Appendix N1 – Geotechnical Report

Pacific Geotech
Consulting Geotechnical Engineers

GEOTECHNICAL REPORT: Proposed Expansion

Hanson Tweed Sand Plant

Cudgen, NSW

March 2021

PG-3427

VERSION 3

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Pacific Geotech
Consulting Geotechnical Engineers

Ref: PG-3427, 2021-02-12, GR VER 3
Author: Curtis Skinner

9th March, 2021

Hanson Tweed Sand Plant
Email: murraay.graham@hanson.com.au
CC: jwebster@oska.net.au

ATTN: MURRAY GRAHAM

Dear Sir,

GEOTECHNICAL STABILITY INVESTIGATION
PROPOSED EXPANSION
HANSON TWEED SAND PLANT, CUDGEN, NSW

Enclosed is a copy of our draft report for the above project dated March 2021. An electronic copy of the report has been issued.

Should you have any queries regarding this report, please do not hesitate to contact Curtis Skinner or Peter Elkington at this office.

Yours faithfully,

C. SKINNER **P. ELKINGTON (RPEQ 7226)**

For and on behalf of
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Appendices

1.0 INTRODUCTION

This report contains the results of the preliminary geotechnical investigation and provides advice and recommendations relating to the following:

- Subsurface conditions in accordance with AS 1726
- Lake Stability assessment
- Indicative pavement design parameters
- Construction considerations

Proposed Development

It is understood that the proposed development is to comprise the design of two lakes for sand extraction purposes. The sand will be extracted via suction dredge following staged clearing of the surface overburden.

An internal haul road will be constructed around the perimeter of the northern lake to connect with the Tweed Valley Way offramp and Pacific Motorway, for transport of sand from site.

The proposed development is indicated below.

PROPOSED LAYOUT

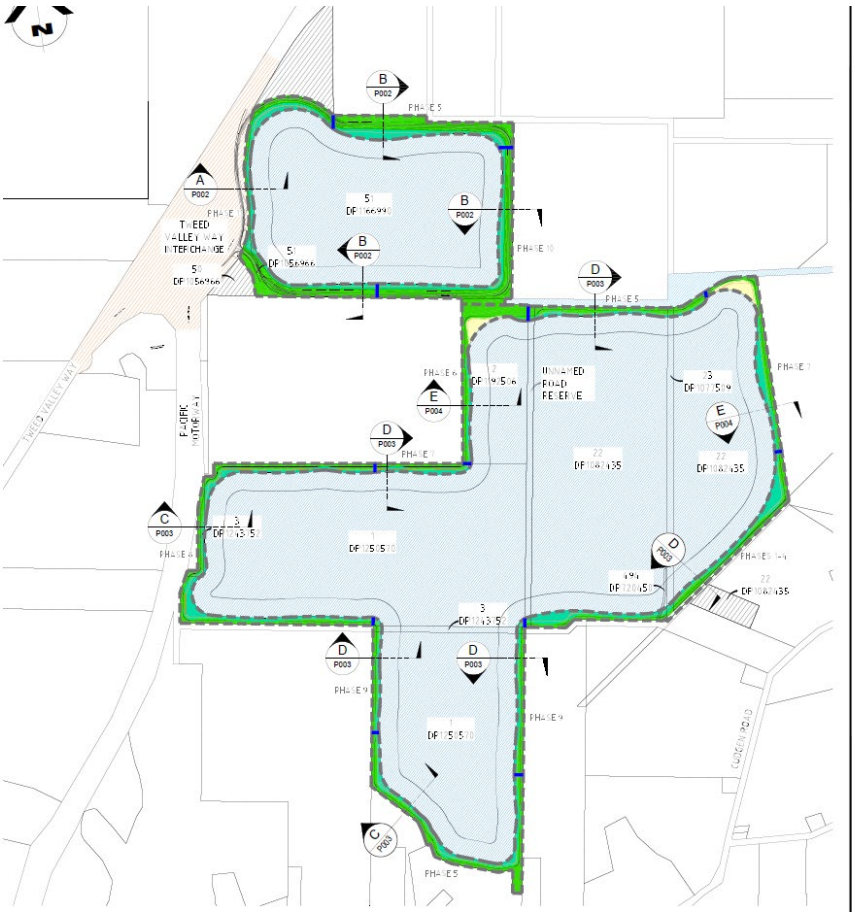
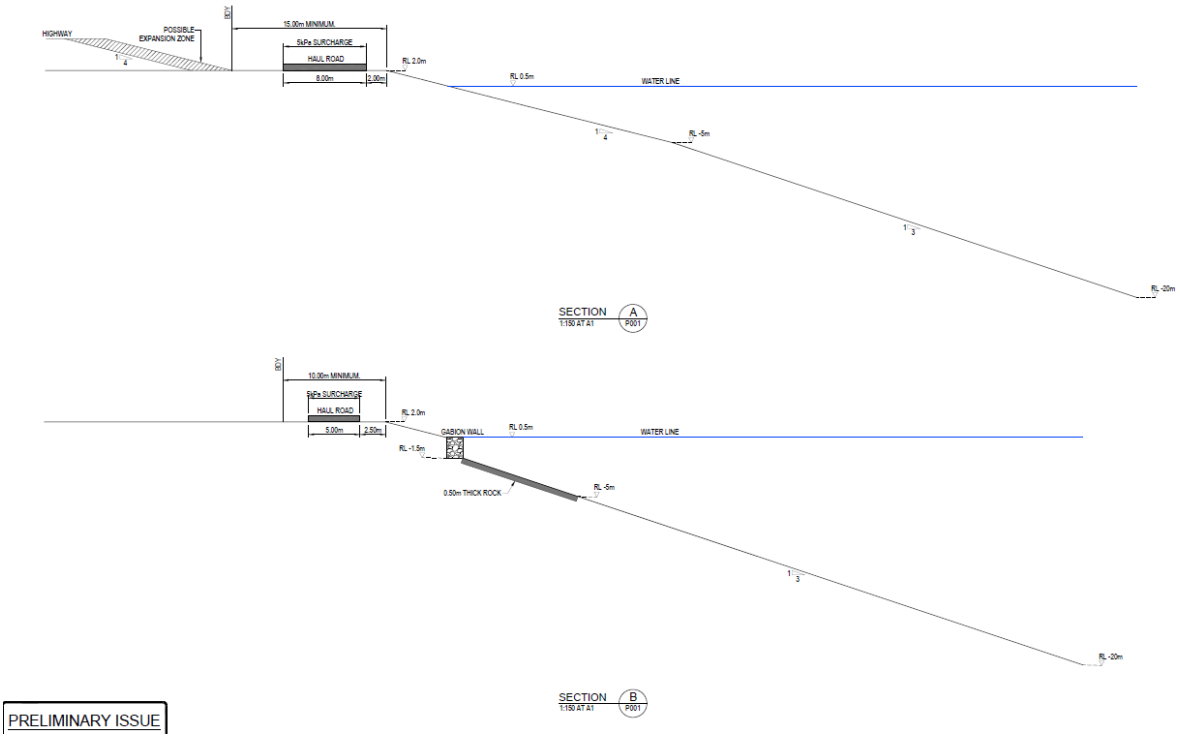


FIGURE 1

The expected lake edge dredging profile is indicated in Figure 2.

PROPOSED LAKE EDGE PROFILE



PRELIMINARY ISSUE

FIGURE 2

2.0 METHODOLOGY

The geotechnical investigation comprised the drilling and sampling of 5 boreholes to depths of between 28.5m to 50m, using an IH800 drilling rig and a combination of 100mm solid flight augers and washboring techniques. Additionally, 6 boreholes were drilled to depths of 1.5m for the pavement investigation using a Compac 018 drilling rig and solid flight auger techniques. Dynamic Cone Penetrometer (DCP) testing was conducted adjacent to the shallow boreholes.

The soil classification descriptions and field tests were carried out in general accordance with Australian Standards.

AS 1726	Geotechnical Site Investigations
AS 1289	Methods of Testing Soils for Engineering Purposes

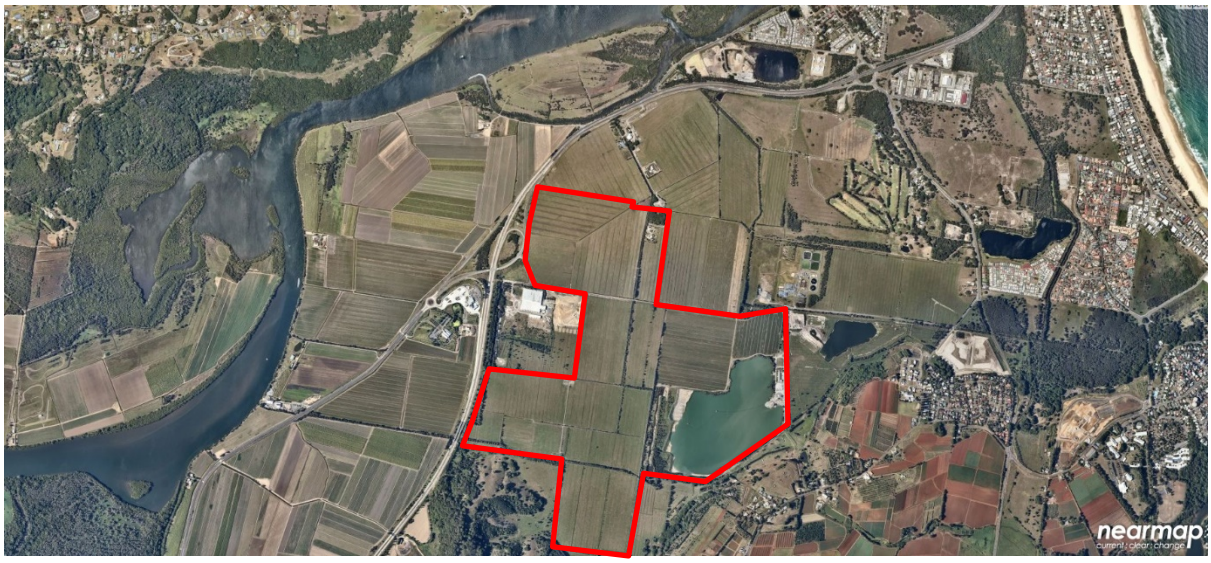
3.0 SITE DESCRIPTION

The site of the proposed development is located within the existing Hanson Tweed Sand Plant and several adjoining farm lots.

At the time of the investigation, the site was vacant farm land. The area is generally low lying and regularly untrafficable due to the water build up. Adjacent to the site, on the western boundary, Tweed Valley Way and the Pacific Highway run parallel.

Refer following aerial and site photographs for typical site conditions.

AERIAL IMAGE



SITE PHOTOGRAPHS

4.0 GEOTECHNICAL MODEL

The subsurface conditions typically encountered in the deep boreholes consisted of a natural thin layer of soft clay overlying a very loose to dense sand profile to depths of between 17.8m and 19.0m. This depth is generally consistent with the 85 vibrocores completed on site previously. A layer of firm to very stiff silty clay was then encountered in the boreholes overlying a clayey sand / clayey gravel to the termination depths of testing.

In BH103, BH104 and BH105, a highly weathered greywacke/metasiltstone was encountered at depths of between 25.9m and 48.0m.

The subsurface profile typically encountered in the shallow boreholes comprised of surficial soft silty sandy clay (in BH's 01 & 02) overlying loose sand for the depth of the investigations.

Table 1 presents a summary of the encountered subsurface profile. Detailed borehole record sheets are appended to this report.

TABLE 1 SUBSURFACE PROFILE SUMMARY

BH No.	FILL	NATURAL							BH TD
		SAND				CLAY	GRAVEL	GREYWACKE	
		V. Loose	Loose	M. Dense	Dense – V. Dense				
BH101	NE	1.0-4.0 18.0-19.0	4.0-6.0	6.0-9.0 10.5-12.0 28.5-30.0	9.0-10.5 12.0-18.0	19.0-25.0 31.5-TD	25.0-28.5 30.0-31.5	NE	31.95
BH102	NE	0.3-0.6	0.6-4.0 16.0-17.8 25.7-26.0 28.0-30.0 31.5-34.0	4.0-7.0 14.5-16.0 30.0-31.5 37.5-45.0	7.0-14.5	0.0-0.3 17.8-25.7 26.0-28.0 34.0-37.5	45.0-TD	NE	46.0
BH103	NE	0.6-1.5	1.5-4.5 6.0-9.0 18.0-19.0	4.5-6.0 9.0-15.0 30.0-33.0 36.5-46.0	15.0-18.0	0.0-0.6 19.0-30.0 32.0-36.5	46.0-48.0	48.0-TD	50.0
BH104	NE	0.4-4.5	4.5-6.0 7.5-15.0	6.0-7.5 31.0-38.0	15.0-21.0 41.0-43.9	0.0-0.4 21.0-31.0	38.0-41.0	43.9-TD	44.0
BH105	NE	0.0-7.0	18.0-19.5	7.0-14.5 19.5-22.0	14.5-18.0 22.0-23.5	0.0-0.5 23.5-26.8	NE	26.8-TD	28.5
BH01	NE	NE	NE	0.0-0.1 0.3-TD	NE	0.1-0.3	NE	NE	1.5
BH02	NE	NE	0.2-TD	NE	NE	0.0-0.2	NE	NE	1.5
BH03	0.0-0.2	NE	NE	0.2-TD	NE	NE	NE	NE	1.5
BH04	NE	NE	0.0-0.2	0.2-TD	NE	NE	NE	NE	1.5
BH05	NE	NE	0.0-0.2	0.2-TD	NE	NE	NE	NE	1.5
BH06	NE	NE	0.0-0.2	0.2-TD	NE	NE	NE	NE	1.5

Notes:
1. All depths in metres below ground level at time of investigation.
2. NE - Not Encountered; TD - Termination Depth.

Groundwater was encountered in the shallow boreholes at depths of between 0.8m and 1.4m at the time of drilling. Groundwater was not recorded in the deeper boreholes due to the drilling method adopted. Increases in the groundwater levels would be expected following periods of rainfall.

5.0 LABORATORY TESTING

Laboratory testing was carried out on samples retrieved from the site investigation program and was directed towards assessing the reactivity and subgrade characteristics of the subsurface material.

Laboratory testing included:-

- California Bearing Ratio - to assess the subgrade characteristics of the subsurface material under soaked conditions.
- Triaxial Testing – to assess the strength parameters of the underlying material.

The results of the laboratory testing are contained in Appendix C.

6.0 STABILITY ASSESSMENT

An assessment of the geotechnical stability of the proposed lake batters that are adjacent to Tweed Valley Way and the Pacific Highway was undertaken to determine a long term factor of safety and suitable revetment profile.

The areas of the proposed critical lake edge profile are indicated in Figure 3.

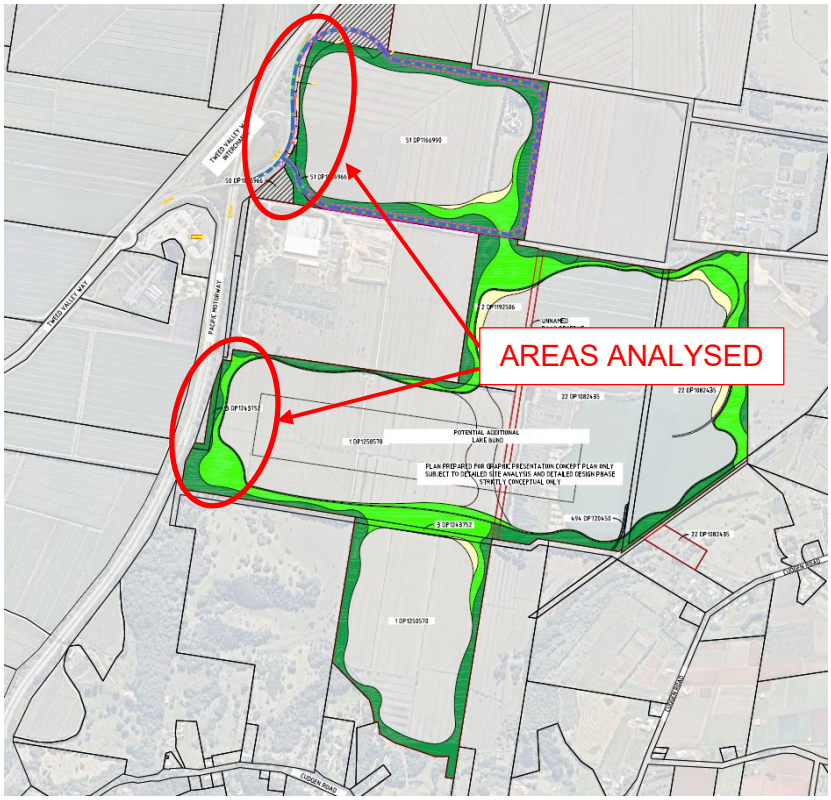


FIGURE 3

Various batter profiles, as indicated below, have been considered for options under construction.

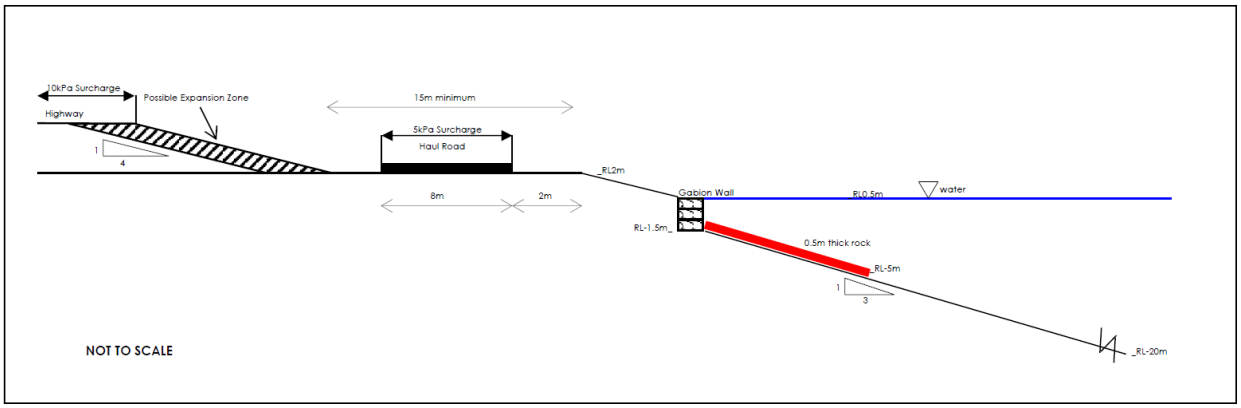


FIGURE 4 – OPTION A

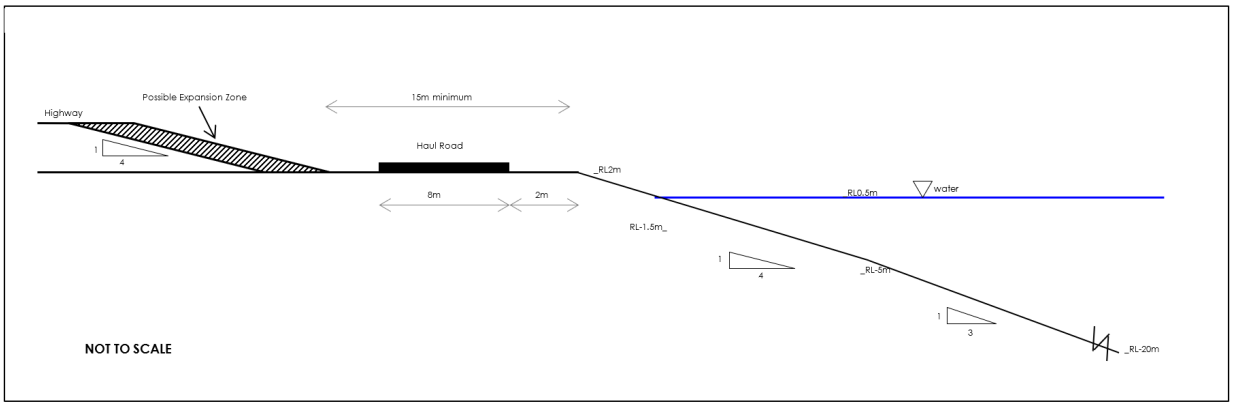


FIGURE 5 – OPTION B

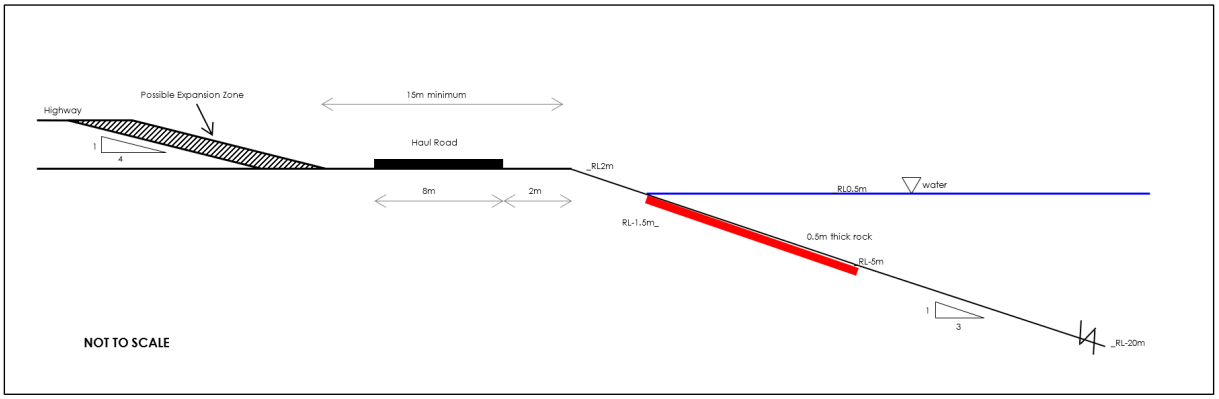


FIGURE 6 – OPTION C

Assumptions

- The road reserve has been modelled with an allowance for future widening of the adjacent highway and onramps by approximately 4.0m towards the proposed lakes.
- A road embankment height of 3m above ground level has been modelled as the worst-case scenario.
- A minimum distance of 15m for the closest point between the top of the proposed lake edge and the highway embankment toe has been adopted.

6.1 Material Parameters

The selection of parameters for use in stability analysis has been based on the interpretation of the results of the field and laboratory testing from the investigation and the results of earlier investigations across the Hanson Tweed Sand Plant and in the immediate area.

Table 2 presents the strength parameters adopted for stability analysis.

TABLE 2 ADOPTED STRENGTH PROFILE

Material	Total Stress		Effective Stress	
	Cu (kPa)	ϕ (°)	C' (kPa)	ϕ' (°)
Sand - Very Loose / Loose	-	28	0	28
Sand – Medium Dense	-	32 to 34	0	32 to 34
Sand - Dense	-	38 to 40	0	38 to 40
Clay – Stiff - Very Stiff	50 125	0 0	5 10	26 30
Gravels / Sands - Dense	-	42	25	42

Conditions for Analysis

Two conditions are considered possible critical conditions from a geotechnical stability perspective (total stress and effective stress) and have been analysed for the soil profile developed and a number of loading conditions.

Both the total stress and effective stress cases have been analysed.

A minimum factor of safety of 1.3 is typically considered acceptable for the total stress situation (short term) and 1.5 is generally considered acceptable for the effective stress (long term) case, for the adopted soil parameters and loading conditions.

Method of Analysis

The stability assessment has been carried out using the "G Slope" computer program developed by Mitre Software Corporation. This program allows the use of Bishop's

Modified Method and Janbu's Simplified Method applied to circular, composite and fully specified failure surfaces.

Failure conditions are analysed by dividing the failure body into a number of vertical slices. The forces acting on each slice are evaluated and the equilibrium of the entire failure body is determined by assessing the forces on all the slices.

A factor of safety is computed for each failure surface considered. A minimum factor of safety for the section under analysis is found by analysing a large number of potential failure surfaces.

6.2 *Stability Results*

A surcharge load of 5kPa for the proposed haul road for a distance of 2m from the top of the bank for a distance of the length of the edge was adopted and 10kPa surcharge adopted for the highway.

It has been assumed that the water level in the lake will be maintained at a minimum level of RL0m, following excavation of the lake.

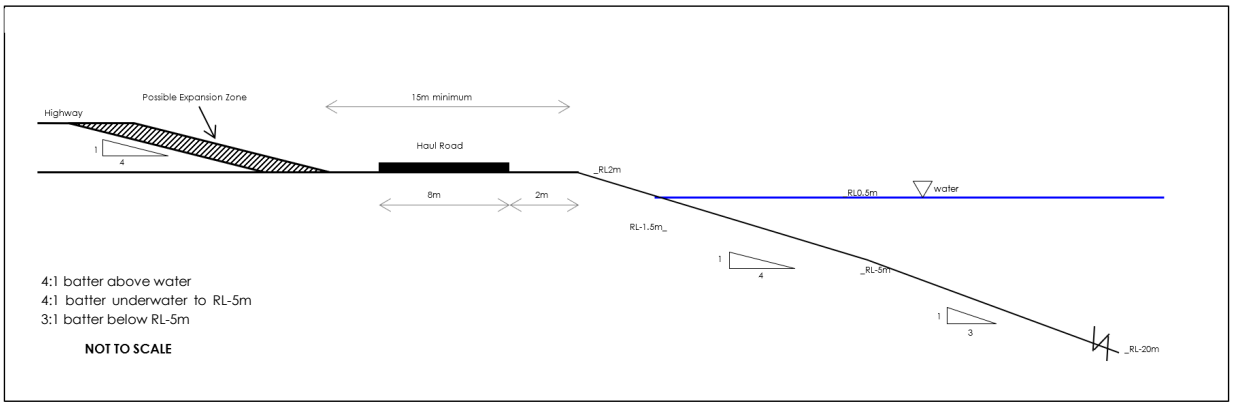


FIGURE 5 – OPTION A

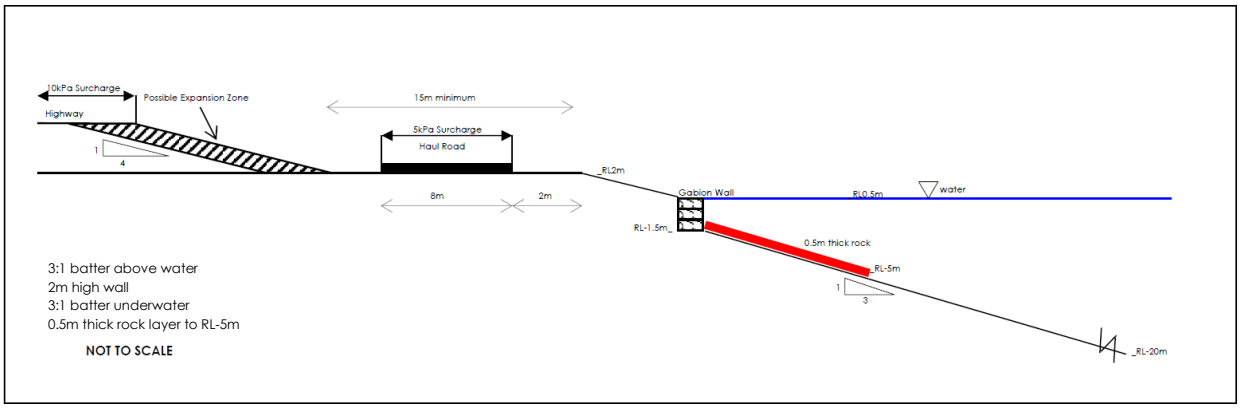


FIGURE 4 – OPTION B

For both the total and effective stress analysis for the above adopted profiles, a global factor of safety in excess of 1.5 occurs.

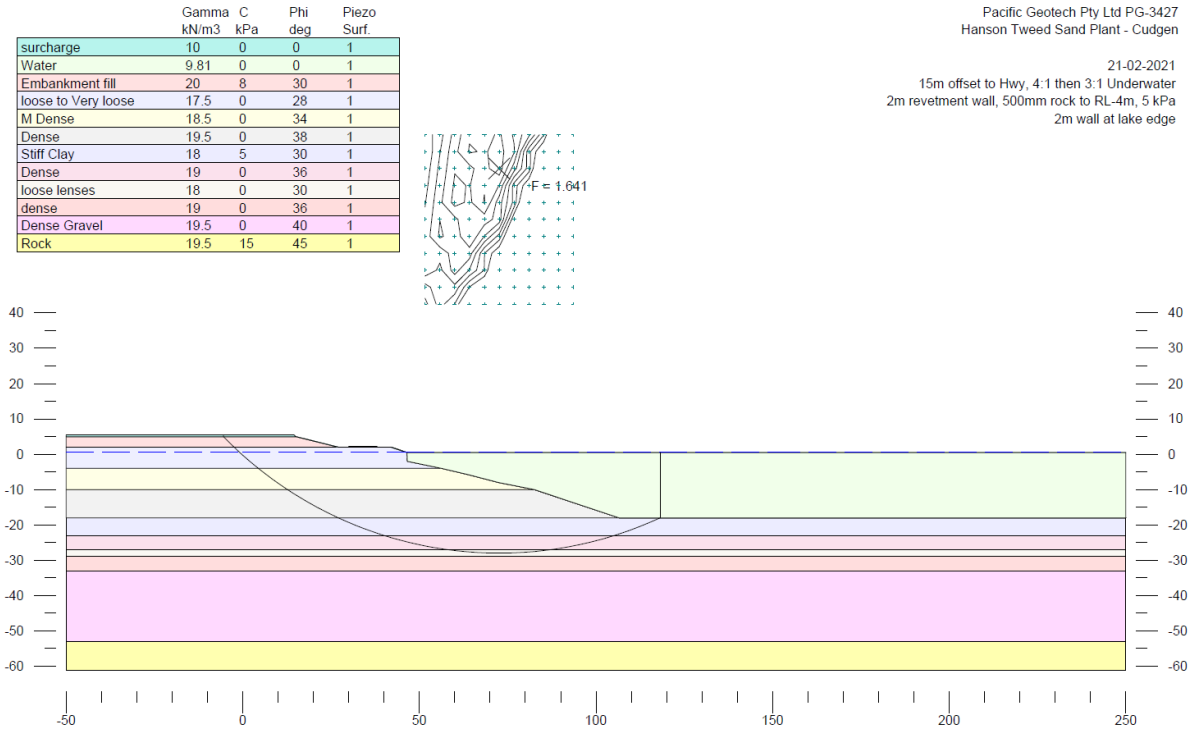


FIGURE 7 – G-SLOPE MODEL

It is likely that some minor slumping of the upper level loose sands will occur with some of the above profiles prior to the placement of the revetment/protection rock but this will not impact on the overall global stability of the batter profile. Options to stabilise the upper level soil profile below the water could include the installation of a rock protection layer of the completion of batter profiling (say 500mm thick with a suitable geofabric under) or further flattening of the batter profile to 6H:1V.

Consideration could be given to maintaining a 2m bench at approximately RL-4m as a construction measure to prevent over-excavation of the upper level batter slope during the dredging of the lower level sands.

Risk Assessment

A risk assessment has been undertaken to determine the potential risk associated with the proposed long-term batter profile. As part of the risk assessment, the following mechanisms have been considered using the following risk assessment.

Rating		Description	Examples
5	Almost certain	The event will occur in most conditions	Expected frequency range: greater than one or more per annum
4	Likely	The event will probably occur in most conditions	Expected frequency range: between one in 5 years and one per annum
3	Possible	The event should happen at some time	Expected frequency range: between one in 10 years and one in 5 years
2	Unlikely	The event could happen at some time	Expected frequency range: between one in a 100 years and one in 10 years
1	Rare	The event may only occur in exceptional circumstances	Expected frequency range: less than one in a hundred years

Risk matrix		Severity of risk:				
		No injuries, minor breach of environmental guidelines or standards, incident or damage resulting in direct and/or indirect costs of <$30,000	Minor injuries treated by first aid, short term effect on built or natural environment easily remedied, incident or damage resulting in direct and/or indirect costs of$30,000 to $60,000	Minor medical treatment required, medium term effects on environment from single incident, incident or damage resulting in direct and/or indirect cost of $60,000 to $150,000	Serious injury(s), hospitalisation of multiple people, significant impact on natural or built environment (potentially instigating an external investigation), incident or damage resulting in direct and/or indirect costs of $150,000 to $300,000	Fatality(s), long-term disability, significant environmental impact with long term effects, incident or damage resulting direct and/or indirect costs of >$300,000
		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Likelihood of risk	Almost certain 5	Moderate	High	Extreme	Extreme	Extreme
	Likely 4	Moderate	High	High	Extreme	Extreme
	Possible 3	Low	Moderate	High	High	Extreme
	Unlikely 2	Low	Low	Moderate	High	Extreme
	Rare 1	Low	Low	Moderate	>Moderate	High

Table 1: Likelihood Assessment Guide

Risk	Likelihood of Risk	Severity of Risk	Likelihood
Geological complexity of the site	1	2	Low
Amount and quality of site-specific geotechnical data available	1	4	Moderate.
Assessment of geotechnical data undertaken	1	3	Moderate.
Correlations with non-site specific information	1	2	Low.
Previous experience with similar designs in similar conditions	1	2	Low.
Design method utilised	2	3	Moderate.
Level of geotechnical/designer involvement during construction	2	2	Low.
Degree of post-construction monitoring	3	2	Moderate.
Impact of unforeseen loads	2	4	High.
Failure mechanism uncertainty	1	4	Moderate.
Consequence of Batter Failure	1	2	Low

On the basis of the above assessment and the stability analysis undertaken, the most significant degree of risk involves the impact of additional loads being applied to the top of the embankment slope or over dredging of the sand batter during the dredging operation resulting in steeper batter profiles than those designed. This should be controlled through the strict control and management of development adjacent to the revetment slope to ensure that additional loading does not further impact on the global stability of the revetment profile and monitoring of the dredging and continued underwater surveying during the dredging operation, together with the implementation of a bench in the batter profile.

The likelihood of risk to the development as a consequence of failure of the batter has been assessed as Low provided suitable treatment methods and profile have been adopted.

It is therefore considered that the proposed batter profile indicated in Figure 4 is acceptable in the long term from a geotechnical perspective.

Pacific Geotech should be contacted to determine the effects of possible changes to the proposed revetment profile on the long-term stability of the revetment profile.

The results of this analysis should be reviewed after the additional on-site investigation has been completed to ensure the recommendations of this preliminary assessment are appropriate for construction.

7.0 PAVEMENT DESIGN CONSIDERATIONS

Soaked CBR laboratory testing was conducted on samples recovered from BH01 to BH06, along the proposed haul road. The Soaked CBR tests produced values of 3.0% to 5.0% in the natural soils.

Considering the nature of the loose sand, a design CBR value of 3.0% and a modulus of subgrade reaction of 20kPa/mm are recommended for the natural material for the pavement design. These values should be confirmed with additional on-site sampling and testing following the bulk earthworks/stripping on site.

Specific additional construction considerations are offered in regard to the construction of the pavements on the site:-

- It should be ensured that the subgrade of the pavement is suitably graded to allow any seepage to flow from under the pavement to the perimeter drains.
- Pavement materials should comply with MRS 11.05 specifications and the corresponding minimum dry density ratios are recommended:

i)	Lower Sub-base	(Type 2.5)	95% (Modified)
ii)	Sub-base	(Type 2.3)	95% (Modified)
iii)	Base	(Type 2.1)	98% (Modified)

- Inspections and testing should be carried out by Pacific Geotech following completion of the bulk earthworks to confirm subgrade conditions across the pavement areas.

8.0 EARTHWORKS AND SITE PREPARATION CONSIDERATIONS

Earthworks are expected to comprise of the construction of the haul road.

It is recommended that the following site preparation and earthworks procedures be carried out during development.

- All earthworks operations should be carried out in general accordance with AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments".
- Trafficability across the site at the time of the investigation was assessed to be poor with difficulties encountered.
- If significant rainfall events occur during the earthworks operation, more significant difficulties could be experienced in trafficing the exposed surface.
- All topsoil (i.e. soil containing organic matter) and soils containing deleterious matter should be stripped from the construction area at the commencement of the earthworks operation.
- The use of a bridging layer may be required to improve trafficability across the site. Subject to the subgrade performance at the time of bulk earthworks. The bridging layer is likely to be a minimum 400mm thick and the use of a suitable woven geofabric may assist in minimising the required layer thickness.
- Imported fill should be of fair to good quality with a minimum Soaked CBR value of 10%, a maximum lss=1.0% and a maximum particle size of 75mm.
- All filling should be undertaken in layer thicknesses of approximately 250mm (or as appropriate for the compaction equipment being used). Fill should be compacted to a minimum dry density ratio of 98% Standard in accordance with AS1289 5.1.1.
- Field density testing should be carried out to check the standard of compaction achieved and the placement moisture content. The frequency and extent of testing should be as per guidelines in AS.3798-2007.
- All earthworks operations should be performed under Level 1supervision, in general accordance with the requirements of AS3798 and should be certified as controlled fill by the testing authority.

9.0 LIMITATIONS

We have prepared this report for the Proposed Expansion of Hanson Tweed Sand Plant, Cudgen, NSW. The report is provided for the exclusive use of Hanson Tweed Sand Plant, for this project only and for the purposes outlined in the report. It should not be used by, or relied upon, for other projects on the same or different sites or by a third party. In preparing this report, we have relied upon information provided by the client or their agents.

The results are indicative of the subsurface conditions on site only at the specific testing locations. Subsurface conditions can change between test locations and the design and construction should take the spacing of the testing and testing methods adopted and the potential for variation between the test locations.

It is recommended that Pacific Geotech be engaged to provide advice and ensure the development is undertaken in accordance with the assumptions made in writing this report.

This is not to reduce the level of responsibility accepted by Pacific Geotech, but rather to ensure that the parties who may rely on the information contained in this report are aware of the responsibilities they assume in doing so.

C. SKINNER **P. ELKINGTON (RPEQ 7226)**

For and on behalf of
PACIFIC GEOTECH PTY LTD

APPENDICES

APPENDIX A

NOTES RELATING TO THIS REPORT

Notes Relating to this Report

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis.

Every care has been taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical conditions and contains recommendations or suggestions for design and construction. However, unexpected variations in ground conditions will occur. The potential for this will depend partly on testing, spacing and sampling frequency.

If variations are identified, Pacific Geotech would be pleased to assist with additional investigations or advice to resolve the matter.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Description and Classification Methods

The description and classification of soils and rocks used in this report are based on AS 1726.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the percent of other particles present (e.g. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silty	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density which can be correlated from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very Loose	less than 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) and can be quantified by the Pocket Penetrometer test, Vane Shear test, laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 - 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 - 400
Hard	greater than 400
Friable	strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc.

Sampling

Sampling is undertaken during the fieldwork to allow examination of the soil or rock and to allow laboratory testing to be undertaken.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content and minor constituents. Bulk samples are similar but of greater volume

required for some test procedures such as CBR testing.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and collecting a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

Investigation Methods

Test Pits: These are typically undertaken with a backhoe or a tracked excavator, allowing examination of the insitu soils. Limitations of test pits are the problems associated with collapse of the pits, disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of typical diameter of between 50mm to 75mm advance manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as fill, gravel, hard clays and collapse of the borehole (typically in non-cohesive soil).

Continuous Spiral flight Augers: The borehole is advanced using 65mm to 100mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. Augers of up to 300mm in diameter are used to recover larger volumes of sample. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights. Samples can be disturbed and layers may become mixed. Augering below the groundwater table can be less reliable than augering above the water table.

A Tungsten Carbide (TC) bit for auger drilling into rock can be used to indicate rock strength and continuity by variation in drilling resistance and from examination of recovered rock fragments but provides only an indication of the likely rock strength. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is advanced by a bit attached to the end of a hollow rod string, with water being pumped down the drill rods and returned up the annulus of the borehole, carrying the drill cuttings. Changes in stratification can be determined from the return, together with information from "feel" and rate of penetration.

The borehole can be stabilised through the use of drilling mud as a circulating fluid. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. This technique provides a reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel is used, which gives a core of about 50mm diameter. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a disturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposed", Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer, with a free fall of 760mm. The sample is driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense soils, hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of , say, 4, 6 and 7 blows, as
  N = 13
  4, 6, 7
- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as
  N > 30
  15, 30/40mm

Cone Penetrometer Testing (CPT): Cone Penetrometer Testing with or without pore pressure measurement (CPTu) is carried out using a Cone Penetrometer in general accordance with AS 1289 6.5.1, 1999.

In the tests, a 36mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the fractional resistance on a separate 135mm long sleeve, immediately behind the cone. Pore Pressure is recovered through a pore ring located either within, or more usually immediately behind the cone/tip.

As penetration occurs (at a rate of approximately 20mm per second) and data is recorded every 20mm of penetration, the results are presented graphically.

The information provided on the plot comprises:

- Cone resistance – expressed in mPa
- Sleeve friction – expressed in kPa
- Friction ratio – the ratio of sleeve friction to cone resistance expressed as a percentage.
- Pore pressure in kPa
- Tilt of probe (in degrees).

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and rising to 2% to as high as 8%, and higher in organic soils. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes, etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive.

Dynamic Cone Penetrometers:

Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod into the ground with a 9kg sliding hammer dropping 510mm and counting the blows for successive 100mm increments of penetration.

Logs

The borehole or test pit logs are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of the boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than “straight line” variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

Groundwater

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.

- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be flushed from the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes from which ongoing monitoring can be undertaken.

Fill

The present of fill materials can often be determined only by the inclusion of foreign objects (e.g. bricks, steel ,etc.) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult to reliably determine the extent of the fill.

Laboratory Testing

Laboratory testing is carried out in general accordance with Australian Standard 1289 'Methods of Testing Soil for Engineering Purposes'.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage.

Review of Design

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/constraints are quite complex, it is prudent to have a design review.

Site Inspection

Pacific Geotech would be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related:

Requirements could range from:

i. a site visit to confirm that conditions exposed are no worse than those interpreted, to
ii. a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
iii. full time engineering present on site.

APPENDIX B

BOREHOLE RECORD SHEETS

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 01
Page 1 of 1

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	07/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	SR
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552189.9 m E 6874887.6 m N MGA94 Zone 56		
Drill Model and Mounting:	EVH1750P	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: SR

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	D 0.50-1.50 m			0.10		SM	NATURAL Silty SAND (SM) Medium dense, fine to medium grained, dark brown, low to medium plasticity fines, with organics, moist.	0 5 10 15 20 25
								CI-CH	Silty CLAY (CI-CH) Stiff, medium to high plasticity, dark brown, with fine grained sand, moist.	
						0.30		SP	SAND (SP) Medium dense, fine to medium grained, light yellow brown, moist.	
						1.00		SP	SAND (SP) Medium dense, fine to medium grained, light yellow brown, moist to wet.	
						1.50			Hole Terminated at 1.50 m	

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 1.4m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 02
Page 1 of 1

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	07/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	SR
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552601.7 m E 6874808.4 m N MGA94 Zone 56		
Drill Model and Mounting:	EVH1750P	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: SR

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	B 0.20-1.50 m			0.20		CL	NATURAL CLAY (CL) Soft, low plasticity, dark brown, with fine grained sand, moist.	0 5 10 15 20 25
						1		SP	SAND (SP) Loose to medium dense, fine to medium grained, light yellow brown, moist.	
						1.00		SP	SAND (SP) Loose to medium dense, fine to medium grained, light yellow brown, wet.	
						1.40		SP	SAND (SP) Loose to medium dense, fine to medium grained, light grey, wet.	
						1.50			Hole Terminated at 1.50 m	
						2				
						3				
						4				

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 1.0m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 03
Page 1 of 1

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	07/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	SR
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552931.0 m E 6874737.9 m N MGA94 Zone 56		
Drill Model and Mounting:	EVH1750P	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: SR

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T			D 0.50-1.50 m			0.20		GM	FILL Silty Sandy GRAVEL (GM) Dense, fine to coarse sized, grey brown, medium grained sand, low to medium plasticity fines, with cobbles, dry to moist.	0 5 10 15 20 25
						1		SP	NATURAL SAND (SP) Medium dense, fine to medium grained, light yellow brown, moist.	
						1.40				
						1.50		SP	SAND (SP) Medium dense, fine to medium grained, light grey, wet.	
									Hole Terminated at 1.50 m	
						2				
						3				
						4				

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 1.4m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 04
Page 1 of 1

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	07/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	SR
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552955.0 m E 6874406.2 m N MGA94 Zone 56		
Drill Model and Mounting:	EVH1750P	RL Surface:	No survey
Hole Diameter:		Datum:	AHD
		Operator:	SR

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	B 0.20-1.50 m			0.20		SM	NATURAL Silty SAND (SM) Loose, fine to medium grained, dark brown, low to medium plasticity fines, with organics, moist.	0 5 10 15 20 25
						0.80		SP	SAND (SP) Loose, fine to medium grained, light yellow brown, moist.	
						1		SP	SAND (SP) Loose, fine to medium grained, light grey, wet.	
						1.50			Hole Terminated at 1.50 m	
						2				
						3				
						4				

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 0.8m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
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Borehole No.
BH 05
Page 1 of 1

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	07/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	SR
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552743.1 m E 6874200.0 m N MGA94 Zone 56		
Drill Model and Mounting:	EVH1750P	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: SR

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	D 0.50-1.00 m			0.20		SM	NATURAL Silty SAND (SM) Loose, fine to medium grained, dark brown, low to medium plasticity fines, with organics, moist.	0 5 10 15 20 25
						1		SP	SAND (SP) Loose to medium dense, fine to medium grained, light yellow brown mottled grey, moist to wet.	
						1.20		SP	SAND (SP) Loose, fine to medium grained, grey, wet.	
						1.50			Hole Terminated at 1.50 m	
						2				
						3				
						4				

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 1.2m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 06
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	07/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	SR
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552262.4 m E 6874273.3 m N MGA94 Zone 56		
Drill Model and Mounting:	EVH1750P	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: SR

Drilling Information							Soil Description			DCP
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	DCP TEST (AS 1289.6.3.2-1997) Blows per 100 mm
AD/T		▽	B 0.20-1.50 m			0.20		SM	NATURAL Silty SAND (SM) Loose, fine to medium grained, dark brown, low to medium plasticity fines, with organics, moist.	0 5 10 15 20 25
						1.00		SP	SAND (SP) Loose to medium dense, fine to medium grained, light yellow brown, moist to wet.	
						1.50		SP	SAND (SP) Loose, fine to medium grained, light yellow brown, wet.	
									Hole Terminated at 1.50 m	

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater encountered at 1.0m.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 101
Page 1 of 3

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	18/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552245.8 m E 6874985.4 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T								Cl	NATURAL Silty Sandy CLAY (Cl) Soft, medium plasticity, brown with light orange brown, fine to medium grained sand, moist.
						1.00			
						1.20		SC	Clayey SAND (SC) Very loose to loose, fine to medium grained, grey brown, medium plasticity fines, moist to wet.
						1.50		SC	Clayey SAND (SC) Very loose, fine to medium grained, dark grey, low to medium plasticity fines, wet.
			SPT 1.50-1.95 m 1,2,1 N=3			2		SM	Silty SAND (SM) Very loose, fine to medium grained, dark grey, wet.
						3.00			
			SPT 3.00-3.45 m 2,1,2 N=3					SP	SAND (SP) Very loose, fine to medium grained, grey, moist to wet.
						4.00			
						4		SP	SAND (SP) Loose, fine to medium grained, grey, moist.
			SPT 4.50-4.95 m 3,4,4 N=8						
						6.00			
			SPT 6.00-6.45 m 5,6,10 N=16			6		SP	SAND (SP) Medium dense, fine to medium grained, grey, with seashells, moist.
			SPT 7.50-7.95 m 7,11,13 N=24			8			
						9.00			
			SPT 9.00-9.45 m 10,14,17 N=31			10		SP	SAND (SP) Dense, fine to medium grained, grey, with seashells, moist.
						10.50			
			SPT 10.50-10.95 m 13,16,12 N=28					SP	SAND (SP) Medium dense, fine to medium grained, grey, moist.
						12.00			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 101
Page 2 of 3

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	18/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552245.8 m E 6874985.4 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 12.00-12.45 m 10,14,24 N=38			14		SP	SAND (SP) Dense, fine to medium grained, grey, moist.
			SPT 13.50-13.95 m 12,20,25 N=45			16			
			SPT 15.00-15.45 m 12,19,20 N=39			16.50			
			SPT 16.50-16.95 m 16,26,30 N=56			18		SP	SAND (SP) Very dense, fine to medium grained, grey, moist.
			SPT 18.00-18.45 m 3,1,1 N=2			18.00		SM	Silty SAND (SM) Very loose, fine to medium grained, grey, low to medium plasticity fines, moist.
			U50 19.50-19.95 m PP=100kPa			19.00		CI-CH	Silty CLAY (CI-CH) Stiff, medium to high plasticity, dark grey, moist.
			SPT 21.00-21.45 m 0,0,0 N=0			20			
			SPT 22.50-22.95 m 4,6,6 N=12			21.00		CI-CH	Silty CLAY (CI-CH) Stiff to very stiff, medium to high plasticity, grey, moist.
						22			
						22.50		CH	Silty CLAY (CH) Stiff, high plasticity, grey mottled light orange brown, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Support
C - Casing

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Remarks
1. Groundwater not encountered.

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Consulting Geotechnical Engineers

Borehole No.
BH 101
Page 3 of 3

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	18/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552245.8 m E 6874985.4 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information								Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			U50 24.00-24.50 m PP=sand			25.00		CH	Silty CLAY (CH) Stiff, high plasticity, grey mottled light orange brown, moist. *(continued)*
			SPT 25.50-25.95 m 18,18,16 N=34			26		GM	Silty Sandy GRAVEL (GM) Dense, fine to medium sized, grey with brown light orange brown light grey white, fine to coarse grained sand, low plasticity fines, moist to wet.
			SPT 27.00-27.45 m 12,10,9 N=19			27.00 28		GM	Silty Sandy GRAVEL (GM) Medium dense, fine to medium sized, light orange brown, fine to coarse grained sand, moist to wet.
			SPT 28.50-28.95 m 9,8,8 N=16			28.50		SM	Silty Gravelly SAND (SM) Medium dense, fine to coarse grained, grey brown with dark grey light grey white light yellow brown, fine to coarse sized gravel, moist to wet.
			SPT 30.00-30.45 m 7,12,14 N=26			30.00 30		GM	Silty Sandy GRAVEL (GM) Medium dense, fine to coarse sized, light orange brown with light grey white brown grey, fine to coarse grained sand, low plasticity fines, moist to wet.
			SPT 31.50-31.95 m 7,9,8 N=17			31.50 31.95 32		CH	Silty Gravelly CLAY (CH) Very stiff, high plasticity, grey mottled light orange brown, fine to coarse sized gravel, moist.
						34			Hole Terminated at 31.95 m

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
Consulting Geotechnical Engineers

Borehole No.
BH 102
Page 1 of 4

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	14/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552003.0 m E 6874269.0 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T						0.30		CL	NATURAL Silty CLAY (CL) Soft, low plasticity, dark brown, with fine grained sand, moist.
						0.60		SP	SAND (SP) Very loose, fine to medium grained, with brown yellow grey light, moist.
								SM	Silty SAND (SM) Loose to medium dense, fine to medium grained, grey, wet.
						1.50		SP	SAND (SP) Loose, fine to medium grained, dark grey, moist to wet.
			SPT 1.50-1.95 m 1,1,1 N=2			2			
						2.80		SP	SAND (SP) Loose to medium dense, fine to medium grained, grey, with seashells, moist.
			SPT 3.00-3.45 m 3,4,4 N=8			4			
						4.00		SP	SAND (SP) Medium dense, fine to medium grained, grey, with seashells, moist.
			SPT 4.50-4.95 m 4,6,7 N=13						
			SPT 6.00-6.45 m 5,7,8 N=15			6			
						7.00		SP	SAND (SP) Dense, fine to medium grained, grey, with seashells, moist.
			SPT 7.50-7.95 m 12,15,19 N=34			8			
			SPT 9.00-9.45 m 9,14,16 N=30			10			
			SPT 10.50-10.95 m 12,14,23 N=37			11.50		SP	SAND (SP) Very dense, fine to medium grained, grey, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
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Borehole No.
BH 102
Page 2 of 4

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	14/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552003.0 m E 6874269.0 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 12.00-12.29 m 21,30/140mm N=30/140mm					SP	SAND (SP) Very dense, fine to medium grained, grey, moist. *(continued)*
						13.00		SP	SAND (SP) Dense to very dense, fine to medium grained, grey, moist.
			SPT 13.50-13.95 m 20,25,24 N=49			14			
						14.50		SP	SAND (SP) Medium dense, fine grained, dark grey, moist to wet.
			SPT 15.00-15.45 m 8,13,9 N=22			16			
						16.00		SP	SAND (SP) Loose, fine grained, dark grey, moist to wet.
			SPT 16.50-16.95 m 3,3,3 N=6						
						17.80		CI-CH	Silty CLAY (CI-CH) Stiff, medium to high plasticity, dark brown with grey, with fine grained sand and organics, moist.
			SPT 18.00-18.45 m 0,0,0 N=0			18			
						19.00		CI-CH	Silty Sandy CLAY (CI-CH) Stiff, medium to high plasticity, dark brown dark grey, fine grained sand, with seashells, moist.
			SPT 19.50-19.95 m 0,0,0 N=0			20			
			SPT 21.00-21.45 m 1,0,1 N=1			22			
						22.20		CH	Silty CLAY (CH) Hard, high plasticity, grey mottled brown, moist.
			SPT 22.50-22.95 m 4,6,8 N=14						

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

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Borehole No.
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	14/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552003.0 m E 6874269.0 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information								Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 24.00-24.45 m 9,12,13 N=25					CH	Silty CLAY (CH) Hard, high plasticity, grey mottled brown, moist. *(continued)*
			SPT 25.50-25.95 m 16,15,4 N=19			25.70 26.00 26		SM	Silty SAND (SM) Loose, fine to coarse grained, light grey white light brown, low plasticity fines, with fine to medium sized gravel, moist to wet.
			SPT 27.00-27.45 m 2,2,2 N=4			28.00 28		CL-CI	Silty CLAY (CL-CI) Very stiff, low to medium plasticity, grey mottled brown, with fine to medium grained sand, moist.
			SPT 28.50-28.95 m 0,5,4 N=9			30.00 30		SC	Clayey SAND (SC) Loose to medium dense, fine to medium grained, grey, low to medium plasticity fines, moist to wet.
			SPT 30.00-30.45 m 4,8,3 N=11			31.50		SC	Clayey SAND (SC) Medium dense, fine to medium grained, grey, low to medium plasticity fines, moist to wet.
			SPT 31.50-31.95 m 4,5,4 N=9			32		SC	Clayey SAND (SC) Medium dense, fine to medium grained, grey mottled light orange brown, low to medium plasticity fines, moist to wet.
			SPT 33.00-33.45 m 7,5,5 N=10			33.00 34.00 34		SC	Clayey SAND (SC) Loose to medium dense, fine to medium grained, grey mottled light orange brown, low to medium plasticity fines, moist to wet.
			SPT 34.50-34.95 m 0,2,2 N=4			36.00		CI	Silty CLAY (CI) Firm, medium plasticity, grey with dark grey, with fine to medium grained sand, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	14/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552003.0 m E 6874269.0 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 36.00-36.45 m 5,9,7 N=16					CI	Silty CLAY (CI) Very stiff, medium plasticity, grey light orange brown, with fine to medium grained sand, moist.
			SPT 37.50-37.95 m 8,12,16 N=28			37.50		SC	Clayey SAND (SC) Medium dense, fine to medium grained, grey, low to medium plasticity fines, moist.
			SPT 39.00-39.45 m 6,8,8 N=16			38			
			SPT 40.50-40.95 m 5,9,10 N=19			40			
						42			
						44			
						45.00		GC	Clayey Sandy GRAVEL (GC) Dense, fine to coarse sized, grey with dark grey light grey white, low plasticity fines, fine to coarse grained sand, wet.
			SPT 46.00-46.45 m 10,16,22 N=38			46.00			Hole Terminated at 46.00 m

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	19/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552130.6 m E 6874622.1 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T						0.60		CL-Cl	NATURAL Silty CLAY (CL-Cl) Soft, low to medium plasticity, dark brown, with fine grained sand, moist.
						1.20		SM	Silty SAND (SM) Very loose, fine to medium grained, grey, moist.
						1.50		SM	Silty SAND (SM) Very loose, fine to medium grained, grey, wet.
			SPT 1.50-1.95 m 1,1,2 N=3			2		SP	SAND (SP) Loose, fine to medium grained, grey, wet.
			SPT 3.00-3.45 m 3,3,3 N=6			4			
			SPT 4.50-4.95 m 5,8,9 N=17			4.50		SP	SAND (SP) Medium dense, fine to medium grained, grey, moist.
			SPT 6.00-6.45 m 3,4,5 N=9			6.00		SP	SAND (SP) Loose, fine to medium grained, grey, moist.
						8			
			SPT 9.00-9.45 m 7,10,10 N=20			9.00		SP	SAND (SP) Medium dense, fine to medium grained, grey, moist.
						10			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	19/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552130.6 m E 6874622.1 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 12.00-12.45 m 7,9,13 N=22			14		SP	SAND (SP) Medium dense, fine to medium grained, grey, moist. *(continued)*
			SPT 15.00-15.45 m 11,16,18 N=34			15.00 16		SP	SAND (SP) Dense, fine to medium grained, grey, moist.
			SPT 18.00-18.45 m 0,0,0 N=0			18.00 18		SC	Clayey Silty SAND (SC) Loose, fine to medium grained, grey, low to medium plasticity fines, trace of fine to medium sized gravel, moist to wet.
			U50 19.50-19.95 m PP=200kPa			19.00 20		CI	Silty CLAY (CI) Very stiff, medium plasticity, dark grey, trace of fine grained sand, with seashells, moist.
			U50 21.00-21.50 m PP=150kPa			22			
			U50 22.50-23.00 m PP=>600kPa			22.00		CH	Silty CLAY (CH) Very stiff, high plasticity, brown mottled grey, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	19/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552130.6 m E 6874622.1 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			U50 24.00-24.50 m PP=400kPa			26		CH	Silty CLAY (CH) Very stiff, high plasticity, brown mottled grey, moist. *(continued)*
			SPT 27.00-27.45 m 0,2,3 N=5			27.00 28		CI-CH	Sandy CLAY (CI-CH) Firm to stiff, medium to high plasticity, brown mottled grey, fine to medium grained sand, moist.
			SPT 30.00-30.45 m 8,11,9 N=20			30.00 30 32		SM	Silty SAND (SM) Medium dense, fine to coarse grained, grey with light orange brown, with medium plasticity fines, moist.
			SPT 33.00-33.45 m 0,7,8 N=15			32.00 34 36.00		CH	Silty Gravelly CLAY (CH) Stiff to very stiff, high plasticity, grey mottled brown with light orange brown, fine to medium sized gravel, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	19/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552130.6 m E 6874622.1 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 36.00-36.45 m 5,6,9 N=15			36.50		CH	Silty Gravelly CLAY (CH) Stiff to very stiff, high plasticity, grey mottled light orange brown, fine to medium sized gravel, with fine to medium grained sand, moist. (bands of Clayey sand)
								SM	Silty Gravelly SAND (SM) Medium dense, fine to coarse grained, brown, fine to coarse sized gravel, low plasticity fines, moist.
			SPT 39.00-39.45 m 10,13,11 N=24			38			
						40			
			SPT 42.00-42.45 m 16,26,30 N=56			42			
						44.00		SM	Silty Gravelly SAND (SM) Medium dense, fine to coarse grained, dark grey, fine to coarse sized gravel, low plasticity fines, moist.
			SPT 45.00-45.45 m 8,13,15 N=28			46.00		GM	Silty Sandy GRAVEL (GM) Very dense, fine to coarse sized, dark grey, fine to coarse grained sand, moist.
						48.00			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	19/01/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	552130.6 m E 6874622.1 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum: AHD	Operator: MH

Drilling Information							***Soil Description***		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 48.00-48.41 m 21,21,30/110mm						GREYWACKE (HW) Highly weathered, high strength, dark grey, dry to moist.
						49.95 50 50.00			GREYWACKE (SW) Slightly weathered, extremely high strength, dark grey, dry. Hole Terminated at 50.00 m
						52			
						54			
						56			
						58			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks
1. Groundwater not encountered.

Support
C - Casing

Classification Symbols and Soil Descriptions
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Borehole No.
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	02/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551878.0 m E 6873760.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T						0.40		CI	NATURAL Silty CLAY (CI) Firm, medium plasticity, brown, moist.
						1.00		SM	Silty SAND (SM) Very loose, fine to medium grained, yellow brown mottled pale grey, trace low plasticity clay fines, wet to moist.
			SPT 1.50-1.95 m 0,1,0 N=1			2		SP	SAND (SP) Very loose, fine to medium grained, grey, wet.
			SPT 3.00-3.45 m 1,0,1 N=1			4			
			SPT 4.50-4.95 m 2,4,5 N=9			4.50		SP	SAND (SP) Loose, fine to medium grained, grey, wet.
			SPT 6.00-6.45 m 9,9,7 N=16			6		SP	SAND (SP) Medium dense, fine to medium grained, grey, wet.
			SPT 7.50-7.95 m 2,3,4 N=7			7.50		SP	SAND (SP) Loose to medium dense, fine to medium grained, grey, wet.
			SPT 9.00-9.45 m 2,2,3 N=5			8			
						10			
						11.00		SP	SAND (SP) Medium dense, fine to medium grained, grey, wet.
						12.00			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks

Support
C - Casing

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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	02/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551878.0 m E 6873760.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 12.00-12.45 m 7,9,13 N=22			14		SP	SAND (SP) Medium dense, fine to medium grained, grey, wet.
			SPT 15.00-15.41 m 12,22,30/110mm			15.00 16		SP	SAND (SP) Very dense, fine to medium grained, grey, wet.
			SPT 18.00-18.45 m 12,20,22 N=42			18.00 18 20		SP	SAND (SP) Dense, fine to medium grained, grey, wet.
			U50 21.00-21.50 m PP = 200			21.00 22		CI-CH	Silty CLAY (CI-CH) Stiff to very stiff, medium to high plasticity, grey, trace fine to medium grained sand, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Support
C - Casing

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Classification Symbols and Soil Descriptions
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Remarks

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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	02/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551878.0 m E 6873760.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			U50 24.00-24.50 m PP = 200			26		CI-CH	Silty CLAY (CI-CH) Stiff to very stiff, medium to high plasticity, grey, trace fine to medium grained sand, moist. *(continued)*
						26.30		CI-CH	Silty CLAY (CI-CH) Stiff, medium to high plasticity, grey, trace fine to medium grained sand, moist.
			SPT 27.00-27.45 m 0,0,1 N=1			28			
			SPT 30.00-30.45 m 3,2,2 N=4			30			
						31.00		SC	Clayey Silty SAND (SC) Medium dense, fine to medium grained, grey brown, low to medium plasticity clay, moist.
			SPT 33.00-33.45 m 3,4,7 N=11			32			
						34			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks

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C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	02/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551878.0 m E 6873760.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 36.00-36.45 m 7,9,9 N=18					SC	Clayey Silty SAND (SC) Medium dense, fine to medium grained, grey brown, low to medium plasticity clay, moist. *(continued)*
						38			
						38.00		GW	Sandy GRAVEL (GW) Dense, fine to coarse sized, light orange brown grey and light yellow brown mottled, fine to coarse grained sand, trace low plasticity clay fines, moist.
			SPT 39.00-39.45 m 13,20,16 N=36			40			
						41.00		SW	Gravelly SAND (SW) Dense, fine to coarse grained, grey brown light yellow brown and light orange brown mottled, fine to medium sized gravel, moist.
						42			
						43.90			
						44			
						44.00			SILTSTONE (HW) Highly weathered, high strength, fine to medium grained, grey, moist.
									Hole Terminated at 44.00 m
						46			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks

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C - Casing

Classification Symbols and Soil Descriptions
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	01/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551810.4 m E 6873424.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T						0.50		CL-CI	NATURAL Silty CLAY (CL-CI) Firm, low to medium plasticity, brown mottled dark brown, moist.
			SPT 1.50-1.95 m 0,0,0 N=0			2		SM	Silty SAND (SM) Very loose, fine to medium grained, yellow brown mottled pale grey, wet.
			SPT 3.00-3.45 m 0,1,0 N=1			4			
			SPT 4.50-4.95 m 0,0,1 N=1			6			
			SPT 6.00-6.45 m 0,1,0 N=1			6.00		SP	SAND (SP) Very loose, fine to medium grained, grey, wet.
			SPT 7.50-7.95 m 8,10,12 N=22			7.00		SP	SAND (SP) Medium dense, fine to medium grained, grey, moist.
			SPT 9.00-9.45 m 7,10,11 N=21			8			
			SPT 10.50-10.95 m 8,10,13 N=23			10			
						12.00			

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks

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C - Casing

Classification Symbols and Soil Descriptions
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BH 105
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Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	01/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551810.4 m E 6873424.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			SPT 12.00-12.45 m 6,9,12 N=21			14		SP	SAND (SP) Medium dense, fine to medium grained, grey, with seashells throughout, moist.
			SPT 13.50-13.95 m 9,9,11 N=20			14.50		SP	SAND (SP) Dense, fine to medium grained, grey, with seashells throughout, moist.
			SPT 15.00-15.45 m 11,18,23 N=41			16			
			SPT 16.50-16.95 m 13,19,22 N=41			18			
			SPT 18.00-18.45 m 8,4,4 N=8			18.00		SM	Silty SAND (SM) Loose, fine to medium grained, grey, with low to medium plasticity clay fines, wet to moist.
			SPT 19.50-19.95 m 8,12,16 N=28			19.50		SP	SAND (SP) Medium dense, fine to coarse grained, grey, with seashells throughout, moist.
			SPT 21.00-21.45 m 8,13,18 N=31			20			
			SPT 22.50-22.90 m 16,28,30/100mm			21.00		SP	SAND (SP) Medium dense to dense, fine to coarse grained, grey, with seashells throughout, moist.
						22			
						22.00		SW	SAND (SP) Very dense, fine to coarse grained, grey, with seashells throughout, moist.
						23.50		CH	Silty Sandy CLAY (CH) Hard, high plasticity, grey mottled light yellow brown, fine grained sand, moist.

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Pacific Geotech
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Borehole No.
BH 105
Page 3 of 3

Project No.: PG-3427

Client:	Hanson Sand Plant	Commenced:	01/03/2021
Project Name:	Proposed Highway Stability Assessment	Logged By:	MH
Hole Location:	Hanson Tweed Sand Plant, Cudgen	Checked By:	
Hole Position:	551810.4 m E 6873424.3 m N MGA94 Zone 56		
Drill Model and Mounting:	IH800	RL Surface:	No survey
Hole Diameter:		Datum:	AHD Operator: MH

Drilling Information							Soil Description		
Method	Casing	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional
AD/T			U50 24.00-24.50 m PP = 500					CH	Silty Sandy CLAY (CH) Hard, high plasticity, grey mottled light yellow brown, fine grained sand, moist. *(continued)*
			SPT 25.50-25.95 m 6,13,27 N=40			25.90 26			SILTSTONE (XW) Extremely weathered, extremely low to low strength, fine to medium grained, grey.
			SPT 27.00-27.34 m 30/40mm			26.80			SILTSTONE (HW) Highly weathered, low to medium strength, fine to medium grained, grey.
						28 28.50			
			SPT 28.50-28.84 m 30/40mm			30 32 34			Hole Terminated at 28.50 m

Method
AS - Auger
RR - Rock Roller
WB - Washbore

Water
Level (Date)
Inflow

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
B - Bulk Sample

Remarks

Support
C - Casing

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

APPENDIX C

LABORATORY TEST CERTIFICATES

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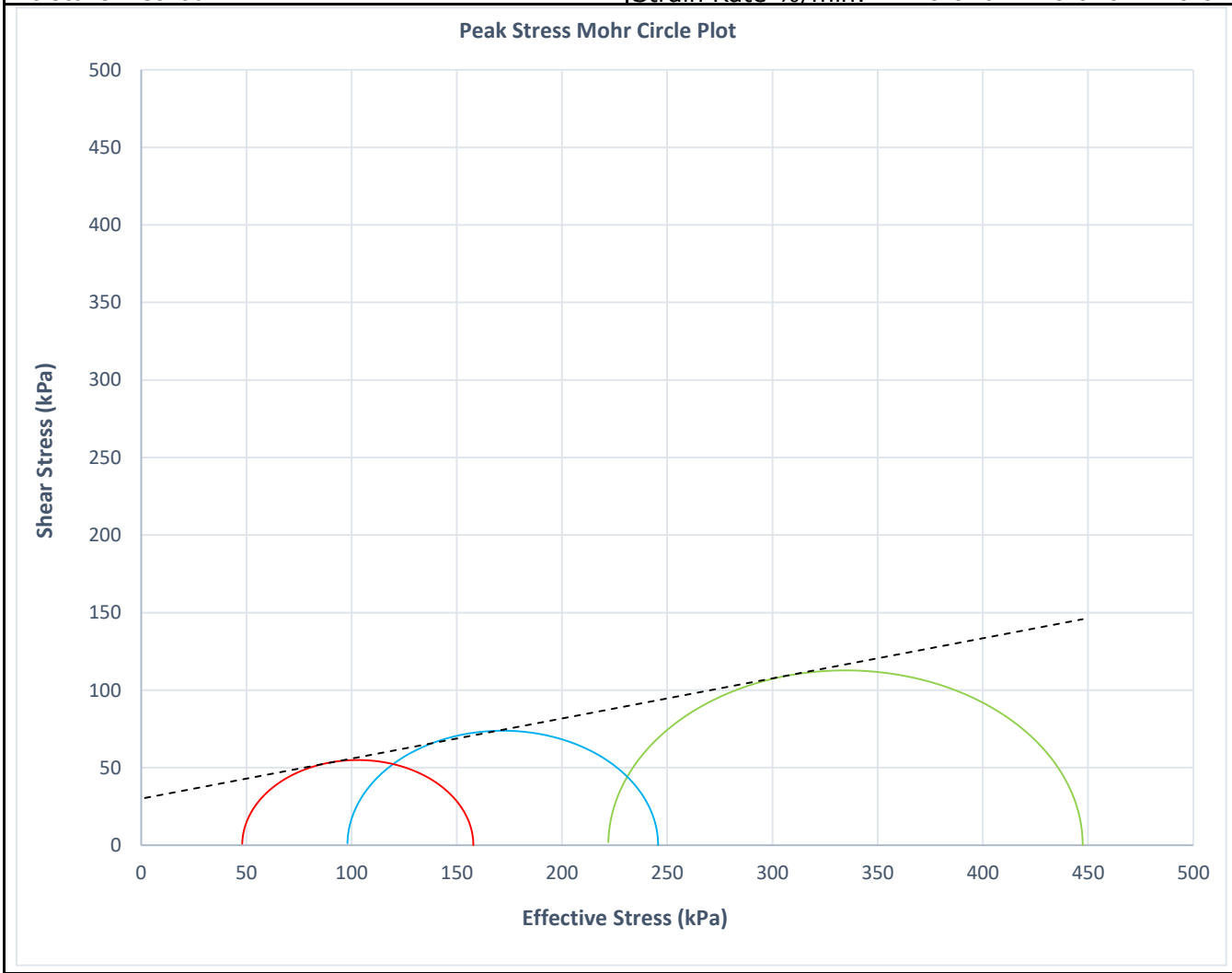
Consolidated Undrained Soil Triaxial Report

Client:	**Pacific Geotech**	Report Number:	**21-1472A**
Address:	**Po Box 499, Paradise QLD 4216**	Report Date:	**5/02/2021**
Project Number:	**M30857**	Order Number:	**PG-3427**
Project Name:	**Proposed Highway Stability Assessment**	Test Method	**AS 1289.6.4.2**
Location:	**Bore Hole: BH101, Depth: 19.50m**	**Page 1**	

Date Sampled:	Unknown	Material Description:	Dark Brown Clay
Date Tested:	1/02/2021	Initial Wet Density:	1.68 t/m^3
Sampled By:	Client	Initial Dry Density:	1.10 t/m^3
Initial Sample Height:	101.6 mm	L/D Ratio:	2.1 :1
Initial Sample Diameter:	47.7 mm	Skempton's B Response:	97 %
Initial Moisture:	53.6 %	Sample Type:	Undisturbed, Single Specimen, From U50 Tube
Final Moisture:	44.5 %		
Sampling Method:	Sampled by Client		
Moisture Method:	AS 1289.2.1.1	Strain Rate %/min:	0.026 0.016 0.013



Effective Cohesion C' (kPa):	30.0
Effective Angle of Friction ϕ' (Degrees):	14.5
Failure Criteria:	Peak Deviator Stress

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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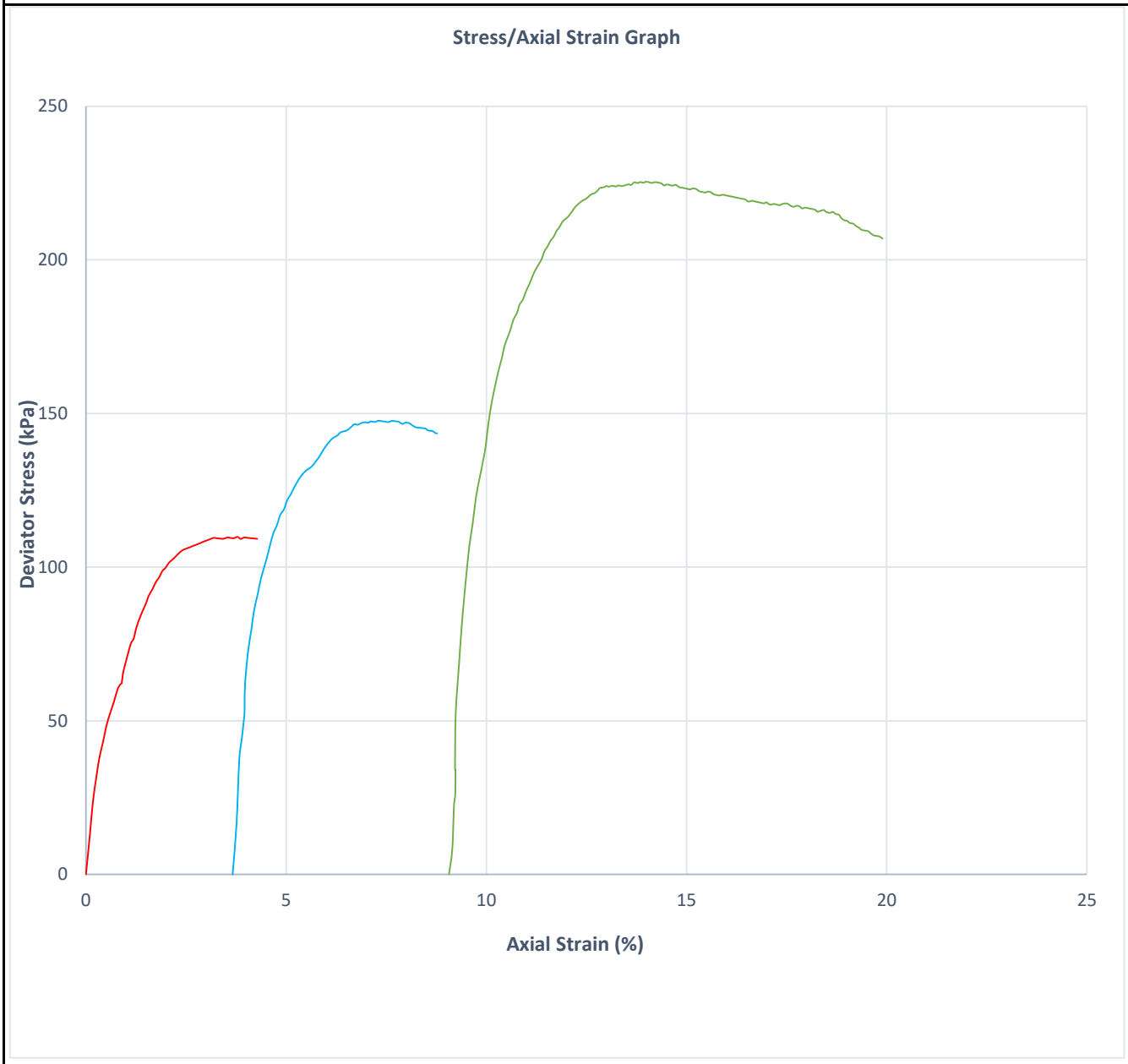
Address:	**Po Box 499, Paradise QLD 4216**	Report Date:	**5/02/2021**
Project Number:	**M30857**	Order Number:	**PG-3427**
Project Name:	**Proposed Highway Stability Assessment**	Test Method	**AS 1289.6.4.2**
Location:	**Bore Hole: BH101, Depth: 19.50m**	**Page 2**	



Failure Details

Cell Pressure (kPa)	Back Pressure (kPa)	Effictive Pressure (kPa)	Initial Pore Pressure (kPa)	Failure Pore Pressure (kPa)	Principal Effective Stress			Deviator Stress (kPa)	Strain (%)
					σ'1 (kPa)	σ'3 (kPa)	σ'1/σ'3		
300	201	99	196	252	158	48	3.289	110	3.79
400	201	199	200	302	246	98	2.507	148	7.30
600	199	401	206	378	447	222	2.016	225	13.99

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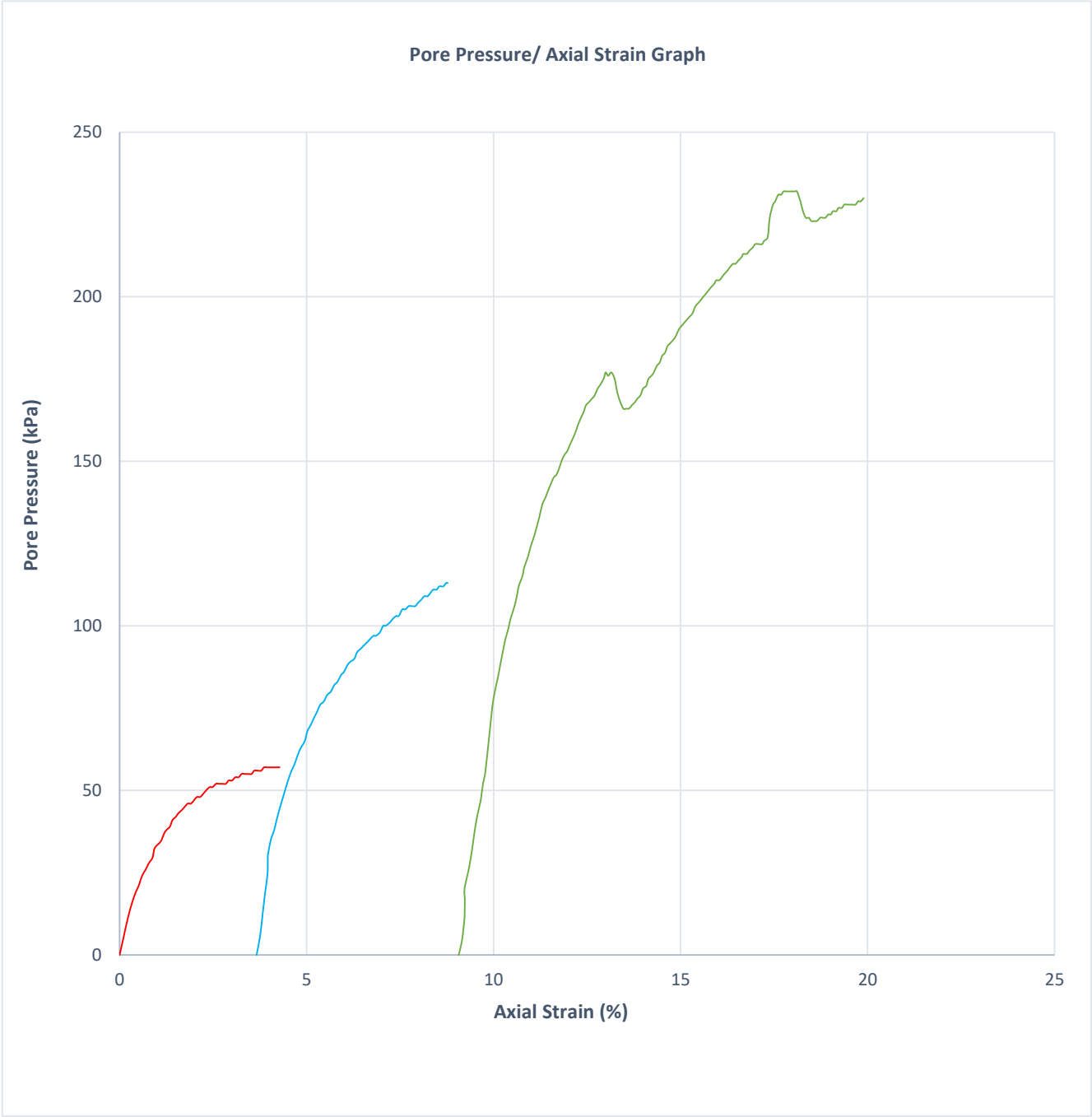
Project Number:	**M30857**	Order Number:	**PG-3427**
Project Name:	**Proposed Highway Stability Assessment**	Test Method	**AS 1289.6.4.2**
Location:	**Bore Hole: BH101, Depth: 19.50m**	**Page 3**	



Sample/s supplied by	Client	Note:	Graph not to scale	Membrane Thickness:	0.3mm

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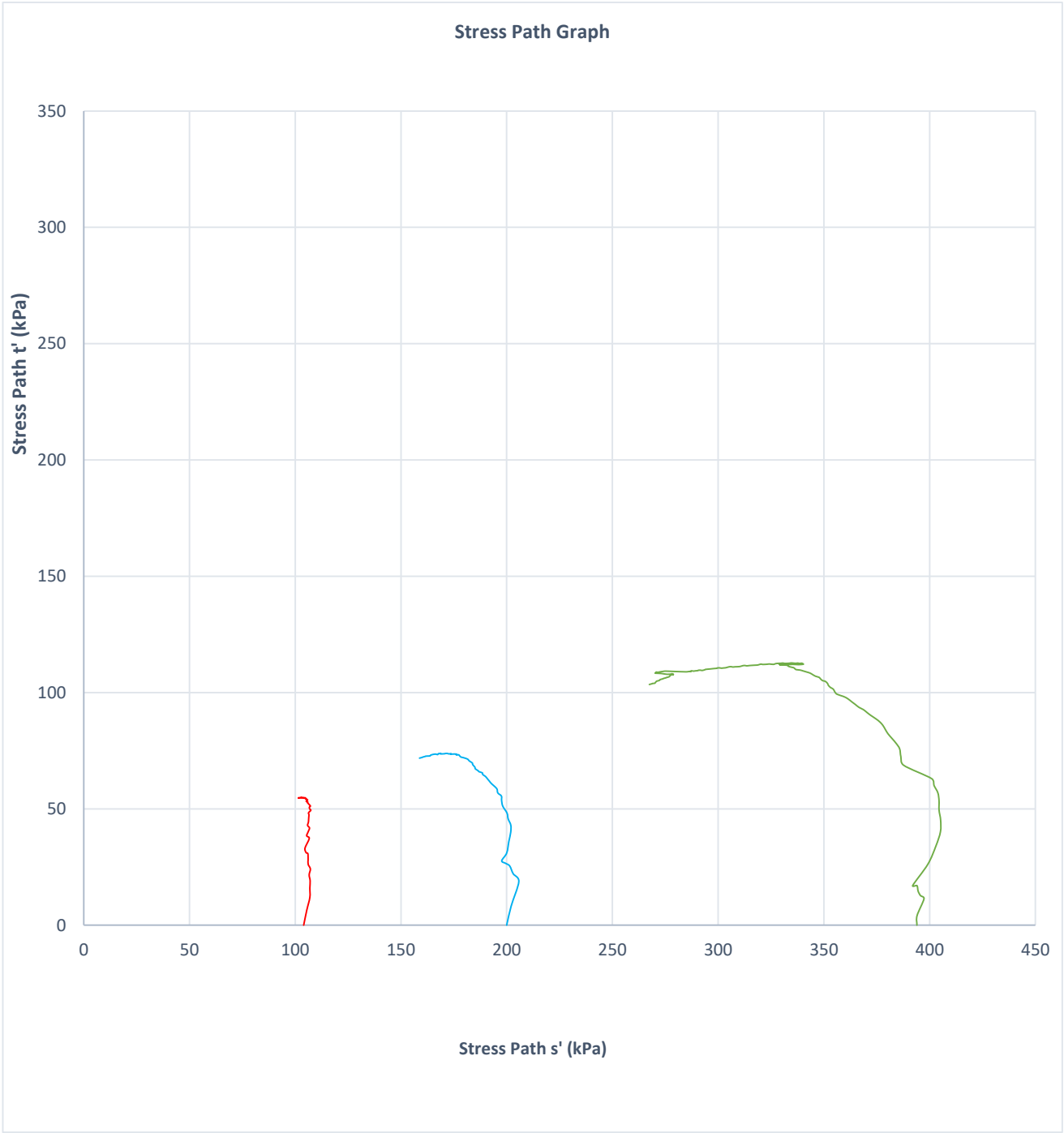
Address:	**Po Box 499, Paradise QLD 4216**	Report Date:	**5/02/2021**
Project Number:	**M30857**	Order Number:	**PG-3427**
Project Name:	**Proposed Highway Stability Assessment**	Test Method	**AS 1289.6.4.2**
Location:	**Bore Hole: BH101, Depth: 19.50m**	**Page 4**	



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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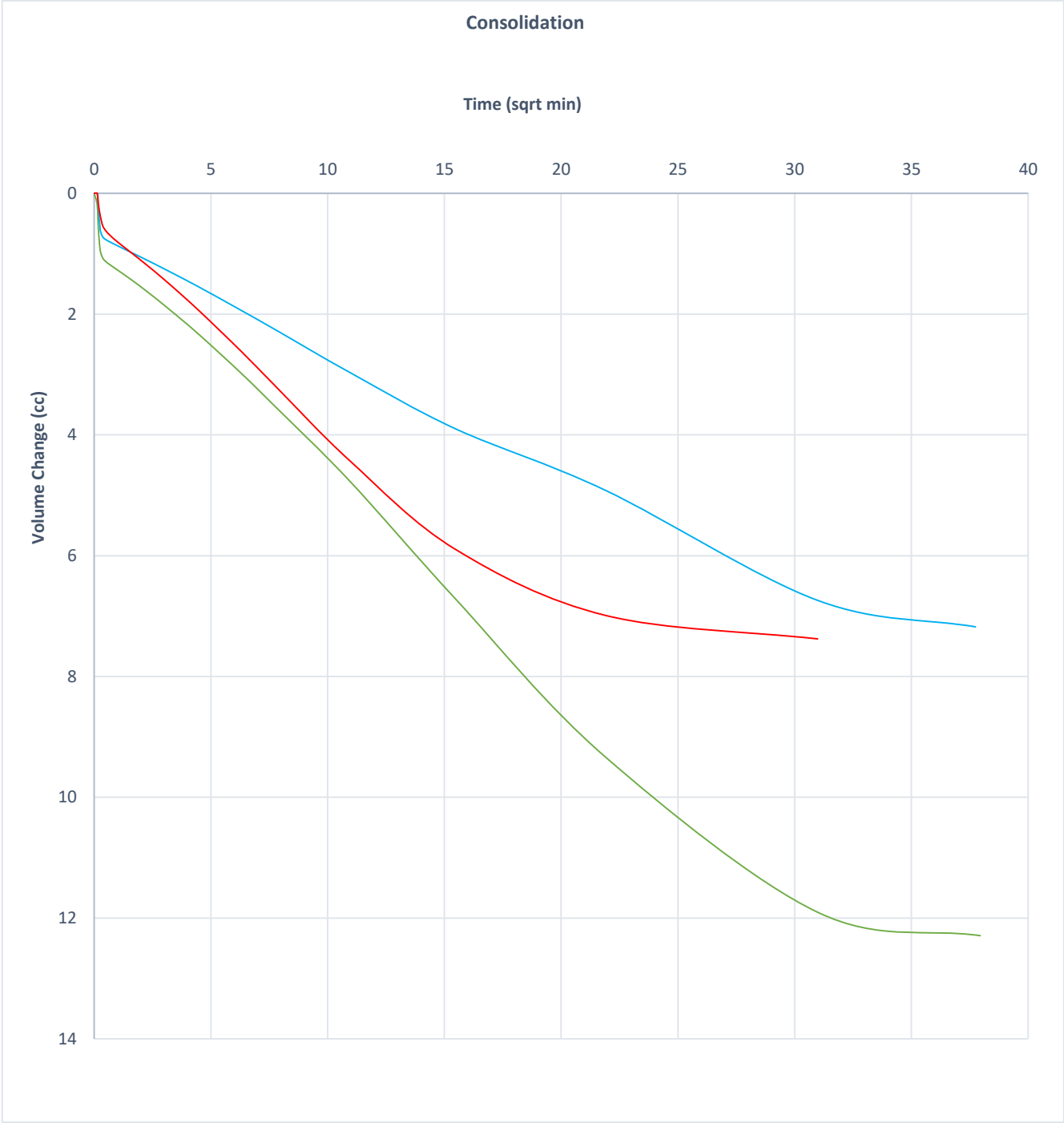
Project Number:	**M30857**	Order Number:	**PG-3427**
Project Name:	**Proposed Highway Stability Assessment**	Test Method	**AS 1289.6.4.2**
Location:	**Bore Hole: BH101, Depth: 19.50m**	**Page 5**	



Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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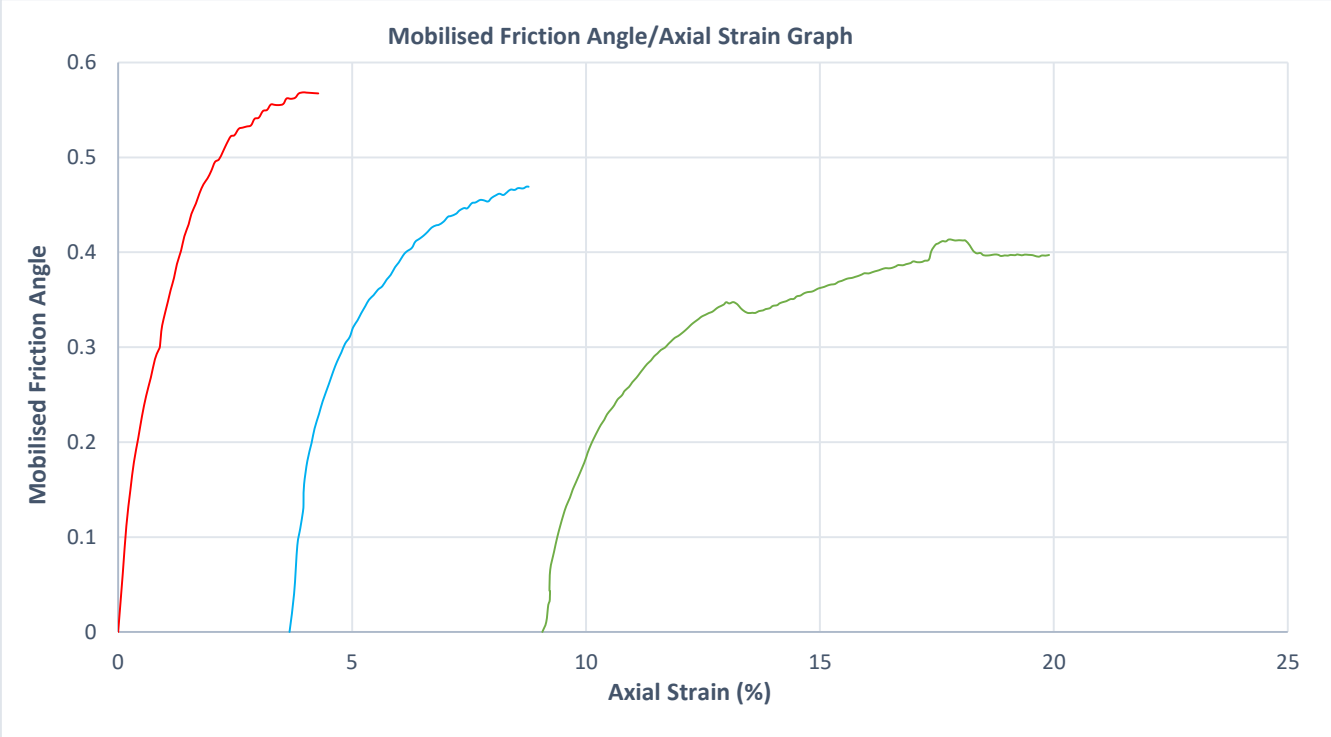
Project Number:	**M30857**	Order Number:	**PG-3427**
Project Name:	**Proposed Highway Stability Assessment**	Test Method	**AS 1289.6.4.2**
Location:	**Bore Hole: BH101, Depth: 19.50m**	**Page 6**	



Sample Before Test	Sample After Test
	

Sample/s supplied by Client Note: Graph not to scale Membrane Thickness: 0.3mm

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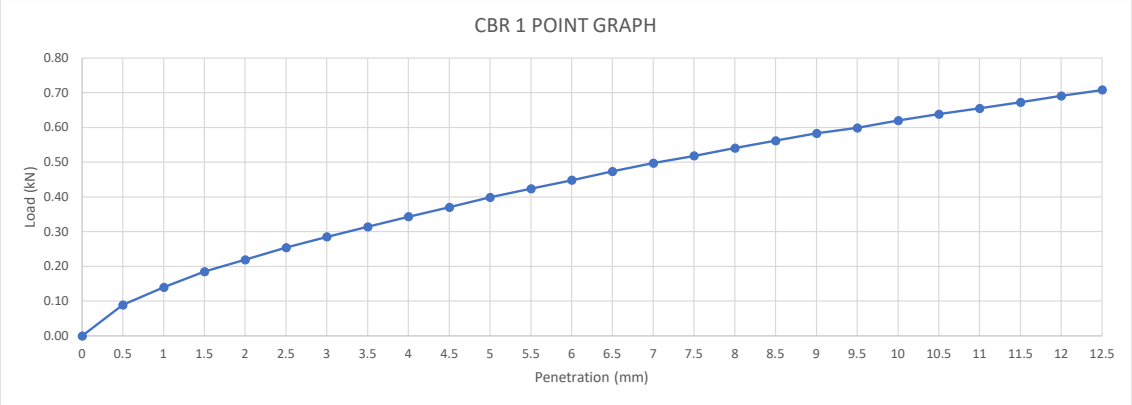
CALIFORNIA BEARING RATIO REPORT (1 POINT)			
CLIENT:	Hanson	PROJECT NUMBER:	PG-3427
ADDRESS:	Hanson Tweed Sand Plant, Cudgen	REPORT NUMBER:	PG-3427-CBR-01
PROJECT NAME:	Proposed Highway Stability Assessment	REPORT DATE:	15/01/2021
		TEST METHOD:	AS 1289.6.1.1

SAMPLE LOCATION:	BH01, 0.5m
SAMPLING METHOD:	DISTURBED
SAMPLED BY:	PACIFIC GEOTECH
DATE SAMPLED:	
DATE TESTED:	12/01/2021
PREPERATION METHOD:	AS 1289.1.1
MOISTURE METHOD:	AS 1289.2.1.1
MATERIAL TYPE:	BULK

MAXIMUM DRY DENSITY (t/m³):	1.62
OPTIMUM MOISTURE CONTENT (%):	19.15
COMPACTIVE EFFORT:	Standard
COMPACTIVE HAMMER:	AS 1289.5.1.1
LABORATORY DENSITY RATIO:	100
LABORATORY MOISTURE RATIO:	100
DRY DENSITY BEFORE SOAK (t/m³):	1.62
DRY DENSITY AFTER SOAK (t/m³):	1.55
MOISTURE CONTENT BEFORE SOAK (%):	19.2
MOISTURE CONTENT OF TOP 30mm AFTER PENETRATION (%):	24.6
MOISTURE CONTENT REST OF SAMPLE AFTER PENETRATION (%):	20.6
SWELL (%):	0
CBR SURCHARGE (kg):	4.5
SOAK PERIOD (days):	4
CURING HOURS:	12
OVERSIZE MATERIAL (%):	0
CBR 2.5mm (%):	2.0
CBR 5 mm (%):	2.0
CBR VALUE (%):	**2.0**



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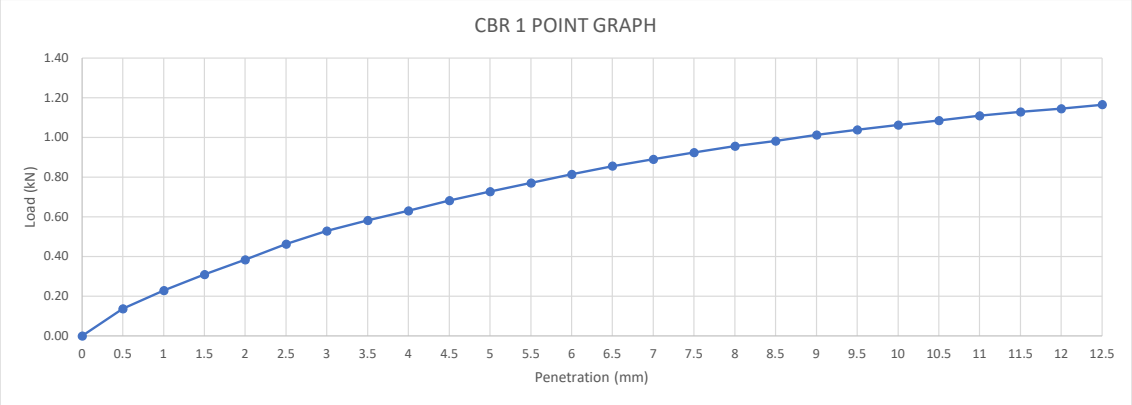
CALIFORNIA BEARING RATIO REPORT (1 POINT)			
CLIENT:	Hanson	PROJECT NUMBER:	PG-3427
ADDRESS:	Hanson Tweed Sand Plant, Cudgen	REPORT NUMBER:	PG-3427-CBR-02
PROJECT NAME:	Proposed Highway Stability Assessment	REPORT DATE:	15/01/2021
		TEST METHOD:	AS 1289.6.1.1

SAMPLE LOCATION:	BH03, 0.5m
SAMPLING METHOD:	DISTURBED
SAMPLED BY:	PACIFIC GEOTECH
DATE SAMPLED:	
DATE TESTED:	12/01/2021
PREPERATION METHOD:	AS 1289.1.1
MOISTURE METHOD:	AS 1289.2.1.1
MATERIAL TYPE:	BULK

MAXIMUM DRY DENSITY (t/m³):	1.58
OPTIMUM MOISTURE CONTENT (%):	19.51
COMPACTIVE EFFORT:	Standard
COMPACTIVE HAMMER:	AS 1289.5.1.1
LABORATORY DENSITY RATIO:	100
LABORATORY MOISTURE RATIO:	100
DRY DENSITY BEFORE SOAK (t/m³):	1.58
DRY DENSITY AFTER SOAK (t/m³):	1.58
MOISTURE CONTENT BEFORE SOAK (%):	19.5
MOISTURE CONTENT OF TOP 30mm AFTER PENETRATION (%):	22.9
MOISTURE CONTENT REST OF SAMPLE AFTER PENETRATION (%):	20.9
SWELL (%):	0
CBR SURCHARGE (kg):	4.5
SOAK PERIOD (days):	4
CURING HOURS:	12
OVERSIZE MATERIAL (%):	0
CBR 2.5mm (%):	3.5
CBR 5 mm (%):	3.5
CBR VALUE (%):	**3.5**



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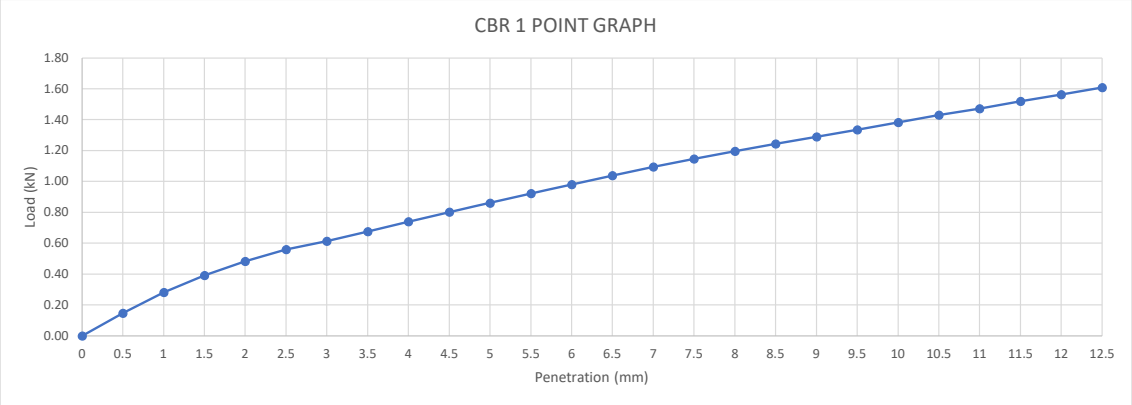
CALIFORNIA BEARING RATIO REPORT (1 POINT)			
CLIENT:	Hanson	PROJECT NUMBER:	PG-3427
ADDRESS:	Hanson Tweed Sand Plant, Cudgen	REPORT NUMBER:	PG-3427-CBR-03
PROJECT NAME:	Proposed Highway Stability Assessment	REPORT DATE:	15/01/2021
		TEST METHOD:	AS 1289.6.1.1

SAMPLE LOCATION:	BH05, 0.5m
SAMPLING METHOD:	DISTURBED
SAMPLED BY:	PACIFIC GEOTECH
DATE SAMPLED:	
DATE TESTED:	12/01/2021
PREPERATION METHOD:	AS 1289.1.1
MOISTURE METHOD:	AS 1289.2.1.1
MATERIAL TYPE:	BULK

MAXIMUM DRY DENSITY (t/m³):	1.82
OPTIMUM MOISTURE CONTENT (%):	19.45
COMPACTIVE EFFORT:	Standard
COMPACTIVE HAMMER:	AS 1289.5.1.1
LABORATORY DENSITY RATIO:	100
LABORATORY MOISTURE RATIO:	100
DRY DENSITY BEFORE SOAK (t/m³):	1.60
DRY DENSITY AFTER SOAK (t/m³):	1.59
MOISTURE CONTENT BEFORE SOAK (%):	19.5
MOISTURE CONTENT OF TOP 30mm AFTER PENETRATION (%):	22.3
MOISTURE CONTENT REST OF SAMPLE AFTER PENETRATION (%):	21.4
SWELL (%):	0
CBR SURCHARGE (kg):	4.5
SOAK PERIOD (days):	4
CURING HOURS:	12
OVERSIZE MATERIAL (%):	0
CBR 2.5mm (%):	4.0
CBR 5 mm (%):	4.5
CBR VALUE (%):	**4.5**



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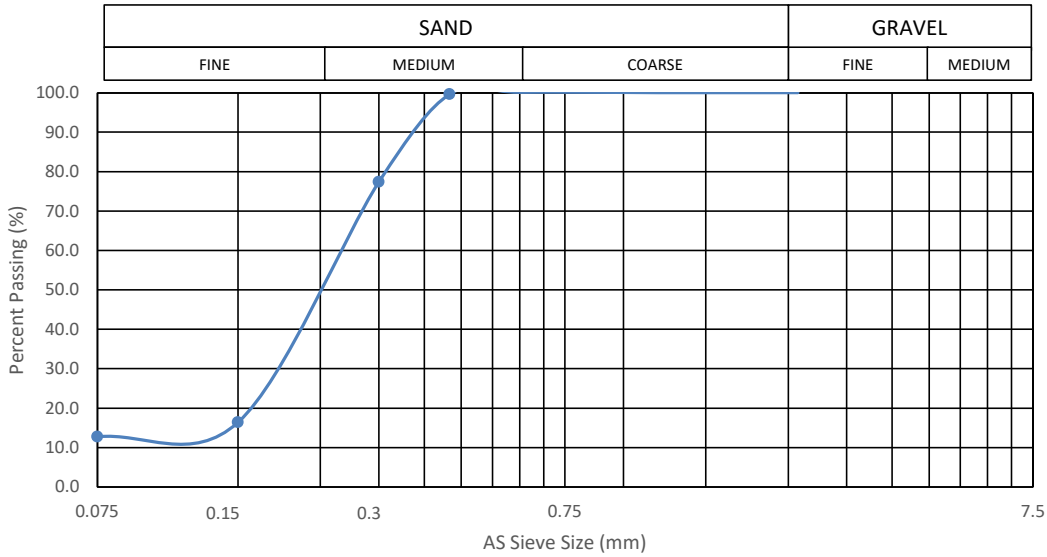
Particle Size Distribution Report			
Client:	Hanson	Project Number:	PG-3427
Address:	Hanson Tweed Sand Plant, Cudgen	Report Number:	PG-3427-PSD-01
Project Name:	Proposed Highway Stability Assessment	Report Date:	
		Test Method:	AS 1289.3.6.1

Sample Location:	BH04
Sampling Method:	DISTURBED
Sampled By:	PACIFIC GEOTECH
Date Sampled:	7/01/2021
Date Tested:	17/02/2021
Material Type:	**Silty Sand**

AS Sieve Size (mm):	Percent Passing (%):
2.36	100
1.18	100
0.600	100
0.425	100
0.300	77
0.150	16
0.075	13



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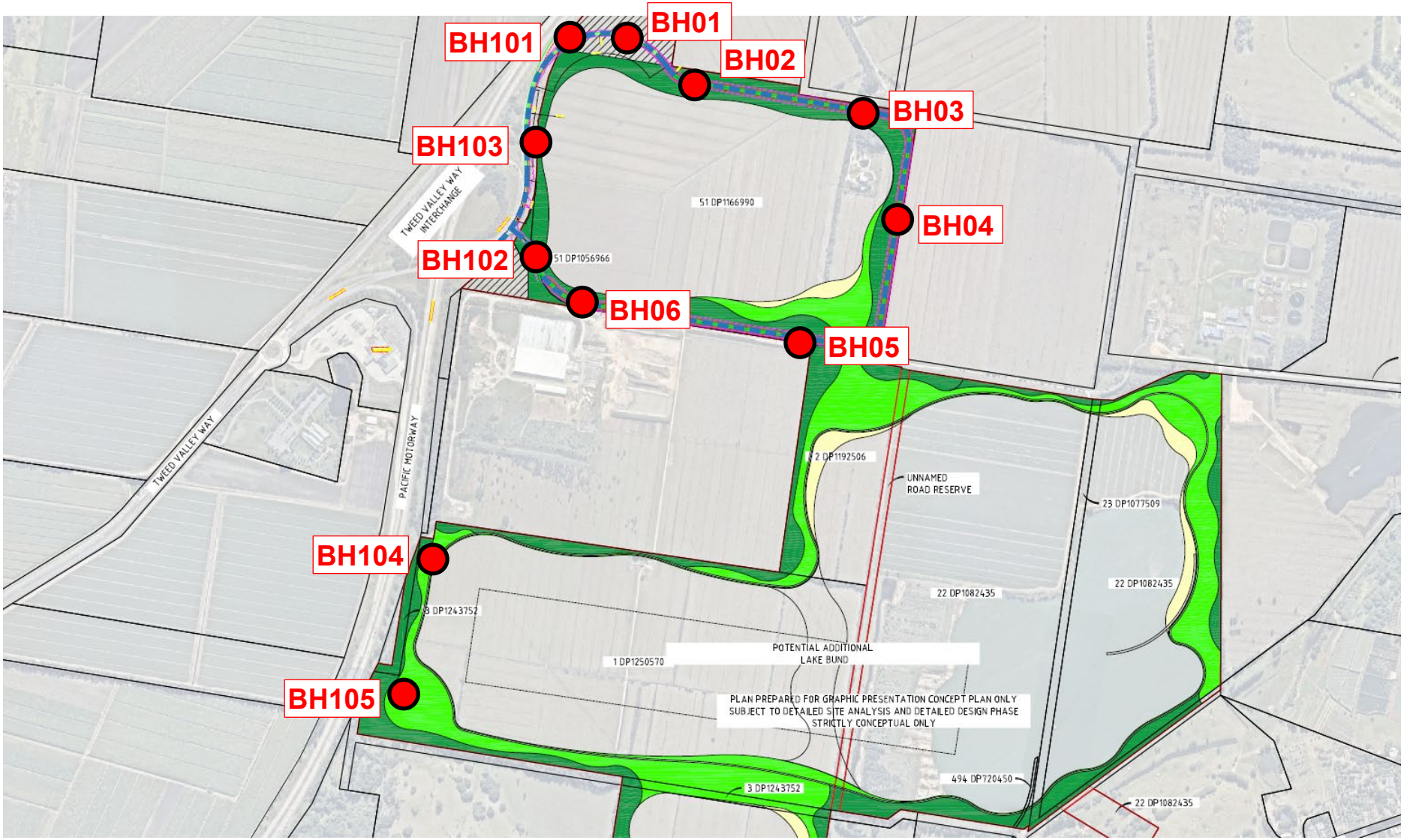
APPENDIX D

SITE PLAN



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Drawn AB	Project:	Proposed Highway Stability Assessment	Drawing No. PG-3427-01	A4
Date March 2021	Location:	Hanson Tweed Sand Plant, Cudgen		
Checked	Client:	Hanson Sand Plant		