Made by : MG
Old Quarrington Quarry | Date: 1-10-2021
Proposed Restoration | Checked :

Units:
kN,m



Units: kN,m

INPUT DATA

PROFILE DATA

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Stratum	Y-Coordinates							
1(GL)	178.00	178.00	178.00	176.38	173.32	173.27	172.70	171.86
2	178.00	178.00	177.00	169.00	153.27	153.00	153.00	153.00
3	178.00	178.00	176.00	168.18	152.00	152.00	152.00	152.00
4	142.70	141.50	141.00	141.00	140.00	139.98	139.79	139.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	243.00	246.04	273.00
Stratum	Y-Coordinates							
1(GL)	168.95	163.38	159.89	159.39	158.70	141.70	141.06	138.50
2	141.00	141.00	141.44	141.50	142.00	141.70	141.05	138.50
3	140.00	140.00	140.44	140.50	141.00	140.52	141.00	138.50
4	139.80	140.00	140.44	140.50	140.90	140.52	140.32	138.50

SOIL PROPERTIES

----- S t r a t u m -----		Bulk unit wt.		-------Strength parameters-------			
No.	Description	below GWL	above GWL	C	Phi	dC/dY	Datum for C
		kN/m3	kN/m3	kN/m2	(deg)	kN/m2/m	
1	Inert Waste	18.00	18.00	0.00	25.00	Ru = 0.200	
2	Liner	20.00	20.00	0.00	30.00		
3	Old Waste	15.00	15.00	0.00	25.00		
4	Coal Measures	25.00	25.00	0.00	45.00		

GROUND WATER CONDITIONS

Unit wt. of water = 10.00 kN/m3

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	243.00	246.04	273.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

CIRCULAR SLIP SURFACE DATA

Grid of centres:	X	Y
Corner of grid	220.00	190.00
Grid increment	5.00	5.00
No. of grid lines	10	10

The grid of centres will be extended automatically
until a minimum factor of safety has been found.

Common point(s):	X	Y
Coordinates of (first) point	190.00	146.00
Increment between points	5.00	0.00

Number of points = 8

ANALYSIS OPTIONS

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength
Partial factor of safety on tan(phi) = 1.000
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on soil weight = 1.000
Partial factor of safety on surcharge loads = 1.300
Minimum number of slices = 10

Units: kN,m

Brief results for selected circles through common point no.1

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
220.00	255.00	113.05	1.504	13325	363351	546505	13.26
				(0)	(7)	(0)	(4)
220.00	260.00	117.88	1.518	13512	380607	577753	12.35
				(0)	(13)	(0)	(4)
220.00	265.00	122.72	1.533	13743	399068	611740	12.12
				(0)	(12)	(0)	(4)
225.00	290.00	148.19	1.540	14720	512389	788982	11.99
				(0)	(10)	(0)	(4)
220.00	270.00	127.58	1.549	13926	416085	644381	11.96
				(0)	(12)	(0)	(4)
220.00	275.00	132.44	1.564	14141	434516	679401	11.87
				(0)	(11)	(0)	(4)
220.00	280.00	137.32	1.579	14363	453293	715564	11.77
				(0)	(11)	(0)	(4)
220.00	250.00	108.24	1.584	13149	346437	548682	13.07
				(0)	(8)	(0)	(4)
220.00	285.00	142.20	1.594	14590	472418	752866	11.68
				(0)	(10)	(0)	(4)
220.00	290.00	147.09	1.609	14822	491890	791302	11.59
				(0)	(10)	(0)	(4)
220.00	245.00	103.45	1.624	12986	329865	535547	12.94
				(0)	(11)	(0)	(4)
225.00	285.00	143.34	1.640	14568	495265	812198	11.45
				(0)	(14)	(0)	(4)
225.00	280.00	138.50	1.658	14402	477198	791278	12.27
				(0)	(8)	(0)	(4)
225.00	275.00	133.66	1.667	14245	459473	765847	12.29
				(0)	(9)	(0)	(4)
220.00	240.00	98.67	1.729	12838	313654	542284	12.93
				(0)	(13)	(0)	(4)
225.00	270.00	128.84	1.731	14071	441387	764183	12.55
				(0)	(11)	(0)	(4)
225.00	265.00	124.04	1.737	13943	424500	737189	12.64
				(0)	(12)	(0)	(4)
220.00	235.00	93.92	1.743	12711	297772	518887	13.05
				(0)	(14)	(0)	(4)
225.00	260.00	119.25	1.743	13827	407954	711144	12.74
				(0)	(12)	(0)	(4)
220.00	230.00	89.20	1.759	12602	282229	496505	13.16
				(0)	(16)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.2

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
220.00	220.00	78.11	1.394	9863	200600	279618	14.32
				(0)	(8)	(0)	(4)
220.00	225.00	82.86	1.403	10042	215075	301650	14.23
				(0)	(7)	(0)	(4)
225.00	250.00	108.24	1.406	11169	309877	435666	13.95
				(0)	(5)	(0)	(4)
220.00	230.00	87.64	1.413	10231	229821	324789	14.16
				(0)	(7)	(0)	(4)
225.00	255.00	113.05	1.419	11342	325574	462062	12.99
				(0)	(11)	(0)	(4)
220.00	235.00	92.44	1.425	10459	245604	349972	13.87
				(0)	(6)	(0)	(4)
225.00	260.00	117.88	1.433	11524	341603	489577	12.87
				(0)	(10)	(0)	(4)
220.00	240.00	97.27	1.438	10675	261217	375729	13.74
				(0)	(6)	(0)	(4)
225.00	265.00	122.72	1.448	11714	357963	518179	12.76
				(0)	(10)	(0)	(4)
220.00	245.00	102.11	1.453	10899	277166	402634	13.62
				(0)	(6)	(0)	(4)
230.00	290.00	148.19	1.460	12589	459692	671122	12.64
				(0)	(8)	(0)	(4)
225.00	270.00	127.58	1.462	11911	374654	547860	12.66
				(0)	(9)	(0)	(4)
220.00	250.00	106.96	1.468	11130	293451	430658	12.66
				(0)	(11)	(0)	(4)
225.00	275.00	132.44	1.477	12113	391673	578612	12.55
				(0)	(9)	(0)	(4)
220.00	255.00	111.83	1.483	11366	310073	459827	12.55
				(0)	(11)	(0)	(4)
225.00	280.00	137.32	1.493	12347	409689	611725	12.34
				(0)	(9)	(0)	(4)
220.00	260.00	116.71	1.499	11606	327031	490113	12.45
				(0)	(10)	(0)	(4)
225.00	285.00	142.20	1.509	12565	427475	644868	12.23
				(0)	(8)	(0)	(4)
230.00	285.00	143.34	1.511	12420	442716	668762	12.12
				(0)	(10)	(0)	(4)
220.00	265.00	121.60	1.515	11876	344944	522655	12.23
				(0)	(10)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.3

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
225.00	220.00	78.11	1.319	8058	171853	226607	15.13
				(0)	(6)	(0)	(4)
225.00	225.00	82.86	1.324	8233	185343	245336	14.99
				(0)	(5)	(0)	(4)
225.00	230.00	87.64	1.332	8422	199169	265236	14.84
				(0)	(5)	(0)	(4)
230.00	255.00	113.05	1.342	9352	281983	378317	13.70
				(0)	(8)	(0)	(4)
225.00	235.00	92.44	1.342	8599	212671	285496	14.64
				(0)	(5)	(0)	(4)
220.00	205.00	62.30	1.348	7252	121641	164024	14.92
				(0)	(7)	(0)	(4)
220.00	200.00	57.58	1.349	7067	109824	148150	14.90
				(0)	(7)	(0)	(4)
220.00	210.00	67.05	1.351	7461	134172	181232	14.93
				(0)	(6)	(0)	(4)
220.00	195.00	52.92	1.354	6909	98702	133621	14.87
				(0)	(8)	(0)	(4)
225.00	240.00	97.27	1.354	8805	227066	307550	14.52
				(0)	(5)	(0)	(4)
220.00	215.00	71.84	1.355	7698	147643	200013	14.83
				(0)	(6)	(0)	(4)
230.00	260.00	117.88	1.355	9541	297124	402565	13.48
				(-0)	(8)	(0)	(4)
220.00	220.00	76.66	1.362	7933	161188	219614	14.59
				(0)	(6)	(0)	(4)
225.00	245.00	102.11	1.368	9016	241739	330626	14.41
				(0)	(4)	(0)	(4)
230.00	265.00	122.72	1.369	9727	312283	427427	13.35
				(0)	(8)	(0)	(4)
220.00	225.00	81.49	1.373	8192	175472	240934	14.44
				(0)	(5)	(0)	(4)
230.00	250.00	108.24	1.381	9187	267592	369543	14.34
				(0)	(5)	(0)	(4)
225.00	250.00	106.96	1.382	9252	257209	355440	13.28
				(0)	(9)	(0)	(4)
230.00	270.00	127.58	1.383	9919	327763	453323	13.22
				(0)	(7)	(0)	(4)
220.00	230.00	86.35	1.386	8454	190025	263341	14.32
				(0)	(5)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.4

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
230.00	220.00	78.11	1.253	6299	140119	175590	15.59
				(0)	(4)	(0)	(4)
230.00	225.00	82.86	1.259	6442	151225	190360	15.53
				(0)	(4)	(0)	(4)
235.00	250.00	108.24	1.263	7258	220856	279028	14.50
				(0)	(6)	(0)	(4)
230.00	230.00	87.64	1.266	6603	162984	206298	15.47
				(0)	(4)	(0)	(4)
235.00	255.00	113.05	1.273	7424	234197	298171	14.36
				(0)	(6)	(0)	(4)
225.00	200.00	57.58	1.273	5518	89922	114510	15.64
				(0)	(5)	(0)	(4)
230.00	235.00	92.44	1.274	6781	175408	223414	15.41
				(0)	(3)	(0)	(4)
225.00	205.00	62.30	1.274	5668	99671	126950	15.66
				(0)	(5)	(0)	(4)
225.00	210.00	67.05	1.276	5841	110114	140507	15.41
				(0)	(4)	(0)	(4)
225.00	195.00	52.92	1.279	5392	80700	103180	15.66
				(0)	(6)	(0)	(4)
225.00	215.00	71.84	1.282	6040	121333	155509	15.36
				(0)	(4)	(0)	(4)
230.00	240.00	97.27	1.282	6979	188641	241904	14.37
				(0)	(7)	(0)	(4)
235.00	260.00	117.88	1.284	7598	247838	318300	14.22
				(0)	(6)	(0)	(4)
225.00	220.00	76.66	1.289	6256	133224	171719	15.30
				(0)	(4)	(0)	(4)
230.00	245.00	102.11	1.293	7188	202320	261587	14.21
				(0)	(7)	(0)	(4)
235.00	265.00	122.72	1.297	7778	261773	339393	14.09
				(0)	(6)	(0)	(4)
225.00	225.00	81.49	1.297	6485	145804	189150	15.25
				(0)	(4)	(0)	(4)
240.00	285.00	143.34	1.303	8262	322720	420492	13.95
				(0)	(5)	(0)	(4)
230.00	250.00	106.96	1.305	7403	216289	282284	14.06
				(0)	(6)	(0)	(4)
225.00	230.00	86.35	1.306	6733	159235	208025	15.12
				(0)	(4)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.5

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
235.00	220.00	78.11	1.195	4627	107004	127888	16.31
				(0)	(3)	(0)	(4)
235.00	225.00	82.86	1.199	4748	115996	139122	16.22
				(0)	(2)	(0)	(4)
235.00	230.00	87.64	1.206	4884	125532	151336	15.19
				(0)	(5)	(0)	(4)
240.00	250.00	108.24	1.208	5382	170032	205386	15.00
				(0)	(4)	(0)	(4)
230.00	205.00	62.30	1.210	4141	75853	91801	16.30
				(0)	(3)	(0)	(4)
230.00	210.00	67.05	1.211	4294	84495	102308	16.18
				(0)	(3)	(0)	(4)
235.00	235.00	92.44	1.213	5031	135492	164381	14.97
				(0)	(5)	(0)	(4)
230.00	200.00	57.58	1.214	4026	68127	82726	16.41
				(0)	(3)	(0)	(4)
230.00	215.00	71.84	1.215	4464	93700	113857	16.08
				(0)	(3)	(0)	(4)
240.00	255.00	113.05	1.217	5528	181185	220428	14.91
				(0)	(4)	(0)	(4)
235.00	240.00	97.27	1.222	5202	146373	178872	14.88
				(0)	(4)	(0)	(4)
230.00	220.00	76.66	1.222	4647	103450	126421	16.02
				(0)	(3)	(0)	(4)
230.00	195.00	52.92	1.225	3927	60733	74398	16.41
				(0)	(4)	(0)	(4)
240.00	260.00	117.88	1.226	5687	192967	236543	14.82
				(0)	(4)	(0)	(4)
230.00	225.00	81.49	1.230	4841	113734	139939	15.76
				(0)	(2)	(0)	(4)
235.00	245.00	102.11	1.232	5385	157884	194451	14.78
				(0)	(4)	(0)	(4)
225.00	200.00	56.04	1.234	3974	64551	79631	16.01
				(0)	(3)	(0)	(4)
225.00	195.00	51.24	1.235	3759	55881	69019	16.13
				(0)	(3)	(0)	(4)
240.00	265.00	122.72	1.235	5856	205389	253745	14.74
				(0)	(4)	(0)	(4)
225.00	205.00	60.88	1.237	4203	73824	91353	15.89
				(-0)	(3)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.6

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
240.00	225.00	82.86	1.153	3156	79590	91735	15.93
				(0)	(3)	(0)	(4)
240.00	220.00	78.11	1.154	3054	72561	83746	15.99
				(0)	(3)	(0)	(4)
240.00	230.00	87.64	1.155	3264	86864	100293	15.81
				(0)	(3)	(0)	(4)
245.00	250.00	108.24	1.156	3645	119361	138022	15.66
				(0)	(2)	(0)	(4)
240.00	235.00	92.44	1.159	3400	95067	110196	15.69
				(0)	(3)	(0)	(4)
235.00	215.00	71.84	1.163	2978	64717	75279	16.84
				(0)	(1)	(0)	(4)
245.00	255.00	113.05	1.164	3772	128302	149286	15.54
				(0)	(2)	(0)	(4)
235.00	220.00	76.66	1.165	3127	72314	84267	15.72
				(-0)	(3)	(0)	(4)
235.00	210.00	67.05	1.166	2834	57424	66940	16.90
				(-0)	(1)	(0)	(4)
240.00	240.00	97.27	1.166	3549	103833	121054	15.55
				(0)	(3)	(0)	(4)
235.00	225.00	81.49	1.171	3301	80796	94578	15.57
				(-0)	(3)	(0)	(4)
235.00	205.00	62.30	1.172	2719	51008	59769	16.86
				(0)	(2)	(0)	(4)
245.00	260.00	117.88	1.172	3911	137777	161460	15.44
				(0)	(2)	(0)	(4)
245.00	245.00	103.45	1.173	3531	111002	130203	15.31
				(0)	(3)	(0)	(4)
240.00	245.00	102.11	1.174	3709	113140	132847	15.44
				(0)	(2)	(0)	(4)
235.00	230.00	86.35	1.178	3487	89851	105878	15.43
				(-0)	(3)	(0)	(4)
230.00	205.00	60.88	1.179	2826	51576	60793	16.71
				(-0)	(2)	(0)	(4)
235.00	200.00	57.58	1.180	2636	45512	53684	16.80
				(-0)	(2)	(0)	(4)
230.00	210.00	65.73	1.181	3021	59387	70119	16.56
				(0)	(2)	(0)	(4)
245.00	265.00	122.72	1.181	4058	147782	174538	15.36
				(0)	(2)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.7

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
255.00	270.00	128.84	1.120	2295	91691	102656	14.02
				(0)	(2)	(0)	(4)
250.00	250.00	108.24	1.120	2060	69170	77485	14.10
				(0)	(2)	(0)	(4)
250.00	255.00	113.05	1.121	2172	76116	85342	14.05
				(0)	(2)	(0)	(4)
250.00	245.00	103.45	1.121	1966	63050	70696	16.27
				(0)	(1)	(0)	(4)
255.00	275.00	133.66	1.124	2397	98951	111258	13.91
				(0)	(2)	(0)	(4)
250.00	260.00	117.88	1.125	2295	83583	94031	13.96
				(0)	(2)	(0)	(4)
245.00	240.00	97.27	1.125	2037	61305	68979	16.22
				(0)	(1)	(0)	(4)
245.00	235.00	92.44	1.126	1915	54733	61634	16.23
				(0)	(1)	(0)	(4)
245.00	245.00	102.11	1.127	2176	68604	77331	16.14
				(0)	(1)	(0)	(4)
245.00	230.00	87.64	1.127	1814	49105	55365	16.22
				(0)	(1)	(0)	(4)
245.00	225.00	82.86	1.129	1733	44322	50053	16.20
				(0)	(1)	(0)	(4)
255.00	280.00	138.50	1.131	2516	107101	121104	13.79
				(0)	(2)	(0)	(4)
250.00	265.00	122.72	1.131	2419	91301	103263	13.83
				(0)	(2)	(0)	(4)
245.00	220.00	78.11	1.132	1675	40321	45633	16.18
				(0)	(1)	(0)	(4)
240.00	230.00	86.35	1.132	2046	54422	61618	16.14
				(0)	(1)	(0)	(4)
245.00	250.00	106.96	1.132	2316	76176	86261	15.99
				(0)	(1)	(0)	(4)
240.00	225.00	81.49	1.133	1891	47469	53775	16.17
				(0)	(1)	(0)	(4)
240.00	220.00	76.66	1.134	1759	41486	47063	16.16
				(0)	(1)	(0)	(4)
240.00	235.00	91.22	1.136	2214	62028	70437	16.04
				(-0)	(1)	(0)	(4)
240.00	215.00	71.84	1.137	1648	36374	41340	16.15
				(0)	(1)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.8

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
265.00	285.00	144.64	1.101	919	41703	45898	9.56
				(0)	(1)	(0)	(4)
265.00	280.00	139.84	1.101	861	37785	41587	9.56
				(0)	(1)	(0)	(4)
265.00	290.00	149.45	1.101	989	46394	51064	9.56
				(0)	(1)	(0)	(4)
265.00	275.00	135.06	1.101	816	34585	38070	9.56
				(0)	(1)	(0)	(4)
260.00	270.00	128.84	1.102	878	35481	39110	9.55
				(0)	(1)	(0)	(4)
260.00	265.00	124.04	1.102	817	31777	35028	9.55
				(0)	(1)	(0)	(4)
260.00	275.00	133.66	1.102	953	39935	44023	9.55
				(0)	(1)	(0)	(4)
260.00	260.00	119.25	1.102	769	28762	31709	9.55
				(0)	(1)	(0)	(4)
260.00	280.00	138.50	1.103	1041	45203	49837	9.55
				(0)	(1)	(0)	(4)
260.00	285.00	143.34	1.103	1143	51353	56629	9.55
				(-0)	(1)	(0)	(4)
260.00	255.00	114.48	1.103	735	26384	29098	9.55
				(-0)	(1)	(0)	(4)
260.00	290.00	148.19	1.104	1259	58418	64499	9.52
				(0)	(1)	(0)	(4)
255.00	255.00	113.05	1.105	836	29605	32699	14.22
				(0)	(0)	(0)	(4)
255.00	250.00	108.24	1.105	771	26125	28858	14.21
				(0)	(0)	(0)	(4)
255.00	260.00	117.88	1.105	916	33808	37345	14.21
				(0)	(0)	(0)	(4)
255.00	265.00	122.72	1.105	1010	38803	42869	14.21
				(0)	(1)	(0)	(4)
255.00	245.00	103.45	1.105	720	23308	25751	14.21
				(0)	(0)	(0)	(4)
255.00	270.00	127.58	1.105	1118	44660	49353	14.21
				(0)	(1)	(0)	(4)
255.00	240.00	98.67	1.105	683	21096	23318	14.21
				(0)	(0)	(0)	(4)
255.00	275.00	132.44	1.106	1242	51476	56916	14.19
				(0)	(1)	(0)	(4)

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.000
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

Exclusion options

The summary results and selected results for each exit point exclude:
All slip surfaces where the interlock value in any slice is less than 0.1000
All slip surfaces where the slipped mass is less than 500 kN/m run

Critical Factor of Safety for each Common Point

Common point		Critical circle			
Point no.	X coord	Y coord	Centre X	Centre Y	Radius	Factor of safety
1	190.00	146.00	220.00	255.00	113.05	1.504
2	195.00	146.00	220.00	220.00	78.11	1.394
3	200.00	146.00	225.00	220.00	78.11	1.319
4	205.00	146.00	230.00	220.00	78.11	1.253
5	210.00	146.00	235.00	220.00	78.11	1.195
6	215.00	146.00	240.00	225.00	82.86	1.153
7	220.00	146.00	255.00	270.00	128.84	1.120
8	**225.00**	**146.00**	**265.00**	**285.00**	**144.64**	**1.101**	**<---**

FACTORS OF SAFETY AT CENTRES OF CIRCLES

	X-coordinates									
	220.00	230.00	240.00	250.00	260.00	270.00				
Y-coord										
290.00	1.570	1.479	1.395	1.320	1.257	1.206	1.161	1.125	1.104	1.101	1.222
285.00	1.551	1.460	1.376	1.302	1.242	1.192	1.148	1.116	1.103	1.101	1.519
280.00	1.532	1.440	1.357	1.285	1.228	1.178	1.137	1.109	1.103	1.101	2.001
275.00	1.512	1.420	1.338	1.269	1.214	1.165	1.126	1.106	1.102	1.101	.
270.00	1.492	1.401	1.319	1.253	1.199	1.152	1.117	1.105	1.102	1.126	.
265.00	1.472	1.381	1.302	1.239	1.185	1.139	1.111	1.105	1.102	1.265	.
260.00	1.451	1.361	1.284	1.224	1.170	1.128	1.109	1.105	1.102	1.599	.
255.00	1.431	1.342	1.269	1.209	1.156	1.120	1.108	1.105	1.103	2.143	.
250.00	1.411	1.324	1.253	1.194	1.144	1.114	1.108	1.105	1.126	2.733	.
245.00	1.391	1.307	1.238	1.178	1.132	1.113	1.108	1.105	1.213	3.348	.
240.00	1.372	1.290	1.223	1.164	1.124	1.112	1.108	1.105	1.335	.	.
235.00	1.353	1.275	1.207	1.151	1.120	1.112	1.108	1.106	1.830	.	.
230.00	1.336	1.260	1.191	1.140	1.119	1.112	1.108	1.128	2.487	.	.
225.00	1.321	1.245	1.177	1.132	1.119	1.112	1.109	1.186	3.190	.	.
220.00	1.307	1.229	1.163	1.130	1.119	1.112	1.110	1.304	3.823	.	.
215.00	1.293	1.214	1.153	1.130	1.118	1.113	1.112	1.742	4.457	.	.
210.00	1.278	1.200	1.147	1.129	1.118	1.114	1.133	2.446	.	.	.
205.00	1.264	1.188	1.148	1.129	1.119	1.115	1.198	3.154	.	.	.
200.00	1.252	1.181	1.148	1.130	1.120	1.118	1.384	3.844	.	.	.
195.00	1.241	1.180	1.149	1.130	1.156	1.123	1.848	4.549	.	.	.
190.00	1.236	1.185	1.151	1.131	1.232	1.130	2.624	5.184	.	.	.

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.000
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

DETAILED RESULTS FOR CRITICAL CIRCLE

Factor of safety = 1.101

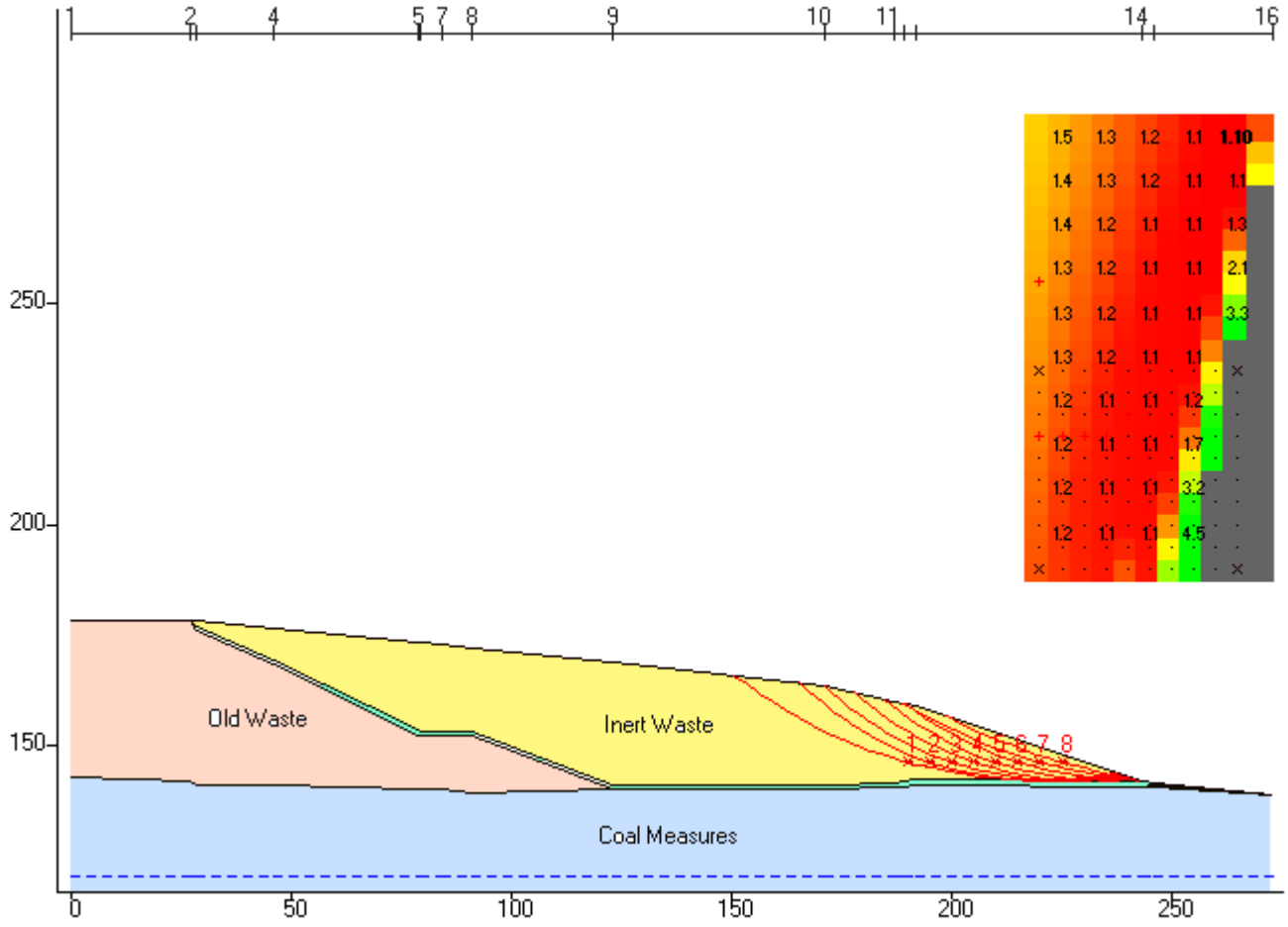
Slipped mass = 919 kN/m Out of balance vertical force = 0 kN/m
Delta =9.6deg. Out of balance horizontal force = 1 kN/m
Centre of circle: X = 265.00 Y = 285.00 Radius = 144.64
Overturning moment = 41703 kN.m/m Restoring moment = 45898 kN.m/m

Slip surface coordinates			Piezometric	Interslice forces		
			elevation	horizontal		vertical
No.	X	Y	Y(w)	E(total)	E'(effective)	Q
				kN/m	kN/m	kN/m
1	198.60	156.50	156.50	0	0	0
2	203.64	154.02	154.31	5	4	1
3	208.76	151.74	152.23	16	12	3
4	213.97	149.66	150.28	25	19	4
5	219.26	147.78	148.44	29	23	5
6	224.62	146.11	146.73	26	20	4
7	230.03	144.65	145.14	17	14	3
8	235.50	143.40	143.69	6	5	1
9	241.02	142.36	142.36	1	1	0

Slice	Cohesion	Tan(phi)	Pore	Weight	Forces on base of slice		
No.			pressure	of slice	normal		shear
	(avge)	(avge)	(avge)	W	P	P'	S
	kN/m2		kN/m2	kN/m	kN/m	kN/m	kN/m
1	0.00	0.4663	1.44	36	34	26	11
2	0.00	0.4663	3.91	100	94	72	31
3	0.00	0.4663	5.56	145	137	105	45
4	0.00	0.4663	6.39	169	160	124	53
5	0.00	0.4663	6.39	171	163	127	54
6	0.00	0.4663	5.56	151	145	113	48
7	0.00	0.4663	3.91	107	104	82	35
8	0.00	0.4663	1.44	40	39	31	13

WARDELL ARMSTRONG | Sheet No.
Program: SLOPE Version 12R.05 Revision A18.B14.R58 |
Licensed from GEOSOLVE | Job No. NT14345
Run ID. 1-in-3-waste-Ru0-2 | Made by : MG
Old Quarrington Quarry | Date: 1-10-2021
Proposed Restoration | Checked :

Units:
kN,m



Units: kN,m

INPUT DATA

PROFILE DATA

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Stratum	Y-Coordinates							
1(GL)	178.00	178.00	178.00	176.38	173.32	173.27	172.70	171.86
2	178.00	178.00	177.00	169.00	153.27	153.00	153.00	153.00
3	178.00	178.00	176.00	168.18	152.00	152.00	152.00	152.00
4	142.70	141.50	141.00	141.00	140.00	139.98	139.79	139.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	200.50	243.00	246.04
Stratum	Y-Coordinates							
1(GL)	168.95	163.38	161.69	161.19	160.50	158.70	141.70	141.06
2	141.00	141.00	141.44	141.50	142.00	141.95	141.70	141.05
3	140.00	140.00	140.44	140.50	141.00	140.92	140.52	141.00
4	139.80	140.00	140.44	140.50	140.90	140.84	140.52	140.31

Grid line	17
X-Coord	273.00
Stratum	Y-Coordinates
1(GL)	138.50
2	138.50
3	138.50
4	138.50

SOIL PROPERTIES

----- S t r a t u m -----		Bulk unit wt.		-------Strength parameters-------			
No.	Description	below GWL	above GWL	C	Phi	dC/dY	Datum for C
		kN/m3	kN/m3	kN/m2	(deg)	kN/m2/m	
1	Inert Waste	18.00	18.00	0.00	25.00		
2	Liner	20.00	20.00	0.00	30.00		
3	Old Waste	15.00	15.00	0.00	25.00		
4	Coal Measures	25.00	25.00	0.00	45.00		

GROUND WATER CONDITIONS

Unit wt. of water = 10.00 kN/m3

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	200.50	243.00	246.04
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

Grid line	17
X-Coord	273.00
Ground water level	
	120.00

CIRCULAR SLIP SURFACE DATA

Grid of centres:	X	Y
Corner of grid	220.00	190.00
Grid increment	5.00	5.00
No. of grid lines	10	10

The grid of centres will be extended automatically
until a minimum factor of safety has been found.

Common point(s):	X	Y
Coordinates of (first) point	190.00	146.00
Increment between points	5.00	0.00

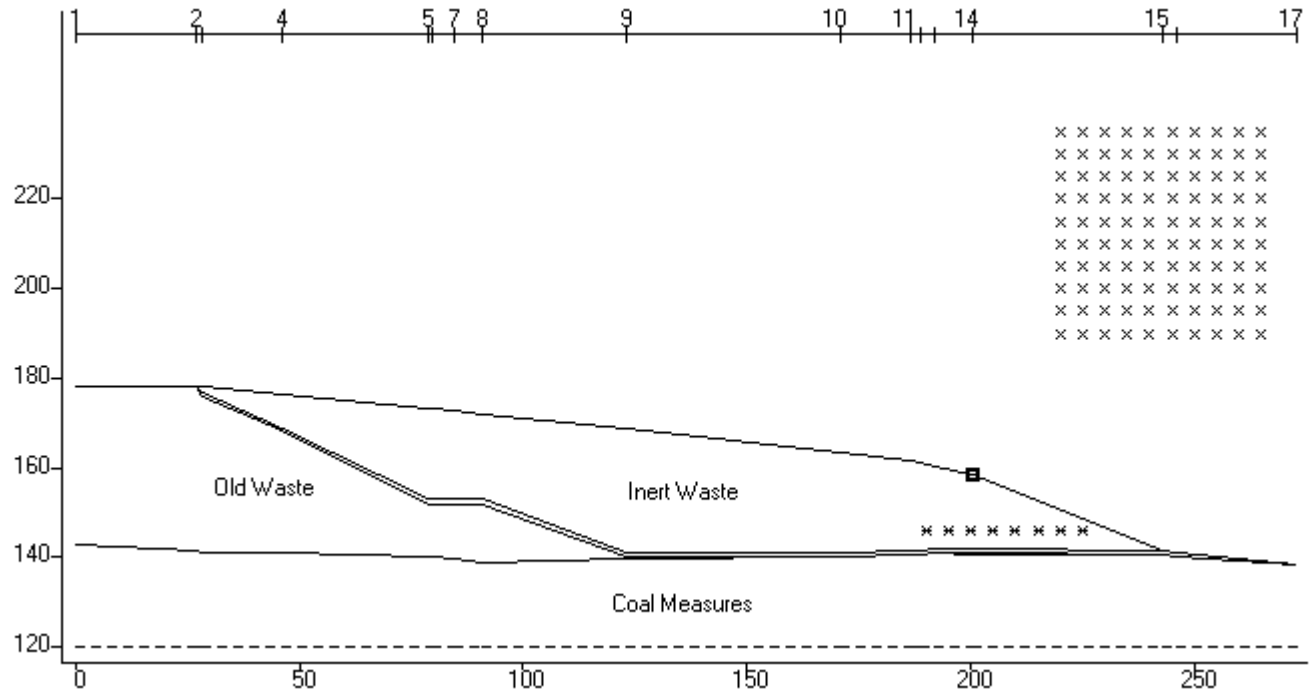
Number of points = 8

ANALYSIS OPTIONS

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength
Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on soil weight = 1.000
Partial factor of safety on surcharge loads = 1.300
Minimum number of slices = 10

WARDELL ARMSTRONG | Sheet No.
Program: SLOPE Version 12R.05 Revision A18.B14.R58 |
Licensed from GEOSOLVE | Job No. NT14345
Run ID. 1-in-2_5-waste-Ru0 | Made by : MG
Old Quarrington Quarry | Date: 1-10-2021
Proposed Restoration | Checked :

Units:
kN,m



Units: kN,m

Brief results for selected circles through common point no.1

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
220.00	240.00	98.67	1.660	14688	342778	569001	14.53
				(0)	(-9)	(0)	(4)
220.00	235.00	93.92	1.661	14562	326873	542883	14.63
				(-0)	(-10)	(0)	(4)
220.00	230.00	89.20	1.662	14455	311304	517402	14.75
				(0)	(-10)	(0)	(4)
220.00	225.00	84.50	1.800	14348	295277	531480	14.56
				(0)	(-5)	(0)	(4)
220.00	220.00	79.85	2.035	14351	281516	572780	14.15
				(0)	(7)	(0)	(4)
225.00	240.00	100.30	2.090	15481	383407	801363	11.71
				(0)	(36)	(0)	(4)
225.00	235.00	95.63	2.158	15517	368771	795768	11.90
				(0)	(39)	(0)	(4)
220.00	215.00	75.24	2.186	14369	267195	584008	14.43
				(0)	(5)	(0)	(4)
225.00	230.00	91.00	2.243	15567	353880	793878	14.36
				(0)	(2)	(0)	(4)
220.00	210.00	70.68	2.307	14442	253242	584347	14.59
				(0)	(5)	(0)	(4)
225.00	225.00	86.41	2.335	15724	341084	796305	14.60
				(0)	(2)	(0)	(4)
230.00	240.00	102.16	2.353	16964	433251	1019391	14.49
				(0)	(1)	(0)	(4)
225.00	220.00	81.86	2.408	15909	327568	788683	14.77
				(0)	(4)	(0)	(4)
220.00	205.00	66.19	2.415	14583	239411	578136	14.78
				(0)	(8)	(0)	(4)
230.00	235.00	97.58	2.417	17192	419748	1014387	14.55
				(0)	(2)	(0)	(4)
230.00	230.00	93.04	2.485	17478	406578	1010432	14.58
				(0)	(4)	(0)	(4)
225.00	215.00	77.37	2.489	16155	314450	782559	14.91
				(0)	(5)	(0)	(4)
220.00	200.00	61.77	2.537	14792	225747	572826	14.98
				(0)	(10)	(0)	(4)
230.00	225.00	88.55	2.561	17829	393655	1008072	14.57
				(0)	(6)	(0)	(4)
225.00	210.00	72.95	2.581	16474	301512	778207	15.05
				(0)	(7)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.2

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
220.00	220.00	78.11	1.469	11725	230640	338785	13.94
				(0)	(9)	(0)	(4)
220.00	225.00	82.86	1.488	11880	244456	363691	13.73
				(0)	(8)	(0)	(4)
220.00	230.00	87.64	1.506	12067	259229	390440	13.64
				(0)	(8)	(0)	(4)
220.00	215.00	73.39	1.511	11567	216407	326931	14.40
				(0)	(6)	(0)	(4)
225.00	240.00	98.67	1.523	12708	317242	483259	13.44
				(0)	(11)	(0)	(4)
220.00	235.00	92.44	1.524	12293	275039	419265	13.33
				(0)	(7)	(0)	(4)
225.00	235.00	93.92	1.529	12614	303625	464188	13.54
				(0)	(12)	(0)	(4)
225.00	230.00	89.20	1.530	12515	289404	442732	13.65
				(0)	(14)	(0)	(4)
220.00	210.00	68.71	1.531	11431	202418	309916	14.71
				(0)	(5)	(0)	(4)
220.00	240.00	97.27	1.544	12508	290677	448664	13.21
				(0)	(7)	(0)	(4)
220.00	205.00	64.08	1.557	11321	188721	293840	15.04
				(0)	(5)	(0)	(4)
225.00	225.00	84.50	1.648	12440	275461	453931	13.25
				(0)	(21)	(0)	(4)
220.00	200.00	59.51	1.802	11286	175942	317113	15.64
				(0)	(-2)	(0)	(4)
225.00	220.00	79.85	1.863	12404	261837	487912	12.74
				(0)	(34)	(0)	(4)
230.00	240.00	100.30	1.920	13405	353796	679260	12.01
				(0)	(33)	(0)	(4)
225.00	215.00	75.24	1.971	12424	248520	489938	12.97
				(-0)	(40)	(0)	(4)
230.00	235.00	95.63	1.982	13444	340490	674847	12.26
				(0)	(36)	(0)	(4)
220.00	195.00	55.01	2.003	11322	163347	327179	15.29
				(0)	(11)	(0)	(4)
230.00	230.00	91.00	2.050	13519	327502	671337	12.52
				(0)	(40)	(0)	(4)
225.00	210.00	70.68	2.087	12500	235664	491769	15.44
				(0)	(3)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.3

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
225.00	220.00	78.11	1.350	9908	210371	284045	14.97
				(0)	(7)	(0)	(4)
220.00	195.00	52.92	1.361	8689	125829	171269	15.11
				(0)	(10)	(0)	(4)
225.00	225.00	82.86	1.368	10082	223902	306379	14.71
				(0)	(7)	(0)	(4)
225.00	215.00	73.39	1.371	9765	197429	270580	15.34
				(0)	(5)	(0)	(4)
220.00	200.00	57.58	1.372	8872	138234	189639	14.97
				(0)	(9)	(0)	(4)
220.00	205.00	62.30	1.386	9074	150969	209314	14.81
				(0)	(8)	(0)	(4)
225.00	230.00	87.64	1.388	10269	237751	329904	14.47
				(0)	(6)	(0)	(4)
220.00	190.00	48.33	1.391	8533	113750	158253	15.45
				(0)	(9)	(0)	(4)
220.00	210.00	67.05	1.404	9290	164031	230239	14.65
				(0)	(8)	(0)	(4)
225.00	210.00	68.71	1.405	9644	184794	259548	15.36
				(0)	(7)	(0)	(4)
230.00	240.00	98.67	1.406	10781	288168	405088	14.15
				(0)	(9)	(0)	(4)
225.00	235.00	92.44	1.408	10465	251876	354528	14.27
				(0)	(6)	(0)	(4)
230.00	235.00	93.92	1.408	10657	274668	386828	14.24
				(0)	(10)	(0)	(4)
230.00	230.00	89.20	1.410	10552	261491	368820	14.40
				(0)	(12)	(0)	(4)
225.00	205.00	64.08	1.416	9572	172734	244587	15.87
				(0)	(4)	(0)	(4)
220.00	215.00	71.84	1.422	9527	177621	252615	14.40
				(0)	(7)	(0)	(4)
225.00	240.00	97.27	1.429	10649	265552	379500	14.03
				(0)	(6)	(0)	(4)
220.00	220.00	76.66	1.441	9768	191481	275996	14.13
				(0)	(7)	(0)	(4)
220.00	225.00	81.49	1.464	10007	205222	300360	13.84
				(0)	(6)	(0)	(4)
220.00	230.00	86.35	1.485	10267	219793	326404	13.69
				(0)	(6)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.4

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
225.00	195.00	52.92	1.239	7065	111192	137769	16.40
				(0)	(8)	(0)	(4)
230.00	220.00	78.11	1.244	8124	185620	230947	15.86
				(0)	(6)	(0)	(4)
225.00	200.00	57.58	1.250	7220	122197	152696	16.16
				(0)	(7)	(0)	(4)
230.00	225.00	82.86	1.262	8274	197667	249392	15.66
				(0)	(5)	(0)	(4)
225.00	190.00	48.33	1.263	6916	100016	126361	16.74
				(0)	(7)	(0)	(4)
225.00	205.00	62.30	1.264	7408	133847	169205	16.06
				(0)	(7)	(0)	(4)
230.00	215.00	73.39	1.268	7960	173243	219681	15.75
				(0)	(9)	(0)	(4)
225.00	210.00	67.05	1.281	7637	146381	187475	15.59
				(-0)	(6)	(0)	(4)
230.00	230.00	87.64	1.281	8449	210242	269318	15.45
				(0)	(5)	(0)	(4)
230.00	210.00	68.71	1.282	7869	162330	208076	15.78
				(0)	(11)	(0)	(4)
235.00	230.00	89.20	1.294	8626	228418	295565	15.26
				(0)	(9)	(0)	(4)
235.00	235.00	93.92	1.295	8722	240239	311222	15.09
				(-0)	(8)	(0)	(4)
230.00	205.00	64.08	1.297	7785	151203	196076	15.84
				(0)	(13)	(0)	(4)
235.00	240.00	98.67	1.299	8835	252374	327920	14.94
				(0)	(7)	(0)	(4)
225.00	215.00	71.84	1.300	7858	158842	206524	15.38
				(0)	(6)	(0)	(4)
230.00	235.00	92.44	1.301	8633	223119	290290	15.26
				(0)	(5)	(0)	(4)
220.00	190.00	46.49	1.303	6551	86751	113070	15.78
				(0)	(8)	(0)	(4)
220.00	195.00	51.24	1.316	6827	98379	129488	15.71
				(0)	(7)	(0)	(4)
225.00	220.00	76.66	1.321	8087	171611	226691	15.17
				(0)	(5)	(0)	(4)
230.00	240.00	97.27	1.322	8830	236433	312493	15.01
				(0)	(4)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.5

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
230.00	190.00	48.33	1.142	5273 (0)	81560 (6)	93108 (0)	17.81 (4)
230.00	195.00	52.92	1.143	5408 (-0)	91169 (6)	104197 (0)	17.55 (4)
230.00	200.00	57.58	1.149	5577 (0)	101509 (5)	116655 (0)	17.32 (4)
235.00	220.00	78.11	1.150	6336 (0)	155188 (4)	178479 (0)	17.04 (4)
235.00	215.00	73.39	1.154	6191 (0)	144264 (6)	166532 (0)	16.89 (4)
230.00	205.00	62.30	1.160	5771 (0)	112439 (5)	130400 (0)	17.08 (4)
235.00	225.00	82.86	1.167	6496 (0)	166389 (4)	194107 (0)	16.83 (4)
230.00	210.00	67.05	1.175	5976 (0)	123643 (5)	145237 (0)	16.83 (4)
235.00	210.00	68.71	1.179	6067 (0)	133641 (8)	157614 (0)	16.64 (4)
235.00	230.00	87.64	1.185	6649 (0)	177361 (4)	210190 (0)	16.58 (4)
225.00	190.00	46.49	1.187	5060 (0)	72666 (6)	86241 (0)	17.08 (4)
240.00	235.00	93.92	1.190	6802 (0)	199622 (5)	237625 (0)	16.20 (4)
240.00	240.00	98.67	1.192	6918 (0)	210692 (5)	251133 (0)	16.17 (4)
240.00	230.00	89.20	1.192	6701 (0)	188833 (6)	225166 (0)	16.25 (4)
230.00	215.00	71.84	1.193	6174 (0)	134693 (4)	160685 (0)	16.54 (4)
225.00	195.00	51.24	1.195	5331 (0)	83604 (6)	99894 (0)	16.83 (4)
240.00	225.00	84.50	1.196	6619 (0)	178349 (7)	213241 (0)	16.41 (4)
235.00	205.00	64.08	1.196	5974 (0)	123476 (9)	147658 (0)	16.76 (4)
235.00	235.00	92.44	1.205	6844 (0)	189537 (4)	228317 (0)	16.16 (4)
225.00	200.00	56.04	1.209	5609 (0)	94929 (5)	114774 (0)	16.56 (4)

Units: kN,m

Brief results for selected circles through common point no.6

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
235.00	195.00	52.92	1.063	3821	68455	72763	19.03
				(0)	(4)	(0)	(4)
235.00	200.00	57.58	1.067	3968	76902	82056	18.61
				(0)	(3)	(0)	(4)
240.00	220.00	78.11	1.072	4556	118475	127052	18.10
				(0)	(3)	(0)	(4)
240.00	215.00	73.39	1.076	4412	108954	117283	17.83
				(0)	(4)	(0)	(4)
235.00	205.00	62.30	1.076	4121	85537	92078	18.26
				(0)	(3)	(0)	(4)
235.00	190.00	48.33	1.077	3717	60867	65532	19.17
				(0)	(3)	(0)	(4)
240.00	225.00	82.86	1.085	4720	128715	139691	17.85
				(0)	(3)	(0)	(4)
240.00	210.00	68.71	1.088	4303	100198	109045	17.84
				(0)	(5)	(0)	(4)
235.00	210.00	67.05	1.089	4312	95229	103671	17.96
				(0)	(3)	(0)	(4)
230.00	190.00	46.49	1.091	3609	55662	60702	18.47
				(0)	(4)	(0)	(4)
230.00	195.00	51.24	1.099	3821	64315	70700	18.14
				(0)	(4)	(0)	(4)
245.00	235.00	93.92	1.099	4946	153852	169160	17.30
				(0)	(3)	(0)	(4)
245.00	240.00	98.67	1.100	5072	164091	180527	17.30
				(0)	(3)	(0)	(4)
240.00	230.00	87.64	1.100	4897	139406	153379	17.57
				(0)	(3)	(0)	(4)
235.00	215.00	71.84	1.103	4522	105651	116495	17.68
				(0)	(3)	(0)	(4)
245.00	230.00	89.20	1.103	4838	144034	158827	17.34
				(0)	(4)	(0)	(4)
245.00	225.00	84.50	1.109	4758	134884	149602	17.40
				(-0)	(4)	(0)	(4)
240.00	205.00	64.08	1.111	4235	92314	102601	17.91
				(0)	(6)	(0)	(4)
230.00	200.00	56.04	1.112	4072	74040	82307	17.77
				(0)	(4)	(0)	(4)
240.00	235.00	92.44	1.117	5081	150381	168002	16.22
				(0)	(5)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.7

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
245.00	215.00	73.39	1.000	2762	71796	71800	19.67
				(0)	(1)	(0)	(2)
245.00	220.00	78.11	1.005	2888	79331	79737	19.46
				(0)	(1)	(0)	(3)
240.00	200.00	57.58	1.006	2447	49736	50032	19.84
				(0)	(2)	(0)	(3)
240.00	205.00	62.30	1.007	2587	56747	57157	19.60
				(0)	(2)	(0)	(3)
240.00	195.00	52.92	1.012	2328	43302	43825	19.85
				(0)	(2)	(0)	(3)
245.00	210.00	68.71	1.014	2661	64838	65774	19.10
				(0)	(2)	(0)	(3)
240.00	210.00	67.05	1.015	2753	64503	65449	19.39
				(0)	(2)	(0)	(3)
245.00	225.00	82.86	1.016	3038	87620	89008	22.45
				(0)	(-3)	(0)	(3)
250.00	235.00	93.92	1.019	3146	103210	105183	17.46
				(0)	(3)	(0)	(3)
240.00	190.00	48.33	1.021	2258	38128	38931	19.77
				(0)	(2)	(0)	(3)
235.00	195.00	51.24	1.022	2413	43113	44065	19.52
				(0)	(2)	(0)	(3)
250.00	240.00	98.67	1.023	3269	111614	114138	17.54
				(0)	(3)	(0)	(3)
250.00	230.00	89.20	1.023	3042	95313	97476	18.67
				(0)	(2)	(0)	(3)
235.00	190.00	46.49	1.025	2221	35978	36878	19.74
				(0)	(2)	(0)	(3)
240.00	215.00	71.84	1.026	2939	72979	74900	18.95
				(0)	(2)	(0)	(3)
235.00	200.00	56.04	1.029	2626	50965	52436	19.30
				(0)	(2)	(0)	(3)
245.00	230.00	87.64	1.029	3187	96059	98842	17.54
				(0)	(3)	(0)	(3)
250.00	225.00	84.50	1.034	2972	88181	91210	18.40
				(0)	(2)	(0)	(3)
240.00	220.00	76.66	1.041	3125	81669	85014	18.58
				(0)	(2)	(0)	(3)
235.00	205.00	60.88	1.041	2858	59530	61985	18.81
				(0)	(2)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.8

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
255.00	235.00	93.92	0.960	1540	52712	50589	23.76
				(0)	(-1)	(0)	(4)
255.00	230.00	89.20	0.963	1431	46454	44712	23.59
				(0)	(-1)	(0)	(4)
255.00	240.00	98.67	0.963	1658	59397	57213	23.61
				(-0)	(-1)	(0)	(4)
250.00	225.00	82.86	0.964	1509	45428	43804	23.69
				(0)	(-1)	(0)	(4)
250.00	220.00	78.11	0.965	1383	39209	37832	23.69
				(0)	(-1)	(0)	(4)
250.00	215.00	73.39	0.966	1285	34214	33052	23.67
				(0)	(-1)	(0)	(4)
250.00	230.00	87.64	0.968	1651	52360	50691	23.55
				(0)	(-1)	(0)	(3)
250.00	210.00	68.71	0.969	1218	30322	29390	23.55
				(0)	(-1)	(0)	(3)
245.00	215.00	71.84	0.971	1491	38744	37609	23.60
				(0)	(-1)	(0)	(3)
245.00	210.00	67.05	0.972	1338	32425	31501	23.59
				(-0)	(-1)	(0)	(3)
245.00	205.00	62.30	0.973	1215	27334	26593	23.57
				(0)	(-1)	(0)	(3)
245.00	220.00	76.66	0.975	1662	45872	44723	23.41
				(0)	(-1)	(0)	(3)
245.00	200.00	57.58	0.975	1124	23328	22748	23.53
				(0)	(-1)	(0)	(3)
250.00	235.00	92.44	0.977	1808	59991	58616	23.29
				(0)	(-1)	(0)	(3)
245.00	195.00	52.92	0.979	1066	20290	19857	23.47
				(0)	(-1)	(0)	(3)
255.00	225.00	84.50	0.980	1370	41840	41001	18.13
				(0)	(1)	(0)	(3)
240.00	205.00	60.88	0.981	1493	32639	32003	23.44
				(0)	(-1)	(0)	(3)
240.00	200.00	56.04	0.982	1307	26290	25807	20.11
				(0)	(1)	(0)	(3)
240.00	195.00	51.24	0.983	1153	21180	20830	20.09
				(0)	(1)	(0)	(3)
245.00	190.00	48.33	0.984	1046	18118	17831	20.09
				(0)	(1)	(0)	(3)

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

Exclusion options

The summary results and selected results for each exit point exclude:
All slip surfaces where the interlock value in any slice is less than 0.1000
All slip surfaces where the slipped mass is less than 500 kN/m run

Critical Factor of Safety for each Common Point

Common point		Critical circle			
Point no.	X coord	Y coord	Centre X	Centre Y	Radius	Factor of safety
1	190.00	146.00	220.00	240.00	98.67	1.660
2	195.00	146.00	220.00	220.00	78.11	1.469
3	200.00	146.00	225.00	220.00	78.11	1.350
4	205.00	146.00	225.00	195.00	52.92	1.239
5	210.00	146.00	230.00	190.00	48.33	1.142
6	215.00	146.00	235.00	195.00	52.92	1.063
7	220.00	146.00	245.00	215.00	73.39	1.000
8	**225.00**	**146.00**	**255.00**	**235.00**	**93.92**	**0.960** **<---**

FACTORS OF SAFETY AT CENTRES OF CIRCLES

	X-coordinates								
	220.00	230.00	240.00	250.00	260.00				
Y-coord									
240.00	1.499	1.377	1.264	1.169	1.093	1.035	0.989	0.963	1.022
235.00	1.473	1.347	1.237	1.144	1.072	1.016	0.977	0.960	1.217
230.00	1.446	1.319	1.210	1.120	1.052	1.000	0.968	0.963	1.508
225.00	1.419	1.291	1.182	1.097	1.032	0.985	0.964	0.980	1.849
220.00	1.389	1.263	1.156	1.075	1.013	0.975	0.965	1.023	2.252
215.00	1.361	1.234	1.131	1.054	0.997	0.971	0.966	1.175	2.675
210.00	1.332	1.207	1.108	1.033	0.985	0.972	0.969	1.533	.
205.00	1.304	1.180	1.085	1.014	0.981	0.973	0.993	1.925	.
200.00	1.277	1.156	1.063	1.001	0.982	0.975	1.044	2.396	.
195.00	1.251	1.134	1.043	0.997	0.983	0.979	1.278	2.878	.
190.00	1.229	1.113	1.028	0.999	0.987	0.984	1.705	3.380	.

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

DETAILED RESULTS FOR CRITICAL CIRCLE

Factor of safety = 0.960

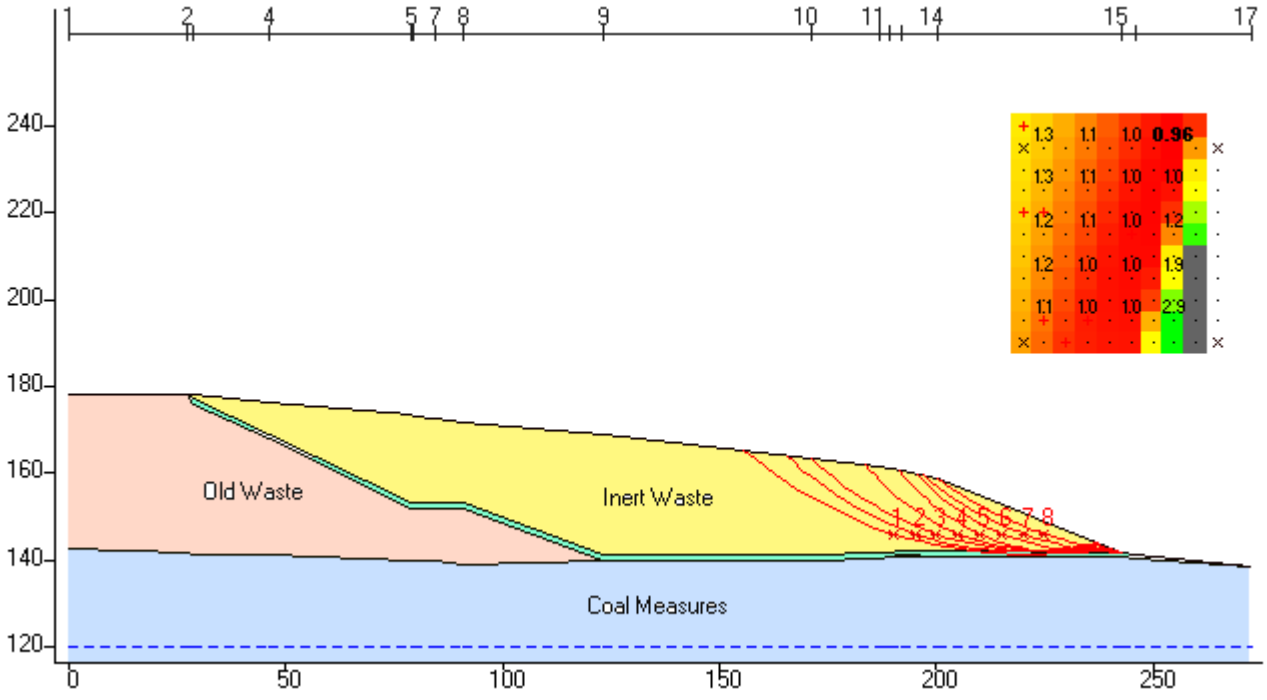
Slipped mass = 1540 kN/m Out of balance vertical force = 0 kN/m
Delta =23.8deg. Out of balance horizontal force = -1 kN/m
Centre of circle: X = 255.00 Y = 235.00 Radius = 93.92
Overturning moment = 52712 kN.m/m Restoring moment = 50589 kN.m/m

Slip surface coordinates		Piezometric	Interslice forces		
		elevation	horizontal		vertical
No.	X	Y	Y(w)	E(total)	E'(effective)	Q
				kN/m	kN/m	kN/m
1	200.12	158.78	120.00	0	0	0
2	200.50	158.51	120.00	0	0	0
3	205.23	155.35	120.00	14	14	6
4	210.15	152.48	120.00	39	39	17
5	215.23	149.91	120.00	62	62	27
6	220.46	147.66	120.00	72	72	32
7	225.82	145.73	120.00	65	65	29
8	231.28	144.13	120.00	42	42	19
9	236.83	142.85	120.00	14	14	7
10	242.44	141.92	120.00	-1	-1	0

Slice	Cohesion	Tan(phi)	Pore	Weight	Forces on base of slice		
No.			pressure	of slice	normal		shear
	(avge)	(avge)	(avge)	W	P	P'	S
	kN/m2		kN/m2	kN/m	kN/m	kN/m	kN/m
1	0.00	0.3730	0.00	1	1	1	0
2	0.00	0.3730	0.00	70	61	61	24
3	0.00	0.3730	0.00	169	149	149	58
4	0.00	0.3730	0.00	240	216	216	84
5	0.00	0.3730	0.00	280	257	257	100
6	0.00	0.3730	0.00	284	268	268	104
7	0.00	0.3730	0.00	251	244	244	95
8	0.00	0.3730	0.00	179	180	180	70
9	0.00	0.3730	0.00	66	70	70	27

WARDELL ARMSTRONG | Sheet No.
Program: SLOPE Version 12R.05 Revision A18.B14.R58 |
Licensed from GEOSOLVE | Job No. NT14345
Run ID. 1-in-2_5-waste-Ru0 | Made by : MG
Old Quarrington Quarry | Date: 1-10-2021
Proposed Restoration | Checked :

Units:
kN,m



Units: kN,m

INPUT DATA

PROFILE DATA

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Stratum	Y-Coordinates							
1(GL)	178.00	178.00	178.00	176.38	173.32	173.27	172.70	171.86
2	178.00	178.00	177.00	169.00	153.27	153.00	153.00	153.00
3	178.00	178.00	176.00	168.18	152.00	152.00	152.00	152.00
4	142.70	141.50	141.00	141.00	140.00	139.98	139.79	139.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	243.00	246.04	273.00
Stratum	Y-Coordinates							
1(GL)	168.95	163.38	159.89	159.39	158.70	141.70	141.06	138.50
2	141.00	141.00	141.44	141.50	142.00	141.70	141.05	138.50
3	140.00	140.00	140.44	140.50	141.00	140.52	141.00	138.50
4	139.80	140.00	140.44	140.50	140.90	140.52	140.32	138.50

SOIL PROPERTIES

----- S t r a t u m -----		Bulk unit wt. below GWL	Bulk unit wt. above GWL	-------Strength parameters------- C	Phi	dC/dY	Datum for C
No.	Description	kN/m3	kN/m3	kN/m2	(deg)	kN/m2/m	
1	Inert Waste	18.00	18.00	0.00	25.00		
2	Liner	20.00	20.00	0.00	25.00		
3	Old Waste	15.00	15.00	0.00	25.00		
4	Coal Measures	25.00	25.00	0.00	45.00		

GROUND WATER CONDITIONS

Unit wt. of water = 10.00 kN/m3

Grid line	1	2	3	4	5	6	7	8
X-Coord	0.00	27.00	28.50	46.00	79.00	79.56	84.50	91.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

Grid line	9	10	11	12	13	14	15	16
X-Coord	123.00	171.00	186.80	189.00	192.00	243.00	246.04	273.00
Ground water level								
	120.00	120.00	120.00	120.00	120.00	120.00	120.00	120.00

SURCHARGE LOADS

Load No.	Loaded area from	to	---- Line load ----- vertical kN/m run	horizontal kN/m run	Equiv. distrib. load vertical kN/m2	horizontal kN/m2
1	200.00	205.00 D	(50.00)	(0)	10.00	0

CIRCULAR SLIP SURFACE DATA

Grid of centres:	X	Y
Corner of grid	220.00	190.00
Grid increment	5.00	5.00
No. of grid lines	10	10

The grid of centres will be extended automatically
until a minimum factor of safety has been found.

Common point(s):	X	Y
Coordinates of (first) point	192.00	158.70
Increment between points	6.00	-2.00

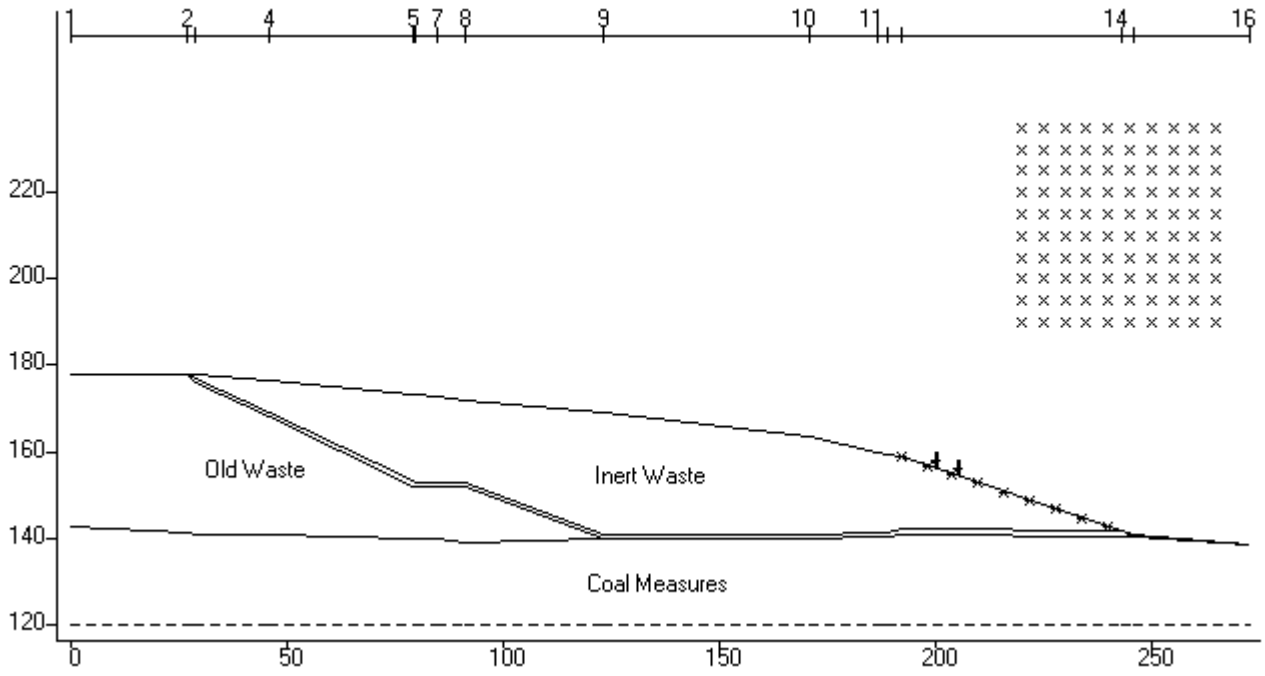
Number of points = 9

ANALYSIS OPTIONS

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength
Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on soil weight = 1.000
Partial factor of safety on surcharge loads = 1.300
Minimum number of slices = 10

WARDELL ARMSTRONG | Sheet No.
Program: SLOPE Version 12R.05 Revision A18.B14.R58 |
Licensed from GEOSOLVE | Job No. NT14345
Run ID. 1-in-3-waste-Ru0-plant-surcharge | Made by : MG
Old Quarrington Quarry | Date: 1-10-2021
Proposed Restoration | Checked :

Units:
kN,m



Units: kN,m

Brief results for selected circles through common point no.1

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of (Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
235.00	235.00	87.58	1.116	633	19434	21689	13.88
				(0)	(0)	(0)	(4)
230.00	225.00	76.42	1.119	540	14674	16413	13.83
				(0)	(0)	(0)	(4)
235.00	230.00	83.26	1.122	876	24839	27874	13.84
				(0)	(1)	(0)	(4)
230.00	220.00	72.12	1.125	772	19103	21488	13.82
				(0)	(1)	(0)	(4)
240.00	235.00	90.14	1.128	1312	39182	44214	16.04
				(0)	(1)	(0)	(4)
225.00	210.00	61.00	1.130	681	14346	16209	15.93
				(-0)	(0)	(0)	(4)
235.00	225.00	79.02	1.131	1188	31197	35274	15.97
				(0)	(1)	(0)	(4)
230.00	215.00	67.92	1.135	1082	24506	27812	15.93
				(0)	(1)	(0)	(4)
240.00	230.00	85.95	1.138	1712	47932	54533	15.98
				(0)	(1)	(0)	(4)
220.00	200.00	49.90	1.140	598	10354	11805	15.86
				(0)	(0)	(0)	(4)
235.00	220.00	74.88	1.142	1592	38845	44361	15.93
				(0)	(1)	(0)	(4)
225.00	205.00	56.86	1.142	990	18767	21437	15.88
				(0)	(1)	(0)	(4)
245.00	235.00	92.90	1.144	2337	69703	79761	20.15
				(0)	(-2)	(0)	(4)
230.00	210.00	63.84	1.149	1486	30857	35451	15.82
				(0)	(1)	(0)	(4)
240.00	225.00	81.85	1.149	2208	57961	66601	20.08
				(0)	(-2)	(0)	(4)
220.00	195.00	45.84	1.155	920	14015	16192	15.72
				(-0)	(1)	(0)	(4)
235.00	215.00	70.84	1.156	2100	47588	55025	20.00
				(0)	(-2)	(0)	(4)
245.00	230.00	88.84	1.160	2945	82700	95909	19.97
				(0)	(-3)	(0)	(4)
225.00	200.00	52.86	1.161	1412	24163	28053	16.81
				(0)	(1)	(0)	(4)
215.00	190.00	38.84	1.161	532	7152	8305	20.03
				(0)	(-0)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.2

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
235.00	220.00	73.32	1.089	561	14957	16282	14.23
				(0)	(1)	(0)	(4)
240.00	230.00	84.48	1.093	656	19748	21594	14.22
				(0)	(1)	(0)	(4)
225.00	195.00	46.86	1.101	639	10678	11752	16.31
				(0)	(1)	(0)	(4)
230.00	205.00	57.94	1.101	716	14629	16106	16.37
				(0)	(1)	(0)	(4)
235.00	215.00	69.05	1.103	807	19421	21420	16.39
				(0)	(0)	(0)	(4)
240.00	225.00	80.18	1.105	910	25140	27788	16.40
				(0)	(0)	(0)	(4)
245.00	235.00	91.32	1.108	1025	31924	35367	14.25
				(0)	(1)	(0)	(4)
240.00	220.00	75.97	1.119	1240	31590	35342	20.66
				(0)	(-1)	(0)	(4)
245.00	230.00	87.07	1.119	1359	39466	44154	20.66
				(0)	(-1)	(0)	(4)
235.00	210.00	64.88	1.119	1135	24811	27775	20.55
				(0)	(-1)	(0)	(4)
230.00	200.00	53.84	1.123	1048	19091	21430	20.49
				(0)	(-1)	(0)	(4)
225.00	190.00	42.87	1.131	986	14298	16167	17.21
				(0)	(1)	(0)	(4)
245.00	225.00	82.91	1.131	1776	48203	54518	20.52
				(0)	(-1)	(0)	(4)
250.00	235.00	93.99	1.134	1911	58475	66295	20.44
				(0)	(-1)	(0)	(4)
240.00	215.00	71.85	1.134	1661	39128	44370	20.49
				(0)	(-1)	(0)	(4)
235.00	205.00	60.84	1.139	1567	31248	35606	17.39
				(0)	(1)	(0)	(4)
230.00	195.00	49.91	1.149	1502	24477	28135	17.16
				(0)	(1)	(0)	(4)
245.00	220.00	78.84	1.150	2309	58331	67095	20.28
				(0)	(-2)	(0)	(4)
240.00	210.00	67.86	1.152	2197	47856	55129	17.30
				(0)	(1)	(0)	(4)
235.00	200.00	56.96	1.164	2132	38775	45122	17.23
				(0)	(1)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.3

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of (Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
235.00	205.00	59.09	1.126	501	9604	10814	14.40
				(0)	(0)	(0)	(4)
240.00	215.00	70.23	1.127	586	13295	14978	14.33
				(0)	(1)	(0)	(4)
245.00	225.00	81.38	1.127	681	17832	20100	14.28
				(0)	(1)	(0)	(4)
250.00	235.00	92.54	1.128	786	23303	26280	14.24
				(0)	(1)	(0)	(4)
250.00	230.00	88.24	1.136	1061	29726	33757	14.17
				(0)	(1)	(0)	(4)
245.00	220.00	77.10	1.137	948	23233	26412	20.49
				(0)	(-0)	(0)	(4)
240.00	210.00	65.99	1.139	846	17763	20229	20.49
				(0)	(-0)	(0)	(4)
235.00	200.00	54.89	1.142	757	13226	15108	20.48
				(0)	(-1)	(0)	(4)
245.00	215.00	72.92	1.148	1293	29653	34047	20.33
				(0)	(-1)	(0)	(4)
230.00	190.00	43.84	1.149	684	9534	10956	20.44
				(0)	(-1)	(0)	(4)
250.00	225.00	84.01	1.151	1414	37217	42818	20.25
				(0)	(-1)	(0)	(4)
240.00	205.00	61.86	1.154	1193	23159	26719	20.29
				(0)	(-1)	(0)	(4)
235.00	195.00	50.84	1.163	1114	17688	20570	20.21
				(0)	(-1)	(0)	(4)
245.00	210.00	68.84	1.169	1743	37107	43371	20.05
				(0)	(-1)	(0)	(4)
240.00	200.00	57.86	1.173	1653	29571	34674	20.06
				(0)	(-2)	(0)	(4)
235.00	190.00	46.98	1.190	1605	23075	27470	17.08
				(0)	(1)	(0)	(4)
240.00	195.00	54.04	1.208	2270	36987	44681	16.88
				(0)	(1)	(0)	(4)
255.00	235.00	95.13	1.281	1631	46390	59442	13.54
				(0)	(1)	(0)	(4)
250.00	220.00	79.88	1.302	1922	46032	59920	14.19
				(0)	(2)	(0)	(4)
245.00	205.00	64.89	1.467	2392	45946	67416	13.28
				(0)	(5)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.4

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
255.00	235.00	93.80	1.135	588	17281	19620	13.99
				(0)	(0)	(0)	(4)
250.00	220.00	78.29	1.143	708	17277	19741	13.95
				(0)	(1)	(0)	(4)
245.00	210.00	67.14	1.145	613	12810	14672	13.94
				(0)	(1)	(0)	(4)
240.00	200.00	56.01	1.149	528	9188	10561	13.92
				(0)	(1)	(0)	(4)
255.00	230.00	89.44	1.151	821	22727	26160	13.71
				(0)	(1)	(0)	(4)
245.00	205.00	62.93	1.156	888	17270	19963	20.12
				(0)	(-1)	(0)	(4)
250.00	215.00	74.04	1.159	993	22663	26260	20.03
				(0)	(-1)	(0)	(4)
240.00	195.00	51.86	1.164	802	12803	14902	20.03
				(0)	(-1)	(0)	(4)
245.00	200.00	58.84	1.179	1268	22726	26797	19.81
				(0)	(-1)	(0)	(4)
240.00	190.00	47.87	1.185	1186	17255	20443	19.80
				(0)	(-1)	(0)	(4)
215.00	215.00	62.50	1.275	575	11286	14392	12.90
				(0)	(0)	(0)	(4)
220.00	235.00	82.91	1.283	545	14155	18156	23.95
				(0)	(-1)	(0)	(4)
215.00	220.00	67.49	1.305	691	14089	18380	12.55
				(0)	(0)	(0)	(4)
215.00	225.00	72.47	1.332	812	17213	22928	12.31
				(0)	(1)	(0)	(4)
255.00	225.00	85.16	1.335	1197	29487	39373	12.64
				(0)	(1)	(0)	(4)
250.00	210.00	69.88	1.339	1426	29179	39082	13.62
				(0)	(2)	(0)	(4)
215.00	230.00	77.46	1.358	938	20680	28081	12.06
				(0)	(1)	(0)	(4)
215.00	235.00	82.45	1.381	1071	24534	33887	11.88
				(0)	(1)	(0)	(4)
245.00	195.00	54.90	1.549	1833	29134	45126	12.89
				(0)	(4)	(0)	(4)
255.00	220.00	80.96	2.003	1817	37535	75201	11.11
				(0)	(3)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.5

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
220.00	205.00	54.45	1.147	530	10082	11560	20.11
				(0)	(-0)	(0)	(4)
245.00	195.00	52.95	1.153	560	9187	10594	20.15
				(0)	(-0)	(0)	(4)
225.00	225.00	74.84	1.158	526	13607	15753	13.71
				(0)	(0)	(0)	(4)
250.00	205.00	64.07	1.159	650	12827	14867	13.70
				(0)	(1)	(0)	(4)
255.00	220.00	79.52	1.159	525	12830	14871	13.43
				(0)	(0)	(0)	(4)
220.00	210.00	59.43	1.172	669	13312	15600	13.63
				(-0)	(1)	(0)	(4)
215.00	190.00	39.31	1.178	748	9755	11488	19.77
				(0)	(-1)	(0)	(4)
245.00	190.00	48.84	1.182	862	12792	15121	19.76
				(0)	(-1)	(0)	(4)
225.00	230.00	79.81	1.183	648	17157	20301	13.39
				(0)	(0)	(0)	(4)
220.00	215.00	64.42	1.199	814	16919	20285	13.28
				(-0)	(1)	(0)	(4)
215.00	195.00	44.31	1.202	916	13018	15651	19.50
				(0)	(-1)	(0)	(4)
225.00	235.00	84.78	1.209	775	21079	25484	13.12
				(0)	(0)	(0)	(4)
220.00	220.00	69.42	1.226	965	20922	25651	13.02
				(0)	(1)	(0)	(4)
215.00	200.00	49.31	1.229	1089	16693	20517	19.03
				(0)	(-1)	(0)	(4)
220.00	225.00	74.41	1.252	1124	25388	31794	12.76
				(0)	(1)	(0)	(4)
215.00	205.00	54.31	1.256	1267	20784	26107	18.70
				(0)	(-1)	(0)	(4)
220.00	230.00	79.40	1.277	1288	30269	38662	12.59
				(0)	(1)	(0)	(4)
215.00	210.00	59.31	1.282	1454	25381	32546	18.34
				(0)	(-1)	(0)	(4)
220.00	235.00	84.39	1.301	1457	35584	46287	12.44
				(0)	(1)	(0)	(4)
215.00	215.00	64.31	1.307	1644	30410	39750	18.08
				(0)	(-1)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.6

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
225.00	200.00	51.39	1.102	563	10419	11487	16.20
				(0)	(0)	(0)	(4)
230.00	220.00	71.75	1.112	560	14318	15921	13.86
				(-0)	(0)	(0)	(4)
225.00	205.00	56.38	1.126	718	13988	15747	15.93
				(0)	(0)	(0)	(4)
230.00	225.00	76.72	1.128	708	18695	21093	13.79
				(0)	(1)	(0)	(4)
225.00	210.00	61.37	1.142	892	18367	20979	15.87
				(-0)	(1)	(0)	(4)
230.00	230.00	81.69	1.147	864	23562	27025	13.59
				(0)	(1)	(0)	(4)
220.00	190.00	41.35	1.159	999	13650	15822	16.72
				(0)	(1)	(0)	(4)
225.00	215.00	66.37	1.161	1074	23266	27021	15.62
				(0)	(1)	(0)	(4)
230.00	235.00	86.67	1.168	1029	28967	33824	13.37
				(0)	(1)	(0)	(4)
220.00	195.00	46.34	1.173	1203	18032	21150	16.73
				(0)	(1)	(0)	(4)
225.00	220.00	71.36	1.183	1265	28734	33986	15.36
				(0)	(1)	(0)	(4)
220.00	200.00	51.34	1.191	1414	22969	27344	16.45
				(0)	(1)	(0)	(4)
225.00	225.00	76.36	1.205	1462	34703	41813	15.11
				(0)	(1)	(0)	(4)
220.00	205.00	56.34	1.211	1635	28510	34521	19.14
				(0)	(-2)	(0)	(4)
225.00	230.00	81.36	1.227	1660	41093	50415	18.92
				(0)	(-1)	(0)	(4)
220.00	210.00	61.33	1.232	1858	34520	42541	18.86
				(0)	(-2)	(0)	(4)
225.00	235.00	86.35	1.248	1871	48147	60109	18.59
				(0)	(-1)	(0)	(4)
220.00	215.00	66.33	1.254	2090	41151	51605	18.56
				(0)	(-2)	(0)	(4)
215.00	190.00	41.89	1.275	2289	28290	36056	15.72
				(0)	(2)	(0)	(4)
220.00	220.00	71.33	1.275	2324	48306	61600	18.34
				(0)	(-2)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.7

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
235.00	215.00	68.66	1.082	586	14652	15856	21.19
				(0)	(-0)	(0)	(4)
240.00	235.00	89.11	1.096	608	19374	21241	14.11
				(0)	(0)	(0)	(4)
230.00	200.00	53.34	1.098	762	14323	15721	21.04
				(0)	(-1)	(0)	(4)
235.00	220.00	73.63	1.104	739	19046	21030	16.28
				(0)	(0)	(0)	(4)
230.00	195.00	48.34	1.115	599	9739	10858	20.96
				(0)	(-0)	(0)	(4)
235.00	225.00	78.61	1.119	913	24440	27360	13.86
				(0)	(1)	(0)	(4)
230.00	205.00	58.33	1.120	942	18715	20953	16.15
				(0)	(1)	(0)	(4)
235.00	230.00	83.59	1.131	1102	30703	34731	13.75
				(0)	(1)	(0)	(4)
230.00	210.00	63.33	1.135	1144	24108	27354	15.93
				(0)	(1)	(0)	(4)
235.00	235.00	88.58	1.146	1301	37652	43131	13.61
				(0)	(1)	(0)	(4)
230.00	215.00	68.33	1.146	1360	30374	34809	15.81
				(0)	(1)	(0)	(4)
225.00	190.00	43.40	1.156	1292	18374	21235	16.96
				(0)	(1)	(0)	(4)
230.00	220.00	73.33	1.160	1587	37355	43344	15.64
				(0)	(1)	(0)	(4)
225.00	195.00	48.39	1.167	1526	23769	27746	16.75
				(0)	(1)	(0)	(4)
225.00	200.00	53.38	1.176	1771	30036	35323	16.65
				(0)	(1)	(0)	(4)
230.00	225.00	78.33	1.177	1823	45013	52983	15.41
				(0)	(1)	(0)	(4)
225.00	205.00	58.38	1.188	2028	37056	44036	16.47
				(0)	(1)	(0)	(4)
230.00	230.00	83.32	1.195	2059	53129	63497	15.15
				(0)	(1)	(0)	(4)
225.00	210.00	63.37	1.204	2294	44789	53917	16.23
				(0)	(1)	(0)	(4)
230.00	235.00	88.32	1.213	2305	61949	75174	14.99
				(0)	(1)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.8

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of (Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Itera tions)
245.00	235.00	90.97	1.094	784	25041	27397	14.49
				(0)	(1)	(0)	(4)
240.00	220.00	75.54	1.103	950	24713	27258	20.96
				(0)	(-1)	(0)	(4)
245.00	230.00	86.01	1.108	628	18151	20112	14.52
				(0)	(0)	(0)	(4)
240.00	225.00	80.52	1.117	1144	31031	34672	16.22
				(0)	(1)	(0)	(4)
240.00	215.00	70.56	1.117	770	17992	20103	20.84
				(0)	(-0)	(0)	(4)
235.00	205.00	60.31	1.120	1202	24382	27311	20.76
				(0)	(-1)	(0)	(4)
240.00	230.00	85.51	1.128	1361	38516	43442	16.05
				(0)	(1)	(0)	(4)
235.00	210.00	65.31	1.134	1425	30698	34809	20.31
				(0)	(-1)	(0)	(4)
235.00	200.00	55.31	1.136	992	17830	20253	20.64
				(0)	(-1)	(0)	(4)
240.00	235.00	90.50	1.136	1596	47186	53623	15.95
				(0)	(1)	(0)	(4)
235.00	215.00	70.31	1.144	1671	38180	43672	15.91
				(-0)	(1)	(0)	(4)
240.00	210.00	65.58	1.146	612	12490	14316	13.93
				(0)	(1)	(0)	(4)
235.00	220.00	75.31	1.152	1936	46853	53966	15.82
				(-0)	(2)	(0)	(4)
230.00	190.00	45.48	1.159	1631	24043	27860	17.46
				(0)	(1)	(0)	(4)
235.00	225.00	80.31	1.163	2205	56181	65318	15.62
				(0)	(2)	(0)	(4)
235.00	190.00	45.31	1.165	641	8928	10404	20.02
				(0)	(-0)	(0)	(4)
235.00	195.00	50.31	1.166	807	12483	14556	20.01
				(0)	(-1)	(0)	(4)
230.00	195.00	50.46	1.169	1883	30354	35477	16.93
				(0)	(1)	(0)	(4)
230.00	200.00	55.44	1.176	2158	37832	44473	16.77
				(0)	(1)	(0)	(4)
235.00	230.00	85.31	1.176	2487	66388	78064	15.42
				(0)	(2)	(0)	(4)

Units: kN,m

Brief results for selected circles through common point no.9

---Centre--- X	Y	Radius R	Factor of safety	Slipped mass (Out of Vert. kN/m	Overturning moment balance Horiz.	Restoring moment forces) Moment) kN.m/m	Delta (Iterations)
245.00	225.00	82.45	1.119	1410	38747	43345	20.81
				(0)	(-1)	(0)	(4)
250.00	235.00	92.84	1.120	989	30054	33674	14.40
				(0)	(1)	(0)	(4)
245.00	230.00	87.44	1.128	1654	47505	53604	20.48
				(0)	(-1)	(0)	(4)
245.00	220.00	77.46	1.131	1193	29894	33805	20.64
				(0)	(-1)	(0)	(4)
245.00	235.00	92.44	1.136	1911	57402	65192	16.01
				(0)	(1)	(0)	(4)
240.00	210.00	67.30	1.137	1746	38400	43656	20.62
				(0)	(-2)	(0)	(4)
250.00	220.00	77.94	1.138	513	12493	14219	13.97
				(0)	(0)	(0)	(4)
250.00	225.00	82.91	1.140	652	16888	19247	13.97
				(0)	(0)	(0)	(4)
250.00	230.00	87.87	1.141	810	22208	25342	13.96
				(0)	(1)	(0)	(4)
240.00	215.00	72.30	1.146	2020	47162	54031	20.28
				(0)	(-2)	(0)	(4)
245.00	205.00	62.50	1.149	644	12489	14350	13.92
				(0)	(1)	(0)	(4)
240.00	205.00	62.30	1.150	1500	29728	34192	20.42
				(0)	(-1)	(0)	(4)
245.00	210.00	67.49	1.151	806	16882	19423	20.19
				(0)	(-0)	(0)	(4)
245.00	215.00	72.47	1.152	988	22201	25572	20.17
				(0)	(-1)	(0)	(4)
240.00	220.00	77.30	1.152	2308	57062	65742	20.05
				(0)	(-2)	(0)	(4)
240.00	225.00	82.30	1.158	2619	68423	79215	19.95
				(0)	(-2)	(0)	(4)
240.00	230.00	87.30	1.166	2940	80712	94111	19.79
				(0)	(-2)	(0)	(4)
240.00	190.00	47.30	1.173	862	12480	14634	19.94
				(0)	(-1)	(0)	(4)
240.00	200.00	57.30	1.173	1265	22187	26016	19.94
				(0)	(-1)	(0)	(4)
240.00	195.00	52.30	1.173	1054	16871	19783	19.94
				(0)	(-1)	(0)	(4)

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

Exclusion options

The summary results and selected results for each exit point exclude:
All slip surfaces where the interlock value in any slice is less than 0.1000
All slip surfaces where the slipped mass is less than 500 kN/m run

Critical Factor of Safety for each Common Point

Common point		Critical circle				
Point no.	X coord	Y coord	Centre X	Centre Y	Radius	Factor of safety	
1	192.00	158.70	235.00	235.00	87.58	1.116	
2	198.00	156.70	235.00	220.00	73.32	1.089	
3	204.00	154.70	235.00	205.00	59.09	1.126	
4	210.00	152.70	255.00	235.00	93.80	1.135	
5	216.00	150.70	220.00	205.00	54.45	1.147	
6	222.00	148.70	225.00	200.00	51.39	1.102	
7	**228.00**	**146.70**	**235.00**	**215.00**	**68.66**	**1.082**	**<---**
8	234.00	144.70	245.00	235.00	90.97	1.094	
9	240.00	142.70	245.00	225.00	82.45	1.119	

FACTORS OF SAFETY AT CENTRES OF CIRCLES

	X-coordinates									
	215.00	225.00	235.00	245.00	255.00	265.00				
Y-coord										
235.00	1.381	1.283	1.209	1.168	1.116	1.096	1.094	1.120	1.135	2.203	3.331
230.00	1.358	1.277	1.183	1.147	1.122	1.093	1.108	1.136	1.151	1.754	.
225.00	1.332	1.252	1.158	1.119	1.119	1.105	1.119	1.140	1.335	2.569	4.921
220.00	1.305	1.226	1.183	1.112	1.089	1.103	1.131	1.138	1.159	2.272	.
215.00	1.275	1.199	1.161	1.135	1.082	1.117	1.148	1.159	1.427	3.201	7.056
210.00	1.282	1.172	1.130	1.135	1.119	1.137	1.145	1.339	2.236	3.861	8.723
205.00	1.256	1.147	1.126	1.101	1.120	1.150	1.149	1.159	1.639	4.253	.
200.00	1.229	1.140	1.102	1.098	1.136	1.149	1.179	1.383	2.644	4.877	.
195.00	1.202	1.155	1.101	1.115	1.163	1.164	1.153	2.202	3.420	5.368	.
190.00	1.161	1.159	1.131	1.149	1.165	1.173	1.182	1.441	3.330	6.450	.

Units: kN,m

Analysis options

Method of analysis: JANBU - Parallel inclined interslice forces
Factors of safety calculated on Soil Strength

Partial factor of safety on tan(phi) = 1.250
Partial factor of safety on drained cohesion = 1.250
Partial factor of safety on undrained cohesion = 1.400
Partial factor of safety on surcharge loads = 1.300

DETAILED RESULTS FOR CRITICAL CIRCLE

Factor of safety = 1.082

Slipped mass = 586 kN/m Out of balance vertical force = 0 kN/m
Delta =21.2deg. Out of balance horizontal force = -0 kN/m
Centre of circle: X = 235.00 Y = 215.00 Radius = 68.66
Overturning moment = 14652 kN.m/m Restoring moment = 15856 kN.m/m

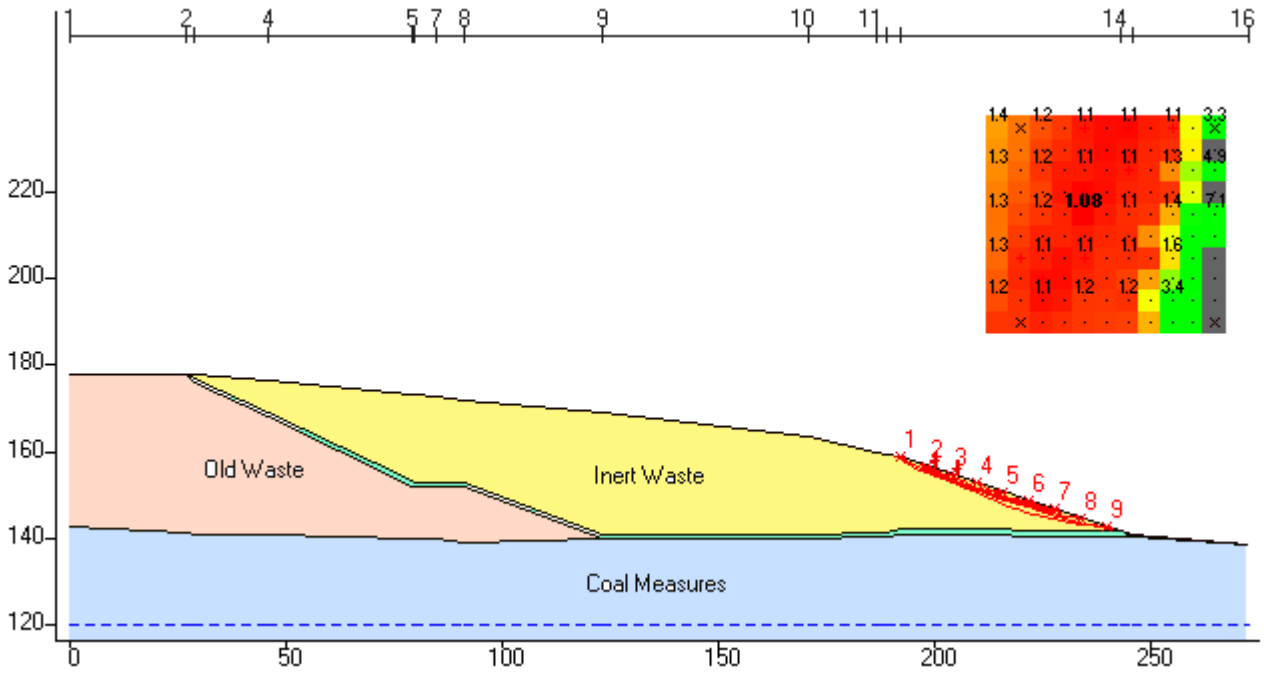
Slip surface coordinates		Piezometric	Interslice forces		
		elevation	horizontal		vertical
No.	X	Y	Y(w)	E(total)	E'(effective)	Q
				kN/m	kN/m	kN/m
1	199.62	156.16	120.00	0	0	0
2	200.00	155.93	120.00	0	0	0
3	202.47	154.54	120.00	9	9	3
4	205.00	153.24	120.00	18	18	7
5	208.12	151.82	120.00	25	25	10
6	211.32	150.56	120.00	29	29	11
7	214.57	149.45	120.00	29	29	11
8	217.87	148.51	120.00	23	23	9
9	221.21	147.74	120.00	14	14	6
10	224.59	147.14	120.00	5	5	2
11	228.00	146.70	120.00	-0	-0	0

Slice	Cohesion	Tan(phi)	Pore	Weight	Forces on base of slice		
No.			pressure	of slice	--- normal ---		shear
	(avge)	(avge)	(avge)	W	P	P'	S
	kN/m2		kN/m2	kN/m	kN/m	kN/m	kN/m
1	0.00	0.3730	0.00	0	0	0	0
2	0.00	0.3730	0.00	17	44	44	15
3	0.00	0.3730	0.00	41	67	67	23
4	0.00	0.3730	0.00	74	68	68	23
5	0.00	0.3730	0.00	92	86	86	30
6	0.00	0.3730	0.00	100	95	95	33
7	0.00	0.3730	0.00	98	95	95	33
8	0.00	0.3730	0.00	84	83	83	29
9	0.00	0.3730	0.00	58	59	59	21
10	0.00	0.3730	0.00	21	23	23	8

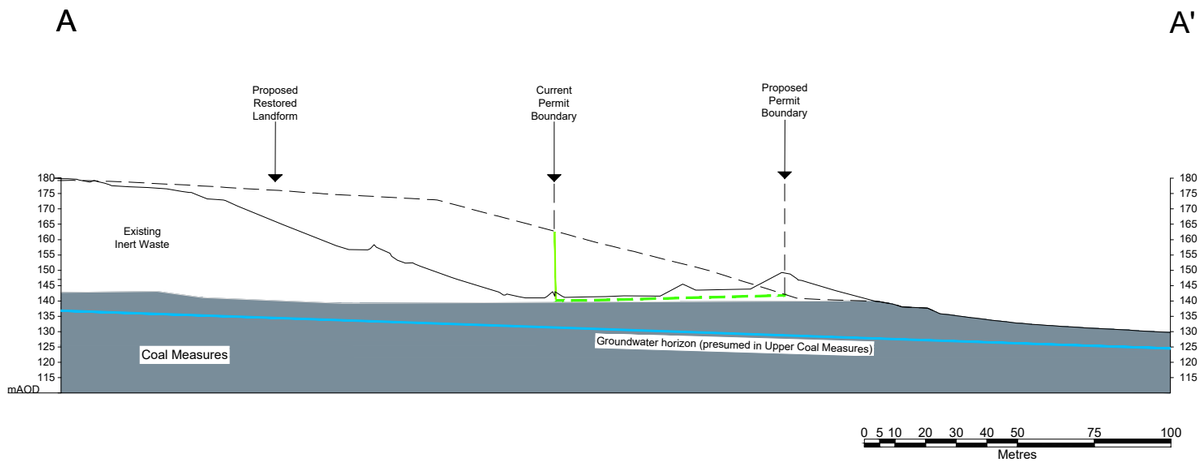
Slice No.	-- Surcharge loads -- vertical load kN/m	horizontal load kN/m	Water load on submerged vertical kN/m	ground horizontal kN/m
1	0	0	0	0
2	32	0	0	0
3	33	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0

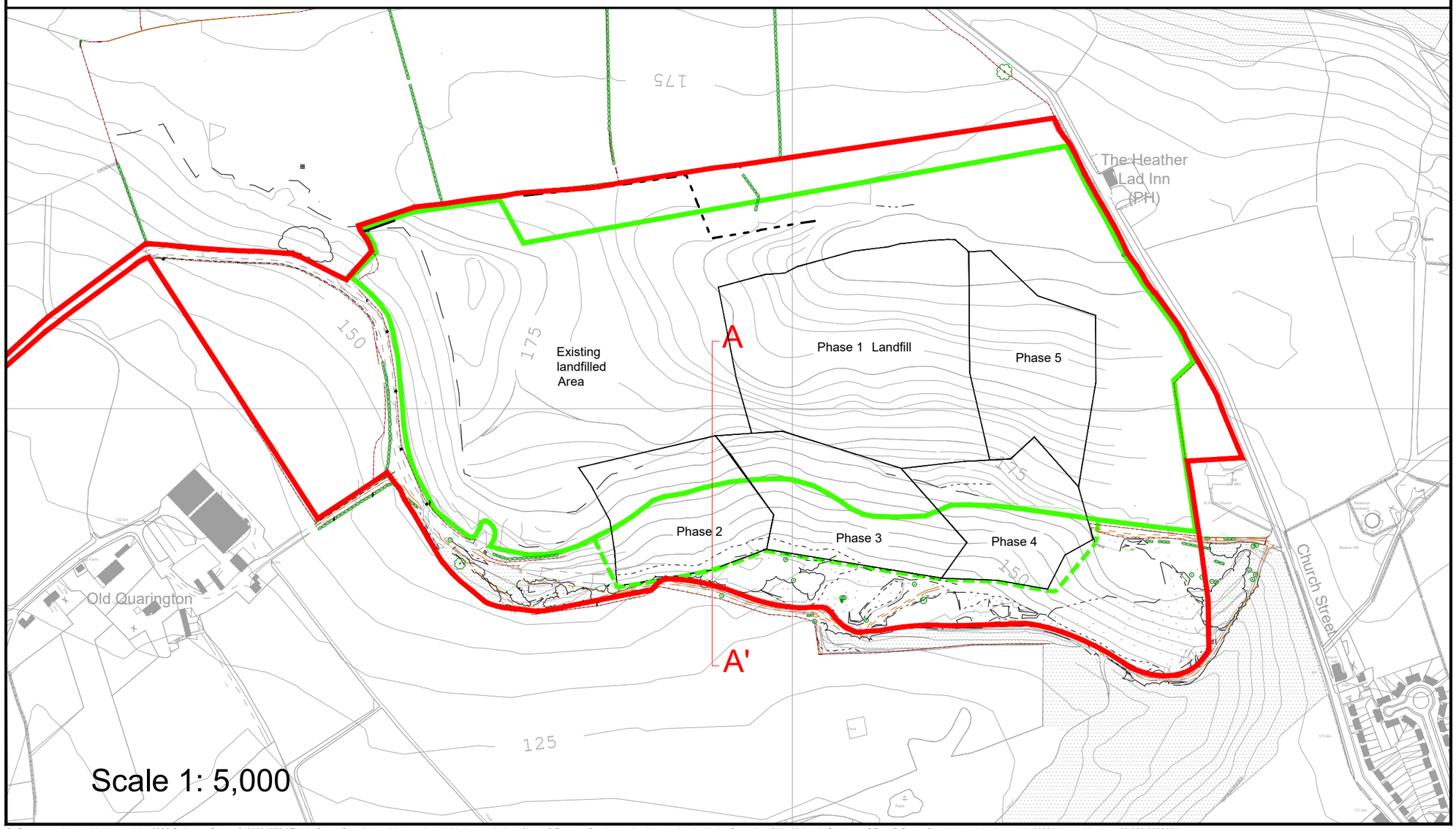
WARDELL ARMSTRONG | Sheet No.
Program: SLOPE Version 12R.05 Revision A18.B14.R58 |
Licensed from GEOSOLVE | Job No. NT14345
Run ID. 1-in-3-waste-Ru0-plant-surcharge | Made by : MG
Old Quarrington Quarry | Date: 1-10-2021
Proposed Restoration | Checked :

Units:
kN,m



DRAWINGS





Legend

- Planning Boundary
- Quarry Extraction Boundary
- Environmental Permit Boundary
- Permit Variation Application Boundary
- Phase 1 — Landfill Phasing Boundary

wardell armstrong

TARMAC
A CRH COMPANY

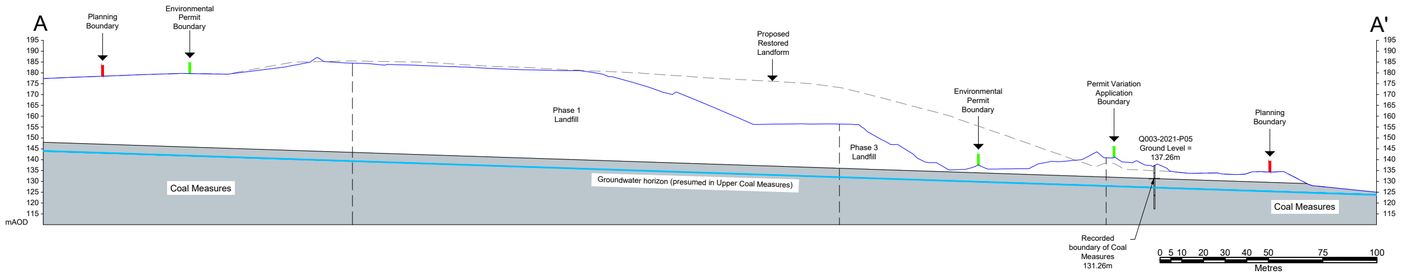
Site Name:
Q003 - Old Quarrington

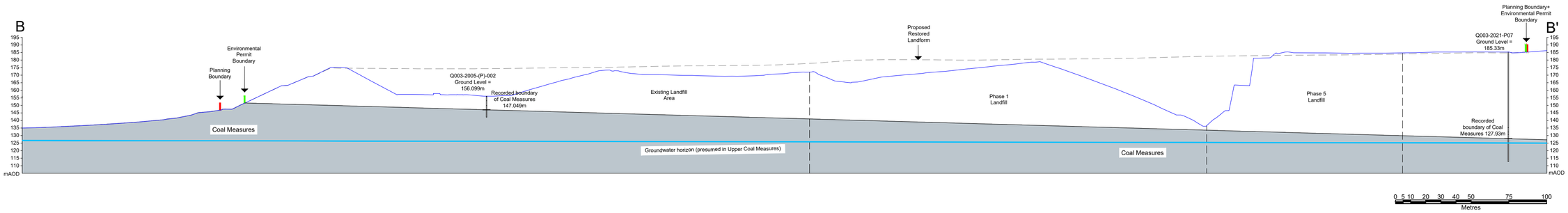
Drawing Name:
Proposed Restoration Contours

Drawn By:	***Scale @ A3:***
M Donaldson	1 :10 000
Date:	***Drawing Number:***
March 2021	Q003-00197-00 WA Ref. NT14345-012

N

Cross Sections
Scale @ 1:2000

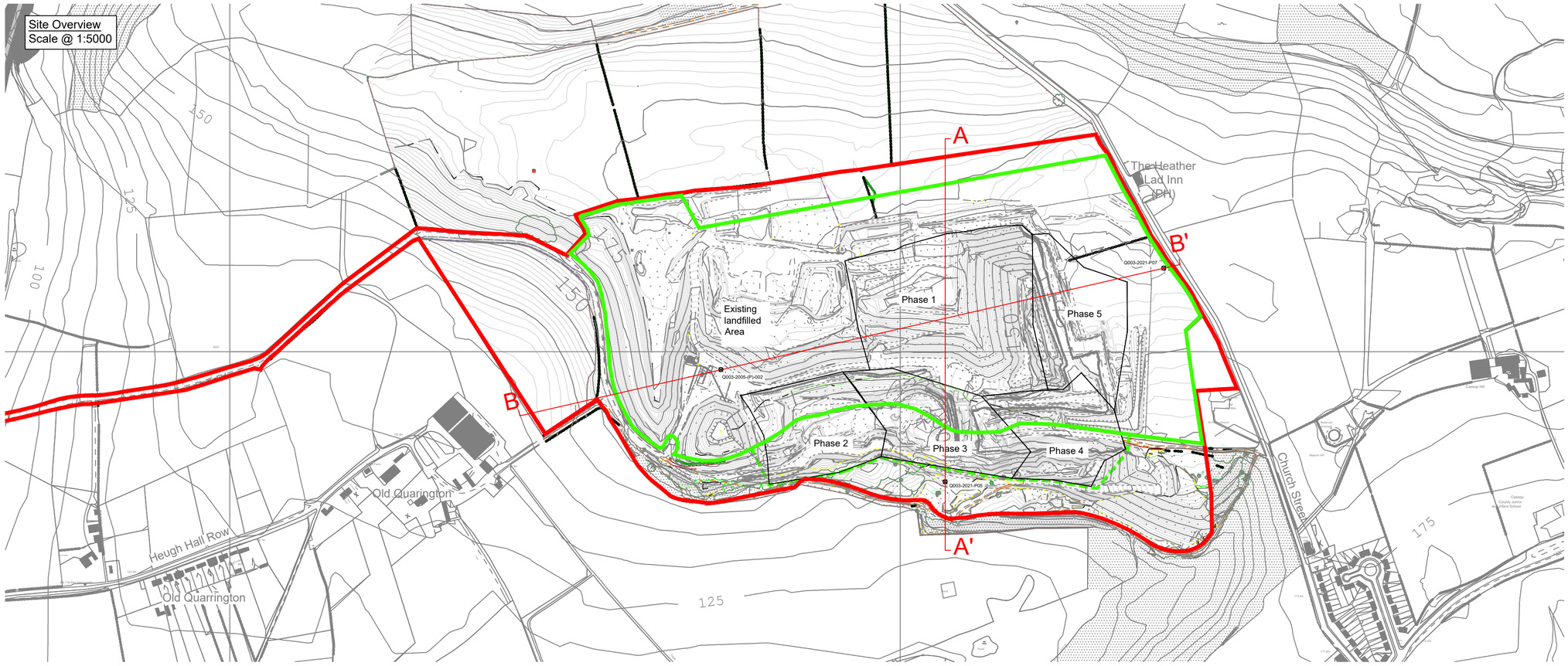




Legend

- Planning Boundary
- Quarry Extraction Boundary
- Environmental Permit Boundary
- Permit Variation Application Boundary
- Phase 1 — Landfill Phasing Boundary
- Groundwater Monitoring Borehole

Site Overview
Scale @ 1:5000



wardell armstrong

TARMAC
A CRH COMPANY

Site Name:
Q003- Old Quarrington Quarry

Drawing Name:
Proposed Permit Extension Area and Cross Section

Drawn By:	***Scale @ A2:***
P Gill	As Shown
Date:	***Drawing Number:***
August 2021	Q003-00197-48

N

wardell-armstrong.com

STOKE-ON-TRENT
Sir Henry Doulton House
Forge Lane
Etruria
Stoke-on-Trent
ST1 5BD
Tel: +44 (0)1782 276 700

BIRMINGHAM
Two Devon Way
Longbridge Technology Park
Longbridge
Birmingham
B31 2TS
Tel: +44 (0)121 580 0909

BOLTON
41-50 Futura Park
Aspinall Way
Middlebrook
Bolton
BL6 6SU
Tel: +44 (0)1204 227 227

BURY ST EDMUNDS
6 Brunel Business Court
Eastern Way
Bury St Edmunds
Suffolk
IP32 7AJ
Tel: +44 (0)1284 765 210

CARDIFF
Tudor House
16 Cathedral Road
Cardiff
CF11 9LJ
Tel: +44 (0)292 072 9191

CARLISLE
Marconi Road
Burgh Road Industrial
Estate Carlisle
Cumbria
CA2 7NA
Tel: +44 (0)1228 550 575

EDINBURGH
Great Michael House
14 Links Place
Edinburgh
EH6 7EZ
Tel: +44 (0)131 555 3311

GLASGOW
2 West Regent Street
Glasgow
G2 1RW
Tel: +44 (0)141 433 7210

LEEDS
36 Park Row
Leeds
LS1 5JL
Tel: +44 (0)113 831 5533

LONDON
Third Floor
46 Chancery Lane
London
WC2A 1JE
Tel: +44 (0)207 242 3243

NEWCASTLE UPON TYNE
City Quadrant
11 Waterloo Square
Newcastle upon Tyne
NE1 4DP
Tel: +44 (0)191 232 0943

SHEFFORD
PI House
R/O 23 Clifton Road
Shefford
Bedfordshire
SG17 5AF
Tel: +44 (0)1462 850 483

TRURO
Baldhu House
Wheal Jane Earth Science Park
Baldhu
Truro
TR3 6EH
Tel: +44 (0)187 256 0738

International offices:

ALMATY
29/6 Satpaev Avenue Regency
Hotel
Office Tower
Almaty
Kazakhstan
050040
Tel: +7(727) 334 1310

MOSCOW
21/5 Kuznetskiy Most St.
Moscow
Russia
Tel: +7(495) 626 07 67

wardell armstrong