Report on Pavement Investigation

East Seaham Road, Stage 5
East Seaham

82218013

Prepared for
Port Stephens Council

October 2017

Cardno
Shaping the Future

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1 Introduction

This report presents the results of a pavement investigation and design undertaken by Cardno for Port Stephens Council (PSC) on a section of East Seaham Road, East Seaham. The section of road being investigated is known as Stage 5 of the East Seaham Road Works and is approximately 1.2 kilometres in length. The work was commissioned by Mr. Steven Startin of PSC.

With reference to the supplied Request for Quotation (RFQ) documentation, it is understood that the proposed works comprise of:

> Widening and sealing of the gravel road;

> Upgrading of existing drainage culverts; and

> Formation of new table drains.

It is also understood that a realignment of the existing road section is being considered where the large bend in the alignment is to be elevated and straightened. Referring to the supplied drawing file DWG survey of the horizontal alignment titled "PSC_SURVEY_S3_4_5_Design.dwg", the bend is located approximately between chainages Ch 3500–3700 m. The existing horizontal alignment is described in Section 2.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions as a basis for the following comments and recommendations:

> Assessment of existing pavement material and the potential suitability for reuse in reconstruction.

> Evaluation of existing subgrade conditions with field testing.

> Pavement thickness designs for the range of potential reconstruction and rehabilitation options.

> Recommendations for earthworks procedures and guidelines.

The RFQ document supplied by Port Stephens Council also contained aerial imagery highlighting the extent of the investigation and was adopted into our investigation planning. Additionally, the following documents were supplied to Cardno by PSC:

> A drawing of the stage 4 pavement design by ACOR Consultants (NNSW) Pty Ltd titled "TYPICAL CROSS SECTION AND PAVEMENT DETAILS" (Project No. NE150093, Dwg. No. C03-01, Drawn 02.11.16)

> An initial planning sketch of the vertical alignment titled "HU170024-SK01 REV B.pdf"

> A drawing file survey of the horizontal alignment titled "PSC_SURVEY_S3_4_5_Design.dwg"

These documents have been utilised in the design to determine approximate chainages of test pits, indications of design and design levels.

2 Site Description

East Seaham Road is a narrow two-lane, single carriageway, unsealed, rural road approximately 12.4km in length that traverses between Seaham and east of Clarence Town along the east side of the Williams River in a south-west to north-east direction.

The Stage 5 section of East Seaham Road is approximately 1.2 kilometres in length, extending from a point in the road adjacent the northern boundary of 747 East Seaham Rd to 70 m south of the driveway to 873 East Seaham Rd. The section will be referred to herein as having an initial and final chainage of Ch 3180 m and Ch 4334 m respectively as displayed in the supplied documents. It is worth noting all other intermediate chainages are approximated using the supplied aerial image, survey data, vertical alignment and constructed drawing (dwg) files.

The site surroundings include;

> Land heavily vegetated with grass, shrubs and mature gum trees on both the eastern and western sides of the road corridor;

> Rural residential properties on the western side of the road corridor separating East Seaham road and Williams River;

> Stage 4 of the East Seaham road upgrade adjoining the southern site, which was currently undergoing construction at the time of investigation; and

> Existing East Seaham Road continuing for approximately another 4 km before intersecting with Limeburners Creek Rd on the northern side of the road section site extent.

Topographically, the section of East Seaham Road is situated on the foot slopes of a south-west to north-east trending dominant ridgeline located further to the east of the site. Slopes in the area generally fall from the ridgeline to the north-west towards lower lying terrain coincident with the Williams River. The road section traverses gently undulating terrain associated with gullies and spurs that descend from the ridgeline. The following site features were also observed at the time of fieldwork.

> The existing road alignment has been constructed predominantly on-grade with minor cut/fill in the order of 0.5-1.0 m involving cut on the uphill side of the road and fill on the downhill as well as in proximity to culverts in the gullies.

> The road crosses a south-east to north-west flowing gully at approximately chainage 3188 m, with a concrete culvert constructed in the gully approximately 1.5 m below the existing road level and a fill embankment in proximity to the culvert.

> Generally informal and shallow table drains parallel to the road formation.

> The existing vertical alignment traverses the gently undulating terrain, commencing at RL 32.94 m and finishes at RL 11.98 m.

3 Investigation Methodology

3.1 Fieldwork

Fieldwork was undertaken on the 10 August 2016, under full traffic control provided by RMS accredited traffic controllers, and comprised the following.

> Location of services and marking out of test bore locations by an accredited service locater.

> A total of fifteen test bores (TB01-TB15) were drilled along East Seaham Road by a 300 mm mechanical auger mounted to a 3.5 tonne mini excavator as follows:

- The majority of test bores (TB01, TB03-TB06 & TB08-TB15) were bored in the existing road pavement, covering both lanes of the two-lane road. All test bores refused on rock at depths between

0.2 m and 1.2 m, with TB01 in proximity to the culvert unable to be advanced potentially due to the auger jamming on cobbles in fill material (or possible rock refusal) at approximate 1.7 m below ground level (bgl).

- TB07 was drilled outside of the road alignment, inside the existing bend noted to assess the subsurface conditions within the proposed road straightening area. Refusal on rock was encountered at 1.5m bgl.
- TB02 was also drilled adjacent the existing road pavement on the southern side.

> Dynamic Cone Penetrometer (DCP) testing was intended to be conducted within test bores at approximate subgrade level to assess the in situ soil strength conditions. However, due to the presence of shallow rock and coarse-grained materials, the DCPs within TB07 and TB14 were the only tests able to be conducted to a significant depth (1.35 m and 1.2 m depth respectively).

> Engineering assessment and logging of the subsurface profiles encountered by a geotechnical engineer from Cardno. Engineering logs of the test bores are contained within Appendix B.

> Sampling of material considered representative of existing pavement and subgrade materials encountered for the purpose of laboratory assessment.

> Backfilling of the test bores with excavation spoil and roadbase type gravel.

The bores were identified by evenly dividing the total site length by the number of boreholes requested by PSC, targeting areas of interest where required. A .kmz place mark file was generated and the locations were marked out during the location of services using a hand-held tablet. During the field investigation, consistent conditions were encountered and several proposed locations were not investigated in the northern site portion following discussion with the PSC representative. The approximate bore locations are shown on site plans Figure 1 and Figure 2 attached in Appendix A.

3.2 Laboratory Testing

Laboratory testing was undertaken on samples recovered during fieldwork for the purpose of geotechnical assessment. The geotechnical testing was conducted at Cardno's NATA accredited construction materials testing laboratory and comprised of the following testing.

Existing Pavement

> Three (3) four-day soaked California Bearing Ratio (CBR) tests on subgrade samples.

> Five (5) Atterberg Limit on pavement material samples.

> Five (5) Particle Size Distributions (PSD) on pavement material samples.

Proposed Realignment

> One (1) four-day soaked California Bearing Ratio (CBR) test on a subgrade sample.

Laboratory test results are summarised in Section 4.3 and shown, in full, on report sheets attached in Appendix C.

4 Investigation Findings

4.1 Published Data

Reference to the Newcastle Coalfield Regional Geology map, Geological series sheet 9231 [1], indicates that the subject section is underlain by undifferentiated strata. Such area is known to comprise of Tuff and ignimbrite interbedded with conglomerate, sandstone, shale and residual soils derived from the decomposition of these rocks.

4.2 Subsurface Conditions

The subsurface conditions encountered in the test bores at the time of fieldwork have been categorised and summarised as follows:

> Existing FILL/PAVEMENT; Silty Gravelly SAND and Silty Sandy GRAVEL brown in colour, with a component of cobbles in all test bores located in travelling lanes (TB03-TB06, TB08-TB15) to depths of 0.15m to 0.6m bgl. Fill material was encountered in TB01 to a depth of 1.7m associated with the filling of the natural gully surrounding the concrete culvert. A thin layer of FILL was also encountered adjacent the existing travelling lanes in TB02 to a depth of 0.05m.

> Existing RESIDUAL Soil Subgrade materials; Residual Soils comprising Silty Sandy CLAY, Clayey Silty SAND and Clayey Sandy SILT were encountered to depths of 1.2 m in test bores TB02, TB05, TB08-10, TB12-15. All other bores (excluding TB07) encountered shallow extremely weathered rock directly beneath the existing FILL/PAVEMENT (refer below).

> Existing SLOPEWASH Subgrade materials; Clayey Sand SILT material of probable SLOPEWASH origin, with high moisture content encountered adjacent the existing road alignment at the inside of the bend (TB07) to depths of 1.4m.

> BEDROCK; Extremely Weathered ROCK (Igneous and Conglomerate observed on site) material encountered in most test bores (TB02-TB15) at depths of 0.2m to 1.5m below ground level.

The existing residual subgrade materials were assessed as dense to very dense and stiff to hard consistency from DCP testing and tactile assessment. The probable slopewash materials were of firm to hard consistency.

No seepage or groundwater was encountered during the investigation. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site conditions.

For further details of subsurface conditions encountered, reference should be made to the engineering logs attached in Appendix B.

4.3 Laboratory Test Results

The results of standard compaction and CBR testing are summarised below in Table 4-1.

Table 4-1 Laboratory CBR test results

Bore No.	Depth (m)	Material description	W (%)	SOMC (%)	SMDD (t/m^3)	Swell (%)	CBR (%)
TB07	0.6-0.8	Clayey Sandy SILT	15.8	13.0	1.9	-0.5	8.0
TB08	0.7-0.9	Silty Sandy CLAY	12.4	14.5	1.8	1.5	4.0
TB13	0.5-0.8	Clayey Silty SAND	6.7	11.0	1.95	0.0	16.0
TB15	0.4-0.7	Clayey Silty SAND	6.7	11.0	1.93	0.0	20.0

Notes to table
W Field moisture content
SOMC Standard Optimum Moisture Content
SMDD Standard Maximum Dry Density

CBR testing was undertaken on remoulded specimens compacted to a target 100% maximum standard density and soaked for four days. Samples were surcharged with 4.5 kg prior to soaking.

Results of material quality testing including Atterberg Limits and PSD testing on samples of the existing pavement materials are summarised below in Table 4-2.

Table 4-2 Material quality test results

Bore No.	Depth (m)	Material description	Passing 2.36 mm (%)	Passing 75 µm (%)	LL (%)	PL (%)	PI (%)
TB03	0.1-0.3	Silty Gravelly SAND (existing pavement)	60	18	21	14	7
TB06	0.0-0.2	Silty Gravelly SAND (existing pavement)	64	16	18	15	3
TB09	0.0-0.3	Silty Gravelly SAND (existing pavement)	60	17	21	15	6
TB12	01-0.4	Silty Sandy GRAVEL (existing pavement)	59	19	22	14	8
TB15	0.1-0.3	Silty Gravelly SAND (existing pavement)	67	27	22	14	8

Notes to table
LL: Liquid Limit
PL: Plastic Limit
PI: Plasticity Index

For details of the laboratory testing conducted, reference should be made to report sheets attached in Appendix C.

5 Discussion and Comment

5.1 Reconstruction and Remedial Options

5.1.1 Existing Material Quality

Laboratory tests were undertaken to assess the suitability of the existing fill materials to be reused in the construction of the proposed Stage 5 East Seaham Road. The results of PSD, Atterberg limits and CBR tests, shown in Table 4-1 and Table 4-2 were compared with the required engineering properties of granular base and subbase, and material to be bound materials from RMS QA specification [2].

The available results indicate that the existing materials do not conform to the requirements of RMS QA Specification 3051 [2] for use as unbound granular base, subbase or material to be bound. All tested materials met the plasticity index requirements for both DGS20 and DGS40, however do not consistently meet the grading requirements. The PSD testing indicates that generally the existing pavement materials contain excess sand and clay/silt fines which are detrimental to material quality with reference to RMS 3051 [2]. The existing pavement material would have limited suitability for re-use in new pavements, and it is recommended suitable quality basecourse and subbase materials are imported, as discussed further below.

5.1.2 Geotechnical Considerations

The following factors have been considered during assessment of pavement rehabilitation suitability, and recommendations made in Section 6 below.

> Based upon the initial concept design provided, proposed pavement levels are generally at or above the existing pavement, with maximum fill in the range of 0.5-0.7 m, and as such material import will be required.

> Rehabilitation through granular overlay and in-situ stabilisation would be expected to provide a significantly shorter design life and higher maintenance requirement considering the relatively low quality of the existing pavement material as discussed.

> The adjoining Stage 4 upgrade that is currently under construction, with similar pavement and subgrade conditions, comprises construction of a new flexible pavement from imported materials.

> Rehabilitation options not involving full reconstruction are of higher risk as they do not address the variability of existing subsurface conditions, along with drainage issues and existing subgrade conditions.

5.1.3 Recommended Reconstruction

Considering the existing pavement material quality, the proposed vertical alignment and interfacing with the adjoining Stage 4 works, full pavement reconstruction is recommended for the section. A full depth pavement reconstruction utilising flexible unbound granular material is provided in Section 6 below.

It is critical that drainage conditions are improved as part of the works, particularly reforming / deepening of roadside drains as excess water is responsible for the majority of pavement failures.

6 Pavement Thickness Design

6.1 Design Parameters

Pavement thickness design has been performed in accordance with Austroads AGPT02-12 Guide to Pavement Technology, Part 2: Pavement Structural Design [4] based on the design traffic parameters outlined in **Error! Reference source not found.**.

Table 6-1 Design traffic based on the project specific data

Design period (years)	Annual Growth Rate (%)	Annual Average Daily Traffic	Direction Factor	Lane Direction factor	Average Percentage of Heavy Vehicles (%)	Average Number of Axle Group/HV	Design Traffic (DESA)
30	2	561	0.5	1.0	11	2.49	8.0×10^5

The design traffic in **Error! Reference source not found.** has been determined on the basis of the following d ata and assumptions and considering Austroads [4] AGPT02-12 Example traffic load distribution (TLD).

> A Pavement Design Life of 30 years as provided by PSC.

> Annual Average Daily Traffic (AADT) of 561 vehicles per day as provided by PSC.

> A percentage of heavy vehicles (HV) of 11% provided by PSC.

> A heavy vehicle growth rate of 2% per year assumed in the absence of supplied data.

The details of design traffic calculation are attached in Appendix E. Where input data varies from the information provided, review of pavement design may be required.

6.1.2 Subgrade Conditions

The design subgrade has been determined in accordance with Section 5 of Austroads 2012 [4], on the basis of both laboratory and field testing results, taking into consideration the effects of pavement surcharge.

Referring to the subsurface conditions encountered in the test bores, subgrade conditions along the proposed Stage 5 road section predominantly consist of residual soil from the shallow bearing rock underneath with the exception of locations near culverts containing fill material at subgrade level. Consequently, sampling difficulties were encountered due to the thinness of the subgrade layers in test bores containing shallow rock, limiting the available sampling locations and laboratory testing of the subgrade materials. As outlined in Section 4.2, the subgrade material varied and included Silty Sandy CLAY, Clayey Silty SAND and Clayey Sandy SILT.

Deeper Residual soils of poorer quality were found adjacent the existing road pavement on the inside of the bend in the road alignment existing approximately at chainages Ch 3560 to Ch 3700. A CBR test was conducted on the silty material (TB07) of high moisture content at subgrade level to assess the subgrade conditions in this location as it is associated with the proposed straightening of the road alignment. A CBR value of 8.0% was returned on the Clayey Sandy SILT material located at a chainage of Ch 3587. A clayey subgrade of similar colour in the adjacent test bore (TB08) at Chainage Ch 3642 returned a CBR of 4%. Based on the CBR results a design CBR of 4% is considered appropriate for pavement thickness design around these locations.

Residual clay material was also encountered in TB02 at chainage 3268m to a depth of approximately 0.45 m, where the pavement design level is expected to be raised 0.1-0.2m according to the supplied civil plan. The pavement at this location therefore has to be designed using a CBR of 4%. This results in a 440mm pavement and removal of most of the clay and replacement with subbase. Potentially a more economical option is over excavation of the minimal depth of clay and replacement with select material, in which case the 10% design CBR option could be adopted. Vertical alignment of the final alignment should also be considered along with the subsurface conditions described in this report when assessing the subgrade conditions and appropriate design option. The existing, site-won pavement materials should prove to be a

suitable select material depending on the moisture conditions at the time of construction; however, reference should be made to Section 7.2.1 for specification and compaction requirements.

The northern portion of the site between TB12 (Ch 4012) and TB15 (Ch 4192) contained subgrade conditions of similar material returning CBR's in TB13 and TB15 of 16% and 20% respectively. Although relatively deeper soil profiles were encountered in these locations (up to 1.2m to rock) these CBR results indicate that a design CBR of 10% can be adopted.

Referring to the provided initial planning sketch, the design levels are to only involve minor fill in some locations up to 0.6-0.7m and generally following existing levels. For this reason, pavement will be founded on relatively shallow rock in many areas as encountered in the field, and in such areas, a design CBR of 10% will be adopted. Areas of proposed fill must have general fill material complying with the material specifications and compaction requirements of Table 7-1 in order for the pavement design to be a valid design.

It is worth noting that the recommendations in this report, including design subgrade levels, are based on the assumption that the provided design levels are final. If any changes to the proposed design levels occurs, the pavement recommendations need to be reconsidered and will no longer be valid.

Considering the aforementioned, the road has been subdivided into sections based on subgrade performance and the vertical alignment and are summarised in Table 6-2. Also worth noting is that the chainages are indicative and based on assumptions by delineation test bores and observing vertical alignment.

Table 6-2 Summary of Road Section for Pavement Design

Chainage (m)	Section Identifier	Length of Section (m)	Adopted Design CBR
3220-3280(1) & 3560- 3700	2, 4	280	4%
3180-3220, 3280-3560 & 3700-4334	1, 3 & 5	240 & 634	10%

Notes:
(1) Chainages are indicative and based on assumptions via delineating test bores and observing vertical alignment. Where pavement is to be founded on clay material subgrade will need to adopt a design CBR of 4% or removal and replacement of clay material with select

6.2 Pavement Reconstruction: Flexible Unbound Pavement

Pavement reconstruction utilising flexible unbound pavement materials is detailed below in Table 6-3 and it is noted that the layer thicknesses are minimum thicknesses regardless of construction tolerances.

Table 6-3 New pavement reconstruction: flexible unbound pavement recommendations

Section	Ch 3220-3280(4) Ch 3420-3700m	Ch 3180-3220, Ch 3280-3560 & Ch 3700-4334m
Design Subgrade CBR	4%	10%
Wearing Surface (1)	Two-coat spray seal	Two-coat spray seal
Basecourse (2)	150mm	150mm
Subbase (2)	290mm	150mm
Select Material	150mm(3) – 300mm(4)	-
Total Thickness	440 mm	300mm
Design Traffic	8.0 x 10^5 DESA	8.0 x 10^5 DESA

Notes to table
(1) Final wearing course design shall be confirmed in consultation with the sealing contractor
(2) Refer to 7.2.1 for material specification and compaction requirements
(3) A select layer may be required as a construction platform for compaction of the overlying layer where clay subgrade is encountered depending on weather conditions at the time of construction and should be assessed during construction. The existing pavement materials should prove to be a suitable select material depending on the moisture conditions at the time of construction however, reference should be made to Section 7.2.1 for specification and compaction requirements
(4) Over excavation of the minimal depth of clay between Ch 3220 and 3280m and replacement with select material could be conducted, in which case the 10% design CBR Pavement option could be adopted. The final vertical alignment of the road should also be considered along with the subsurface conditions described herein when assessing the subgrade conditions and appropriate design option

7 Construction Notes

7.1 Construction Procedures

7.1.1 Subgrade Preparation

Where construction of the new pavement or widening is proposed, subgrade preparation for pavement formation should be in general accordance with the relevant council construction specifications and the following procedures.

> Excavation to design subgrade level, with the stockpiling of the existing pavement material for reuse as select (if required). Care should be exercised during excavation to avoid contamination of suitable granular material with subgrade materials.

> Where reconstruction of pavement occurs in areas with fill or existing pavement materials present at subgrade level, ripping and recompaction of a minimum of 300mm below subgrade level is required.

> Ripping and recompaction of rock subgrade, where encountered, to a minimum depth of 300 mm below subgrade level.

> Elimination of abrupt changes between subgrade conditions, such as transition from rock to soil subgrade or granular to clay subgrade. This could be conducted by methods such as selective grading or mixing of material to provide a transition between material types and moisture/density control of subgrade compaction.

> Static proof-roll the exposed subgrade using a heavy (minimum 10 tonne) roller under the direction of an experienced geotechnical consultant.

> Loose or yielding areas should be excavated and replaced with compacted select fill or suitable subgrade replacement. To prevent zones of variable permeability, which may trap moisture and lead to subgrade deformation, material of similar consistency to the subgrade shall be utilised in the case where localised replacement is required.

> Where filling or subgrade replacement is required, the materials employed shall be free of organic materials or other deleterious material and could comprise the existing pavement materials. The material should also have a maximum particle size of 100 mm or two thirds of the layer thickness and have a CBR value greater than 10%.

> Compaction of the subgrade, general filling or select material should be to a minimum 100% of SMDD in layers of not greater than 300 mm loose thickness. Moisture contents should be within 0 to -3% of SOMC.

Following satisfactory preparation of the subgrade, the pavement should be placed in accordance with the requirements of the appropriate section of this report, depending on the proposed pavement type.

The soils likely to be exposed following excavation to design subgrade level are expected to comprise sand, silt and clay soils, rock and granular filling. Depending on weather conditions prior to and during the works, difficulties in trafficability and compaction during construction on any clayey or silty subgrade could potentially be experienced. As such, allowances should be made for appropriate technique and construction plant.

7.2 Materials

7.2.1 Specification and Compaction Requirements

Pavement materials and compaction requirements for new pavement construction and granular pavement overlay should conform to PSC requirements and the following requirements.

Table 7-1 Material Specification and Compaction Requirements

Pavement Course	Material Specification	Compaction Requirements
Basecourse High quality crushed rock base material	Material complying with RMS QA Specification 3051 [3]	Min 98% Modified (AS1289 5.2.1) or Min 102% Standard (AS1289 5.1.1) (60-90% of OMC)
Subbase Quality crushed rock subbase material	Material complying with RMS QA Specification 3051 [3]	Min 95% Modified (AS1289 5.2.1) or Min 100% Standard (AS1289 5.1.1) (60-90% of OMC)
Select Crushed rock or gravel	CBR ≥ 15%	Min 100% Standard (AS1289 5.1.1) (60-90% of SOMC)
Subgrade or replacement	Clay Subgrade - minimum CBR 3% Silty Clayey SAND Subgrade - minimum CBR 10%	Min 100% Standard (AS1289 5.1.1) (3% dry of SOMC to SOMC)

All granular pavement material quality should be in general accordance with RMS QA Specification 3051 for Traffic Category C "Medium". Although our design traffic suggests a Traffic Category of D corresponding to light traffic, a conservative consideration has been taken.

Minimum testing on all potential imported pavement materials should include four-day soaked CBR, Atterberg Limits, Particle Size Distribution analysis and Wet/Dry strength determination. Pre-treatment of materials prior to testing would be advisable for material subject to breakdown.

7.2.2 Alternative Construction Materials

Based on laboratory test results, pavement materials salvaged from the pavement are considered suitable for use as a select however are generally not suitable basecourse or subbase material.

This suitability for reuse would be subject to weather conditions prior to and during construction, and moisture conditioning may be required.

Other materials used in the construction should comply with the specifications indicated in this report and Cardno should be consulted prior to the use of alternate materials. Contractors should specify materials to be used in construction at the time of tendering, with all materials to be approved by PSC prior to incorporation in the works.

7.2.3 Wearing Courses

Wearing Courses should be designed in accordance with PSC specifications with consideration to RMS Sprayed Sealing Guide [6] and QA Specifications R106 [7] and R111 [8]. The design and construction of wearing courses should be done in consultation with the preferred supplier taking into account traffic volume and type.

7.3 Drainage

The pavement thickness designs have been provided assuming drained pavement conditions. The selection, construction and maintenance of appropriate drainage mechanisms is required for adequate performance. Particular care is required to provide a waterproof seal for the pavement materials, together with adequate surface and sub-surface drainage of the pavement and adjacent areas. The use of low permeability material in the verge areas will also assist with the prevention of moisture ingress into the pavement and reduce moisture variation within the pavement.

Provision of adequate cross fall to direct runoff from the pavement to drainage lines should be achieved regardless of the option adopted and as a minimum, roadside open drains should be reformed and adequately maintained. The drains should be provided where the road is on grade or in cut and be constructed so that the base of the drain is below subgrade level along both the sides of the road. The subgrade should also be constructed with sufficient cross fall (approximately 3%) to assist in any moisture entering the pavement not becoming trapped.

7.4 General Construction Considerations

7.4.1 Pavement Compaction

It is essential to ensure that compaction is achieved through the full thickness of any pavement layers, particularly where bound pavements are utilised. A rough interface and bond is required between all pavement layers. This would generally be achieved by scarification of the first layer prior to placement and compaction of the second and subsequent layers.

7.4.2 Pavement Interface and Tie in

Where new pavement construction abuts an existing pavement, care should be exercised to either create a clean vertical construction joint or bench in the basecourse layer for a minimum of 0.5 m for the entire pavement width.

Adequate compaction of the subgrade and pavements in this area is essential to maximise the performance of the pavement. It is noted that where variable pavements are abutted, the potential for localised failure is generally greater and sealing of cracks that may develop between existing and new pavements should be conducted. The use of a strain relieving membrane along with intra-pavement drainage at the interface may also be appropriate.

7.4.3 Inspections

Where reconstruction is undertaken, the subgrade will require inspection by an experienced geotechnical consultant after boxing out or filling to design subgrade level. The purpose of inspections is to confirm design parameters, assess the suitability of the subgrade to support the pavement, and delineate areas which may require subgrade replacement or remedial treatment prior to construction.

7.4.4 References for Construction

All works and materials used in construction should be designed and constructed in accordance with PSC specifications or as specified within this report. Where discrepancies may occur clarification should be sought from Council.

Earthworks and testing should generally be undertaken in accordance with AS 3798-2007 Guidelines on Earthworks for Commercial and Residential Developments [8] where not otherwise specified.

8 Limitations

Cardno have performed investigation and consulting services for this project in general accordance with current professional and industry standards. The extent of testing was limited to discrete test locations and variations in ground conditions can occur between test locations that cannot be inferred or predicted.

A geotechnical consultant or qualified engineer shall provide inspections during construction to confirm assumed conditions in this assessment. If subsurface conditions encountered during construction differ from those given in this report, further advice shall be sought without delay.

Cardno, or any other reputable consultant, cannot provide unqualified warranties nor does it assume any liability for the site conditions not observed or accessible during the investigations. Site conditions may also change subsequent to the investigations and assessment due to ongoing use.

This report and associated documentation was undertaken for the specific purpose described in the report and shall not be relied on for other purposes. This report was prepared solely for the use by Port Stephens Council and any reliance assumed by other parties on this report shall be at such parties own risk.

References

[1] Newcastle Coalfield Regional 1:100 000 Geology Map, "Geological Series Sheet 9231, and part of 9131, 9132 and 9232 (Edition 1)," Geological Survey of NSW, Department of Mineral Resources, 1995.

[2] RMS QA Specification 3051 (Ed 6 Rev 2), "Granular Base and Subbase Materials for Surfaced Road Pavements," Roads and Maritime Services, April 2011.

[3] Austroads AGPT02-12, "Guide to Pavement Technology Part 2: Pavement Structural Design," Austroads Ltd, 2012.

[4] RMS TP-GLD-001 (Ed 2), "Sprayed Sealing Guide," Roads and Maritime Services, February 1997.

[5] RMS QA Specification R106 (Ed 4 Rev 0), "Sprayed Bituminous Surfacing (with Cutback Bitumen)," Roads and Maritime Services, August 2006.

[6] RMS QA Specification R111 (Ed 2 Rev 0), "Spayed Bituminous Surfacing (with Bitumen Emulsion)," Roads and Maritime Services, August 2006.

[7] RMS QA Specification R37 (Ed 4 Rev 1), "Intra-pavement Drains," Roads and Maritime Services, June 2011.

[8] Australian Standard AS3798-2007, "Guidelines on Earthworks for Commercial and Residential Structures," Standards Australia, 2007.

East Seaham Road, Stage 5
East Seaham

APPENDIX A

DRAWINGS

Cardno
Shaping the Future

NOTES:

Image underlay adapted from nearmaps aerial imagery.

LEGEND:

TBXXX Approximate test bore locations and numbers.

0 50m

SCALE 1:1500 @A3

NORTH

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Drawn	JG	Date 02/08/2017
Checked		Date 02/08/2017
		Date
Verified		Date
Approved		

Client: Port Stephens Council

Project: Geotechnical Investigation and Pavement Design
East Seaham Road, Stage 5
East Seaham

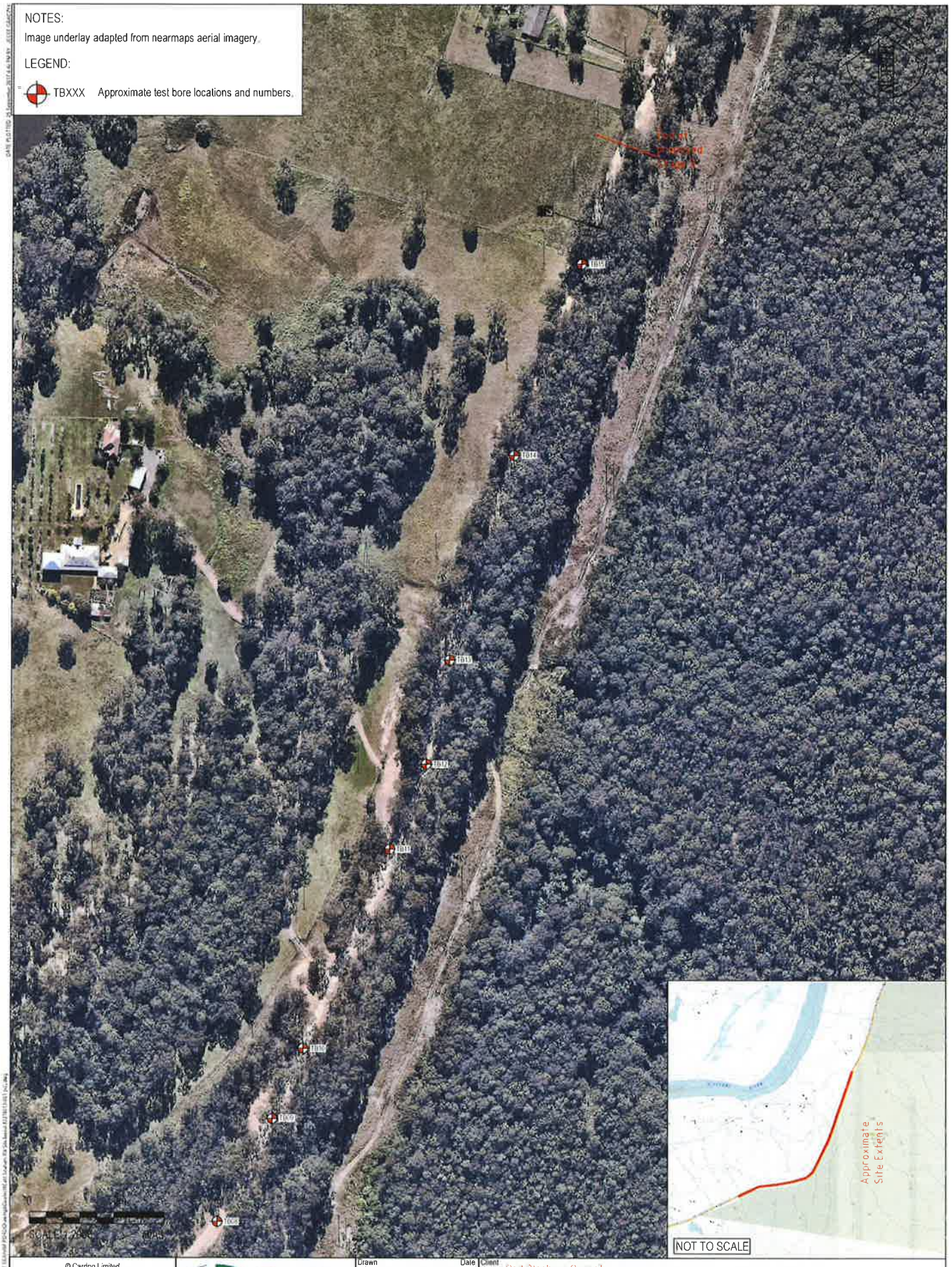
Title: Site Map and Test Layout

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Scale: 1:1500 Size: A3

Drawing Number: Figure 1

Revision: A



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Drawn JG	Date 02/08/2017	Client: Port Stephens Council
Checked	Date 02/08/2017	Project: Geotechnical Investigation and Pavement Design East Seaham Road, Stage 5 East Seaham
	Date	
Verified	Date	Title: Site Map and Test layout Part 2
Approved		

Status: FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Scale 1:2000 | Size A3

Drawing Number: Figure 2 | Revision: A

East Seaham Road, Stage 5
East Seaham

APPENDIX B

ENGINEERINGS LOGS

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Explanatory Notes

The methods of description and classification of soils and rocks used in this report are based on *Australian Standard 1726-2017 Geotechnical Site Investigations* Code. Material descriptions are deduced from field observation or engineering examination, and may be appended or confirmed by in situ or laboratory testing. The information is dependent on the scope of investigation, the extent of sampling and testing, and the inherent variability of the conditions encountered.

Subsurface investigation may be conducted by one or a combination of the following methods.

Method	
Test Pitting: excavation/trench	
BH	Backhoe bucket
EX	Excavator bucket
X	Existing excavation
Natural Exposure: existing natural rock or soil exposure	
Manual drilling: hand operated tools	
HA	Hand Auger
Continuous sample drilling	
PT	Push tube
Hammer drilling	
AH	Air hammer
AT	Air track
Spiral flight auger drilling	
AS	Large diameter short spiral auger
AD/V	Continuous flight spiral auger: V-Bit
AD/T	Continuous flight spiral auger: TC-Bit
Rotary non-core drilling	
WS	Washbore (mud drilling)
RR	Rock roller
Rotary core drilling	
HQ	63 mm diamond-tipped core barrel
NMLC	52 mm diamond-tipped core barrel
NQ	47 mm diamond-tipped core barrel
Concrete coring	
DT	Diatube

Subsurface investigation may be conducted by one or a combination of the following methods.

Sampling method	
Disturbed sampling	
B	Bulk disturbed sample
D	Disturbed sample
ES	Environmental sample
Undisturbed sampling	
SPT	Standard Penetration Test sample
U#	Undisturbed tube sample (# mm diameter)
WS	Water sample
EW	Environmental water sample

Field testing may be conducted as a means of assessment of the in-situ conditions of materials encountered.

Field testing	
SPT	Standard Penetration Test
HP/PP	Hand/Pocket penetrometer
Dynamic Penetrometers (blows/150 mm)	
	DCP Dynamic Cone Penetrometer
	PSP Perth Sand Penetrometer
VS	Vane Shear
PBT	Plate Bearing Test

If encountered with SPT or dynamic penetrometer testing, refusal (R), virtual refusal (VR) or hammer bouncing (HB) may be noted.

The quality of the rock can be assessed by the degree of fracturing and the following.

Rock quality description	
TCR	Total core recovery (%) (Length of core recovered, divided by the length of the core run)
RQD	Rock Quality Designation (%) (sum of axial lengths of core greater than 100 mm long divided by the length of the core run)

Notes on groundwater conditions encountered may include the following.

Groundwater	
Not encountered	Excavation is dry in the short term
Not observed	Groundwater observation not possible
Seepage	Groundwater seeping into hole
Inflow	Groundwater flowing/flooding into hole

Notes on the stability of excavation may include the following.

Rock quality description	
Spalling	Material falling into excavation, may be described as minor or major spalling
Unstable	Collapse of the majority, or one or more face of the excavation

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Explanatory Notes – General soil Description

The methods of description and classification of soils and rocks used in this report are *based on Australian Standard 1726-2017 Geotechnical Site Investigations Code*. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. In general, descriptions cover: soil type, strength / relative density, moisture, colour, plasticity and inclusions.

Soil types are described according to the dominant particle size on the basis of the following assessment.

Soil classification	Particle size (mm)	
CLAY	< 0.002	
SILT	0.002 to 0.075	
SAND	*fine*	0.075 to 0.21
	medium	0.21 to 0.60
	coarse	0.60 to 2.36
GRAVEL	*fine*	2.36 to 6.7
	medium	6.7 to 19
	coarse	19 to 63
COBBLES	63 to 200	
BOULDERS	> 200	

Soil types are qualified by the presence of minor components on the basis of field examination or grading.

Terminology	In coarse grained soils		In fine grained soils
	% Fines	% coarse fraction	% Sand/gravel
Trace	≤ 5	≤ 15	≤ 15
With	> 5 to ≤ 12	> 15 to ≤ 30	> 15 to ≤ 30

The strength of cohesive soils is classified by engineering assessment or field/laboratory testing as follows

Strength	Symbol	Undrained shear strength (kPa)
Very Soft	VS	≤12
Soft	S	>12 to ≤25
Firm	F	>25 to ≤50
Stiff	St	>50 to ≤100
Very Stiff	VSt	>100 to ≤200
Hard	H	>200

Cohesionless soils are classified on the basis of relative density as follows.

Strength	Symbol	Density Index (%)
Very Loose	VL	≤15
Loose	L	>15 to ≤35
Medium Dense	MD	>35 to ≤65
Dense	D	>65 to ≤85
Very Dense	VD	>85

The moisture condition of soil is described by appearance and feel and may be described in relation to the Plastic Limit (PL) or Optimum Moisture Content (OMC). For granular soils, the following guide is adopted.

Moisture condition	Description
Dry	Non-cohesive and free-running
Moist	Cool feel and darkened colour, soils tends to stick together
Wet	Cool feel and darkened colour, free-water forms when handling, soils tend to cohere

The following guide is adopted for cohesive soils.

Moisture condition	Description
Moist, dry of PL	$w < PL$
Moist, near PL	$w \approx PL$
Moist, wet of PL	$w > PL$
Wet, near LL	$w \approx LL$
Wet, wet of LL	$w > LL$

The plasticity of cohesive soils is defined as follows.

Plasticity	LL for Silt (%)	LL for Clay (%)
Low	≤50	≤35
Medium	N/A	>35 to ≤50
High	>50	>50

The structure may include; defects such as softened zones, fissures, cracks, joints and root-holes; and coarse grained soils may be described as strongly/weakly cemented.

The soil origin may also be noted if possible to deduce.

Soil origin	Description
Fill	Man-made deposits or disturbed material
Topsoil	Material affected by roots and root fibres
Colluvial soil	Transported down slopes by gravity
Aeolian soil	Transported and deposited by wind
Estuarine soil	Deposited in coastal estuaries
Alluvial soil	Deposited by streams and rivers
Lacustrine soil	Deposited in freshwater lakes
Marine soil	Deposited in marine environment
Extremely weathered material	Developed from in-situ weathering, with structure/fabric of parent rock intact
Residual soil	Developed from in-situ weathering, with structure/fabric of parent rock

The origin of the soil generally cannot be deduced on the appearance of the material and may be assumed based on further geological evidence or field observation. Where there is doubt, the terms 'possibly' or 'probably' shall be used.

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Explanatory Notes – General Rock Description

The methods of description and classification of soils and rocks used in this report are *based on Australian Standard 1726-2017 Geotechnical Site Investigations Code*. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. In general, descriptions cover: soil type, strength / relative density, moisture, colour, plasticity and inclusions.

Sedimentary rock types are generally described according to the predominant grain size as follows

Rock Type	Description
CONGOLMERATE	Large rounded gravel sized fragments > 2 mm cemented in a finer matrix
BRECCIA	Angular/irregular rock fragments > 2 mm in a finer matrix
SANDSTONE	Sand sized particles defined by grain size and often cemented by other materials fine 0.06 mm to 0.2 mm medium 0.2 mm to 0.6 mm coarse 0.6 mm to 2 mm
SILTSTONE	Predominantly silt sized particles
SHALE	Fine particles (silt or clay) and fissile
CLAYSTONE	Predominantly clay sized particles

The classification of rock weathering is described based on definitions outlined in AS 1726-2017 as follows

Term	Symbol	Definition
Residual Soil	RS	Soil developed on extremely weathered rock; mass structure and substance are no longer evident
Extremely weathered	XW	Weathered to such an extent that it has 'soil' properties. Mass structure and substance still visible
Distinctly weathered	DW	Strength usually changed and may be highly discoloured. Porosity may be increased by leaching, or decreased due to deposition in pores
Slightly weathered	SW	Slightly discoloured; little/no change of strength from fresh rock
Fresh	FR	Rock shows no sign of decomposition or staining

Rock strength (distinct from mass strength which can be significantly weaker due to the effect of defects) can be defined based on point load index as follows

Term	Symbol	Point Load Index I_{s50} (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	> 10

For preliminary assessment and in cases where no point load testing is available, the rock strength may be assessed using the field guide specified in AS 1726-2017.

The defect spacing and bedding thickness of rocks measured normal to defects of the same set or bedding can be described as follows.

Definition	Defect spacing (mm)
Thinly laminated	< 6
Laminated	6 to 20
Very thinly bedded	20 to 60
Thinly bedded	60 to 200
Medium bedded	200 to 600
Thickly bedded	600 to 2000
Very thickly bedded	> 2000

Defects in rock mass are described by the following

Terms		Terms	
Joint	JT	Sheared zone	SZ
Bed parting	BP	Sheared surface	SS
Contact	CO	Seam	SM
Dyke	DK	Crushed Seam	CS
Decomposed zone	DZ	Infilled Seam	IS
Fracture	FC	Foliation	FL
Fracture Zone	FZ	Vein	VN

The shape and roughness of defects in the rock mass are described using the following terms

Planarity		Roughness	
Planar	PR	Very Rough	VR
Curved	CU	Rough	R
Undulating	U	Smooth	S
Irregular	IR	Polished	POL
Stepped	ST	Slickensided	SL

The coating or infill associated with defects in rock mass are described as follows

Definition	Symbol	Description
Clean	CN	No visible coating
Stain	SN	No visible coating; surfaces are discoloured
Veneer	VNR	Visible coating of soil or mineral, too thin to measure; may be patchy
Coating	CT	Visible coating or infilling of soil or mineral substance (up to 1 mm)

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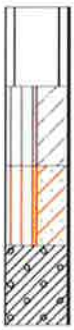
Graphics Symbol Index

CLAYS



CLAY

Silty CLAY

Sandy CLAY

Gravelly CLAY

GRAVELS

GRAVEL

Clayey GRAVEL

Silty GRAVEL

Sandy GRAVEL

METAMORPHIC ROCK

SLATE/PHYLLITE

SCHIST

GNEISS

QUARTZITE

SILTS

SILT

Clayey SILT

Sandy SILT

Gravelly SILT

FILL STRATA

FILL

ASPHALT

CONCRETE

IGNEOUS ROCK

GRANITE

RHYOLITE

BASALT

DOLERITE

VOLCANIC

TUFF

SANDS

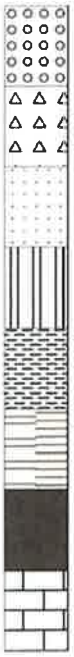
SAND

Clayey SAND

Sandy SAND

Gravelly SAND

SEDIMENTARY ROCKS



CONGLOMERATE

BRECCIA

SANDSTONE

SILTSTONE

SHALE

MUDSTONE
/CLAYSTONE

COAL

LIMESTONE

OTHER SOILS

High plasticity
ORGANIC
CLAYS & SILTS

TOPSOIL

COBBLES &
BOULDERS

BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham		**Job No: 82218013**	**Hole No: TB01** **Sheet: 1 of 1**
Position: 2m OS CL Northlane Approx Ch 3190		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Excavating: Auger 'TC' Bit	Excavating: Washbore	Excavating: Hand Auger	Excavating: Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
0						Not Encountered							FILL/PAVEMENT; Silty Gravelly SAND, fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
							B 0.40 - 0.70 m						
0.5													
1.0													
1.5													BOREHOLE TERMINATED AT 1.70 m Refusal

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client:	**Port Stephens Council**		**Hole No:**
Project:	**East Seaham Rd Stage 5**		
Location:	**East Seaham Rd, East Seaham**	**Job No: 82218013**	**Sheet: 1 of 1**
Position: 5m OS CL Southlane Approx Ch 3268		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
													Silty Sandy CLAY; low to medium plasticity, brown, trace of organic materials, moisture content dry of plastic limit, RESIDUAL
0.5													Extremely Weathered ROCK; Distinctly to Extremely Weathered, Low Strength
													BOREHOLE TERMINATED AT 0.50 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham		**Job No: 82218013**	**Hole No: TB03** **Sheet: 1 of 1**
Position: 1.5m OS CL Northlane Approx Ch 3330		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered	B 0.10 - 0.30 m						FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, dry
													Extremely Weathered ROCK; Distinctly to Extremely Weathered, Low Strength
0.5													BOREHOLE TERMINATED AT 0.40 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham		**Job No:** 82218013	**Hole No: TB04** **Sheet:** 1 of 1
Position: 1.5m OS CL Southlane Approx. Ch 3376		**Angle from Horizontal:** 90°	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller:** ARSK Civil
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed:** 10/8/17	**Logged By:** JG	**Date Logged:** 10/8/17

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT; Silty Sandy GRAVEL; fine to coarse grain, sub-rounded conglomerate to sub-angular igneous, brown with gravels ranging pale white, red, blue to darker colours, trace of sub angular cobbles (70-80mm)
													Extremely Weathered ROCK; pale brown-grey, find sand particle size, distinctly to Extremely Weathered, Low Strength
													BOREHOLE TERMINATED AT 0.20 m Refusal
0.5													
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham			**Hole No: TB05**
		Job No: 82218013	**Sheet: 1 of 1**
Position: 1.5m OS CL Northlane Approx. Ch 3446		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Excavating: Auger 'TC' Bit	Excavating: Washbore	Excavating: Hand Auger	Excavating: Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
0.5													Clayey Silty SAND; fine to medium grained, light brown, trace of gravel and organic material including roots and rootlets, potential extremely weathered conglomerate, RESIDUAL
1.0													Extremely Weathered ROCK; Distinctly to Extremely Weathered, Low Strength
													BOREHOLE TERMINATED AT 1.00 m Refusal
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Port Stephens Council			**Hole No: TB06**
Project: East Seaham Rd Stage 5			
Location: East Seaham Rd, East Seaham	**Job No: 82218013**		**Sheet: 1 of 1**
Position: 1.5m OS CL Southlane Approx. Ch 3513	**Angle from Horizontal: 90°**		**Surface Elevation:**
Rig Type: 3.5t Excavator	**Bit:**		**Driller: ARSK Civil**
Casing Diameter:	**Contractor:**		
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered	B 0.00 - 0.20 m						FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, orange-brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
													Silty Sandy CLAY; low to medium plasticity, brown, trace of organic materials, moisture content dry of plastic limit, RESIDUAL
													Extremely Weathered ROCK; Distinctly to Extremely Weathered, Low Strength
0.5													BOREHOLE TERMINATED AT 0.40 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham			**Hole No: TB07**
		Job No: 82218013	**Sheet: 1 of 1**
Position: 7m OS North of Road Edge Approx. Ch 3587		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered	B 0.20 - 0.40 m		3 8 12				Clayey Sandy SILT; low to medium plasticity, red, trace of gravels and organic material including rootlets etc, moisture content above plastic limit, probably SLOPEWASH
0.5							B 0.60 - 0.80 m		11 7 6				Clayey Sandy SILT; low to medium plasticity, brown-pale grey mottled orange-red with gravels, fine to coarse, and trace of organic material and cobbles (70mm), Moisture Content well above plastic limit, probably SLOPEWASH
1.0							B 1.10 - 1.30 m		8 16 32 R				As above slight change in colour to more grey, increased moisture content to almost wet
													Extremely Weathered ROCK; Distinctly to Extremely Weathered, Low Strength
1.5													BOREHOLE TERMINATED AT 1.50 m Refusal

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client:	**Port Stephens Council**		**Hole No: TB08**
Project:	**East Seaham Rd Stage 5**		
Location:	**East Seaham Rd, East Seaham**	**Job No: 82218013**	**Sheet: 1 of 1**
Position: 1.5m OS CL Southlane Approx. Ch 3642		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry
0.5							B 0.70 - 0.90 m						Silty Sandy CLAY; low to medium plasticity, light brown mottled orange, with rock fragments, fine to coarse, sub-rounded to angular, moisture content well dry of plastic limit, RESIUDAL
1.0													Extremely Weathered ROCK; Extremely Weathered, Low Strength
1.5													BOREHOLE TERMINATED AT 1.10 m Refusal

See Standard Sheets for details of abbreviations & basis of descriptions

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BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham			**Hole No: TB09**
		Job No: 82218013	**Sheet: 1 of 1**
Position: 1.5m OS CL Northlane Ch 3722		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Excavating: Auger 'TC' Bit	Excavating: Washbore	Excavating: Hand Auger	Excavating: Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered	B 0.00 - 0.30 m						FILL/PAVEMENT: Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
													Silty Sandy CLAY; low to medium plasticity, brown, less than trace of organic materials, grading to extremely weathered rock, moisture content dry of plastic limit, RESIDUAL
0.5													Extremely Weathered ROCK; Extremely Weathered, Low Strength
													BOREHOLE TERMINATED AT 0.50 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

1/10 Denney Street
Broadmeadow NSW 2292
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BOREHOLE LOG SHEET

Client: Port Stephens Council			**Hole No: TB10**
Project: East Seaham Rd Stage 5			
Location: East Seaham Rd, East Seaham	**Job No:** 82218013		**Sheet:** 1 of 1
Position: 1.5m OS CL Northlane Ch 3767	**Angle from Horizontal:** 90°	**Surface Elevation:**	
Rig Type: 3.5t Excavator	**Bit:**	**Driller:** ARSK Civil	
Casing Diameter:	**Contractor:**		
Date Started : 10/8/17	**Date Completed:** 10/8/17	**Logged By:** JG	**Date Logged:** 10/8/17

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, dry to moist
							B 0.20 - 0.50 m						Clayey Gravelly SAND; low to medium plasticity, light brown, grading to extremely weathered rock, moisture content dry of plastic limit, RESIDUAL
0.5													Extremely Weathered ROCK; Distinctly weathered to extremely Weathered, Low Strength
													BOREHOLE TERMINATED AT 0.60 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

1/10 Denney Street
Broadmeadow NSW 2292
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FAX: +61 2 4965 4666

BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham			**Hole No: TB11**
		Job No: 82218013	**Sheet: 1 of 1**
Position: 1.5m OS CL Northlane Approx. Ch 3895		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
													Extremely Weathered ROCK; Distinctly weathered to extremely Weathered, Low Strength
0.5													BOREHOLE TERMINATED AT 0.28 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

1/10 Denney Street
Broadmeadow NSW 2292
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BOREHOLE LOG SHEET

Client:	**Port Stephens Council**		**Hole No: TB12**
Project:	**East Seaham Rd Stage 5**		
Location:	**East Seaham Rd, East Seaham**	**Job No: 82218013**	**Sheet: 1 of 1**
Position: 1.5m OS CL Southlane Approx. Ch 3949		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered	B 0.10 - 0.40 m						FILL/PAVEMENT; Silty Sandy GRAVEL; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
													200 to 250mm wide boulder encountered about 0.2-0.3m deep
0.5													Silty Sandy CLAY; low to medium plasticity, brown with gravels, fine to coarse, sub-roudned to angular, trace of organic materials including a 10mm thick root at 0.4m, moisture content below plastic limit, RESIDUAL
													BOREHOLE TERMINATED AT 0.60 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

1/10 Denney Street
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BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham			**Hole No: TB13**
		Job No: 82218013	**Sheet: 1 of 1**
Position: 1.5m OS CL Northlane Approx. Ch 4012		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered							FILL/PAVEMENT: Silty Gravelly SAND: fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry
0.5							B 0.50 - 0.80 m						Clayey Silty SAND; fine to medium, brown, trace of organic materials and gravel, fine to coarse, moisture content dry of plastic limit, RESIDUAL
													Extremely Weathered ROCK: Distinctly weathered to extremely Weathered, Low Strength
1.0													BOREHOLE TERMINATED AT 1.00 m Refusal
1.5													

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1/10 Denney Street
Broadmeadow NSW 2292
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BOREHOLE LOG SHEET

Client: Port Stephens Council			**Hole No: TB14**
Project: East Seaham Rd Stage 5			
Location: East Seaham Rd, East Seaham	**Job No:** 82218013		**Sheet:** 1 of 1
Position: 1.5m OS CL Northlane Approx. Ch 4140	**Angle from Horizontal:** 90°		**Surface Elevation:**
Rig Type: 3.5t Excavator	**Bit:**		**Driller:** ARSK Civil
Casing Diameter:	**Contractor:**		
Date Started : 10/8/17	**Date Completed:** 10/8/17	**Logged By:** JG	**Date Logged:** 10/8/17

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered			32				FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry
0.5									21				Clayey Silty SAND; fine to medium, brown-grey, trace of organic materials including roots upto 5-10mm thick at 0.4m and gravel, fine to coarse, moisture content dry of plastic limit, RESIDUAL
									17				
									27				
1.0									13				
									40				
1.5													BOREHOLE TERMINATED AT 1.20 m Refusal

See Standard Sheets for details of abbreviations & basis of descriptions

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Broadmeadow NSW 2292
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FAX: +61 2 4965 4666

BOREHOLE LOG SHEET

Client: Port Stephens Council **Project:** East Seaham Rd Stage 5 **Location:** East Seaham Rd, East Seaham		**Job No: 82218013**	**Hole No: TB15** **Sheet: 1 of 1**
Position: 1.5m OS CL Southlane Approx. Ch 4192		**Angle from Horizontal: 90°**	**Surface Elevation:**
Rig Type: 3.5t Excavator		**Bit:**	**Driller: ARSK Civil**
Casing Diameter:		**Contractor:**	
Date Started : 10/8/17	**Date Completed: 10/8/17**	**Logged By: JG**	**Date Logged: 10/8/17**

Depth (m)	Excavating: Auger 'V' Bit	Auger 'TC' Bit	Washbore	Hand Auger	Tooth bucket	Groundwater (m)	Sample or Field Test	Recovered	DCP	RL (m AHD)	Graphic Log	USCS Symbol	Description (SYMBOL, SOIL NAME, plasticity/particle characteristics, colour, minor components, moisture, consistency, structure, ORIGIN)
						Not Encountered	B 0.10 - 0.30 m						FILL/PAVEMENT; Silty Gravelly SAND; fine to medium, brown, gravels fine coarse, rounded to angular, trace of cobbles, dry to moist
							B 0.40 - 0.70 m						Clayey Silty SAND; fine to medium, brown-grey, trace of organic materials including roots and gravel, fine to coarse, moisture content dry of plastic limit, RESIDUAL
0.5													
													BOREHOLE TERMINATED AT 0.70 m Refusal
1.0													
1.5													

See Standard Sheets for details of abbreviations & basis of descriptions

1/10 Denney Street
Broadmeadow NSW 2292
PH: +61 2 4949 4300
FAX: +61 2 4965 4666

East Seaham Road, Stage 5
East Seaham

APPENDIX

C

LABORATORY TESTS RESULTS

Cardno
Shaping the Future

Construction Sciences

Construction Sciences Pty Ltd
ABN: 74 128 806 735

Address:
Unit 1, 10 Denney Street
Broadmeadow NSW 2292

Laboratory: Newcastle Laboratory
Phone: 02 4965 4555 Fax: 02 4946 4666

Email: Newcastle@constructionsciences.net

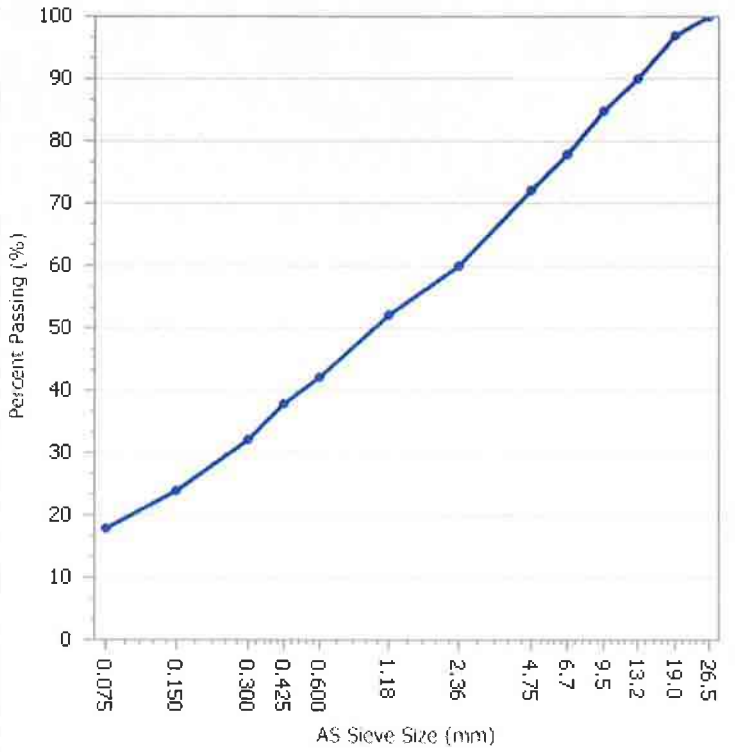
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10587-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 1 of 5

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/39297	Sample Location		
Sampling Method	Tested As Received	Bore No.		TB03
Date Sampled	10/08/2017	Sample Type		Bulk
Sampled By	Client Sampled	Sample Depth	m	0.1-0.3
Date Tested	29/08/2017			
Material Source	-	Material Type	-	

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
26.5		**100**	
19.0		**97**	
13.2		**90**	
9.5		**85**	
6.7		**78**	
4.75		**72**	
2.36		**60**	
1.18		**52**	
0.600		**42**	
0.425		**38**	
0.300		**32**	
0.150		**24**	
0.075		**18**	

PARTICLE SIZE DISTRIBUTION GRAPH



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Accreditation Number: 1986
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Approved Signatory: Joseph Stallard
Form ID: W9Rep Rev 2

Construction Sciences

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ABN: 74 128 806 735

Address:
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Email: Newcastle@constructionsciences.net

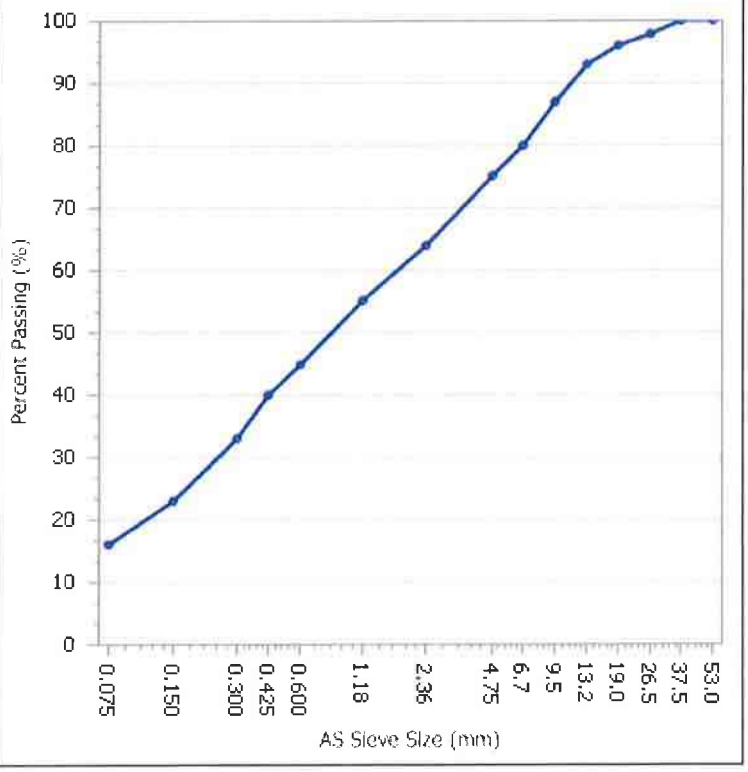
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10587-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 2 of 5

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/39298	Sample Location		
Sampling Method	Tested As Received	Bore No.		TB06
Date Sampled	10/08/2017	Sample Type		Bulk
Sampled By	Client Sampled	Sample Depth	m	0.0-0.2
Date Tested	4/09/2017			
Material Source	-	Material Type	-	

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
53.0		**100**	
37.5		**100**	
26.5		**98**	
19.0		**96**	
13.2		**93**	
9.5		**87**	
6.7		**80**	
4.75		**75**	
2.36		**64**	
1.18		**55**	
0.600		**45**	
0.425		**40**	
0.300		**33**	
0.150		**23**	
0.075		**16**	

PARTICLE SIZE DISTRIBUTION GRAPH



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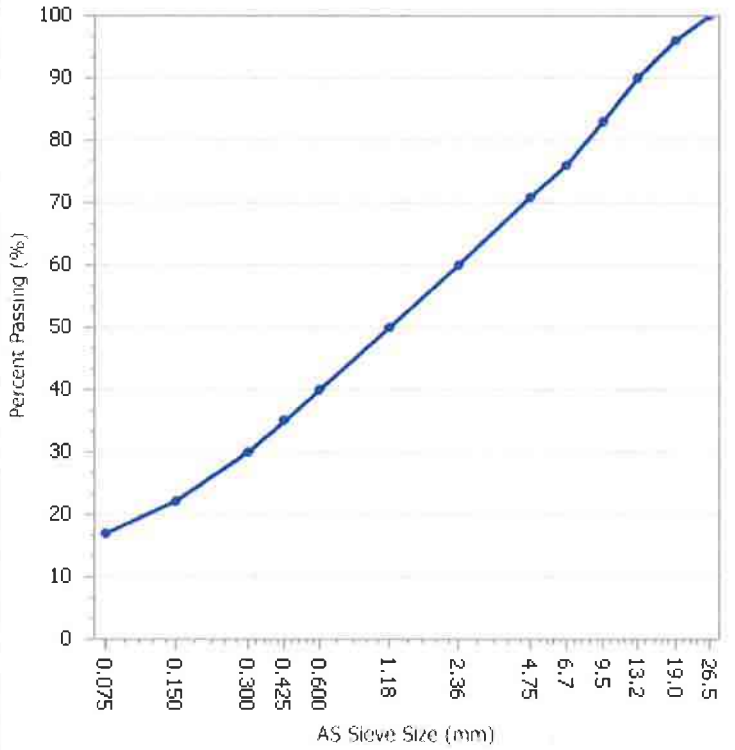
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10587-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 3 of 5

Test Procedures:	AS1289.3.6.1			
Sample Number	16822/S/39301	Sample Location		
Sampling Method	Tested As Received	Bore No.		TB09
Date Sampled	10/08/2017	Sample Type		Bulk
Sampled By	Client Sampled	Sample Depth	m	0.0-0.3
Date Tested	29/08/2017			
Material Source	-	Material Type	-	

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
26.5		**100**	
19.0		**96**	
13.2		**90**	
9.5		**83**	
6.7		**76**	
4.75		**71**	
2.36		**60**	
1.18		**50**	
0.600		**40**	
0.425		**35**	
0.300		**30**	
0.150		**22**	
0.075		**17**	

PARTICLE SIZE DISTRIBUTION GRAPH



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PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10587-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 4 of 5

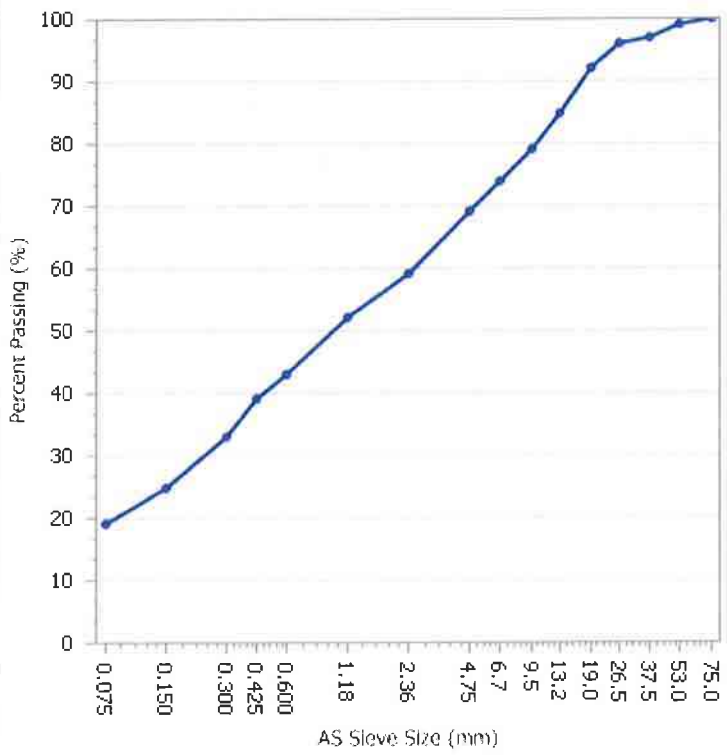
Test Procedures:	AS1289.3.6.1
Sample Number	16822/S/39302
Sampling Method	Tested As Received
Date Sampled	10/08/2017
Sampled By	Client Sampled
Date Tested	4/09/2017
Material Source	-

Sample Location

Bore No.		TB12
Sample Type		Bulk
Sample Depth	m	0.1-0.4
Material Type		-

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
75.0		**100**	
53.0		**99**	
37.5		**97**	
26.5		**96**	
19.0		**92**	
13.2		**85**	
9.5		**79**	
6.7		**74**	
4.75		**69**	
2.36		**59**	
1.18		**52**	
0.600		**43**	
0.425		**39**	
0.300		**33**	
0.150		**25**	
0.075		**19**	

PARTICLE SIZE DISTRIBUTION GRAPH



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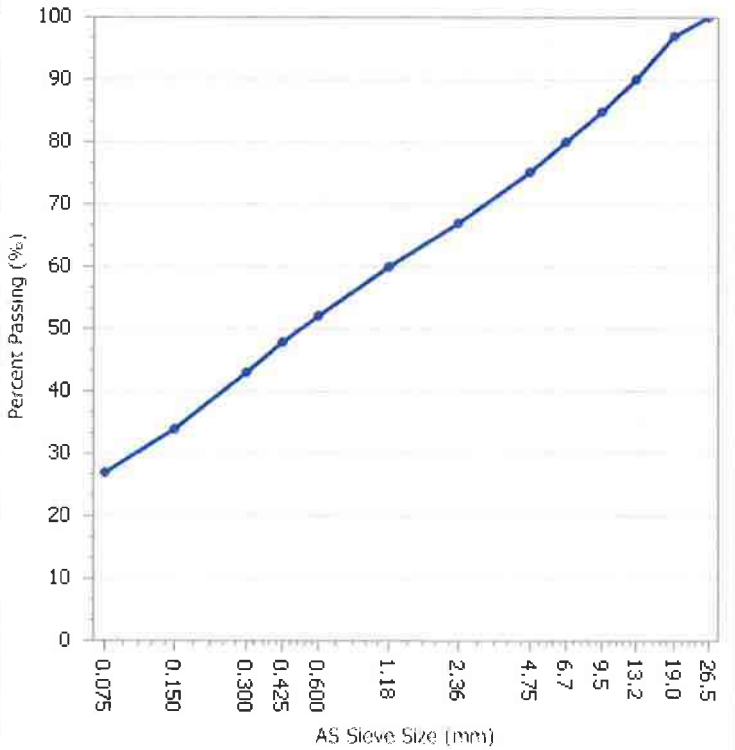
PARTICLE SIZE DISTRIBUTION REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10587-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 5 of 5

Test Procedures:	AS1289.3.6.1		
Sample Number	16822/S/39303	Sample Location	
Sampling Method	Tested As Received	Bore No.	TB15
Date Sampled	10/08/2017	Sample Type	Bulk
Sampled By	Client Sampled	Sample Depth m	0.1-0.3
Date Tested	29/08/2017		
Material Source	-	Material Type -	

AS Sieve (mm)	Specification Minimum	Percent Passing (%)	Specification Maximum
26.5		100	
19.0		97	
13.2		90	
9.5		85	
6.7		80	
4.75		75	
2.36		67	
1.18		60	
0.600		52	
0.425		48	
0.300		43	
0.150		34	
0.075		27	

PARTICLE SIZE DISTRIBUTION GRAPH



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Form ID: W9Rep Rev 2

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Email: Newcastle@constructionsciences.net

CALIFORNIA BEARING RATIO REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10595-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 1 of 4

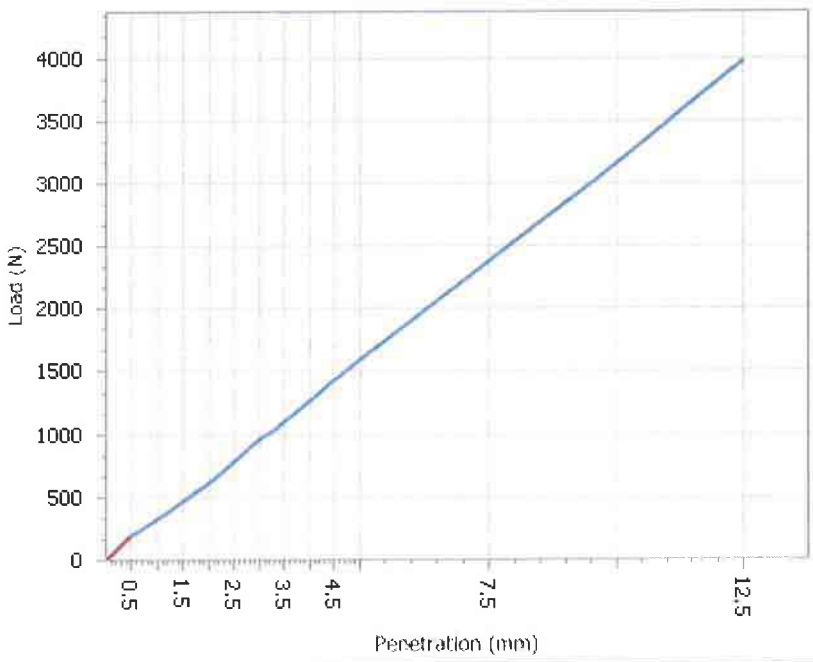
Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1

		Sample Location		
Sample Number	16822/S/39299	Bore No.		TB07
Sampling Method	Tested As Received	Sample Type		Bulk
Date Sampled	10/08/2017	Sample Depth	m	0.6-0.8
Sampled By	Client Sampled			
Date Tested	8/09/2017			
Material Source	-	Material Limit Start		-
Material Type	-	Material Limit End		-
Client Reference	-	Compactive Effort		Standard

Material Description	Clayey Sandy SILT, brown grey mottled orange

Maximum Dry Density (t/m³):	1.90
Optimum Moisture Content (%):	13.0
Field Moisture Content (%):	15.8
Sample Percent Oversize (%)	6.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	100
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.90
Placement Dry Density Ratio (%):	100.0
Placement Moisture Content (%):	12.8
Placement Moisture Ratio (%):	98.5
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.91
Total Curing Time (hrs)	n/a
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	12.9
Moisture (remainder) After Soak (%)	12.7
CBR Swell (%):	-0.5
Minimum CBR Specification (%):	-
CBR Value @ 5.0mm (%):	**8**

CBR PENETRATION PLOT



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Corporate Site Number: 16822

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Approved Signatory: Joseph Stallard
Form ID: W2ASRep Rev2

Construction Sciences

Construction Sciences Pty Ltd
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Broadmeadow NSW 2292

Laboratory: Newcastle Laboratory
Phone: 02 4965 4555 Fax: 02 4946 4666

Email: Newcastle@constructionsciences.net

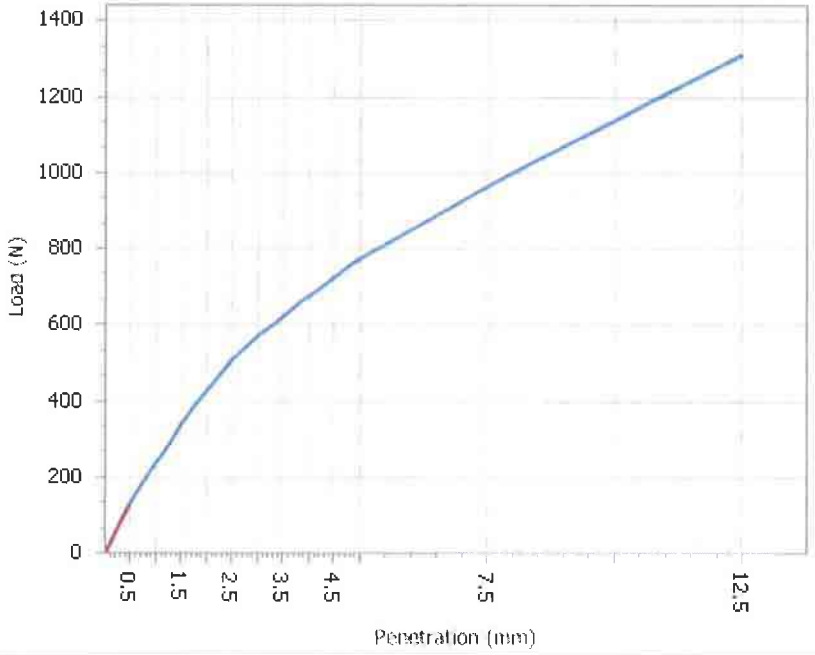
CALIFORNIA BEARING RATIO REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10595-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 2 of 4

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1		
Sample Number	16822/S/39300	Sample Location	
Sampling Method	Tested As Received	Bore No.	TB08
Date Sampled	10/08/2017	Sample Type	Bulk
Sampled By	Client Sampled	Sample Depth m	0.7-0.9
Date Tested	8/09/2017		
Material Source	-	Material Limit Start	-
Material Type	-	Material Limit End	-
Client Reference	-	Compactive Effort	Standard
Material Description	Silty Sandy CLAY, light brown mottled orange		

Maximum Dry Density (t/m³):	1.80
Optimum Moisture Content (%):	14.5
Field Moisture Content (%):	12.4
Sample Percent Oversize (%)	2.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	100
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.79
Placement Dry Density Ratio (%):	99.5
Placement Moisture Content (%):	14.3
Placement Moisture Ratio (%):	99.5
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.76
Total Curing Time (hrs)	n/a
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	19.8
Moisture (remainder) After Soak (%)	17.6
CBR Swell (%):	1.5
Minimum CBR Specification (%):	-
CBR Value @ 5.0mm (%):	**4.0**

CBR PENETRATION PLOT



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CALIFORNIA BEARING RATIO REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10595-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 3 of 4

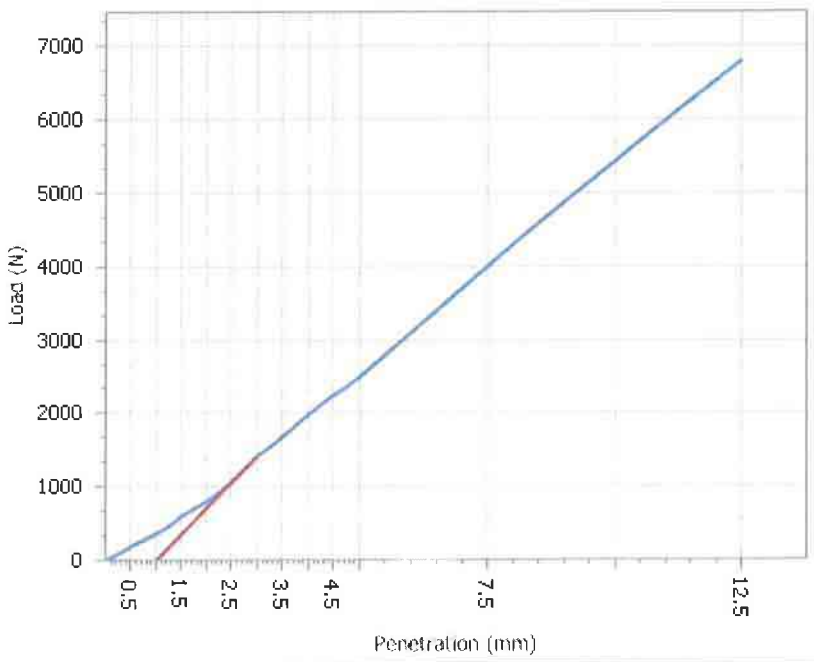
Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1

		Sample Location		
Sample Number	16822/S/39304	Bore No.		TB13
Sampling Method	Tested As Received	Sample Type		Bulk
Date Sampled	10/08/2017	Sample Depth	m	0.5-0.8
Sampled By	Client Sampled			
Date Tested	8/09/2017			
Material Source	-	Material Limit Start		-
Material Type	-	Material Limit End		-
Client Reference	-	Compactive Effort		Standard

Material Description	Clayey Sandy SILT, brown-grey

Maximum Dry Density (t/m³):	1.95
Optimum Moisture Content (%):	11.0
Field Moisture Content (%):	6.7
Sample Percent Oversize (%)	4.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	100
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.95
Placement Dry Density Ratio (%):	100.0
Placement Moisture Content (%):	11.2
Placement Moisture Ratio (%):	101.0
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.95
Total Curing Time (hrs)	n/a
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	11.5
Moisture (remainder) After Soak (%)	11.1
CBR Swell (%):	0.0
Minimum CBR Specification (%):	-
CBR Value @ 5.0mm (%):	**16**

CBR PENETRATION PLOT



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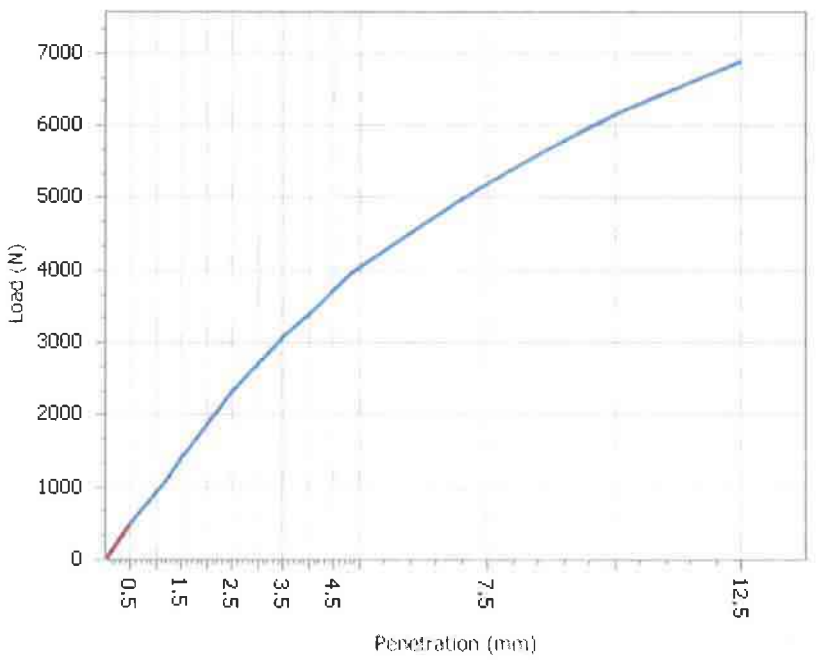
CALIFORNIA BEARING RATIO REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10595-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 4 of 4

Test Procedures	AS1289.6.1.1, AS1289.5.1.1, AS1289.2.1.1		
Sample Number	16822/S/39305	Sample Location	
Sampling Method	Tested As Received	Bore No.	TB13
Date Sampled	10/08/2017	Sample Type	Bulk
Sampled By	Client Sampled	Sample Depth m	0.4-0.7
Date Tested	4/09/2017		
Material Source	-	Material Limit Start	-
Material Type	-	Material Limit End	-
Client Reference	-	Compactive Effort	Standard
Material Description	Clayey Sandy SILT, brown-grey		

Maximum Dry Density (t/m³):	1.93
Optimum Moisture Content (%):	11.0
Field Moisture Content (%):	6.7
Sample Percent Oversize (%)	2.0
Oversize Included / Excluded	Excluded
Target Density Ratio (%):	100
Target Moisture Ratio (%):	100
Placement Dry Density (t/m³):	1.93
Placement Dry Density Ratio (%):	100.0
Placement Moisture Content (%):	10.9
Placement Moisture Ratio (%):	97.5
Test Condition / Soaking Period:	Soaked / 4 Days
CBR Surcharge (kg)	4.5
Dry Density After Soak (t/m³):	1.92
Total Curing Time (hrs)	n/a
Liquid Limit Method	Estimation
Moisture (top 30mm) After Soak (%)	15.1
Moisture (remainder) After Soak (%)	12.0
CBR Swell (%):	0.0
Minimum CBR Specification (%):	-
CBR Value @ 5.0mm (%):	**20**

CBR PENETRATION PLOT



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ATTERBERG LIMITS REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10687-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 1 of 5

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1		
Sample Number	16822/S/39297	Sample Location	
Sampling Method	Tested As Received	Bore No.	TB03
Date Sampled	10/08/2017	Sample Type	Bulk
Sampled By	Client Sampled	Sample Depth m	0.1-0.3
Date Tested	13/09/2017		
Att. Drying Method	Oven Dried	Material Source	-
Atterberg Preparation	Dry Sieved	Material Type	-
Material Description	Silty Gravelly SAND, brown		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		21	
Plastic Limit (%)		14	
Plasticity Index (%)		7	
Linear Shrinkage (%)			
Linear Shrinkage Defects:			

Remarks	Re-Issued Report Replaces Report No 16822/R/10687-1.

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ATTERBERG LIMITS REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10687-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 2 of 5

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1			
Sample Number	16822/S/39298	Sample Location		
Sampling Method	Tested As Received	Bore No.		TB06
Date Sampled	10/08/2017	Sample Type		Bulk
Sampled By	Client Sampled	Sample Depth	m	0.0-0.2
Date Tested	13/09/2017			
Att. Drying Method	Oven Dried	Material Source	-	
Atterberg Preparation	Dry Sieved	Material Type	-	
Material Description	Silty Gravelly SAND			

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**18**	
Plastic Limit (%)		**15**	
Plasticity Index (%)		**3**	
Linear Shrinkage (%)			
Linear Shrinkage Defects:			

Remarks	Re-Issued Report Replaces Report No 16822/R/10687-1.

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ATTERBERG LIMITS REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10687-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 3 of 5

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1

Sample Number	16822/S/39301		Sample Location	
Sampling Method	Tested As Received	Bore No.		TB09
Date Sampled	10/08/2017	Sample Type		Bulk
Sampled By	Client Sampled	Sample Depth	m	0.0-0.3
Date Tested	13/09/2017			
Att. Drying Method	Oven Dried	Material Source	-	
Atterberg Preparation	Dry Sieved	Material Type	-	
Material Description	Silty Gravelly SAND, brown			

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		**21**	
Plastic Limit (%)		**15**	
Plasticity Index (%)		**6**	
Linear Shrinkage (%)			
Linear Shrinkage Defects:			

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ATTERBERG LIMITS REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10687-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 4 of 5

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1		
Sample Number	16822/S/39302	Sample Location	
Sampling Method	Tested As Received	Bore No.	TB12
Date Sampled	10/08/2017	Sample Type	Bulk
Sampled By	Client Sampled	Sample Depth m	0.1-0.4
Date Tested	13/09/2017		
Att. Drying Method	Oven Dried	Material Source -	
Atterberg Preparation	Dry Sieved	Material Type -	
Material Description	Silty Sandy GRAVEL		

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		22	
Plastic Limit (%)		14	
Plasticity Index (%)		8	
Linear Shrinkage (%)			
Linear Shrinkage Defects:			

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ATTERBERG LIMITS REPORT

Client:	Cardno (NSW/ACT) Pty Ltd	Report Number:	16822/R/10687-2
Client Address:	1/10 Denney Street, Broadmeadow	Project Number:	16822/P/77
Project:	East Seaham Rd Stage 5, Pavement Investigation	Lot Number:	
Location:	1/10 Denney Street Broadmeadow	Internal Test Request:	16822/T/8403
Component:		Client Reference/s:	82218013
Area Description:		Report Date / Page:	15/09/2017 Page 5 of 5

Test Procedures:	AS1289.3.1.2, AS 1289.3.3.1, AS1289.3.2.1, AS1289.2.1.1			
Sample Number	16822/S/39303	Sample Location		
Sampling Method	Tested As Received	Bore No.		TB15
Date Sampled	10/08/2017	Sample Type		Bulk
Sampled By	Client Sampled	Sample Depth	m	0.1-0.3
Date Tested	13/09/2017			
Att. Drying Method	Oven Dried	Material Source	-	
Atterberg Preparation	Dry Sieved	Material Type	-	
Material Description	Silty Gravelly SAND, brown			

Atterberg Limits Results

Atterberg Limit	Specification Minimum	Test Result	Specification Maximum
Liquid Limit (%)		22	
Plastic Limit (%)		14	
Plasticity Index (%)		8	
Linear Shrinkage (%)			
Linear Shrinkage Defects:			

Remarks	Re-Issued Report Replaces Report No 16822/R/10687-1.

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East Seaham Road, Stage 5
East Seaham

APPENDIX

D

DESIGN TRAFFIC CALCULATION

Cardno
Shaping the Future

Design Traffic Calculation

Client: Port Stephens Council
Project Reference: 82218013
Project Name: East Seaham Road
Road Section: Stage 5
Location: East Seaham

Traffic Information	
Annual Average Daily Traffic (AADT)	561 vehicles/day
Direction Factor	0.5
Percentage Heavy Vehicles	11.0 %
Lane Distribution Factor	1.00
Traffic Loading	
Number of Axle Groups per Heavy Vehicle (N_{HVAG})	2.5
Traffic Load Distribution	AGPT02-12 Example TLD
Design Life	
Design Period	30 years
Heavy Vehicle Growth Rate	2.0% p.a.

Design Traffic	
Cumulative Heavy Vehicle Axle Groups (HVAG)	**1.14E+06**
Average number of ESA per Heavy Vehicle Axle Group (ESA/HVAG)	0.70
Design number of Equivalent Standard Axles (DESA)	**8.00E+05**
Standard Axle Repetitions per ESA for damage type k (SARk/ESA)	
Fatigue of asphalt: SAR_a/ESA	1.1
Rutting and shape loss (subgrade strain): SAR_s/ESA	1.6
Fatigue of cemented materials: SAR_c/ESA	12
Design number of Standard Axle Repetitions for damage type k (DSARk)	
Fatigue of asphalt: $DSAR_a$	8.80E+05
Rutting and shape loss (subgrade strain): $DSAR_s$	1.28E+06
Fatigue of cemented materials: $DSAR_c$	9.60E+06

Calculated by: IG
Checked by: DGS
Date: 16/5/2017