Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Development
The Landing Precinct
Lots 2 and 3 Great Northern Highway, Port Hedland

Prepared for
Port Village Accommodation Pty Ltd

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Report on Geotechnical Investigation
The Landing Resort Precinct
Lots 2 and 3 Great Northern Highway, Port Hedland

1. Introduction

This report presents the results of a geotechnical investigation undertaken at the proposed Landing Resort Precinct in Port Hedland, WA. The investigation was commissioned in an email dated 29 November 2012, from Mr Robin Cornish of Port Village Accommodation Pty Ltd and was undertaken in accordance with Douglas Partners' revised proposal dated 23 November 2011.

The purpose of the geotechnical investigation is to assess the subsurface conditions beneath the site and thus:

- Identify any areas of uncontrolled fill, if encountered.
- Provide the appropriate classification in accordance with the requirements of AS 2870-2011.
- Provide the appropriate earthquake design factor for the site, in accordance with AS 1170.4.
- Comment on the possible presence of collapsible soils and provide recommendations on procedures to address the issue.
- Provide parameters for retaining wall design calculations.
- Suggest appropriate foundation system(s) for the proposed structure.
- Suggest foundation design parameters including allowable bearing pressures for pad and strip footings.
- Estimate short and long-term settlements associated with the recommended foundation system.
- Provide geotechnical parameters for pile design in accordance with AS2159 (by others) and grouted ground anchors.
- Provide recommendations on site preparation and earthworks, including reuse of existing spoil as fill, specification for any imported fill, protection of footing excavation and compaction control.
- Provide recommendations on the methodology for the preparation and infill of existing basins on site.
- Provide comments on the suitability of locally sourced quarry material for pavement construction.
- Provide recommendations in relation to the founding internal slab panels and external pavements, including indicative external pavement CBR.
- Assess the groundwater level beneath the site at the time of investigation, if encountered.
- Comment on the in-situ soil permeability and potential for stormwater disposal by soak wells or drainage basin.

The investigation included thirteen static cone penetration tests (CPT), the excavation of ten test pits, the drilling of thirteen boreholes, three in-situ permeability tests and laboratory testing of selected

samples. The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

2. Site Description

The site comprises an irregular shaped area of approximately 3.7 hectares and is identified as Lots 2 and 3 Great Northern Highway in Port Hedland, WA. The site lies opposite Port Hedland International Airport. It is bounded by Great Northern Highway to the west, vacant bushland to the north and east and a hotel establishment to the south (Refer to Drawing 1, Appendix A).

At the time of the field work, the western part of the site consisted of the existing Landing Resort and caravan park. A BP service station is adjacent to the Great Northern Highway at the southern end of the site. The eastern section of the site is generally vacant, with some sea containers in use for the construction of a shed. A creek lines the northern boundary of the site. Low grasses are present to the east of this creek. Heavy rains, prior to the investigation left the area behind the BP petrol station and in front of the caravan park with approximately 200 mm of surface water.

Surficial soils, where exposed, comprise brown and red-brown sand. The ground surface level across the site is generally flat, although dipping slightly to the south-east, with levels of approximately RL 10.0 m (AHD) in the north-west falling to RL 8.0 m in the south-east.

The Port Hedland 1:50 000 Environmental Geology sheet indicate that shallow sub-surface conditions beneath the site comprise silty sand (locally known as Pindan Sand). Pindan Sands are known to possibly exhibit collapse potential. Collapse occurs when weakly cemented material undergoes large settlements upon wetting and loading.

3. Field Work Methods

Field work was carried out between 16 and 20 January 2012 and comprised thirteen static cone penetration tests (CPT), the excavation of ten test pits, the drilling of thirteen boreholes and three in-situ permeability tests.

The proposed test locations were scanned for underground services, using an accredited service locator, prior to commencing the field work.

The CPTs (CPT1 to CPT13) were carried out by using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 20 mm/sec into the soil by hydraulic thrust from a ballasted truck mounted rig. Strain gauges in the cone and sleeve measure resistance to penetration and friction along the sleeve. This data is recorded on a computer and analysed to allow the assessment of the type, properties and condition of the materials penetrated. The CPTs were pushed to depths of between 4.9 m and 7.3 m. Upon withdrawing the CPT probe, each location was dipped to measure groundwater levels.

The test pits (TP14 to TP23) were excavated to depth of between 2.5 m and 3.0 m, using a 4.5 tonne Kubota excavator, equipped with a 450 mm wide toothed bucket. Boreholes BH26 to BH28 and BH30

to BH35 were drilled using a 300 mm power auger mounted on the excavator. Boreholes BH24, BH25, BH29 and BH36 were drilled using a 110 mm hand auger.

The test pit and borehole were logged in general accordance with test procedure AS 1726–1993 by a suitably experienced representative from DP. Representative soil samples were recovered from selected locations for subsequent laboratory testing.

Dynamic cone penetrometer (DCP) tests were carried, adjacent to the boreholes and test pits, in accordance with AS 1289.6.3.2 to assess the density of the shallow soils.

Three permeability tests were carried out using the falling head method at a depth of 0.8 m at BH24, BH25 and BH28.

Test locations were positioned using a hand held GPS and chaining from existing site features and are shown on Drawing 1. Surface elevations at each test location were interpolated from a survey provided by the client and are quoted in metres above Australian Height Datum (AHD).

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions, inferred soil behaviour at the CPT locations and results of the field testing are presented in Appendix A. together with the notes defining descriptive terms and classification methods of the ground conditions.

A summary of the ground conditions is given below:

- **Asphalt and Basecourse (Gravelly Sand)** – 10 mm to 30 mm thick dark grey bituminous seal overlying sandy gravelly basecourse to depths of between 0.15 m and 0.20 m at TP15, BH26 and BH32 to BH35
- **Filling (Sand)** – loose to medium dense, red-brown sand filling to depths of between 0.15 m and 0.5 m at TP14 to TP17, TP20, BH29, BH31 and BH36.
- **Sand/Clayey Sand**– generally medium dense to dense, red-brown sand/clayey sand. The clayey content increases with depth.
- **Sandy Clay** – hard sandy clay from a depth generally ranging between 4.0 m and 4.7 m (2.4 m at CPT11) and extending to CPT termination depths of between 4.9 m and 7.3 m. CPT hydraulic refusal was experienced in the sandy clay. The depths below existing surface level and relative levels to the top of hard sandy clay layer are summarised in Table 1 (following page).

An exception to this profile was observed at TP21, where uncontrolled filling was encountered to a depth of 1.6 m, overlying clayey sand. The approximate extent of the uncontrolled filling material was assessed from visual observation and is shown on Drawing 1 in Appendix A. This should be verified by additional investigation if the extent of filling is critical to geotechnical design or project finance.

Table 1: Summary of Depth to Top of the Hard Sandy Clay Layer

Test Location	Surface Level (m AHD)	Depth to Top of Hard Sandy Clay (m)	Level of Top of Hard Sandy Clay (m AHD)
CPT1	6.5	4.4	2.1
CPT2	6.5	4.5	2.0
CPT3	6.5	4.0	2.5
CPT4	6.5	4.4	2.1
CPT5	6.5	4.0	2.5
CPT6	6.2	4.7	1.5
CPT7	6.4	4.2	2.2
CPT8	6.5	4.4	2.1
CPT9	5.1	4.0	1.1
CPT10	5.8	4.2	1.6
CPT11	5.5	2.4	3.1
CPT12	5.5	4.0	1.5
CPT13	5.1	4.0	1.1

Notes: Surface level interpolated from survey provided by client.
Interpolated Level = interpolated surface level – depth to hard sandy clay layer.

4.2 Groundwater

Perched groundwater was observed at several test locations drilled and excavated between 16 January 2012 and 19 January 2012. The CPT holes, the tests pits and the boreholes were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

Note that the fieldwork was undertaken within one week following a cyclonic event, and thus the observed perched groundwater is likely to be a result of recent heavy rainfall.

A summary of the depths to groundwater observed during the field investigation is presented in Table 2 (following page).

Table 2: Summary of Groundwater Depths and Levels

Test Location	Surface Level (m AHD)	Groundwater Depth (m)	Groundwater Level (m AHD)
CPT1	6.5	1.5	5.0
CPT2	6.5	1.5	5.0
CPT3	6.5	Deeper than 0.5 m	Lower than 6.0
CPT4	6.5	1.5	5.0
CPT5	6.5	Deeper than 0.5 m	Lower than 6.0
CPT6	6.2	0.5	5.7
CPT7	6.4	0.7	5.7
CPT8	6.5	Deeper than 0.6 m	Lower than 5.9
CPT9	5.1	0.2	4.9
CPT10	5.8	Deeper than 0.5 m	Lower than 5.3
CPT11	5.5	Deeper than 0.8 m	Lower than 4.7
CPT12	5.5	Deeper than 1.0 m	Lower than 4.5
CPT13	5.1	2.5	2.6
TP14	6.5	1.8	4.7
TP15	6.4	1.1	5.3
TP16	6.5	1.5	5.0
TP17	6.2	0.6	5.6
TP18	5.9	1.1	4.8
TP19	5.4	1.3	4.1
TP20	5.6	1.3	4.3
TP21	5.8	1.3	4.5
TP22	5.5	1.1	4.4
TP23	5.4	1.5	3.9
BH24	6.4	0.6	5.8
BH25	6.0	-	-
BH26	6.7	-	-
BH27	6.5	-	-
BH28	6.5	1.8	4.7
BH29	6.1	0.5	5.6
BH30	6.5	1.4	5.1
BH31	6.4	1.4	5.0
BH32	6.1	1.4	4.7
BH33	6.0	1.4	4.6
BH34	6.0	1.4	4.6
BH35	6.1	1.5	4.6
BH36	6.0	0.6	5.4

4.3 Permeability Analysis

Three in-situ permeability tests using the falling head method were carried out at depth of 0.8 m at BH24, BH25 and BH28. A field permeability value was estimated using the Hvorslev method (1951). The results of the permeability analysis are summarised in Table 3.

Table 3: Summary of the In-Situ Permeability Testing

Test	Depth (m)	Measured Permeability (m/s)	Material
BH24	0.8	1.6×10^{-6}	Sand – some fines
BH25	0.8	1.3×10^{-6}	Sand – slightly clayey
BH28	0.8	5.9×10^{-6}	Sand – some fines

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory on selected samples recovered from the test pits and comprised the determination of:

- The particle size distribution of fourteen samples.
- The Atterberg limits and linear shrinkage of nine samples.
- The Modified maximum dry density (MMDD) and California bearing ratio (CBR) of four samples.
- Double oedometer tests of six samples to assess the collapse potential.

The detailed test report sheets are given in Appendix B and the results are summarised in Tables 4, 5 and 6.

The CBR tests were undertaken at a target compaction level of 95% of modified maximum dry density. The sample was tested after soaking for four days with a confining surcharge of 4.5 kg.

Table 4: Results of Laboratory Testing for Pavement Parameters

Pit	Depth (m)	MMDD (t/m^3)	CBR (%)	OMC (%)	Material
TP20	0.5	2.00	5	10	Clayey Sand
BH27	0.3	1.97	50	8.0	Sand
BH28	0.3	1.96	40	8.0	Sand
BH34	0.4	1.86	25	8.0	Sand

Notes:

- MMDD: modified maximum dry density.
- CBR: California bearing ratio.
- OMC: optimum moisture content.

Table 5: Results of Laboratory Testing for Soil Identification

Pit	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI	LS (%)	Material
TP14	2.5	30	<0.0135	0.33	35	12	23	7.5	Clayey Sand
TP15	1.8	26	<0.0135	0.59	-	-	-	-	Sand - slightly clayey and gravelly
TP15	2.5	23	<0.0135	0.425	-	-	-	-	Clayey Sand - slightly clayey
TP17	1.3	35	<0.0135	0.59	32	11	21	7.5	Clayey Sand
TP17	2.4	30	<0.0135	0.425	38	14	24	9.5	Clayey Sand
TP19	1.2	26	<0.0135	0.36	28	10	18	5.5	Clayey Sand
TP19	2.3	30	<0.0135	0.36	33	11	22	7.5	Clayey Sand
TP20	0.5	28	<0.0135	0.34	39	13	26	6.5	Clayey Sand
TP22	0.9	23	<0.0135	0.39	25	11	14	4.0	Sand - slightly clayey
BH24	0.8	12	0.045	0.40	-	-	-	-	Sand
BH25	0.8	24	<0.0135	0.39	-	-	-	-	Sand - slightly clayey
BH27	0.3	14	0.028	0.40	-	-	-	-	Sand
BH29	0.8	23	<0.0135	0.36	-	-	-	-	Sand - slightly clayey
BH29	1.4	25	<0.0135	0.38	32	12	20	5.5	Sand - slightly clayey
BH36	0.9	-	-	-	36	12	24	7.0	Clayey Sand

Notes:
- The % fines is the amount of particles smaller than 75 µm.
- A d_{10} of 0.17 mm means that 10% of the sample particles are finer than 0.17 mm.
- A d_{60} of 0.23 mm means that 60% of the sample particles are finer than 0.23 mm.
- LL: liquid limit.
- PL: plastic limit.
- PI: plasticity Index.
- LS: linear shrinkage.
- '-' means 'Not Tested'.

The collapse potential was assessed using the method detailed in J.E. Jennings and K. Knight, 1975. An undisturbed soil sample was divided into two sub-samples and placed in oedometers. One sample was placed at field moisture content and the other was soaked prior to placing. Normal consolidation tests were conducted on each sample and settlement results were compared. Test certificates are given in Appendix B and results are presented in Table 6 (following page) and discussed in Section 7.1.

Table 6: Results of Laboratory Testing for Soil Collapse Potential

Pit	Depth (m)	Dry Density (t/m^3)	Settlement under a bearing pressure of 50 kPa			Settlement under a bearing pressure of 200 kPa			Material
			NSC (%)	SC (%)	TS (%)	NSC (%)	SC (%)	TS (%)	
TP14	1.9	1.80	-	-	0.80	-	-	2.79	Clayey Sand
TP14	3.0	1.80	-	-	0.59	-	-	2.64	Clayey Sand
TP15	1.7	1.71	0.25	0.20	0.45	1.27	1.48	2.75	Sand - slightly clayey and
TP15	2.7	1.59	0.12	2.26	2.38	1.31	4.05	5.36	Clayey Sand - slightly
TP17	1.2	1.51	-	-	2.01	-	-	6.49	Clayey Sand
TP19	0.8	1.72	-	-	1.03	-	-	3.40	Clayey Sand

Notes:
- NSC: Unit settlement of non-soaked soil (%).
- SC: Additional unit settlement from collapse of soaked soil (%).
- TS: Total unit settlement of soaked soil (%).

6. Proposed Development

It is understood that the proposed development includes the construction of:

- Two five to six-storey hotels;
- A five to six-storey storey commercial centre;
- Two-storey to three-storey units;
- Areas for the relocation of caravans and associated carpark.

The final layout and detailed plans of the proposed structures were not available at time of report writing.

It is understood that 1.9 m square footings, applying a bearing pressure of up to 130 kPa will be adopted for the proposed two and three storey units if a shallow foundation system is suitable.

7. Comments

7.1 Ground Conditions and Collapsing Soils

The results of the investigation indicate that there is little lateral variation in the shallow ground conditions across the site, which generally consist of loose to medium dense red-brown sand and clayey sand to depths of between 4.0 m and 4.7 m (2.4 m at CPT11), overlying sandy clay. The encountered sand and clayey sand are known as Pindan Sand, a geological soil unit found throughout

the north-west of Western Australia and known to have collapse potential. A collapsing soil is a weakly cemented material that is subject to large settlement upon wetting under load. An assessment was undertaken of the shallow soils to determine the potential for soil collapse from the following locations:

- TP15, at 1.7 m depth.
- TP15, at 2.7 m depth.

The results of the assessment indicate that the shallow soils can be classified as 'moderate trouble' when assessed for soil collapse potential using the method suggested by J.E. Jennings and K. Knight, 1975.

To assess the implications of the soil collapse potential on the proposed development the results of the consolidation testing were analysed to estimate likely total settlements for structures with typical footings designed in accordance with AS 2870-2011.

The results of the analysis indicate that the following settlement (elastic settlement and settlement due to soil collapse) of up to 110 mm can be anticipated under a 1.9 m wide square pad footings applying a bearing pressure of 130 kPa if no specific site preparation is undertaken to reduce the impact of collapsing soils.

7.2 Site Classification

The shallow ground conditions beneath the site generally comprise loose to medium dense sand and clayey sand to depth of between 4.0 m and 4.7 m (2.4 m at CPT11) overlying hard sandy clay. Due to the collapsing nature of the soils, the site should be classified as 'P' in accordance with AS 2870-2011.

However, a settlement analysis for the two to three-storey units indicates that provided site preparation is undertaken in accordance with Section 7.5, total settlement of approximately 20 mm is anticipated in the event of soil collapse. The total ground movement of the soil is the results of the ground movement due to clay reactivity and the total settlement due to collapse. It is therefore considered that an equivalent 'Class S' or 'Class M' site could be achieved in accordance with AS 2870-2011 provided that suitable site preparation is undertaken.

It is noted that AS 2870-2011 is applicable to residential structures and other forms of construction including some light industrial, commercial and institutional buildings if they are similar to houses in size, loading and superstructure flexibility. Therefore, this standard does not cover the foundation design of the proposed structures and footings will need to be designed using engineering principles.

7.3 Soil Classification for Earthquake Design

Ground conditions encountered beneath the site generally comprise loose to medium dense sand and clayey sand overlying hard sandy clay. It is therefore suggested that an earthquake design soil sub-class of Ce is appropriate for this site in accordance with AS 1170.4-2007.

7.4 Design Parameters for Earth Retaining Systems

During construction, it is recommended that batter slopes in sand are no steeper than 2:1 (H:V) if not retained. This batter angle is valid provided no load applies at the top of the slope and no groundwater emanates from the face of the excavation and the slope is protected from concentrated run-on of stormwater. Any excavation that is adjacent to buildings and below the level of existing footings should be supported or the footings underpinned to a level below the influence of the excavation.

Design of temporary and permanent retaining structures can be undertaken using the following suggested design parameters, assuming level backfill and adequate drainage:

- Bulk unit weight: 20 kN/m^3 if compacted, 18 kN/m^3 otherwise;
- Angle of internal friction φ:
  - 32 degrees for the surficial sand;
  - 29 degrees for clayey sand after collapse;
  - 34 degrees for the clayey sand in a non collapsed state.
- Coefficient of Active Earth Pressure Ka
  - 0.31 for the surficial sand;
  - 0.35 for clayey sand after collapse;
  - 0.28 for the clayey sand in a non collapsed state.
- Coefficient of Passive Earth Resistance Kp
  - 3.2 in medium dense surficial sand
  - 2.9 for the clayey sand after collapse;
  - 3.5 for the clayey sand in a non collapsed state.

In addition to the soil pressure, wall design should also allow for external loads such as buildings and live loads.

7.5 Site Preparation

7.5.1 Site Stripping

It is recommended that all site works are undertaken under the supervision of an experienced geotechnical engineer. Prior to excavation for foundations and/or placement of filling, all deleterious material, including vegetation, topsoil, existing pavement and the uncontrolled filling encountered at TP21 and anywhere else across the site, should be stripped from within building envelope areas and road reserves and either removed from site or stockpiled for possible re-use for landscaping purposes only. Advice on possible re-use of the uncontrolled filling is detailed in Section 7.5.4.

Tree roots remaining from any clearing operations should be completely removed and the excavation backfilled and suitably compacted.

7.5.2 Inducing Soil Collapse Under Shallow Foundation Levels

As detailed in Section 7.1, collapsing soils occur across the site. These soils could result in unacceptable settlements of the proposed structures founded on shallow footings, if suitable preparation of the foundation material is not undertaken. The aim of the site preparation is to induce potential collapse of soil beneath the foundation level prior to construction in order to decrease the risk of settlement from possible ground collapse.

It is considered that foundation excavations should be over-excavated below foundation level under the area of the building, extending to a distance of at least 1.0 m beyond the building envelope in plan. The base of the excavation should be wetted well above optimum moisture content and compacted to achieve a dry density of not less than 95% of modified maximum dry density to a minimum depth of 1.0 m below the base of the excavation. The excavated soil should be wetted up to about optimum moisture content and replaced in suitably compacted layers back to foundation level. Each layer should have a loose lift thickness of not more than 200 mm and be compacted to achieve dry density of not less than 95% of modified maximum dry density. The depth of over-excavation should be assessed based on foundation loads and geometry. For example, an over-excavation depth of 2.0 m below foundation level was assessed for a 1.9 m pad applying a bearing pressure of 130 kPa and founded at a depth of 0.8 m, in order to achieve a target settlement of 20 mm following possible collapse.

It is anticipated that over-excavation and replacement of soil at this site will result in a decrease in material volume, therefore additional structural filling material may be required to return excavated areas to surrounding ground level.

7.5.3 Reuse of Excavated Material as Fill

The shallow materials, including the red-brown sand and clayey sand, could be used as structural filling provided that they are free from significant organic material, including vegetation and roots.

Sand and clayey sand excavated from the site for reuse as structural filling, should be placed in layers less than 300 mm loose lift thickness, near optimum moisture content and compacted to a dry density of not less than 95% of MMDD.

Excavating and replacing collapsing soils will induce the collapse of the excavated soils. Therefore, a decrease in bulk volume, say between 5% and 10%, should be anticipated during the reworking of collapsing soils.

7.5.4 Re-use of Uncontrolled Filling

As detailed in Section 4.1, uncontrolled filling was encountered within TP21 to a depth of 1.6 m. This filling comprised sand with steel pipe, steel sheeting, insulation pads and pieces of concrete.

It is considered that, from geotechnical considerations, the sand fraction of the filling could be re-used as structural filling provided that it is suitably treated. Such treatment should include excavation and screening in order to remove any deleterious and organic material, and any particles greater than 150 mm in size. It is recommended that the treated material be inspected by a suitably experienced geotechnical engineer prior to its re-use.

It should be noted that this study has not assessed whether unacceptable levels of contaminants exist within the filling material as this was outside the scope of the current investigation. Such levels, if they occur, may limit or prevent the re-use of this material.

7.5.5 Imported Filling

If required, imported filling should comprise free draining cohesionless well graded sand that:

- Contains less than 5% per weight of particles less than 75 microns.
- Contains no particles greater than 150 mm in size.
- Is free of organic and other deleterious materials.

Sand material, as described above, may be of limited availability within Port Hedland but other materials could be suitable following approval by a geotechnical engineer. It should be noted that AS 2870-2011 suggests that sand with a fines content of up to 15% by weight could be used as filling material without impacting site classification. It is recommended that test certificates are reviewed and approved by the geotechnical engineer prior to importing material to site.

7.5.6 Fill Placement and Compaction Testing

The fill should be placed within 2% of its optimum moisture content, in layers not exceeding 250 mm loose thickness and compacted with a roller of 12 tonne minimum deadweight to achieve a dry density ratio of not less than 95% relative to modified compaction. Care should be taken not to run heavy plant immediately adjacent to existing structures and services. It is recommended that earthworks are carried out with regular inspections by a suitably experienced geotechnical engineer.

It is recommended that compaction control be carried out using a nuclear surface moisture-density gauge, in accordance with test method AS 1289.5.8.1.

During construction, some loosening of the base of the foundation excavations in sands is expected. Therefore the top 300 mm in the base of any excavation in sand should be re-compacted using a vibratory plate compactor prior to construction of any footings. Confirmation of adequate compaction of sands could be obtained by carrying out PSP tests as above.

7.5.7 Preparation of Existing Basin

Any soft or organic materials, if encountered within the basin, should be over-excavated. The basin should be backfilled and suitably compacted. It is recommended that sand backfill be placed in loose lift thickness of not more than 300 mm and compacted to achieve a dry density ratio of not less than 95% relative to modified compaction.

7.6 Foundation Design

7.6.1 Two and Three-Storey Residential Units

7.6.1.1 Shallow Footings

The proposed two and three storey units could be supported on strip and pad footings, provided suitable site preparation is undertaken as detailed in Section 7.5. The results of a settlement analysis for 1.9 m square pad footings applying a bearing pressure of 130 kPa are included in Table 7. The table also details the impact of foundation preparation on minimising anticipated settlement.

Table 7: Anticipated settlement beneath pad footings

Pad Footing (1.9 m x 1.9 m x 0.8 m deep) applying a bearing pressure of 130 kPa	Anticipated Settlement (mm)			
	No site preparation	Collapse induced within 0.5 m of foundation level[1]	Collapse induced within 1.5 m of foundation level[2]	Collapse induced within 2.4 m of foundation level[3]
	100-110	85	40	20

Notes to Table 9:

[1] During construction the base of each foundation excavation should be flooded and allowed to drain. The base of the excavation should then be compacted to at least 0.5 m below the foundation level. The use of a vertical rammer is suggested rather than a plate compactor. Over excavation below the base of foundation may possibly be required to achieve suitable compaction to 0.5 m depth. The base of footing excavations should be inspected by an experienced geotechnical engineer.

[2] During bulk earthworks phase of the construction, the area beneath the building envelope should be over excavated to at least 1.0 m below foundation level. The subgrade at the base of the excavation should be flooded and allowed to drain. The base should then be compacted using a heavy vibrating pad foot roller. The excavated material should be wetted to optimum moisture and placed in layers not exceeding 200 mm thickness. Each layer should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. This method is detailed further in Section 7.5.2.

[3] During bulk earthworks phase of the construction, the area beneath the building envelope should be over excavated to 1.9 m below foundation level. The subgrade at the base of the excavation should be flooded and allowed to drain. The base should then be compacted using a heavy vibrating pad foot roller. The excavated material should be wetted to optimum moisture and placed in layers not exceeding 200 mm thickness. Each layer should be compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. This method is detailed further in Section 7.5.2.

Comparison of the anticipated settlements in Table 9 for the assumed loading conditions indicates that the two and three storey buildings could be supported on pad footings at this site, provided that soil collapse is induced, and the density of foundation material is increased to a depth of 2.4 m below foundation level to achieve a target settlement of 20 mm in the event of soil collapse.

In order to further minimise the likelihood of soil collapse affecting the proposed structures, the following provisions should also be considered:

- Grading of the site surface away for any structures.
- Waterproofing the soil surface within 1 m of building envelopes.
- Drainage of air conditioning condensate away from the edge of buildings.
- Prompt maintenance of leaking pipes.

- The use of flexible pipe connections for water services to all buildings to prevent rupture as a result of differential settlement.

Consideration could also be given to supporting the proposed building on piled foundations founded in the hard sandy clay below the loose collapsing sand.

7.6.1.2 Pile Foundations

It is considered that steel screw piles founded into the hard sandy clay would form a suitable piling system to support the proposed two to three-storey buildings.

Table 8: Pile Design Parameters for Screw Piles

Strata	Level of Strata at Test Locations (m AHD)		Ultimate Base Pressure f_b
	From	To	(kPa)
Sandy Clay - Hard	Between 0.5 and 3.1	<-0.8	3,600

Design ultimate geotechnical strengths for single-helix screw piles, with a ratio between the helix diameter and the shaft diameter of 3 are given Table 9. The analysis was undertaken for two scenarios of pile lengths:

- The helix penetrates the hard sandy clay over a depth greater than four helix diameters; and
- The helix penetrates the hard sandy clay over a depth of less than four helix diameters.

Table 9: Design Ultimate Geotechnical Strength $R_{d,ug}$ for Various Screw Piles Diameter

Screw Pile Diameter (Single Helix)	Design Ultimate Geotechnical Strength - Uplift (kN)		Design Ultimate Geotechnical Strength ($R_{d,ug}$) - Compression (kN)	
	Penetration into hard sandy clay greater than 4 Helix Diameters	Penetration into hard sandy clay of less than 4 Helix Diameter	Penetration into hard sandy clay greater than 4 Helix Diameters	Penetration into hard sandy clay of less than 4 Helix Diameter
0.30 m	130	105	250	165
0.45 m	295	160	570	380
0.60 m	525	189	1000	665

The Piling Code (AS 2159-2009) requires the design action effect (E_d) to be not greater than both the design geotechnical strength ($R_{d,g}$) and the design structural strength. The design geotechnical strength of a pile ($R_{d,g}$) is the ultimate geotechnical strength ($R_{d,ug}$) provided in Table 9 multiplied by the geotechnical strength reduction factor (Φ_g), such that $R_{d,g} = \Phi_g \, . \, R_{d,ug}$.

Selection of the geotechnical strength reduction factor (Φ_g) in accordance with AS2159-2009 Table 4.3.2(A) is based upon a series of individual risk ratings (IRR) and the final value of Φ_g depends on the following factors:

- **Site:** the type, quantity and quality of geotechnical testing.
- **Design:** design methods and parameter selection.
- **Installation:** construction control and monitoring.
- **Pile testing regime:** testing benefit factor based on percentage of piles tested and the type of testing. Some increase in the value of Φ_g may be possible depending on the type and extent of the testing. It is noted that Table 8.2.4(B) of AS 2159-2009 requires that 5% to 15% of piles should be subject to integrity testing if the value of Φ_g adopted by the structural designer exceeds 0.4.
- **Redundancy:** whether other piles can take up load if a given pile settles or fails.

Of the above factors, Douglas Partners can only comment directly upon site factors relating to the site. The structural designer must determine the remaining individual risk factors with knowledge of the pile construction specification that will be applied to the construction contract. Table 10 presents the assessed individual AS2159-2009 risk factors assigned by Douglas Partners to site conditions at the site. The other risk factors should be assessed by the structural engineer in order to derive a suitable Φ_g for the project.

Table 10: Individual Assigned Risk Factors – Site Conditions

Risk Factor	Typical description of risk circumstances for individual risk rating			Assigned Risk Factor
	1 (Very low risk)	3 (Moderate risk)	5 (Very high risk	
Geological complexity of site	Horizontal strata, well-defined soil and rock characteristics	Some variability over site, but without abrupt changes in stratigraphy	Highly variable profile or presence of karstic features or steeply dipping rock levels or faults present on site, or combinations of these.	2
Extent of ground investigation	Extensive drilling investigation covering whole site to an adequate depth	Some boreholes extending at least five pile diameters below the base of the proposed foundation level	Very limited investigation with few shallow boreholes	4

Amount and quality of geotechnical data	Detailed information on strength and compressibility of the main strata	CPT probes over full depth of proposed piles or boreholes confirming rock at proposed founding level for piles	Limited amount of simple in-situ testing (eg SPT) or index tests only	3

7.6.2 Multi-Storey Hotel Hotels and Commercial Centre

Shallow foundation systems comprising slab, pad or strip footings are not suitable owing to the anticipated loading and ground conditions that would result in excessive bearing pressures and settlements for the proposed structures.

It is considered that continuous flight auger (CFA) concrete piles, driven steel piles, driven pre-cast concrete piles founded into the hard sandy clay would form suitable piling systems to support the proposed multi-storey hotels and commercial centre.

The parameters given in Table 11 are suggested for the assessment of the ultimate geotechnical strength for piles in compression founded into the hard sandy clay.

Table 11: Pile Design Parameters

Strata	Level of Strata at Test Locations (m AHD)		CFA		Driven Steel Pile		Driven Pre-cast Concrete Pile	
	From	To	$f_{m,s}$ (kPa)	f_b (kPa)	$f_{m,s}$ (kPa)	f_b (kPa)	$f_{m,s}$ (kPa)	f_b (kPa)
Sand/Clayey Sand Loose to Medium Dense	Surface	Between 0.5 and 3.1	10	N/A	10	NA	15	NA
Sandy Clay Hard	Between 0.5 and 3.1	<-0.8	40	3600	80	6300	80	6300

Notes to Table 11:

$f_{m,s}$: average skin friction

f_b: ultimate base pressure

It is suggest that a reduction factor of 0.75 be applied to calculate the shaft tension load in uplift in the sand/clayey sand.

It is emphasised that the pile capacities derived from the skin friction and base pressure values given in this section are the design ultimate geotechnical strength $R_{d,ug}$ and should be multiplied by the geotechnical strength reduction factor ϕ_g as detailed in Section 7.6.2 in order to obtain the design geotechnical strengths $R_{d,g}$.

CFA piling method is referred to as a non-displacement, or replacement piling technique, that involves removing the column of soil down to the nominated founding level and replacing it with reinforced concrete. Thus, it should be noted that CFA piling will produce spoil that should be handled and suitably disposed of. It is recommended that only skilled piling contractors with demonstrated experience in successfully constructing CFA piles in similar conditions be considered for this contract.

7.6.3 Basement Level

Should a basement level of at least 4 m be proposed under the proposed multi-storey hotel, then shallow foundation systems comprising pad and strip footings founded on the hard sandy clay may be suitable to support the proposed structure. Column loads were not available at the time of writing the report.

A settlement analysis was undertaken for various pad and strip footing dimensions founded at a depth of 1.0 m below basement level (or approximately 5 m below ground level). The results of the analysis are presented in Table 12 (following page).

Table 12: Recommended Bearing Pressures for the Multi-Storey Hotel Building with Basement

Pad and Strip Footing Dimension	Maximum Net Allowable Bearing Pressure (kPa)	Estimated Settlement (mm)
2.5 m x 2.5 m	380	5 – 10
3.0 m x 3.0 m	350	5 – 10
3.5 m x 3.5 m	330	5 – 10
Strip - 2.0 m wide	350	5 – 10

These bearing pressures assume that site preparation and testing is undertaken in accordance with Section 7.5. In particular, it has been assumed that suitable compaction as described in Section 7.5 will be achieved to a depth of 0.5 m below base of the footings. Differential settlements after construction are estimated to be less than about 5 mm.

To avoid post construction swelling and shrinking, it is recommended that no excessive drying and wetting of the exposed clayey materials be allowed. Excessive wetting of the base of the foundation excavations could also lead to softening of the foundation materials. Drying could be avoided by minimising the amount of time during which the base of the excavation is exposed.

It is recommended that further analyses of anticipated settlements are undertaken following the finalisation of loading conditions and foundation layout.

7.7 Passive Anchors Design

If ground anchors are selected as the anchoring system to resist uplift pressures, then a provisional ultimate bond stress in the loose to medium dense sand/clayey sand of 11d kPa is suggested for a type B anchor as set out from BS 8081, where d is the depth below ground level to centre of bond length. It should be noted that bond stresses are highly dependant on drilling technique.

Advice should be sought from specialist contractors regarding the performance of their own proprietary brands and with reference to the results of anchor testing at the site.

As an alternative to the ground anchors, mass concrete anchor blocks to provide uplift capacity, may be considered provided that such practice are acceptable by the local authority.

7.8 Pavement

7.8.1 Pavement Design Parameters

As noted in Section 4.1 the shallow soils across the site comprise sand with some silt and clayey sand sand. This material may constitute the subgrade for the proposed pavements across the site.

Laboratory testing results detailed in Section 5 indicate CBR values between 5% and 50% for 4-day soaked samples compacted to achieve a dry density ratio of not less than 95% relative to modified compaction and tested under a confining surcharge of 4.5 kg. Based on observations made in the field and a review of the available laboratory testing results, a subgrade CBR design value of 5% and 10% are suggested for the design of pavement on the clayey sand and sand material respectively, provided the subgrade is prepared in accordance with Section 7.3, compacted to achieve a dry density ratio of not less than 95% relative to modified compaction and suitably drained.

Pavement edge wear is significant for pavements constructed on Pindan sand and thus an increase in seal width (minimum of 0.5 m on each side) is recommended if Pindan sand forms the filling material. Also, particular attention should be taken to minimise the risk of scouring for embankments made of Pindan sand and suitable erosion provisions should be taken, in particular if high embankments are proposed.

It is also recommended that adequate surface and subsoil drainage be implemented in order to avoid saturation of the subgrade that could lead to soil collapse and to avoid water ingress into the proposed pavement that could lead to premature pavement failure.

7.8.2 Locally Sourced Roadbase Material

It is recommended that the basecourse comprises a crushed rock or laterite provided site preparation is undertaken as detailed in Section 7.8.1

Suitable basecourse and subbase material for the construction of the internal roads and carpark could be provided by Boral in the Port Hedland area. Also, Hanson and Holcim, both based in Karratha should be able to deliver suitable material. Regardless, all pavement materials should comply with the requirements of MRWA specifications 501 “Pavements”.

7.9 Site Drainage

Results of the permeability analysis are summarised in Table 3 Section 4.3 and indicate a permeability values in the order of between 1×10^{-6} m/s and 6.0×10^{-6} m/s for the sand and slightly clayey sand encountered beneath the site.

Given the high fines content of the soils at the site, which is generally increasing with depth, it is considered that stormwater disposal via soakwells is unsuitable. Soakwells may also contribute to collapse of soils not subject to site preparation. An alternative method of stormwater disposal, such as directing water to retention basins or similar should be considered. The implementation of a suitable drainage strategy is suggested to control water collecting on the site surface during the high rainfall events which seasonally occur in the Pilbara region.

The typical approach for ensuring amenity of sites such as this in regional areas includes grading of the lots to allow surface water to flow into roadside drains, and on towards a subsequent suitable outflow.

8. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.2-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Dynamic Cone Penetrometer Test.
3. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings.
5. Australian Standard AS 3798-2007, Guidelines on Earthworks for Commercial and Residential Developments.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for a proposed development at The Landing Resort Precinct in Port Hedland, WA in accordance with DP's revised proposal dated 23 November 2011 and acceptance received by email from Robin Cornish of Port Village Accommodation Pty Ltd on 29 November 2011. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Port Village Accommodation Pty Ltd for this project only and for the purposes described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions

between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

Notes Relating to this Report
Test Location Plan
Results of Field Work

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

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.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole 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. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

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. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

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, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

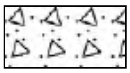
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base

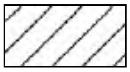

Concrete

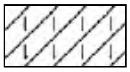

Filling

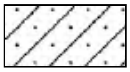
Soils


Topsoil


Peat


Clay

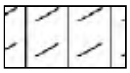

Silty clay

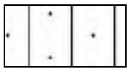

Sandy clay

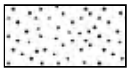

Gravelly clay

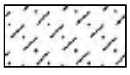

Shaly clay


Silt


Clayey silt


Sandy silt


Sand


Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

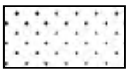

Talus

Sedimentary Rocks


Boulder conglomerate

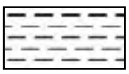

Conglomerate


Conglomeratic sandstone

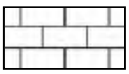

Sandstone


Siltstone

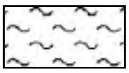

Laminite

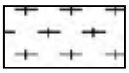

Mudstone, claystone, shale

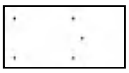

Coal


Limestone

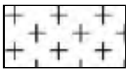
Metamorphic Rocks

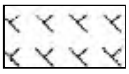

Slate, phyllite, schist

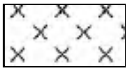

Gneiss

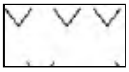

Quartzite

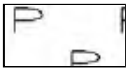
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

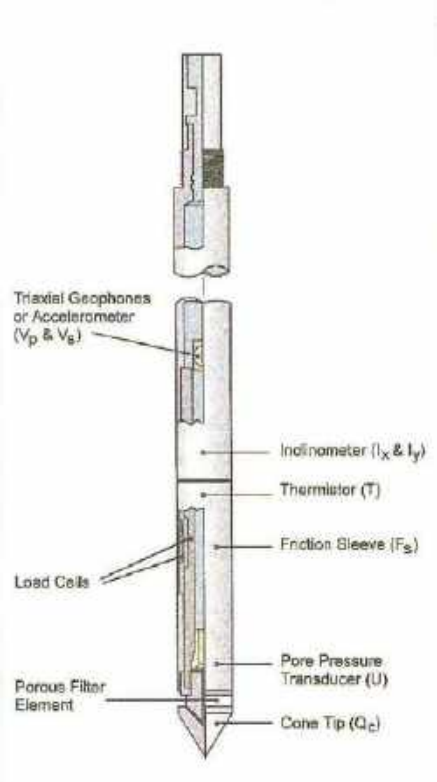


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

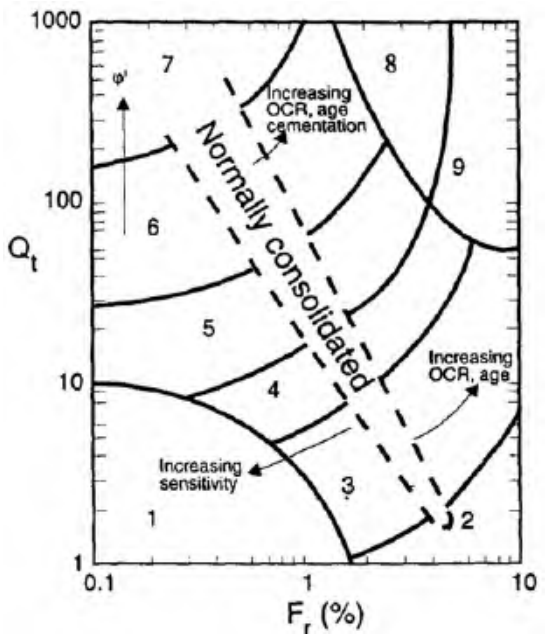


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

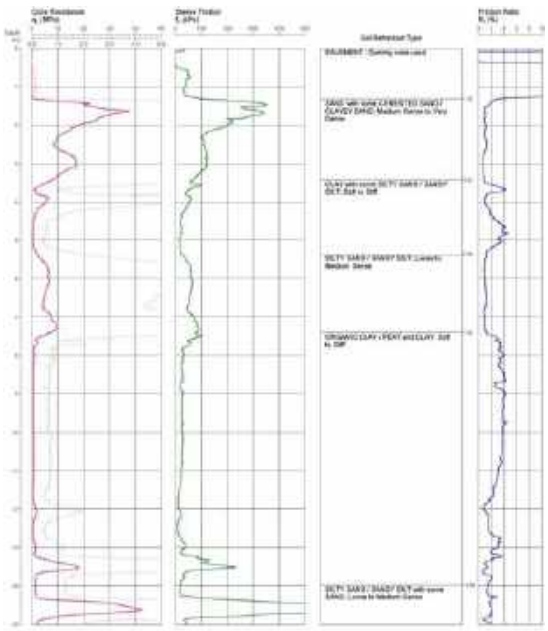


Figure 4: Sample Cone Plot

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil 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.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm 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 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

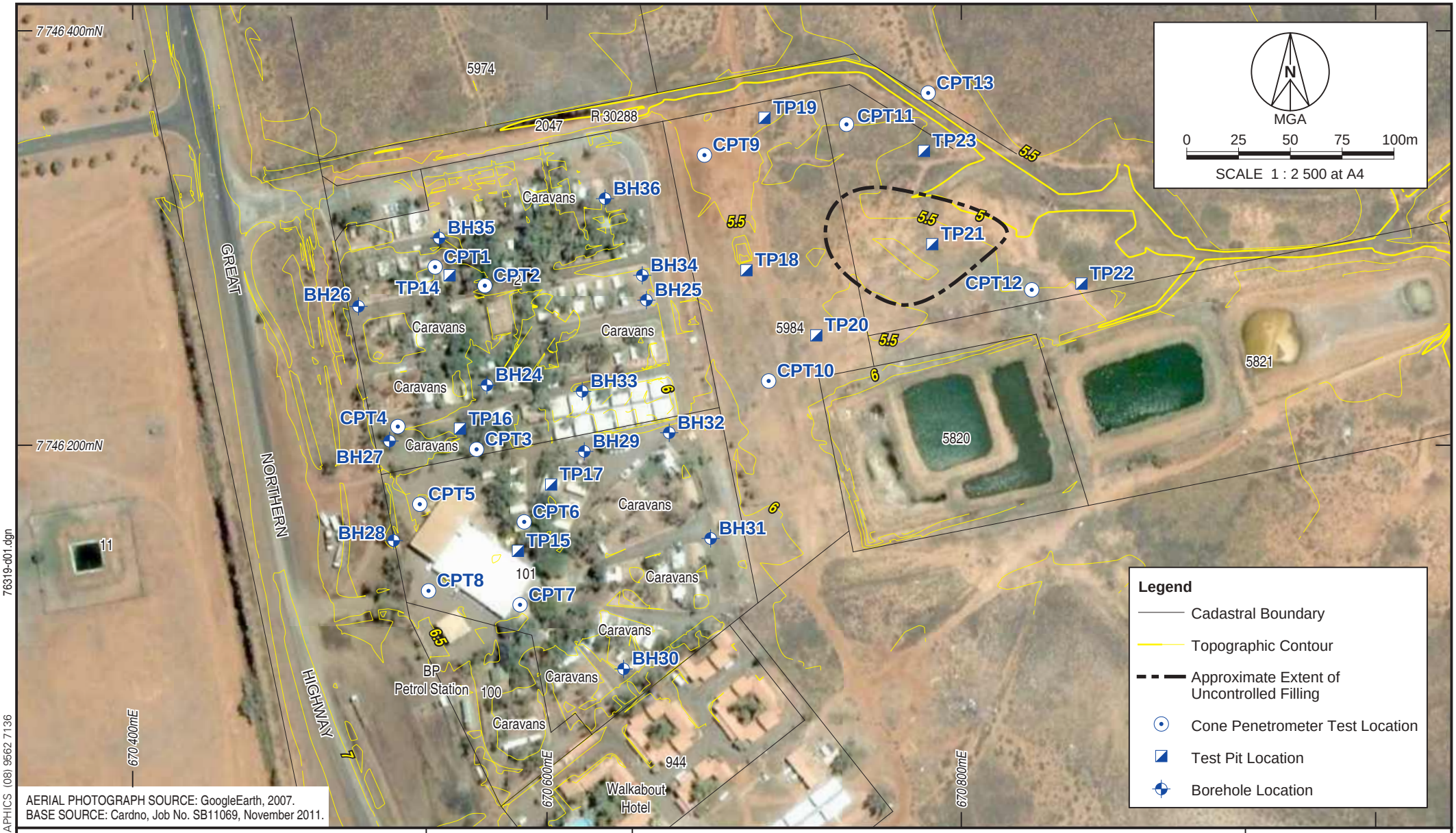
  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.



AERIAL PHOTOGRAPH SOURCE: GoogleEarth, 2007.
BASE SOURCE: Cardno, Job No. SB11069, November 2011.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Port Village Accommodation Pty Ltd	**Location of Tests** **The Landing Resort Precinct** **Port Hedland, WA**	PROJECT No.: 76319
	OFFICE: Perth		DRAWING No.: 1
	DATE: 23 Feb 2012		REVISION: A

PINPOINT CARTOGRAPHICS (08) 9562 7136 76319-d01.dgn

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

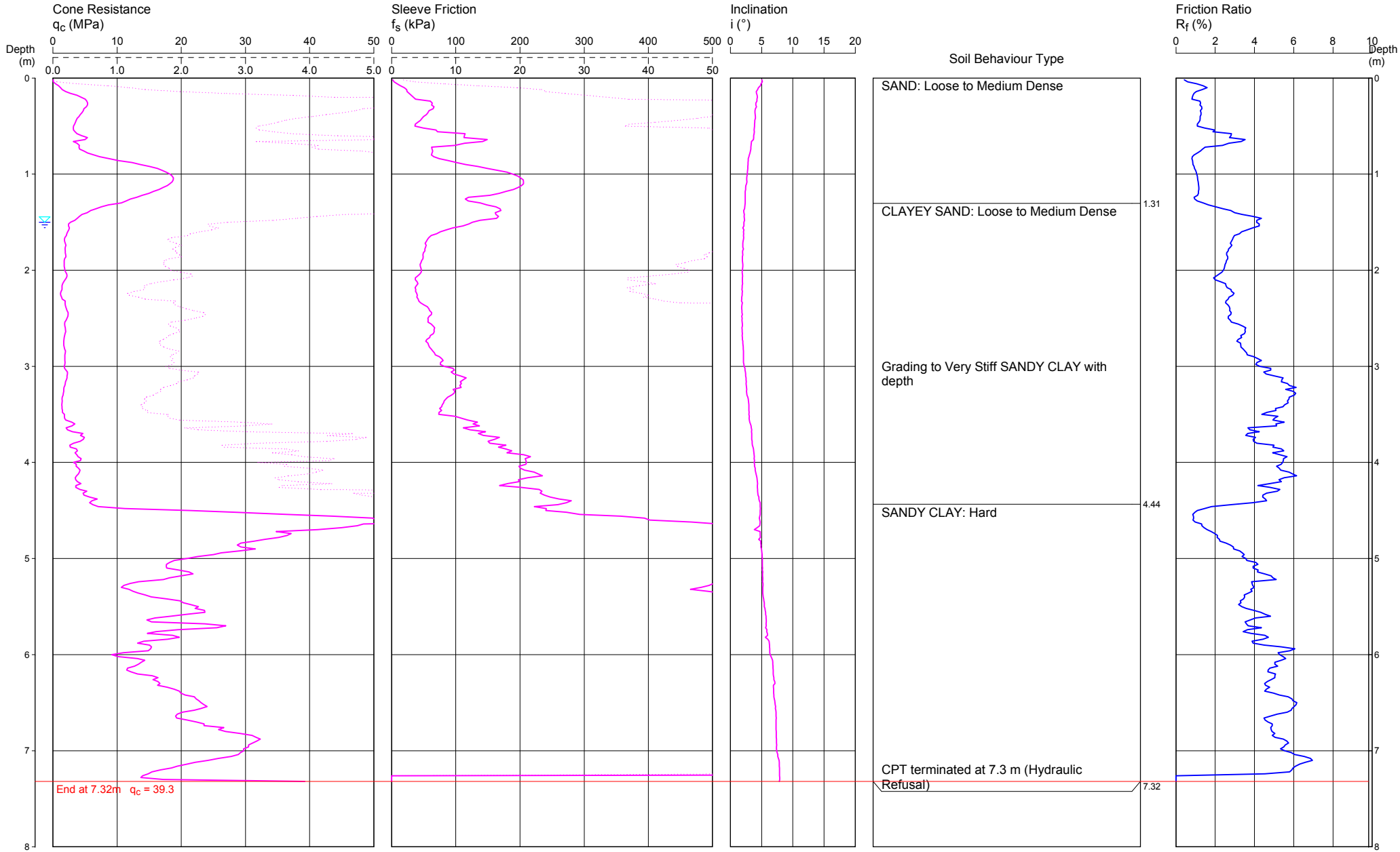
REDUCED LEVEL: 6.5 m AHD*

COORDINATES:

CPT1

DATE 19/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

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Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Water depth after test: 1.50m depth (measured)

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

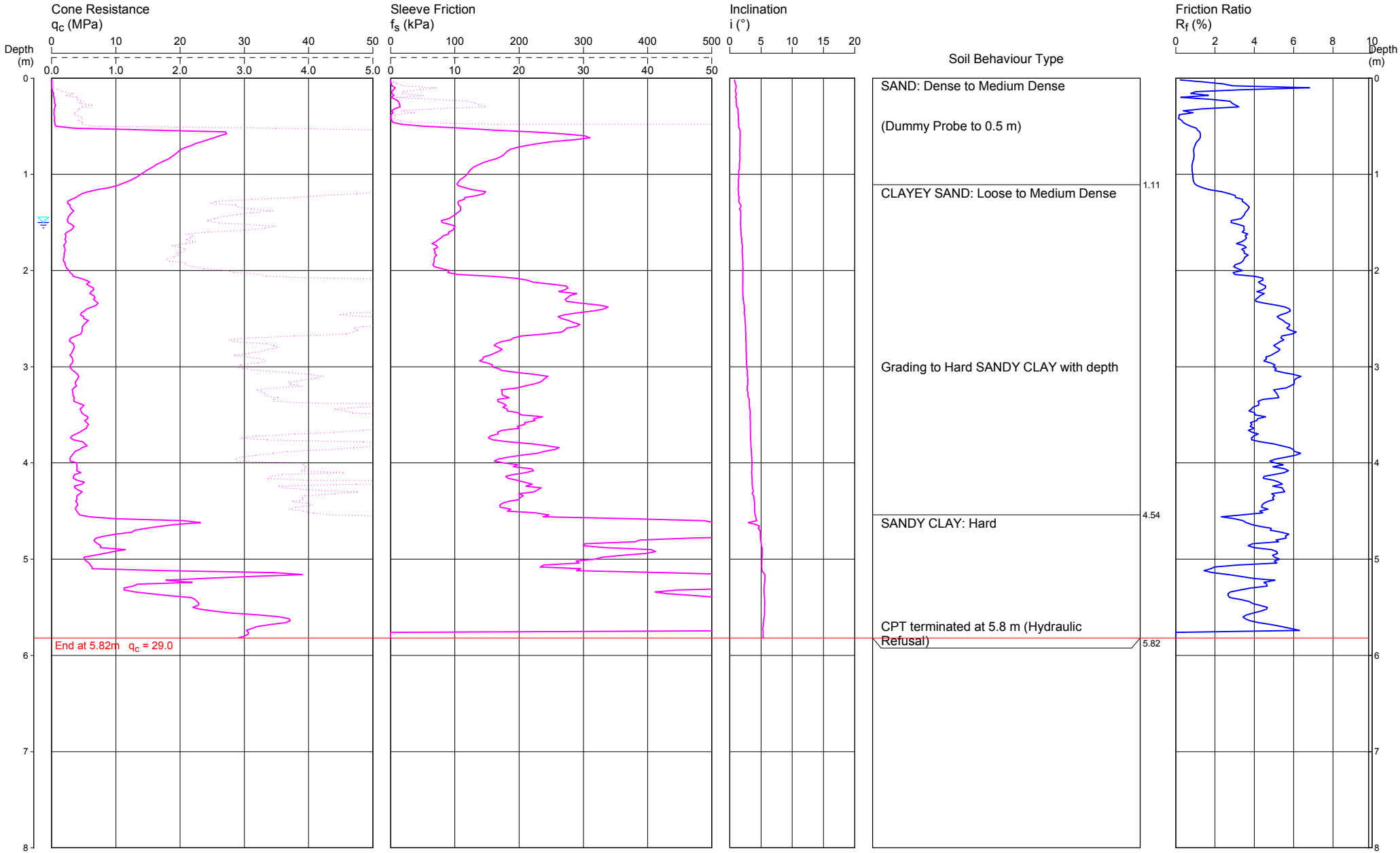
REDUCED LEVEL: 6.5 m AHD*

COORDINATES:

CPT2

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: 1.50m depth (measured)

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Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

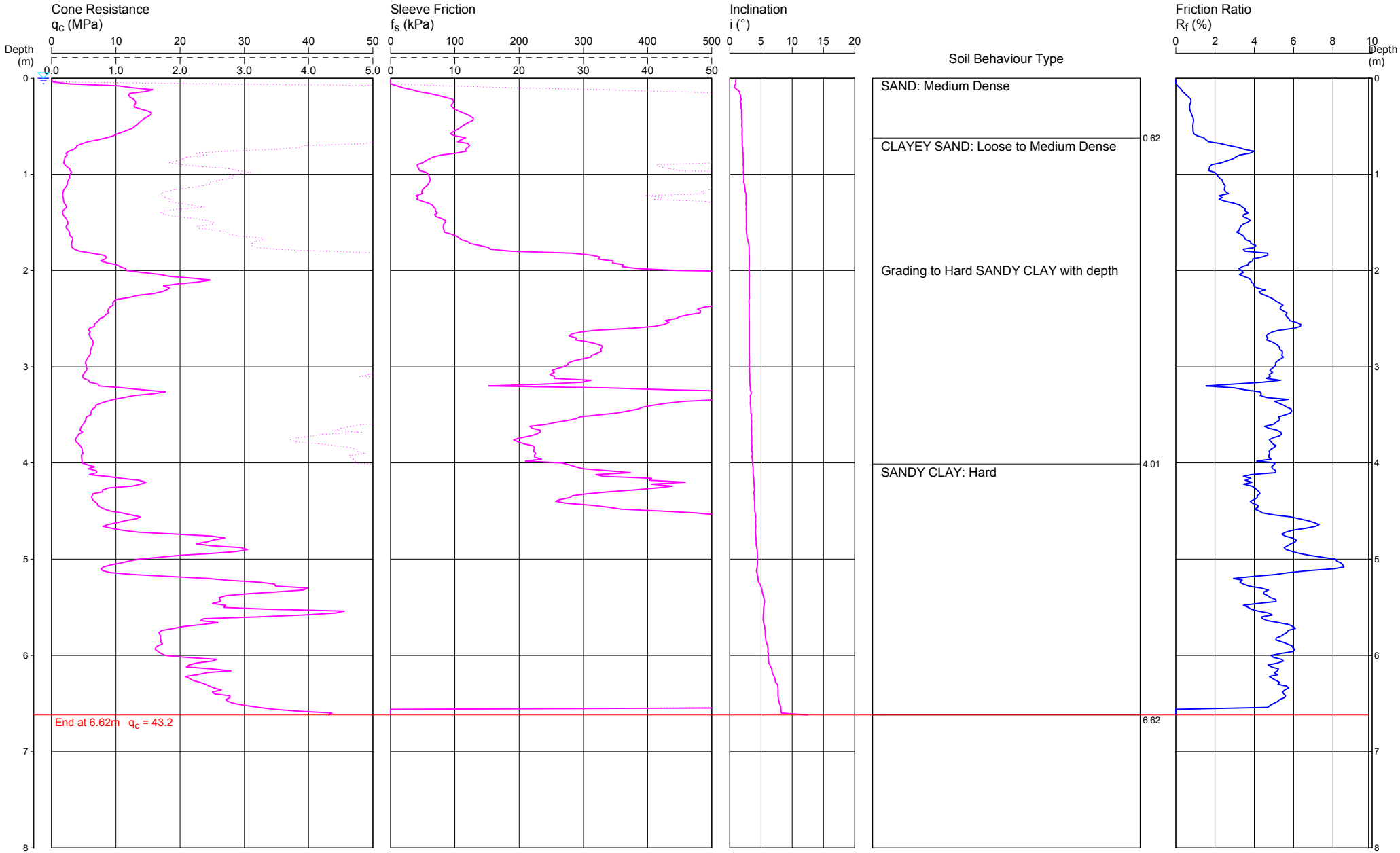
REDUCED LEVEL: 6.5 m AHD*

COORDINATES:

CPT3

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: Dry to 0.5 m

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT3.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

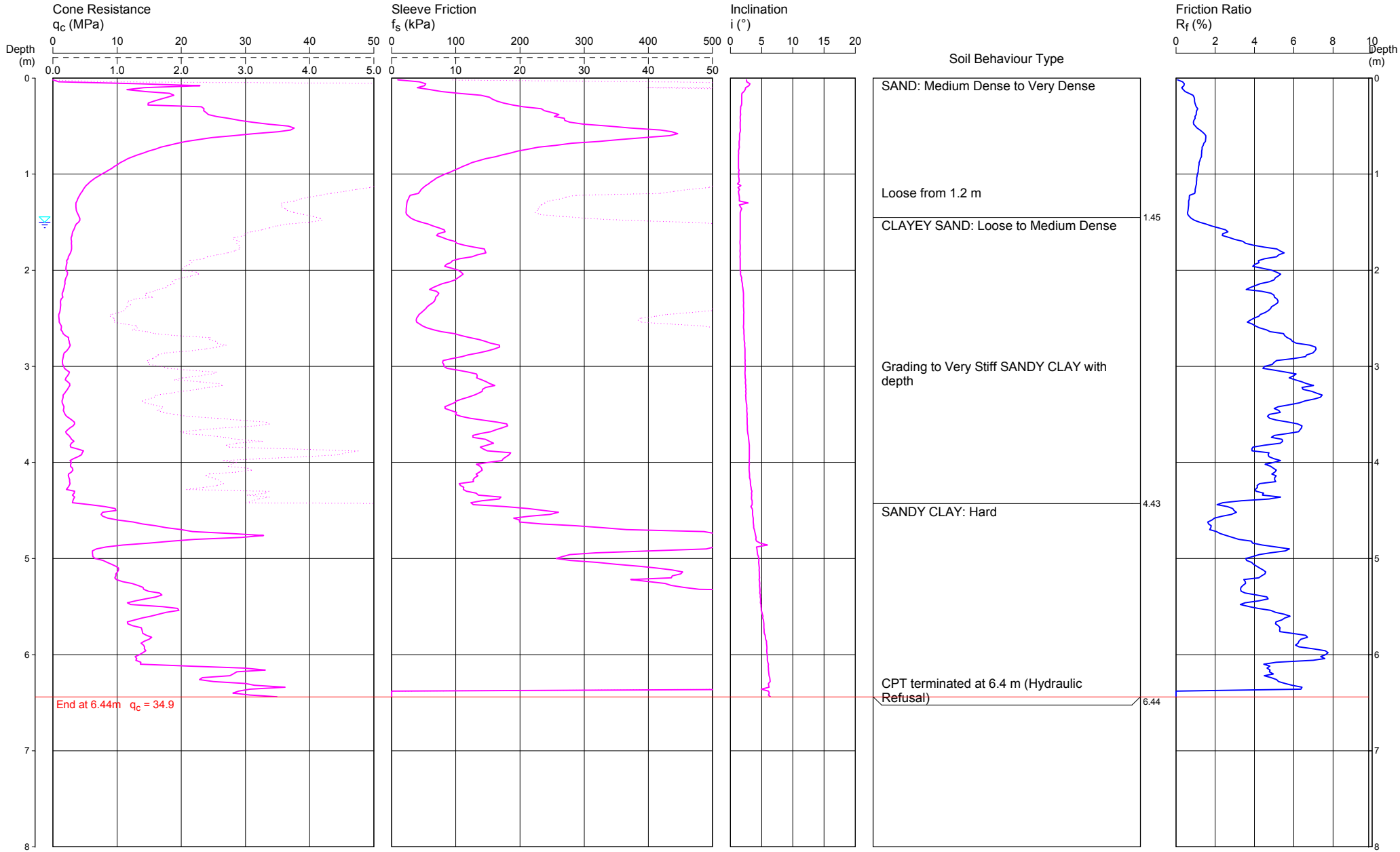
REDUCED LEVEL: 6.5 m AHD*

COORDINATES:

CPT4

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: 1.50m depth (measured)

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Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

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Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

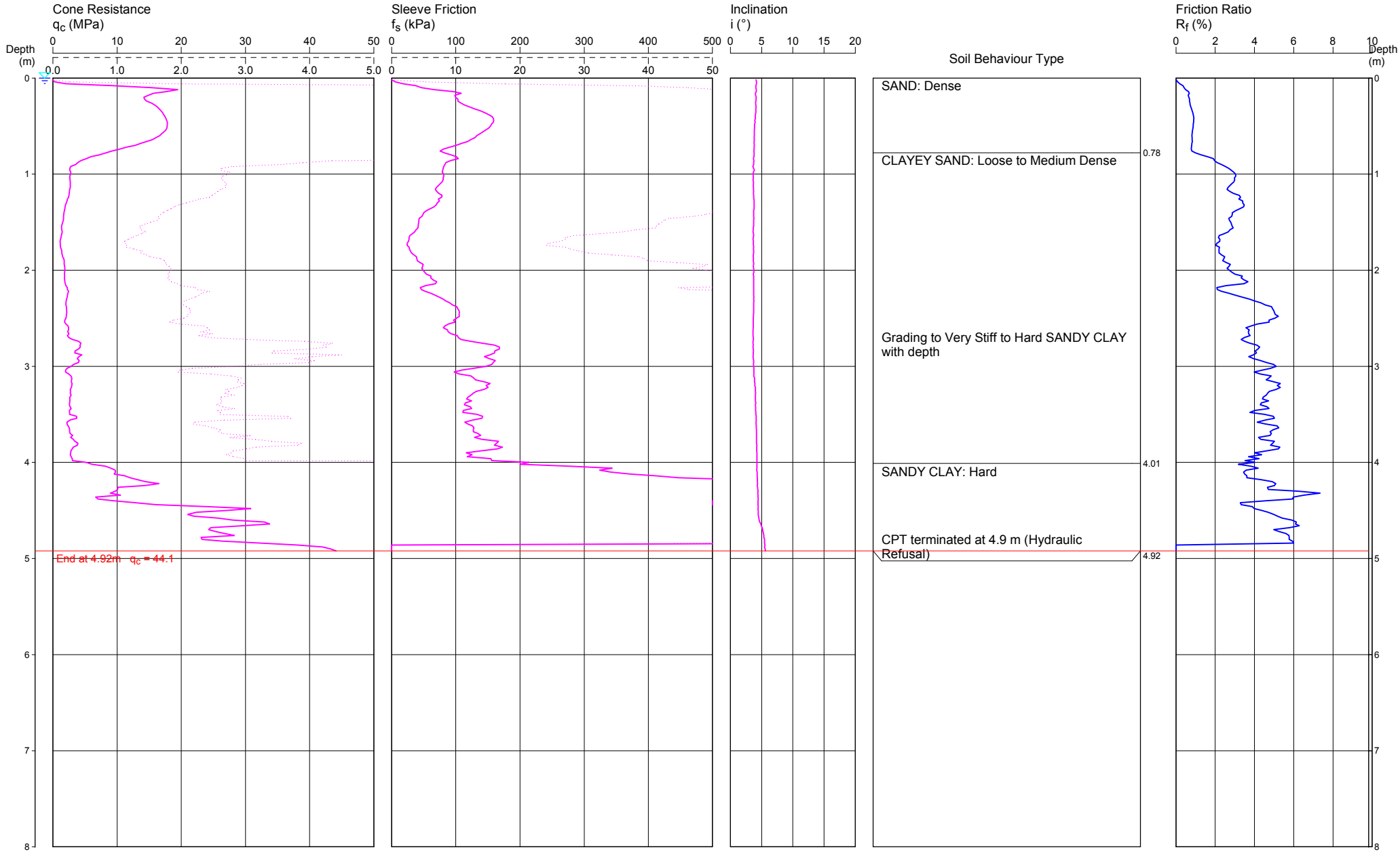
REDUCED LEVEL: 6.5 m AHD*

COORDINATES:

CPT5

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

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Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Water depth after test: Dry to 0.5 m

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

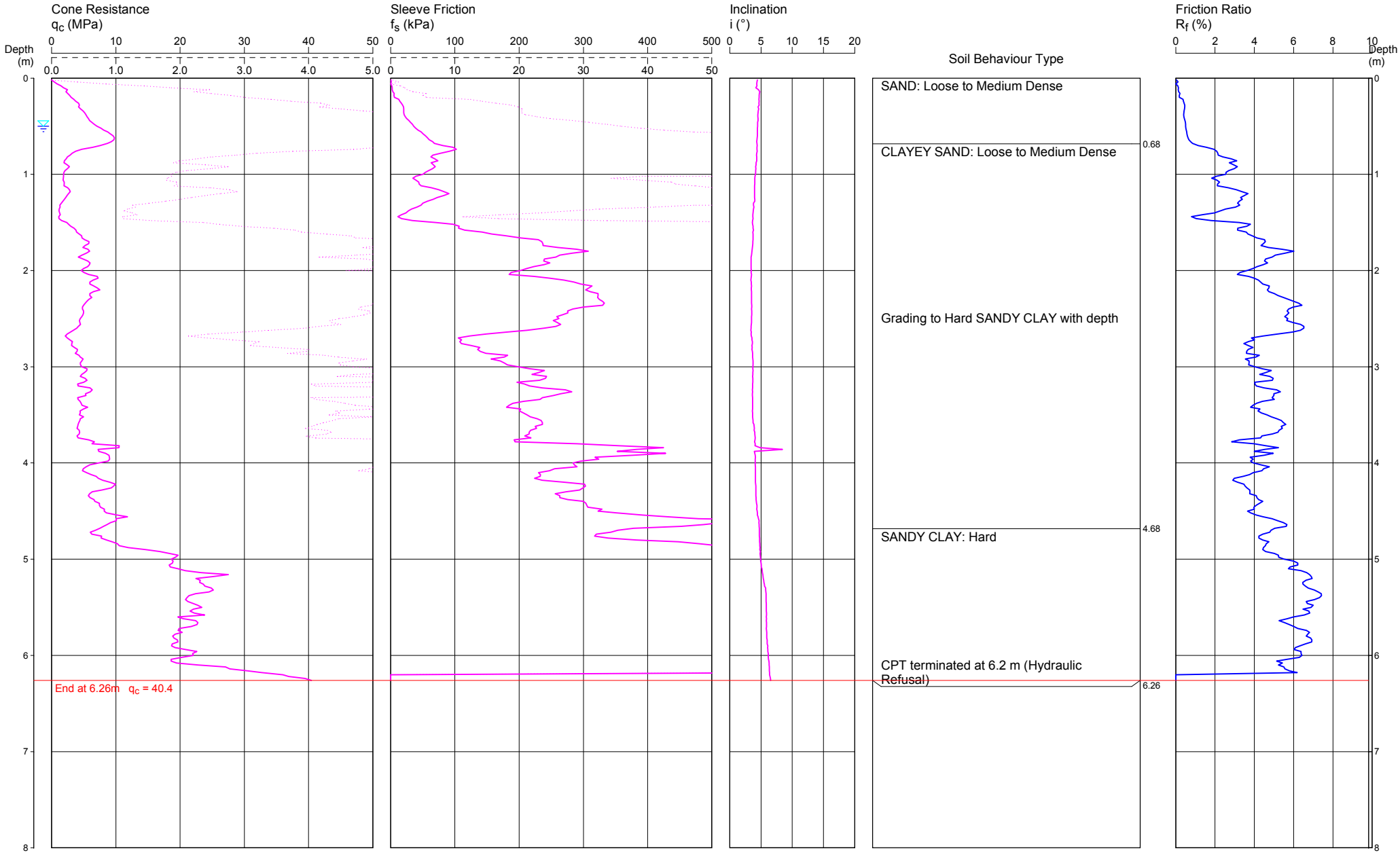
REDUCED LEVEL: 6.2 m AHD*

COORDINATES:

CPT6

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: 0.50m depth (measured)

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Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

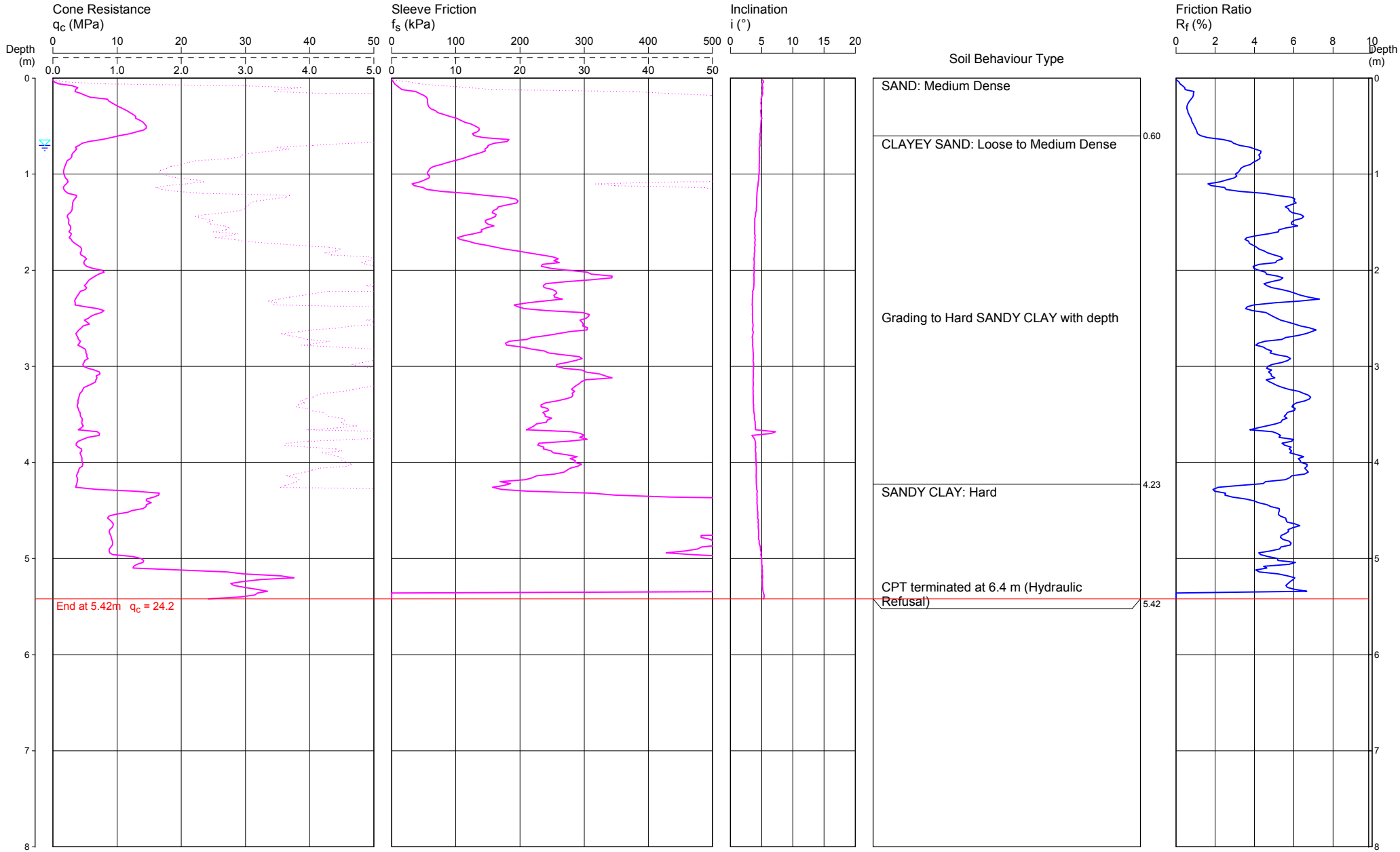
REDUCED LEVEL: 6.4 m AHD*

COORDINATES:

CPT7

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT7.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Water depth after test: 0.70m depth (measured)

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

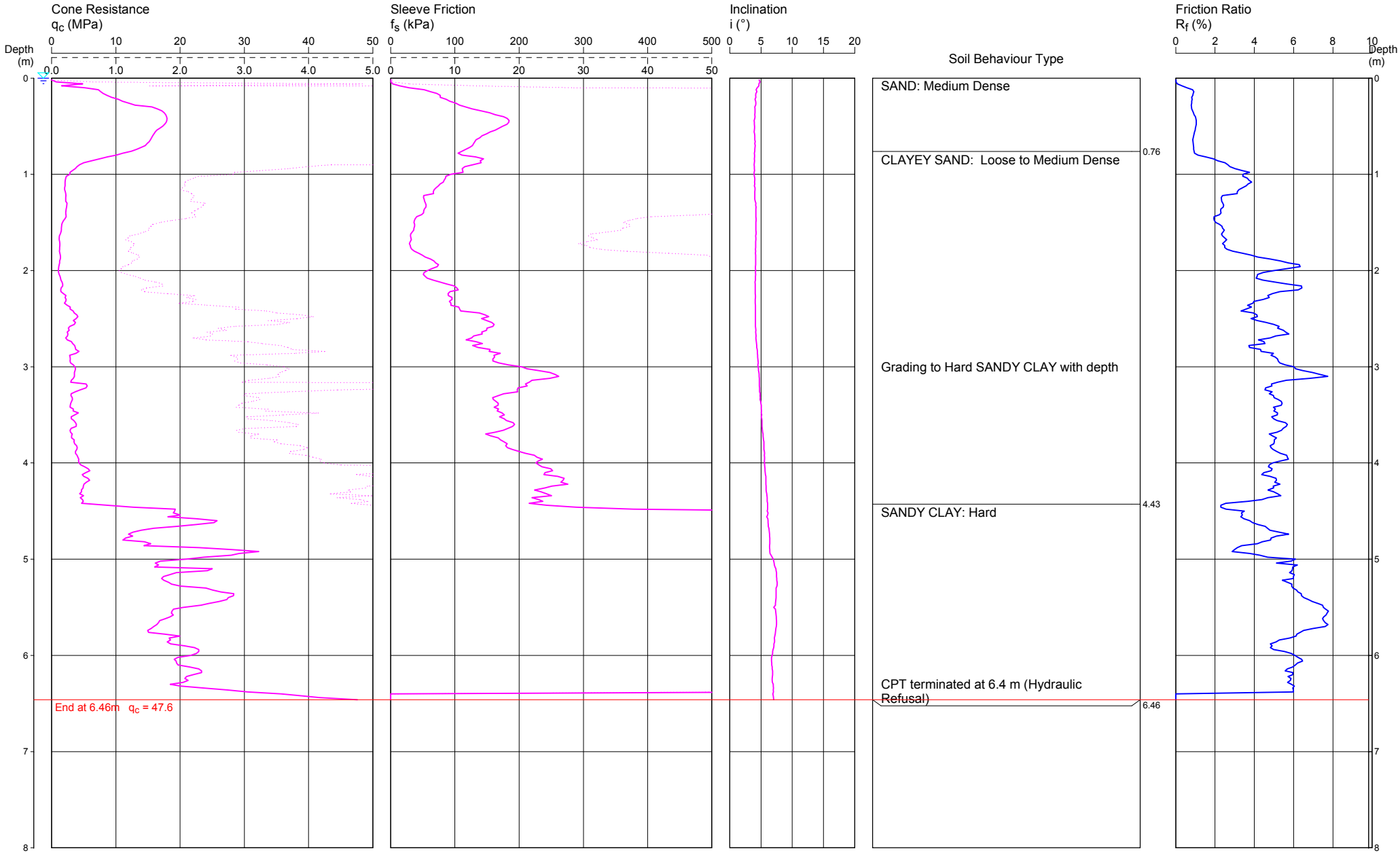
REDUCED LEVEL: 6.5 m AHD*

COORDINATES:

CPT8

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: Dry to 0.6 m

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT8.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
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CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

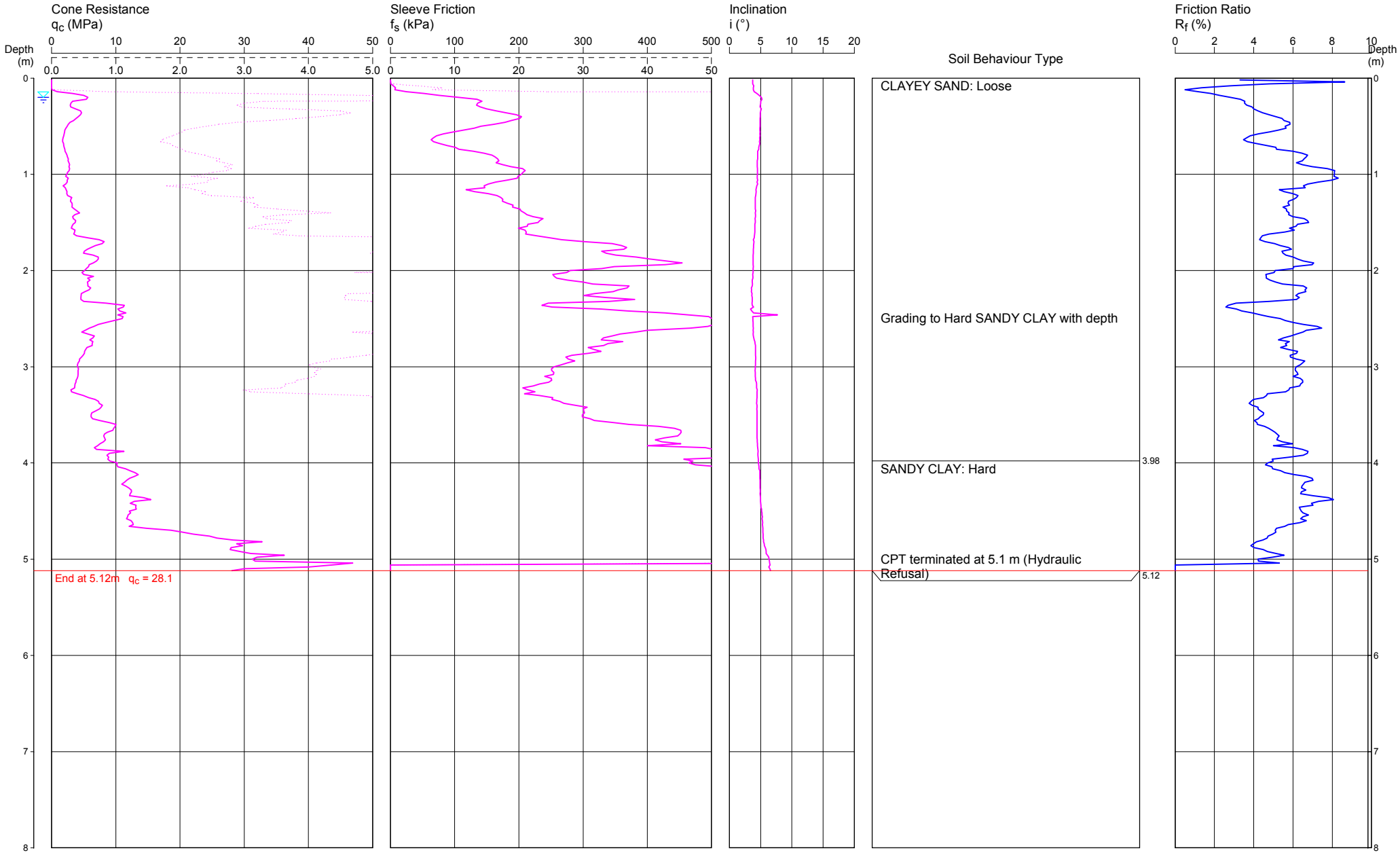
REDUCED LEVEL: 5.1 m AHD*

COORDINATES:

CPT9

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: 0.20m depth (measured)

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT9.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

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CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

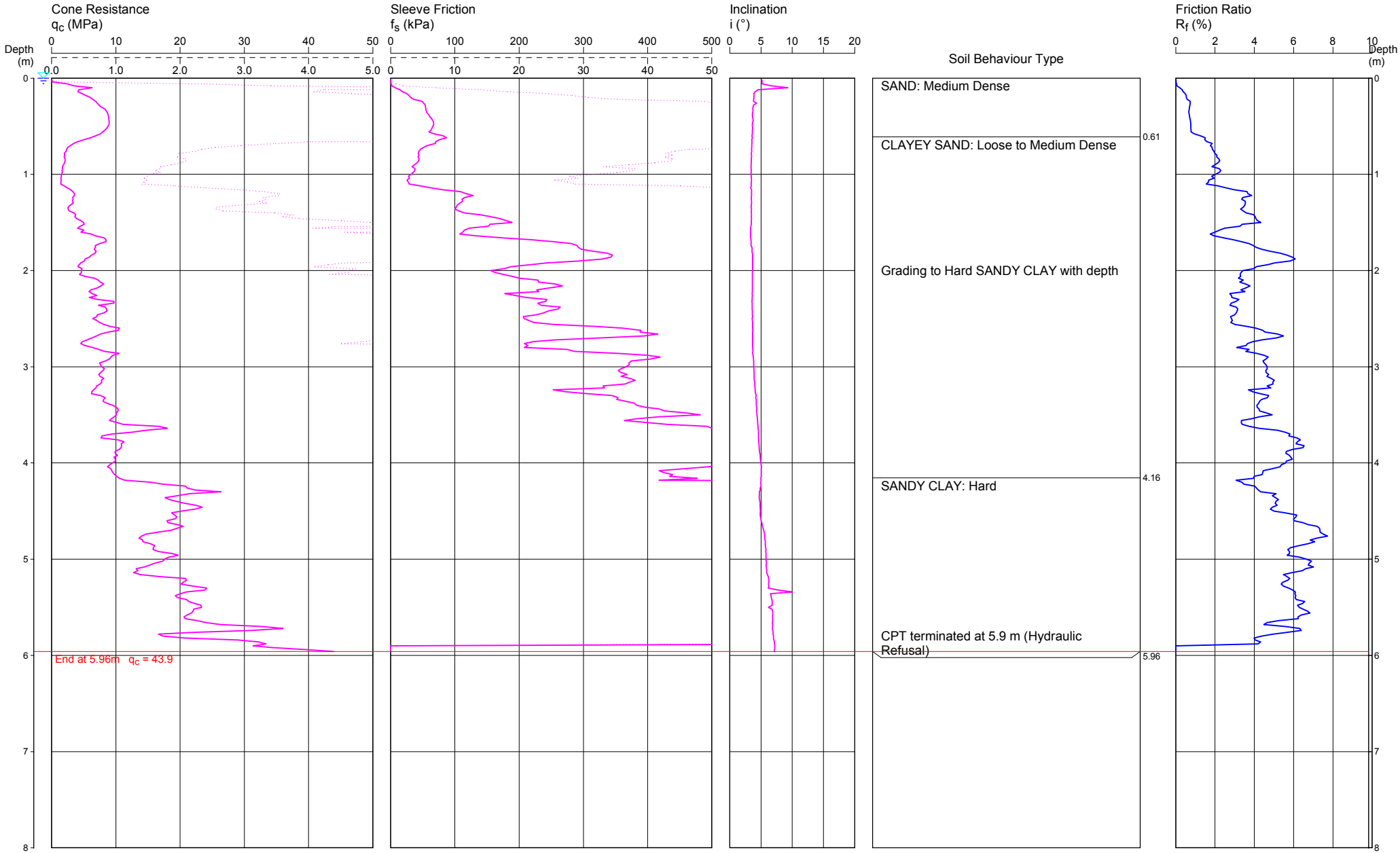
REDUCED LEVEL: 5.8 m AHD*

COORDINATES:

CPT10

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: Dry to 0.5 m

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT10.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

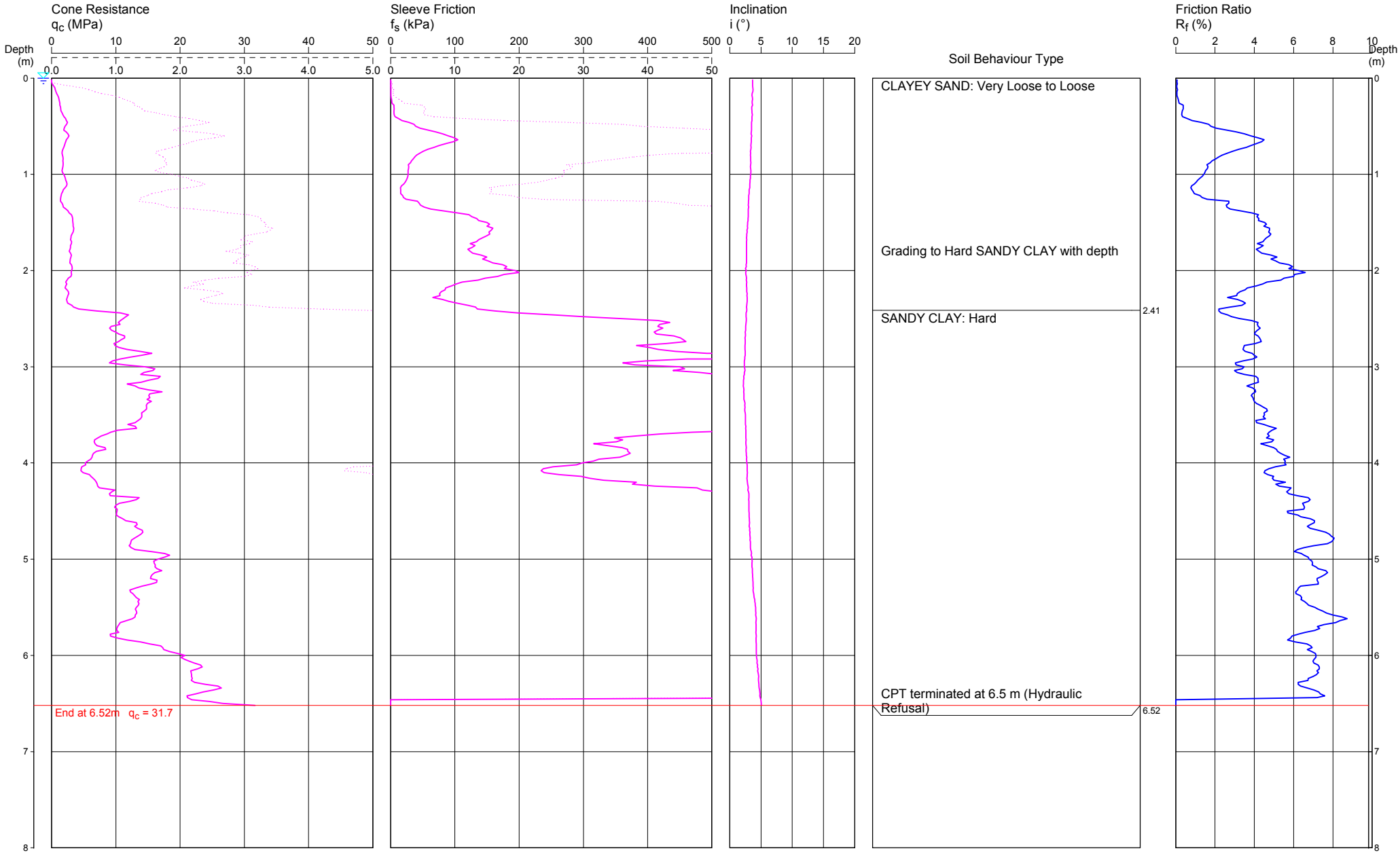
REDUCED LEVEL: 5.5 m AHD*

COORDINATES:

CPT11

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: Dry to 0.8 m

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT11.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

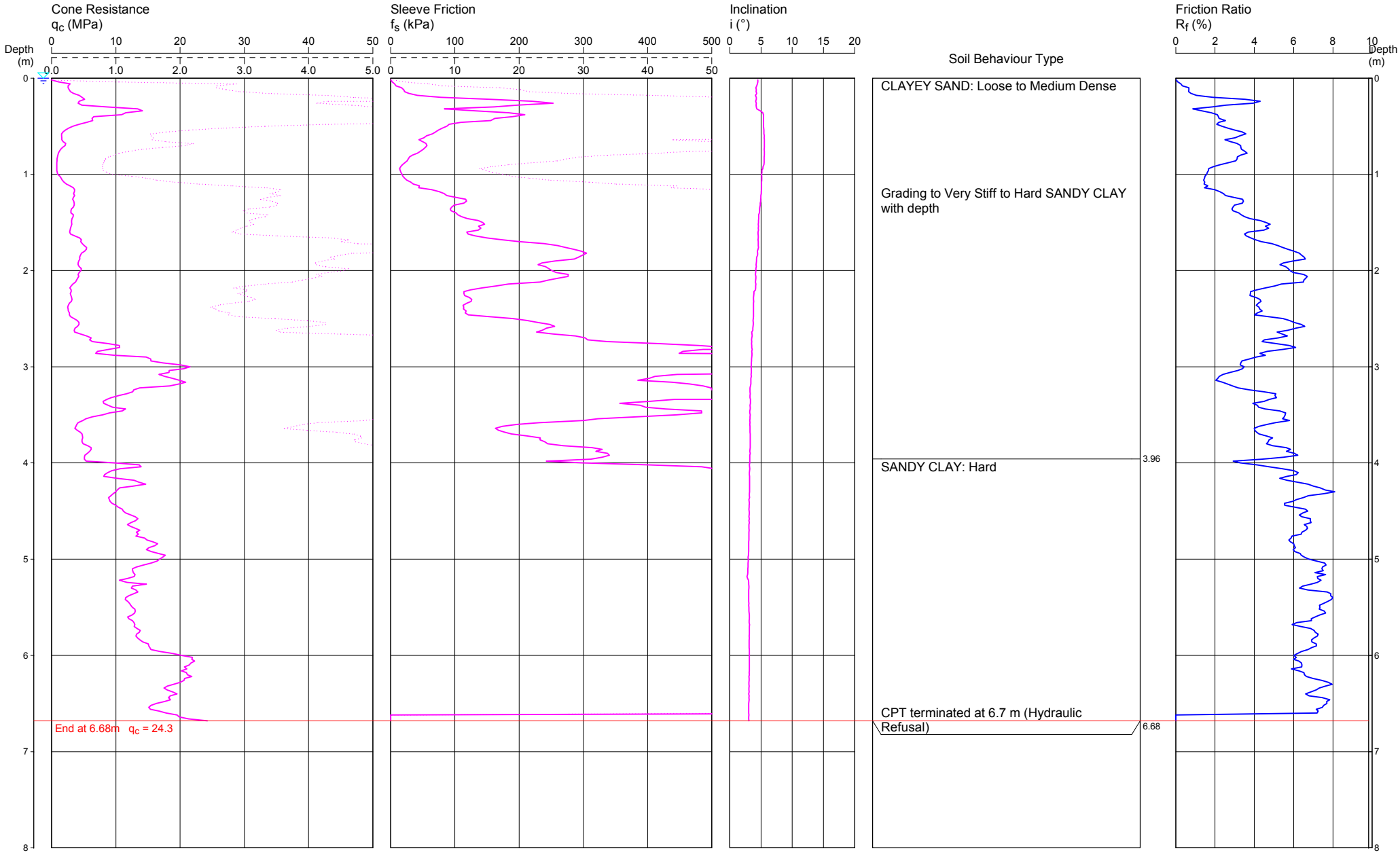
REDUCED LEVEL: 5.5 m AHD*

COORDINATES:

CPT12

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: Dry to 1.0 m

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT12.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

CONE PENETRATION TEST

CLIENT: Port Village Accommodation Pty Ltd

PROJECT: The Landing Resort Precinct

LOCATION: Port Hedland, WA

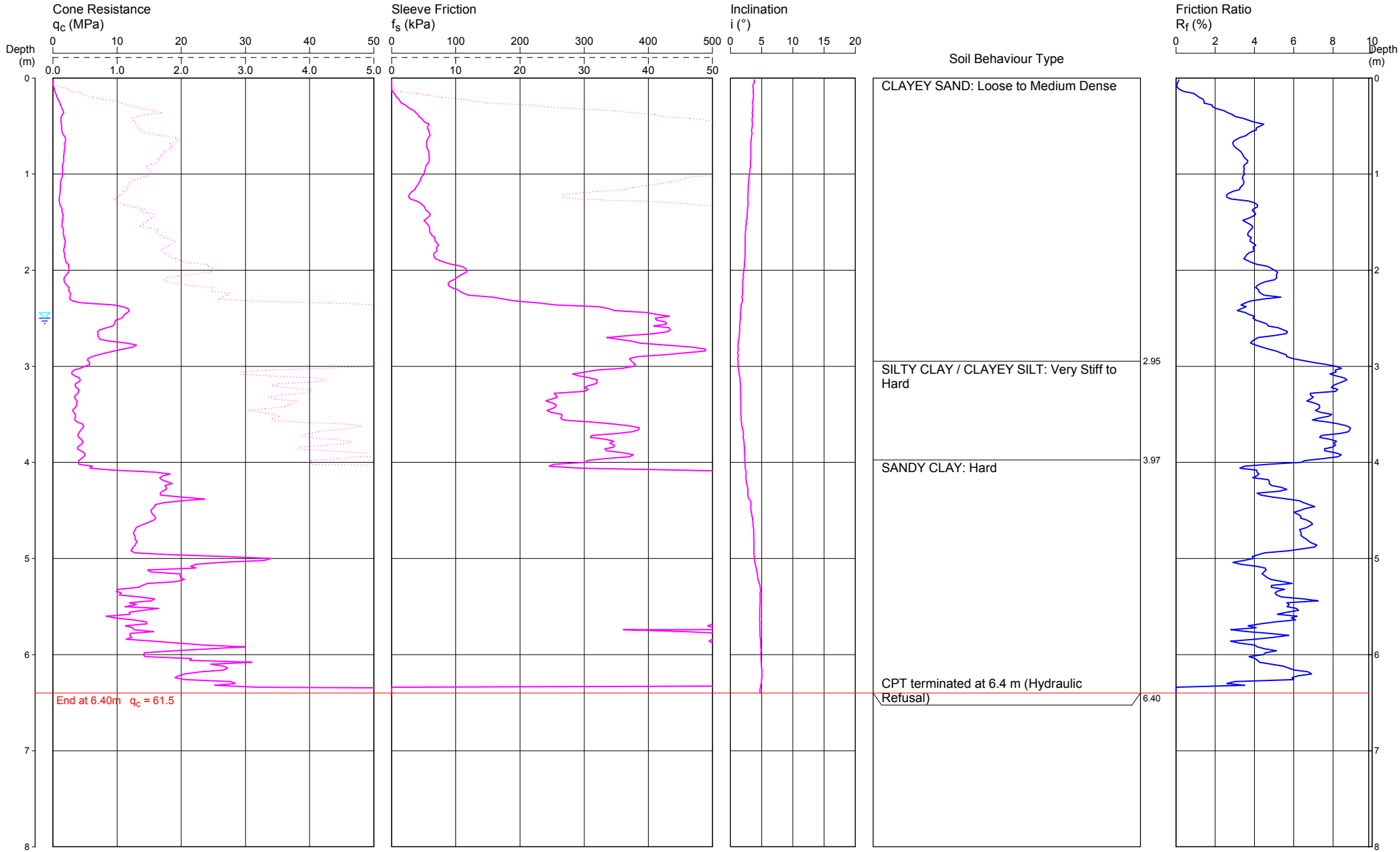
REDUCED LEVEL: 5.1 m AHD*

COORDINATES:

CPT13

DATE 20/01/2012

PROJECT No: 76319



REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

Water depth after test: 2.50m depth (measured)

File: P:\76319 Port Hedland, Lots 2 & 3 Gt Northern Highway\Field\CPT13.CP5
Cone ID: Probedrill **Type:** EC37

ConePlot Version 5.9.1

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.5 m AHD*
EASTING: 670553
NORTHING: 7746282
DIP/AZIMUTH: 90°/--

PIT No: TP14
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.4	FILLING (SAND) - medium dense, red-brown, fine to medium grained sand filling, with some fine to medium sized gravel and roots, moist. A concrete slab lied adjacent to the pit to a depth of 0.4 m.							
		SAND - medium dense to dense, red-brown, fine to medium grained sand, with some silt, moist.		D	0.6				
5	1	- with some clay from 1.1 m.							
	1.7	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, with some silt and a trace of fine sized gravel, moist.			1.8			▼	
				U_{150}					
4	2				2.0				
				D	2.5				
					2.9				
	3.0			U_{150}					
	3	Pit discontinued at 3.0m (Target)			3.1				

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.8 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.4 m AHD*
EASTING: 670586
NORTHING: 7746149
DIP/AZIMUTH: 90°/--

PIT No: TP15
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.01	BITUMINOUS SEAL - dense, dark grey, asphaltic seal with fine to medium sized aggregate, in poor condition.							
	0.15	BASECOURSE (SANDY GRAVEL) - red-brown, fine to medium sized sandy gravel, dyr to moist.							
		FILLING (SAND) - medium dense, red-brown, fine to medium grained sand filling, with some silt, moist.							
	0.5	SAND - medium dense to dense, red-brown, fine to medium grained sand, with some silt, moist.							
	1	- with a trace of clay from 0.9 m.						▼	1
5		- with some clay from 1.2 m.							
		- becoming mottled yellow-brown and slightly clayey, slightly gravelly from 1.5 m.			1.6				
				U_{150}					
				D	1.8				
	2								2
4		- with some gravel from 2.3 m.		D	2.5				
					2.6				
				U_{150}					
					2.8				
	3 3.0	Pit discontinued at 3.0m (Target)							3
3									

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.1 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.5 m AHD*
EASTING: 670558
NORTHING: 7746208
DIP/AZIMUTH: 90°/--

PIT No: TP16
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.4	FILLING (SAND) - loose to medium dense, red-brown, fine to medium grained sand filling, with some silt and roots, moist.		B	0.3				
		SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
5		- becoming mottled yellow-brown with some clay from 1.5 m.		D	1.8			▼	
4	2.0	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, wet.		D	2.5				
	3.0	Pit discontinued at 3.0m (Target)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.5 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.2 m AHD*
EASTING: 670602
NORTHING: 7746181
DIP/AZIMUTH: 90°/--

PIT No: TP17
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6		FILLING (SAND) - loose, brown, fine to medium grained sand, with some silt and rootlets. dry to moist.							
		- becoming red-brown from 0.2 m.							
		- with a piece of plastic pipe, star picket and plastic peg between 0.3 and 0.4 m.							
	0.4	SAND - medium dense, red-brown, fine to medium grained sand, with some silt and a trace of clay, wet.		D	0.6			▼	
	1 1.0	CLAYEY SAND - red-brown mottled yellow-brown, fine to medium grained clayey sand, with some silt and a trace of gravel from 1.0 m.			1.1				1
5				U_{110}					
				D	1.3				
					1.4				
		- becoming mottled white with some fine to medium sized gravel from 1.9 m.							
	2								2
4									
				D	2.4				
	3 3.0	Pit discontinued at 3.0m (Target)							3
3									

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 0.6 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 5.9 m AHD*
EASTING: 670698
NORTHING: 7746273
DIP/AZIMUTH: 90°/--

PIT No: TP18
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
5	0	SAND - medium dense to dense, red-brown, fine to medium grained sand, with some silt, moist.		B	0.3				
		- with some clay from 0.9 m.							
	1	- becoming mottled yellow-brown with some fine to medium sized gravel from 1.0 m.			1.1			▼	
				U_{150}	1.3				
	1.5	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt and fine to medium sized gravel, wet.		D	1.5				
4	2								
				D	2.4				
3	3	3.0 Pit discontinued at 3.0m (Target)							

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.1 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 5.4 m AHD*
EASTING: 670705
NORTHING: 7746358
DIP/AZIMUTH: 90°/--

PIT No: TP19
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
		- with some roots to 0.2 m.							
		- with some clay from 0.6 m.		U_{150}	0.7				
					0.9				
	1.1	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with a trace of silt and gravel, moist.		D	1.2			▼	
		- becoming mottled yellow-brown, with some silt and wet from 2.2 m.		D	2.3				
	3.0	Pit discontinued at 3.0m (Target)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.3 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 5.6 m AHD*
EASTING: 670730
NORTHING: 7746253
DIP/AZIMUTH: 90°/--

PIT No: TP20
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		FILLING (SAND) - medium dense, red-brown and dark grey, fine to medium grained sand filling, with some silt, dry to moist.		D	0.1				
	0.15	CLAYEY SAND - medium dense, red-brown, fine to medium grained, clayey sand, with some silt, moist.							
		- becoming mottled yellow-brown, with a trace of fine to medium sized gravel from 0.4 m.		B	0.5				
				D	1.6				
		- becoming weakly cemented from 2.4 m.		D	2.6				
	2.7	Pit discontinued at 2.7m (Slow digging on cemented material)							

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.3 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 5.8 m AHD*
EASTING: 670786
NORTHING: 7746297
DIP/AZIMUTH: 90°/--

PIT No: TP21
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
5	0	FILLING (SAND) - medium dense, red-brown, fine to medium grained sand filling, with some silt, fine to medium sized gravel, a section of steel pipe, steel sheeting, insulation pads and pieces of concrete, moist.		D	0.5			▼	
	1.6	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained, clayey sand, wet.		D	2.1				
3	3.0	Pit discontinued at 3.0m (Target)							

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.3 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 5.5 m AHD*
EASTING: 670858
NORTHING: 7746278
DIP/AZIMUTH: 90°/--

PIT No: TP22
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
5	0	SAND - loose, red-brown, fine to medium grained sand, with some silt and rootlets, wet.							
		- with some clay from 0.4 m.							
		- becoming slightly clayey, with a trace of fine to medium sized gravel from 0.7 m.		D	0.9				
	1	- becoming dense from 1.2 m.						▼	1
	1.3	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, wet.							
4				D	1.9				
	2								2
3	2.5	Pit discontinued at 2.5m (Due to Collapse)							
	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.1 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 5.4 m AHD*
EASTING: 670782
NORTHING: 7746342
DIP/AZIMUTH: 90°/--

PIT No: TP23
PROJECT No: 76319
DATE: 18/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
5	0	SAND - loose, red-brown, fine to medium grained sand, with some silt, moist.							
		- becoming medium dense from 0.6 m.							
		- with some clay from 0.9 m.		D	1.0				
4	1.4	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, with some silt, wet.						▼	
				D	2.2				
3		- with some fine to medium sized gravel from 2.7 m.							
	3.0	Pit discontinued at 3.0m (Target)							
2									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota (450 mm toothed bucket)
LOGGED: BD
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater at 1.5 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.4 m AHD*
EASTING: 670571
NORTHING: 7746229
DIP/AZIMUTH: 90°/--

BORE No: BH24
PROJECT No: 76319
DATE: 16/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0	SAND - medium dense, red-brown, fine to medium grained sand, with some silt, dry to moist.							
		- becoming dense from 0.15 m.							
		- becoming very dense from 0.45 m.						▼	
		- with a trace of clay and fine to medium sized gravel from 0.6 m.							
	0.8	Bore discontinued at 0.8m (Target)		D	0.8				
5	1								
4	2								
3	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm hand auger **DRILLER:** BD **LOGGED:** BD **CASING:** None

TYPE OF BORING: 110 mm hand auger

WATER OBSERVATIONS: Perched groundwater at 0.6 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6 m AHD*
EASTING: 670648
NORTHING: 7746270
DIP/AZIMUTH: 90°/--

BORE No: BH25
PROJECT No: 76319
DATE: 17/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	VWP Construction Details
6	0.05	FILLING (GRAVEL) - loose, medium sized gravel filling.							
		SAND - medium dense, red-brown, fine to medium grained sand, with a trace of silt, moist.							
		- with a trace of clay from 0.5 m.							
		- becoming slightly clayey, with some gravel and a trace of silt from 0.7 m.							
	0.8	Bore discontinued at 0.8m (Target)		D	0.8				
5	1								1
4	2								2
3	3								3

RIG: 110 mm hand auger **DRILLER:** BD **LOGGED:** BD **CASING:** None

TYPE OF BORING: 110 mm hand auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.7 m AHD*
EASTING: 670509
NORTHING: 7746267
DIP/AZIMUTH: 90°/--

BORE No: BH26
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.03	BITUMINOUS SEAL - dense, dark grey, bituminous seal.							
	0.17	BASECOURSE (SANDY GRAVEL) - dense, red-brown, fine to medium grained sandy gravel, moist.							
		SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.		D	0.6				
5	1.8	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt, wet.		D	2.1				
4		- becoming mottled yellow-brown from 2.6 m.							
	3.0	Bore discontinued at 3.0m (Target)							

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.5 m AHD*
EASTING: 670524
NORTHING: 7746202
DIP/AZIMUTH: 90°/--

BORE No: BH27
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0	SAND - loose, red-brown, fine to medium grained sand, with some clay and silt and a trace of gravel, moist.							
		- becoming medium dense from 0.3 m.		B	0.3				
		- with some roots to 0.5 m.							
	1								1
		- becoming wet from 1.5 m.							
5				D	1.6				
	2								2
	2.1	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, moist.							
		- becoming mottled yellow-brown from 2.3 m.							
4				D	2.6				
		- becoming wet from 2.8 m.							
	3								3
	3.0	Bore discontinued at 3.0m (Target)							

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.5 m AHD*
EASTING: 670526
NORTHING: 7746154
DIP/AZIMUTH: 90°/--

BORE No: BH28
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0	SAND - loose, red-brown, fine to medium grained sand, with some silt, moist.							
		- becoming medium dense from 0.15 m.		B	0.3				
		- with some roots at 0.4 m.							
		- becoming wet at 0.8 m.		D	0.8				
	1								1
		- with some clay from 1.2 m.							
5				D	1.5			▼	
	2	2.0							2
		CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, wet.		D	2.1				
4		- becoming wet from 2.8 m.		D	2.9				
	3	3.0							3
		Bore discontinued at 3.0m (Target)							

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.8 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.1 m AHD*
EASTING: 670618
NORTHING: 7746197
DIP/AZIMUTH: 90°/--

BORE No: BH29
PROJECT No: 76319
DATE: 17/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.15	FILLING (GRAVEL) - loose, medium sized, gravel filling.							
		SAND - loose, red-brown, fine to medium grained sand, with some silt, wet. - with a root at 0.25 m. - becoming medium dense from 0.3 m. - becoming very dense from 0.45 m						▼	
	1	- becoming slightly clayey, wit a trace of gravel from 0.7 m.		D	0.8				1
5		- mottled yellow-brown from 1.2 m.							
	1.3	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, with a trace of silt and gravel, saturated.		D	1.4				
	1.5	Bore discontinued at 1.5m (Due to Collapse)							
	2								2
4									
	3								3
3									

RIG: 110 mm hand auger **DRILLER:** BD **LOGGED:** BD **CASING:** None

TYPE OF BORING: 110 mm hand auger

WATER OBSERVATIONS: Perched groundwater at 0.5 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.5 m AHD*
EASTING: 670637
NORTHING: 7746092
DIP/AZIMUTH: 90°/--

BORE No: BH30
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0	SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.		D	0.3				
	1	- becoming wet from 0.8 m.							
		- with some clay from 1.1 m.		D	1.4			▼	
5	1.8	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, wet.		D	2.0				
4	2								
	2.8	Bore discontinued at 2.8m (Due to Collapse)							
	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.4 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.4 m AHD*
EASTING: 670679
NORTHING: 7746155
DIP/AZIMUTH: 90°/--

BORE No: BH31
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0	FILLING (SAND) - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
	0.3	- with an old pipe at 0.25 m.							
		SAND - dense, red-brown, fine to medium grained sand, with some silt, moist.							
		- becoming medium dense from 0.45 m.							
		- becoming wet from 0.8 m.							
5	1			D	1.0			▼	1
		- with some clay from 1.2 m.							
		- becoming mottled yellow-brown from 1.8 m.							
	1.9	CLAYEY SAND - medium dense, red-brown motttled yellow-brown, fine to medium grained clayey sand, wet.							
4	2			D	2.1				2
	2.6	Bore discontinued at 2.6m (Due to Collapse)							
	3								3
3									

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.4 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.1 m AHD*
EASTING: 670659
NORTHING: 7746206
DIP/AZIMUTH: 90°/--

BORE No: BH32
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.02	BITUMINOUS SEAL - dense, dark grey bituminous seal with medium sized aggregate.							
	0.18	BASECOURSE (SANDY GRAVEL) - dense, red-brown, fine to medium sized sandy gravel, moist.							
		SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
		- becoming wet and with some clay from 0.9 m.		D	1.1			▼	
5	1.8	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt, wet.							
		- with some fine to medium sized gravel from 2.0 m.							
4		- gravel content increasing with depth.		D	2.2				
		- becoming slightly gravelly from 2.8 m.		D	2.9				
3	3.0	Bore discontinued at 3.0m (Target)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.4 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6 m AHD*
EASTING: 670617
NORTHING: 7746226
DIP/AZIMUTH: 90°/--

BORE No: BH33
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.02	BITUMINOUS SEAL - dense, dark grey, bituminous seal with fine to medium sized aggregate.							
	0.13	BASECOURSE (SANDY GRAVEL) - dense, red-brown, fine to medium sized sandy gravel, moist.							
		SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
		- becoming wet and with a trace of fine sized gravel from 0.75 m.		D	0.9				
5	1	- with a trace of clay from 1.2 m.						▼	1
		- with some clay from 1.5 m.							
		- with some fine to medium sized gravel from 1.8 m.							
4	2 2.0	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, wet.		D	2.3				2
		- becoming slightly gravelly from 2.8 m.							
3	3 3.0	Bore discontinued at 3.0m (Target)							3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.4 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6 m AHD*
EASTING: 670646
NORTHING: 7746282
DIP/AZIMUTH: 90°/--

BORE No: BH34
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.02	BITUMINOUS SEAL - dense, dark grey, bituminous seal with fine to medium sized aggregate.							
	0.16	BASECOURSE (SANDY GRAVEL) - dense, red-brown, medium sized sandy gravel, moist. Gravel is granite.							
		SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.		B	0.4				
5	1	- becoming wet and with some clay from 1.0 m.						▼	1
	1.8	CLAYEY SAND - medium dense, red-brown mottled yellow-brown, fine to medium grained clayey sand, with some silt, wet.							
4	2			D	2.1				2
		- with some fine to medium sized gravel from 2.7 m.		D	2.9				
3	3	3.0 Bore discontinued at 3.0m (Target)							3

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.4 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6.1 m AHD*
EASTING: 670548
NORTHING: 7746300
DIP/AZIMUTH: 90°/--

BORE No: BH35
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6	0.01	BITUMINOUS SEAL - dense, dark grey, bituminous seal with fine to medium sized aggregate.							
	0.2	BASECOURSE (SANDY GRAVEL) - dense, red-brown, medium sized sandy gravel, dry to moist. Gravel is granite.							
		FILLING (SAND) - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
		- with a piece of concrete at 0.4 m.							
	0.5	SAND - medium dense to dense, red-brown, fine to medium grained sand, with some silt, moist.							
5	1	- becoming wet and with some clay from 1.1 m.		D	1.5			▼	
4	2 2.0	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt, wet.							
		- with some fine to medium sized gravel from 2.7 m.		D	2.9				
3	3 3.0	Bore discontinued at 3.0m (Target)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 4.5 tonne Kubota **DRILLER:** Rob's Bobcats **LOGGED:** BD **CASING:** None

TYPE OF BORING: 550 mm power auger

WATER OBSERVATIONS: Perched groundwater at 1.5 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Port Village Accommodation Pty Ltd
PROJECT: The Landing Resort Precinct
LOCATION: Port Hedland, WA

SURFACE LEVEL: 6 m AHD*
EASTING: 670628
NORTHING: 7746319
DIP/AZIMUTH: 90°/--

BORE No: BH36
PROJECT No: 76319
DATE: 19/1/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
6		FILLING (GRAVEL) - loose, medium sized gravel filling.							
	0.15	SAND - medium dense, red-brown, fine to medium grained sand, with some silt, moist.							
		- with a tree root at 0.4 m.						▼	
		- becoming wet and with some clay from 0.65 m.							
	0.8	CLAYEY SAND - medium dense, red-brown, fine to medium grained clayey sand, with some silt, wet.		D	0.9				
5	1								1
	1.3	Bore discontinued at 1.3m (Due to Collapse)							
4	2								2
3	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm hand auger **DRILLER:** BD **LOGGED:** BD **CASING:** None

TYPE OF BORING: 110 mm hand auger

WATER OBSERVATIONS: Perched groundwater at 0.6 m.

REMARKS: * Surface level interpolated from survey plan provided by Cardno (WA) Pty Ltd

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Appendix B

Geotechnical Laboratory Testing Certificates

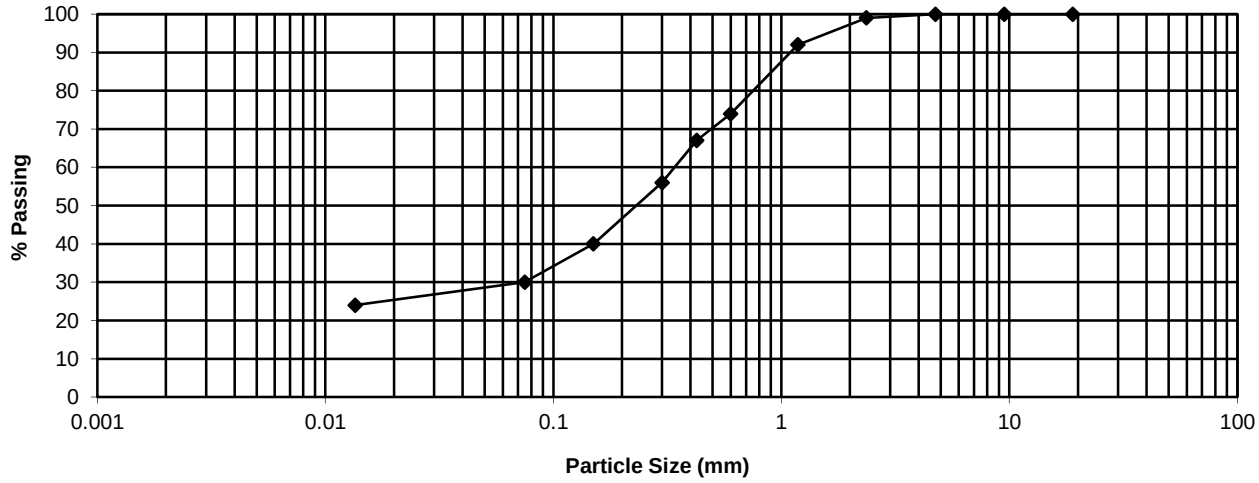
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/510**
Sample No:	**P12/510**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 14**
Depth (m): **2.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	100
2.36	99
1.18	92
0.600	74
0.425	67
0.300	56
0.150	40
0.075	30
0.0135	24

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	35	%
Plastic limit 3.2.1	12	%
Plasticity index 3.3.1	23	%
Linear shrinkage 3.4.1	7.5	%

Cracked ☐
Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

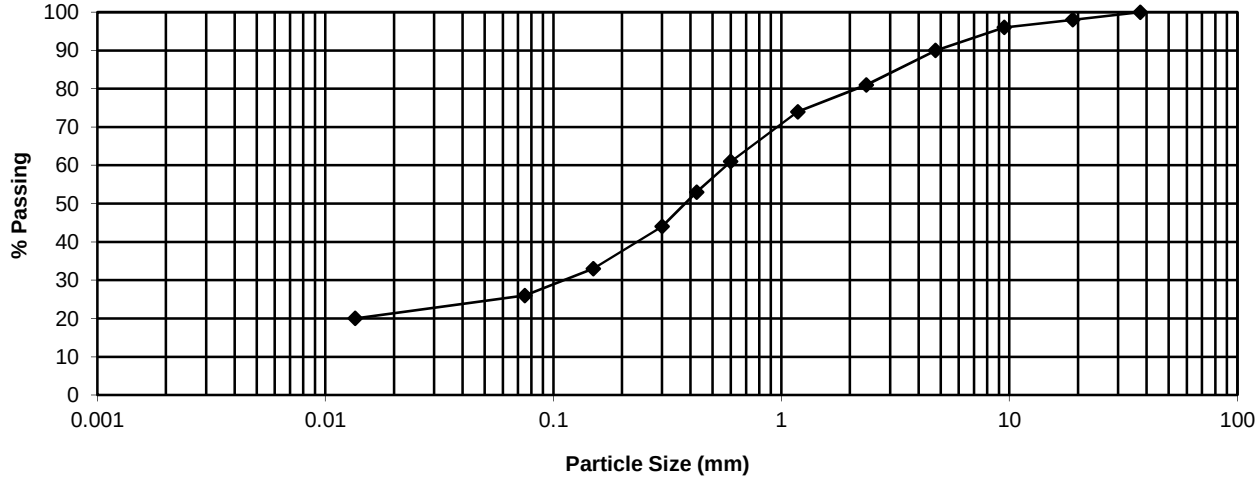
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/511**
Sample No:	**P12/511**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 15**
Depth (m): **1.8**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	98
9.5	96
4.75	90
2.36	81
1.18	74
0.600	61
0.425	53
0.300	44
0.150	33
0.075	26
0.0135	20

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

Particle Size Distribution & Plasticity Index tests

Mining & Civil

Geotest Pty Ltd

unit1/1 Pusey Road, Jandakot, WA 6164

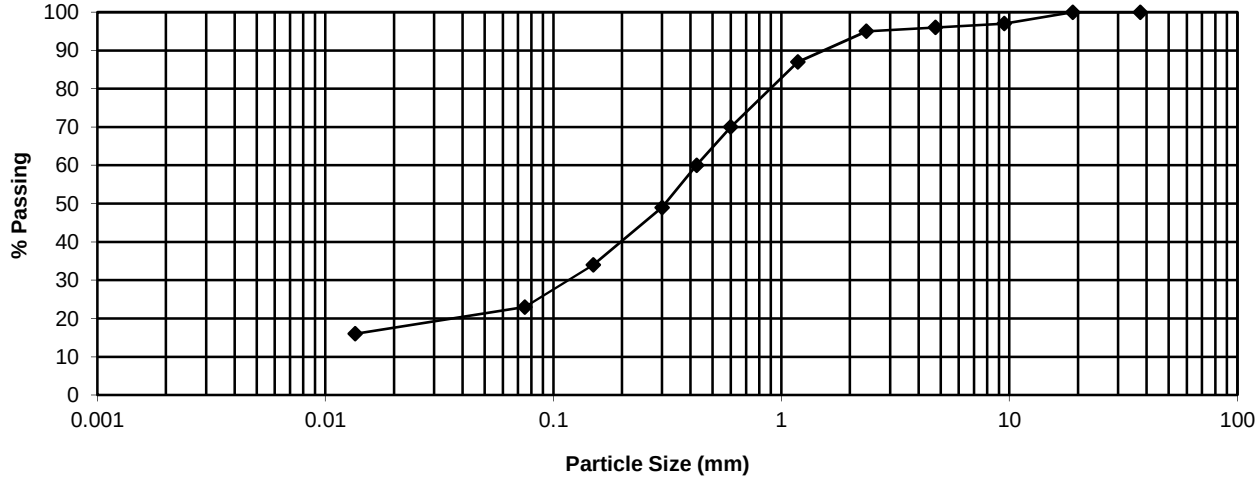
Ph (08) [redacted] **Fax (08) 9414 8011**

Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/512**
Sample No:	**P12/512**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 15**
Depth (m): **2.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	100
9.5	97
4.75	96
2.36	95
1.18	87
0.600	70
0.425	60
0.300	49
0.150	34
0.075	23
0.0135	16

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

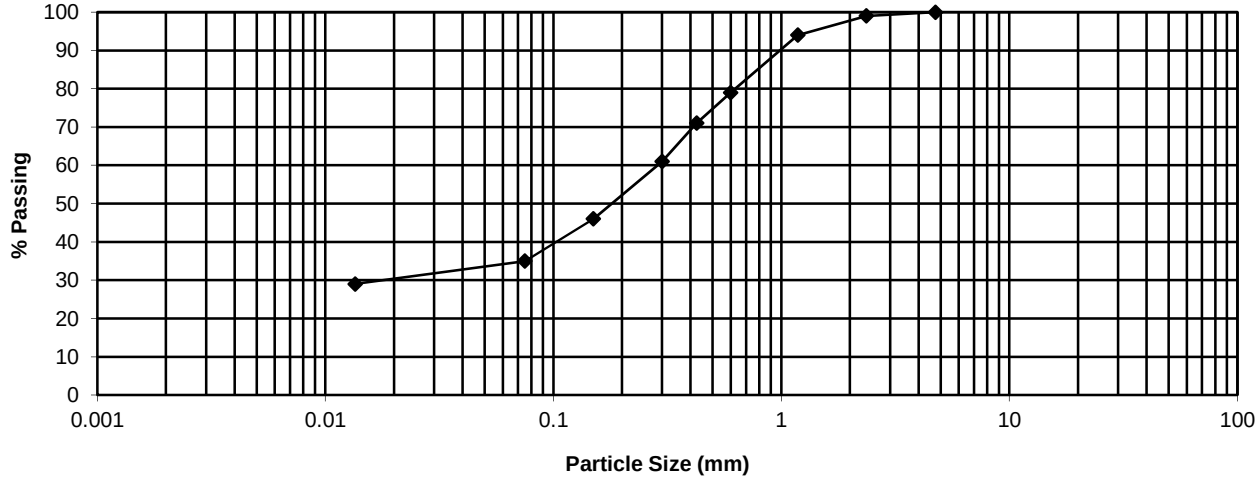
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/513**
Sample No:	**P12/513**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 17**
Depth (m): **1.3**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	94
0.600	79
0.425	71
0.300	61
0.150	46
0.075	35
0.0135	29

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	32	%
Plastic limit 3.2.1	11	%
Plasticity index 3.3.1	21	%
Linear shrinkage 3.4.1	7.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

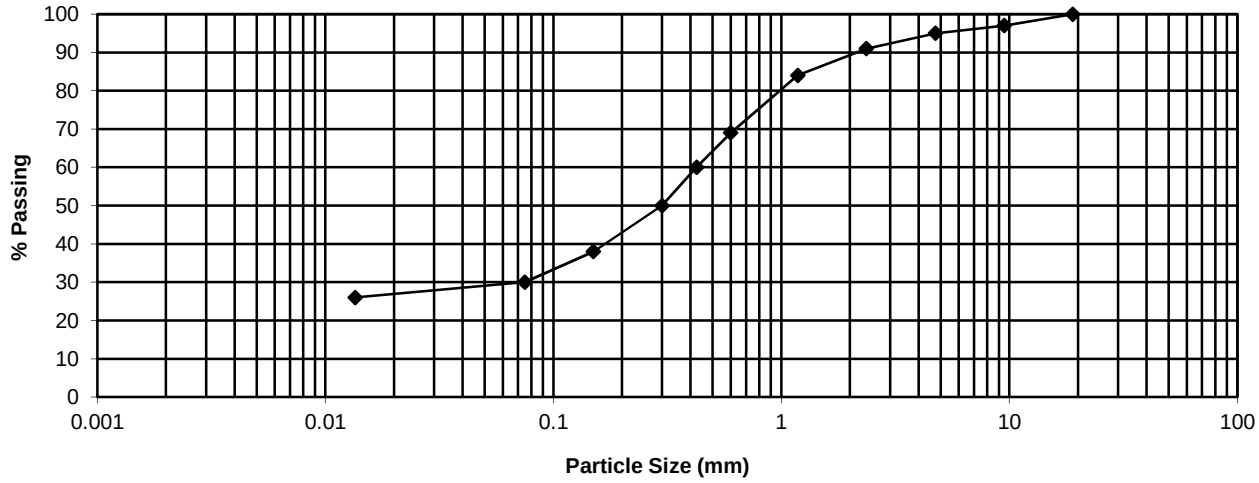
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/514**
Sample No:	**P12/514**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 17**
Depth (m): **2.4**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	97
4.75	95
2.36	91
1.18	84
0.600	69
0.425	60
0.300	50
0.150	38
0.075	30
0.0135	26

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	38	%
Plastic limit 3.2.1	14	%
Plasticity index 3.3.1	24	%
Linear shrinkage 3.4.1	9.5	%

Cracked ☐
Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

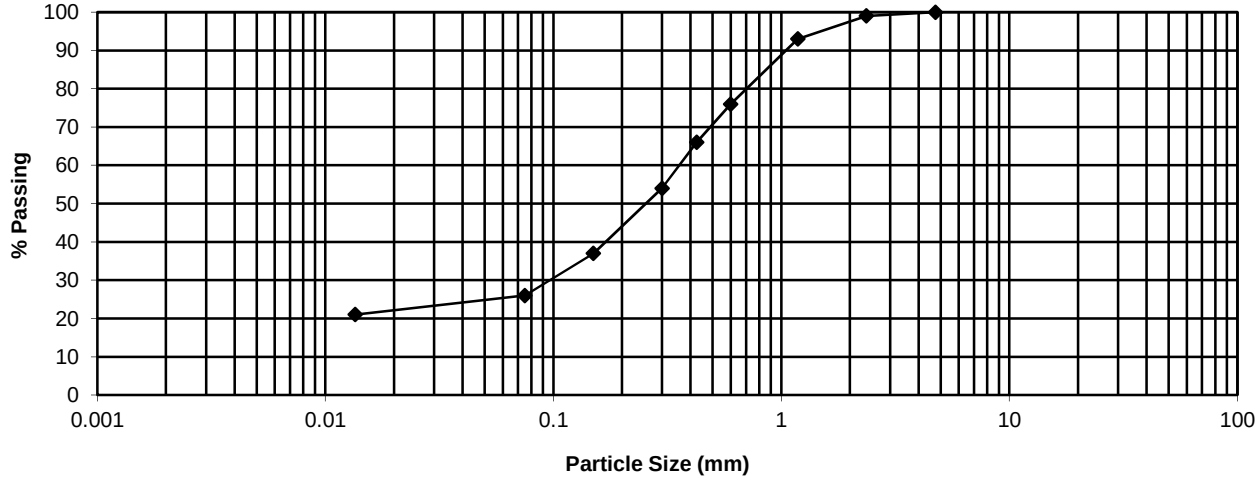
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/515**
Sample No:	**P12/515**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 19**
Depth (m): **1.2**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	93
0.600	76
0.425	66
0.300	54
0.150	37
0.075	26
0.0135	21

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	28	%
Plastic limit 3.2.1	10	%
Plasticity index 3.3.1	18	%
Linear shrinkage 3.4.1	5.5	%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

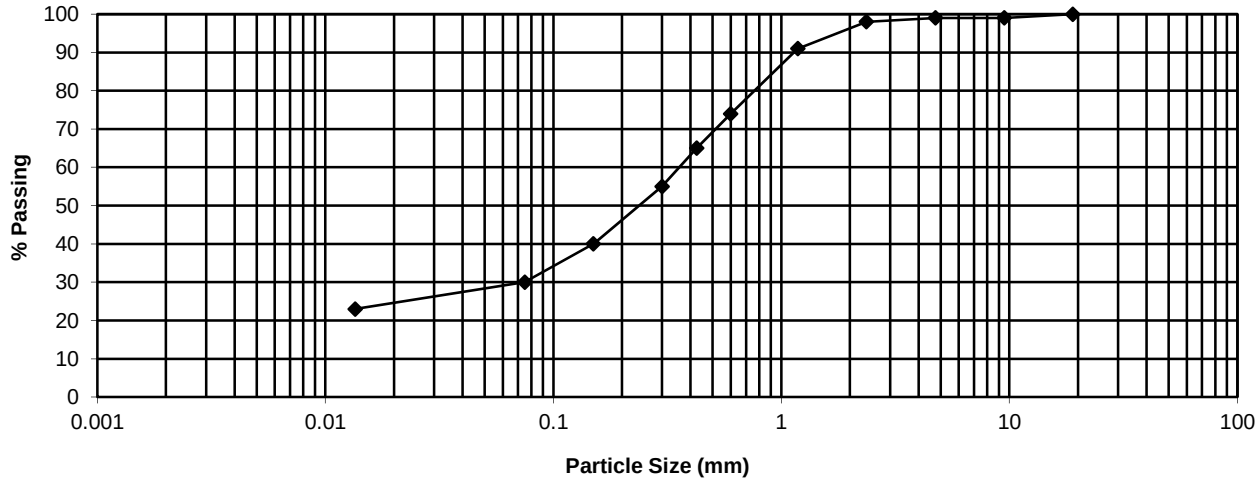
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/516**
Sample No:	**P12/516**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 19**
Depth (m): **2.3**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	99
2.36	98
1.18	91
0.600	74
0.425	65
0.300	55
0.150	40
0.075	30
0.0135	23

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	33	%
Plastic limit 3.2.1	11	%
Plasticity index 3.3.1	22	%
Linear shrinkage 3.4.1	7.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

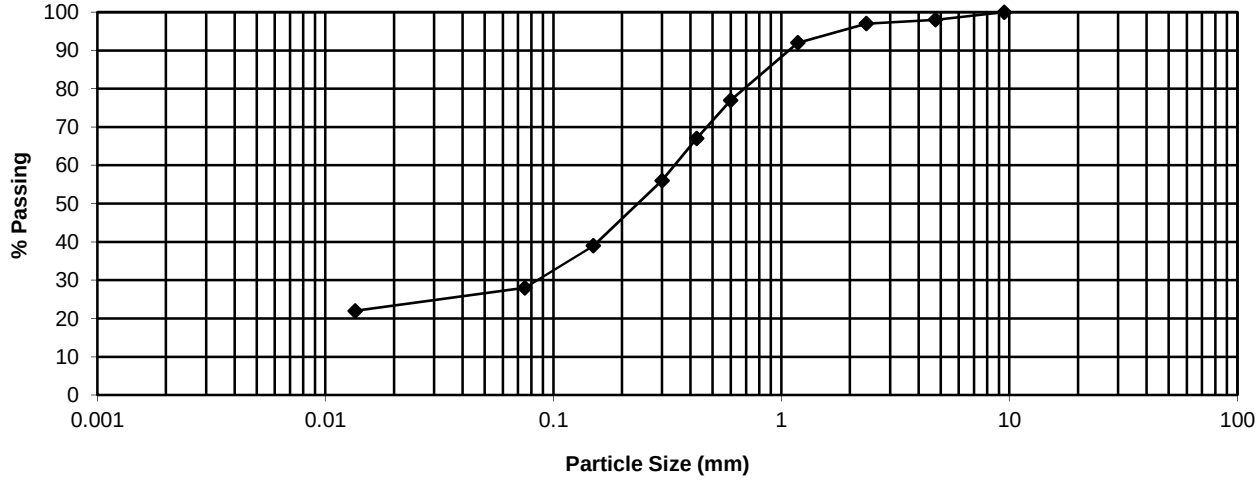
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P12/517**
Sample No:	**P12/517**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 20**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	98
2.36	97
1.18	92
0.600	77
0.425	67
0.300	56
0.150	39
0.075	28
0.0135	22

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	39	%
Plastic limit 3.2.1	13	%
Plasticity index 3.3.1	26	%
Linear shrinkage 3.4.1	6.5	%

Cracked ☐

Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

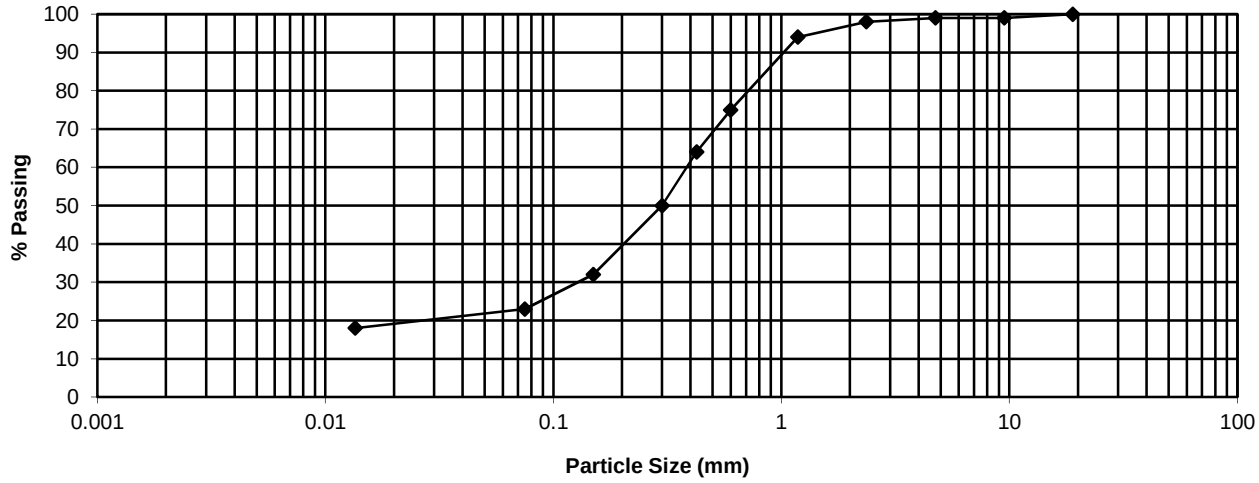
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/518**
Sample No:	**P12/518**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **TP 22**
Depth (m): **0.9**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	99
2.36	98
1.18	94
0.600	75
0.425	64
0.300	50
0.150	32
0.075	23
0.0135	18

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	25	%
Plastic limit 3.2.1	11	%
Plasticity index 3.3.1	14	%
Linear shrinkage 3.4.1	4.0	%

Cracked ☐
Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

Particle Size Distribution & Plasticity Index tests

Mining & Civil

Geotest Pty Ltd

unit1/1 Pusey Road, Jandakot, WA 6164

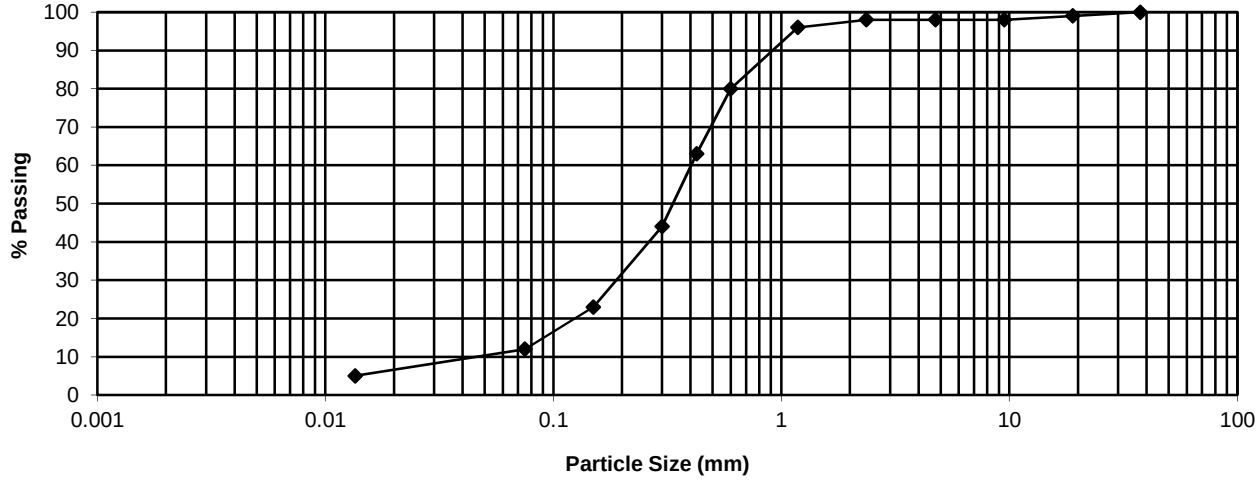
Ph (08) [redacted] **Fax (08) 9414 8011**

Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/519**
Sample No:	**P12/519**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **BH 24**
Depth (m): **0.8**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	99
9.5	98
4.75	98
2.36	98
1.18	96
0.600	80
0.425	63
0.300	44
0.150	23
0.075	12
0.0135	5

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

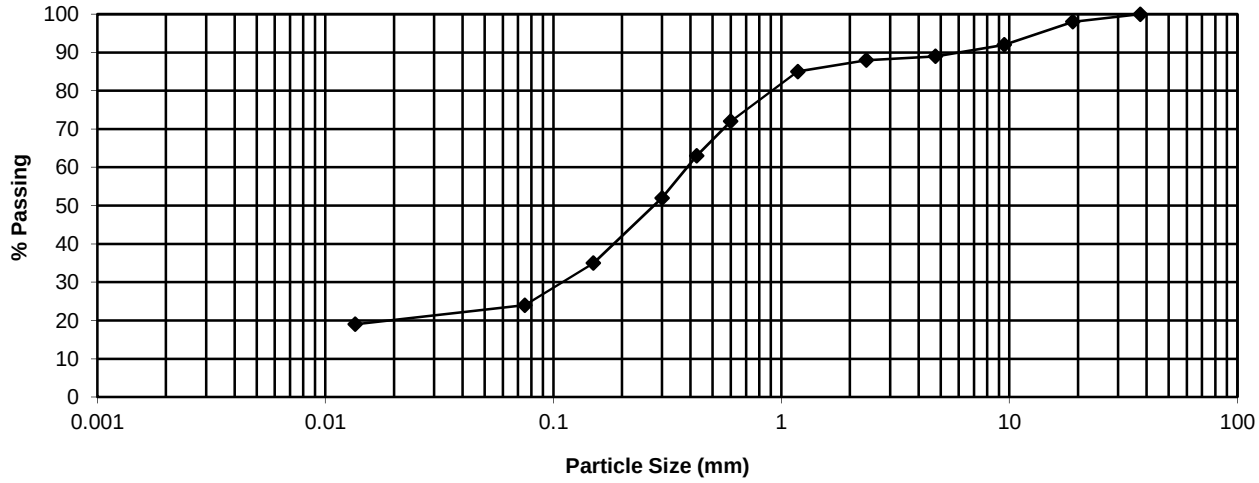
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P12/520**
Sample No:	**P12/520**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **BH 25**
Depth (m): **0.8**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	98
9.5	92
4.75	89
2.36	88
1.18	85
0.600	72
0.425	63
0.300	52
0.150	35
0.075	24
0.0135	19

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

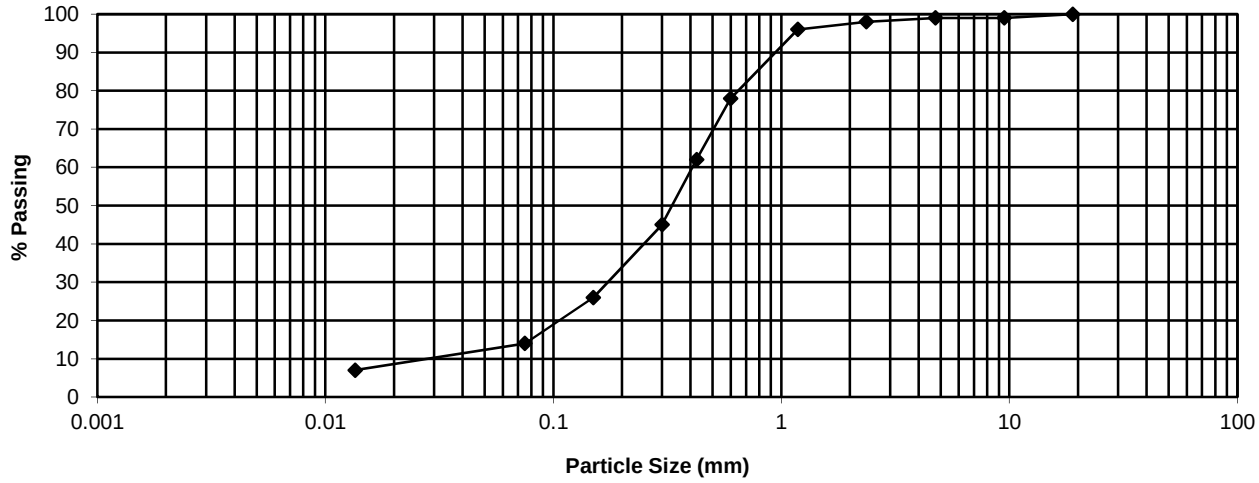
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/521**
Sample No:	**P12/521**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **BH 27**
Depth (m): **0.3**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	99
2.36	98
1.18	96
0.600	78
0.425	62
0.300	45
0.150	26
0.075	14
0.0135	7

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

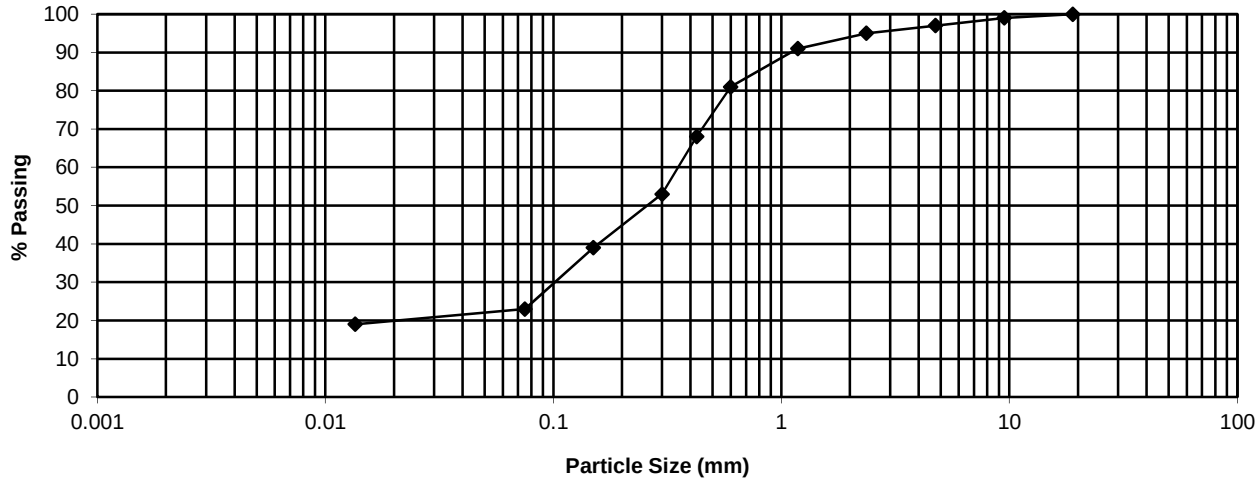
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/523**
Sample No:	**P12/523**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **BH 29**
Depth (m): **0.8**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	97
2.36	95
1.18	91
0.600	81
0.425	68
0.300	53
0.150	39
0.075	23
0.0135	19

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

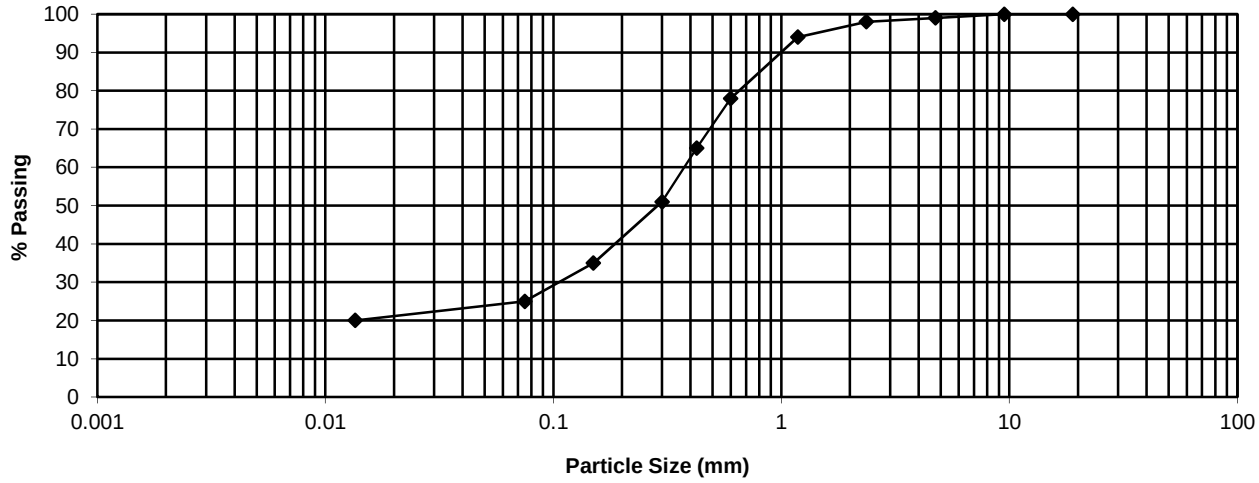
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
Email: [redacted]

Job No:	**60017**
Report No:	**60017-P12/524**
Sample No:	**P12/524**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **BH 29**
Depth (m): **1.4**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	100
4.75	99
2.36	98
1.18	94
0.600	78
0.425	65
0.300	51
0.150	35
0.075	25
0.0135	20

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	32	%
Plastic limit 3.2.1	12	%
Plasticity index 3.3.1	20	%
Linear shrinkage 3.4.1	5.5	%

Cracked ☑
Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

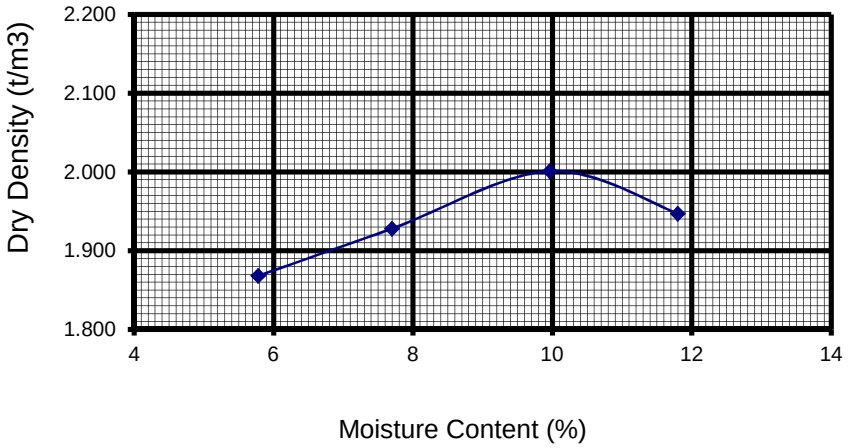
Mining &
Civil
Geotest Pty Ltd
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) [redacted]
Fax (08)9414 8011
Email [redacted]

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P12/517	**Project:**	Port Hedland
Sample No:	P12/517	**Client:**	Port Village Accommodation Pty Ltd
Location:	Lots 2 & 3 Great Northern Highway	**Date of issue:**	15 February 2012
	TP 20, 0.5m	**Job No:**	60017

Maximum Dry Density t/m^3:	2.00	**Conditions at Test**	
Optimum Moisture Content %:	10.0	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	11.1
Mass of hammer kg	4.9	Entire Moisture Ratio %	110.5
Number of layers	5	Top 30mm Moisture Content %	17.6
Number of blows/layer	9	Top 30mm Moisture Ratio %	175.5
Conditions after Compaction		Swell %	0.5
Dry Density t/m^3	1.91	C.B.R. at 5.0 mm Penetration %	5
Moisture Content %	9.7	**Conditions after Soaking**	
Density Ratio %	97.0	Dry Density t/m^3	1.90
Moisture Ratio %	95.5	Moisture Content %	13.8
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.0
		Moisture Ratio %	138.5

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

Approved Sign [redacted]

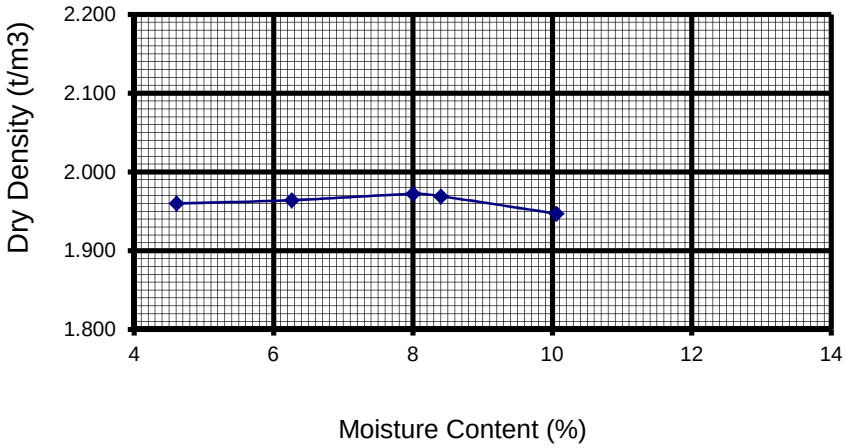
Mining &
Civil
Geotest Pty Ltd
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) [redacted]
Fax (08)9414 8011
Email [redacted]

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P12/521	**Project:**	Port Hedland
Sample No:	P12/521	**Client:**	Port Village Accommodation Pty Ltd
Location:	Lots 2 & 3 Great Northern Highway	**Date of issue:**	15 February 2012
	BH 27, 0.3m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.97	**Conditions at Test**	
Optimum Moisture Content %:	8.0	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	11.1
Mass of hammer kg	4.9	Entire Moisture Ratio %	138.5
Number of layers	5	Top 30mm Moisture Content %	17.6
Number of blows/layer	31	Top 30mm Moisture Ratio %	219.5
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.87	C.B.R. at 5.0 mm Penetration %	50
Moisture Content %	7.8	**Conditions after Soaking**	
Density Ratio %	95.0	Dry Density t/m^3	1.87
Moisture Ratio %	97.5	Moisture Content %	11.4
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.0
		Moisture Ratio %	143.0

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

Approved Sign [redacted]

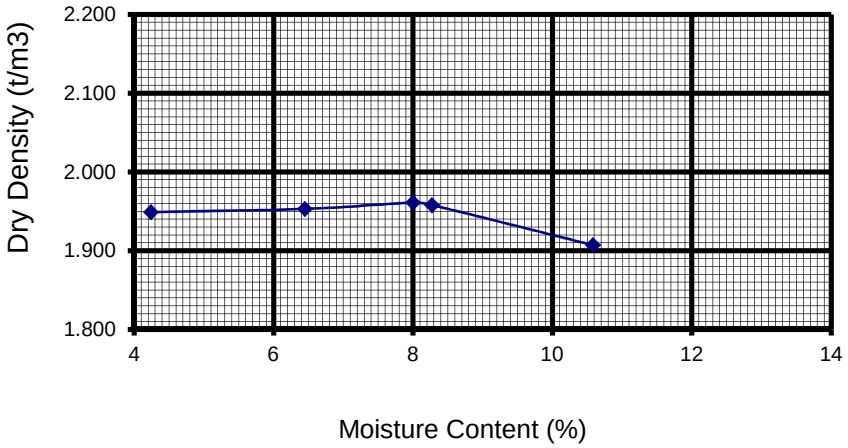
Mining &
Civil
Geotest Pty Ltd
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) [redacted]
Fax (08)9414 8011
Email [redacted]

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P12/522	**Project:**	Port Hedland
Sample No:	P12/522	**Client:**	Port Village Accommodation Pty Ltd
Location:	Lots 2 & 3 Great Northern Highway	**Date of issue:**	15 February 2012
	BH 28, 0.3m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.96	**Conditions at Test**	
Optimum Moisture Content %:	8.0	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	10.1
Mass of hammer kg	4.9	Entire Moisture Ratio %	129.0
Number of layers	5	Top 30mm Moisture Content %	11.9
Number of blows/layer	18	Top 30mm Moisture Ratio %	152.0
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.87	C.B.R. at 2.5 mm Penetration %	40
Moisture Content %	7.6	**Conditions after Soaking**	
Density Ratio %	95.0	Dry Density t/m^3	1.87
Moisture Ratio %	97.5	Moisture Content %	12.0
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.0
		Moisture Ratio %	154.5

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

Approved [redacted]

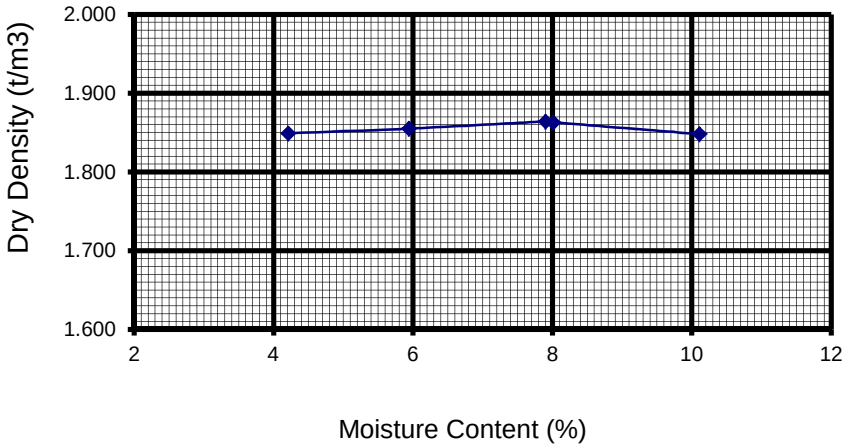
Mining &
Civil
Geotest Pty Ltd
Unit 1/1 Pusey Road, JANDAKOT WA 6164
Ph (08) [redacted]
Fax (08)9414 8011
Email [redacted]

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P12/525	**Project:**	Port Hedland
Sample No:	P12/525	**Client:**	Port Village Accommodation Pty Ltd
Location:	Lots 2 & 3 Great Northern Highway	**Date of issue:**	15 February 2012
	BH 34, 0.4m	**Job No:**	60017

Maximum Dry Density t/m^3:	1.86	**Conditions at Test**	
Optimum Moisture Content %:	8.0	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	12.6
Mass of hammer kg	4.9	Entire Moisture Ratio %	159.5
Number of layers	5	Top 30mm Moisture Content %	13.9
Number of blows/layer	16	Top 30mm Moisture Ratio %	175.5
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.78	C.B.R. at 2.5 mm Penetration %	25
Moisture Content %	7.6	**Conditions after Soaking**	
Density Ratio %	95.0	Dry Density t/m^3	1.78
Moisture Ratio %	96.0	Moisture Content %	14.6
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.0
		Moisture Ratio %	185.0

Comments:



Client address: 36 O'Malley St, Osborne Park

ASMDD-CBR June 2009

Approved Sign [redacted]

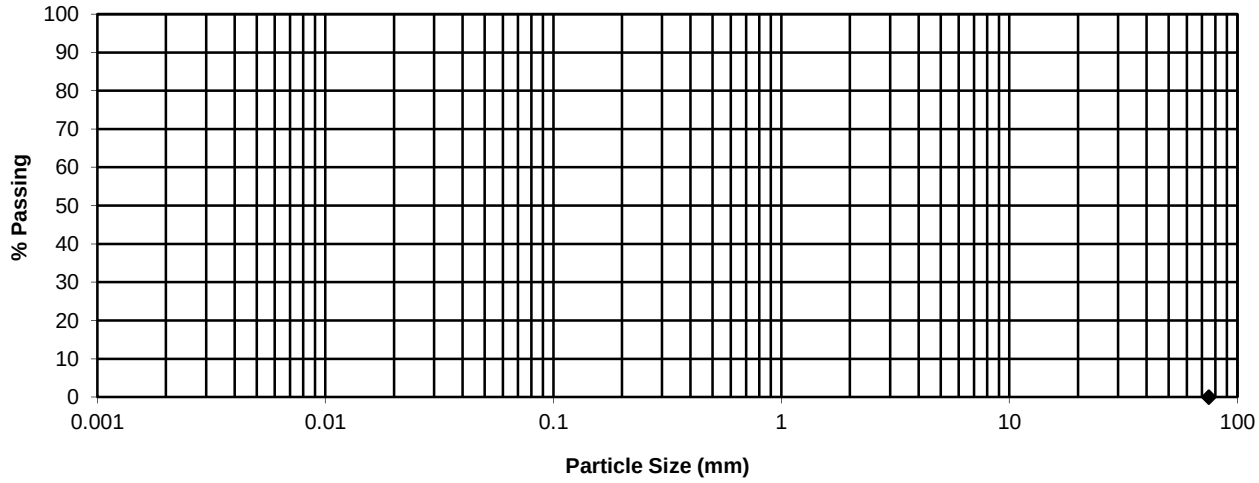
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) [redacted] Fax (08) 9414 8011
[redacted]

Job No:	**60017**
Report No:	**60017-P12/526**
Sample No:	**P12/526**
Issue Date:	**15 February 2012**

Client: **Port Village Accommodation Pty Ltd**
Project: **Lot 2 & 3 Great Northern Highway**
Location: **Port Hedland**

Sample Location: **BH 36**
Depth (m): **0.9**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	na
37.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	
0.075	
0.0135	

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	36	%
Plastic limit 3.2.1	12	%
Plasticity index 3.3.1	24	%
Linear shrinkage 3.4.1	7.0	%

Cracked ☐
Curled ☑

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

Approved signature [redacted]

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] Ph: (08) [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP14, Depth : 1.8 - 2.0m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474001A
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.62
Dry Density (t/m^3) :	1.798	1.930
Moisture Content (%) :	15.6	14.9
Void Ratio :	0.507	0.404
Degree of Saturation :	83.6	100.0

Sample Description :
Dark Brownish Red, Clayey Sand (med - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Natural Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.5075
1.0	19.988	0.002	0.01	0.5073
2.8	19.983	0.007	0.04	0.5069
4.8	19.975	0.015	0.08	0.5063
9.1	19.963	0.027	0.14	0.5054
17	19.931	0.059	0.30	0.5030
34	19.881	0.109	0.55	0.4993
68	19.775	0.215	1.08	0.4913
153	19.576	0.414	2.07	0.4763
340	19.330	0.660	3.30	0.4577
679	19.089	0.901	4.51	0.4395
1358	18.863	1.127	5.64	0.4225
2716	18.621	1.369	6.85	0.4042

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP14, Depth : 1.8 - 2.0m

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.39
Dry Density (t/m^3) :	1.789	1.944
Moisture Content (%) :	15.6	14.5
Void Ratio :	0.515	0.394
Degree of Saturation :	82.3	99.8

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474001B
Date Tested : Feb-2012
Sample Description : Dark Brownish Red, Clayey Sand (med - coarse Gr.)
Sampling Details : nom. 150mm Ø tube sample

CONSOLIDATION DATA (Soaked)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.985	0.000	0.00	0.5152
1.0	19.976	0.009	0.05	0.5145
1.0 **	19.961	0.024	0.12	0.5134
2.8	19.950	0.035	0.18	0.5126
4.8	19.935	0.050	0.25	0.5114
9.1	19.911	0.074	0.37	0.5096
17	19.872	0.113	0.57	0.5067
34	19.815	0.170	0.85	0.5023
68	19.706	0.279	1.40	0.4941
153	19.422	0.563	2.82	0.4725
340	19.164	0.821	4.11	0.4530
679	18.890	1.095	5.48	0.4322
1358	18.643	1.342	6.72	0.4135
2716	18.391	1.594	7.98	0.3944

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client
** Specimen was inundated at the start of this stage

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

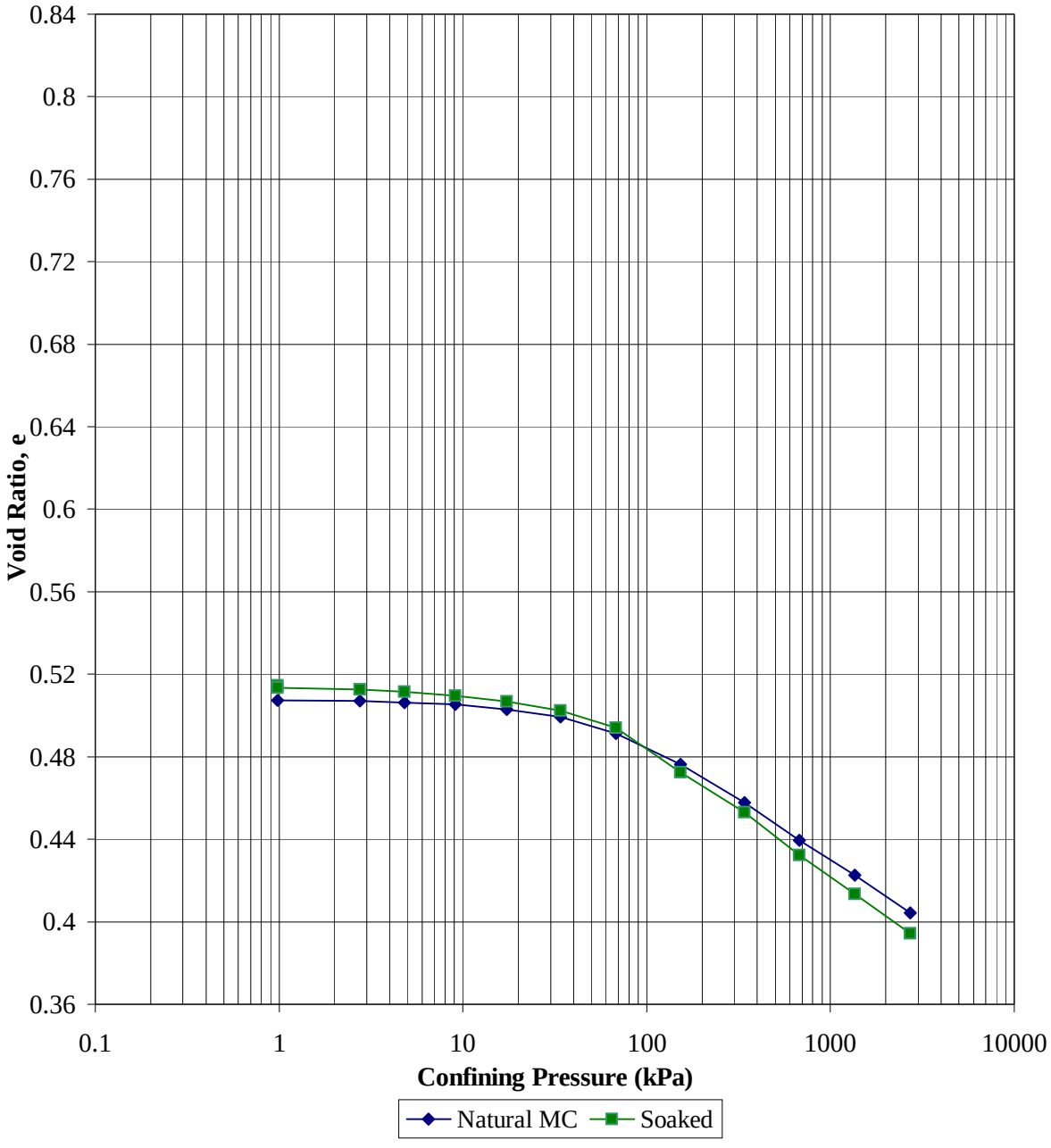
TRICON TESTING
Geotechnical Engineering Laboratory

ONE-DIMENSIONAL CONSOLIDATION TEST
-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT :	Port Village Accommodation Pty Ltd (Job # 76319)	**JOB NO :**	1011471
PROJECT :	Lot 2 & 3 Gt Northern Hwy	**LOCATION :**	Port Hedland
Sample Id :	TP14, Depth : 1.8 - 2.0m	**Lab No. :**	TT 06474001

VOID RATIO Vs CONFINING PRESSURE PLOT



Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP14, Depth : 2.9 - 3.1m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474002A
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.58
Dry Density (t/m^3) :	1.779	1.914
Moisture Content (%) :	14.2	14.2
Void Ratio :	0.523	0.416
Degree of Saturation :	73.7	92.7

Sample Description :
Dark Brownish Red, Clayey Sand (med - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Natural Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.5231
1.0	19.986	0.004	0.02	0.5228
2.8	19.978	0.012	0.06	0.5222
4.8	19.963	0.027	0.14	0.5210
9.1	19.947	0.043	0.22	0.5198
17	19.909	0.081	0.41	0.5169
34	19.835	0.155	0.78	0.5113
68	19.721	0.269	1.35	0.5026
153	19.516	0.474	2.37	0.4870
340	19.268	0.722	3.61	0.4681
679	19.039	0.951	4.76	0.4506
1358	18.823	1.167	5.84	0.4342
2716	18.578	1.412	7.06	0.4155

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : _ [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP14, Depth : 2.9 - 3.1m

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.37
Dry Density (t/m^3) :	1.772	1.928
Moisture Content (%) :	14.2	14.9
Void Ratio :	0.529	0.405
Degree of Saturation :	72.9	99.9

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474002B
Date Tested : Feb-2012
Sample Description : Dark Brownish Red, Clayey Sand (med - coarse Gr.)
Sampling Details : nom. 150mm Ø tube sample

CONSOLIDATION DATA (Soaked)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.985	0.000	0.00	0.5291
1.0	19.976	0.009	0.05	0.5284
1.0 **	19.941	0.044	0.22	0.5258
2.8	19.926	0.059	0.30	0.5246
4.8	19.911	0.074	0.37	0.5235
9.1	19.888	0.097	0.49	0.5217
17	19.843	0.142	0.71	0.5183
34	19.771	0.214	1.07	0.5128
68	19.643	0.342	1.71	0.5030
153	19.388	0.597	2.99	0.4835
340	19.110	0.875	4.38	0.4622
679	18.862	1.123	5.62	0.4432
1358	18.603	1.382	6.92	0.4234
2716	18.368	1.617	8.09	0.4054

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client
** Specimen was inundated at the start of this stage

Authorised Signatory : [redacted]

Date : 22/02/2012
Form No AS1289.6.1.1/1 05/1R

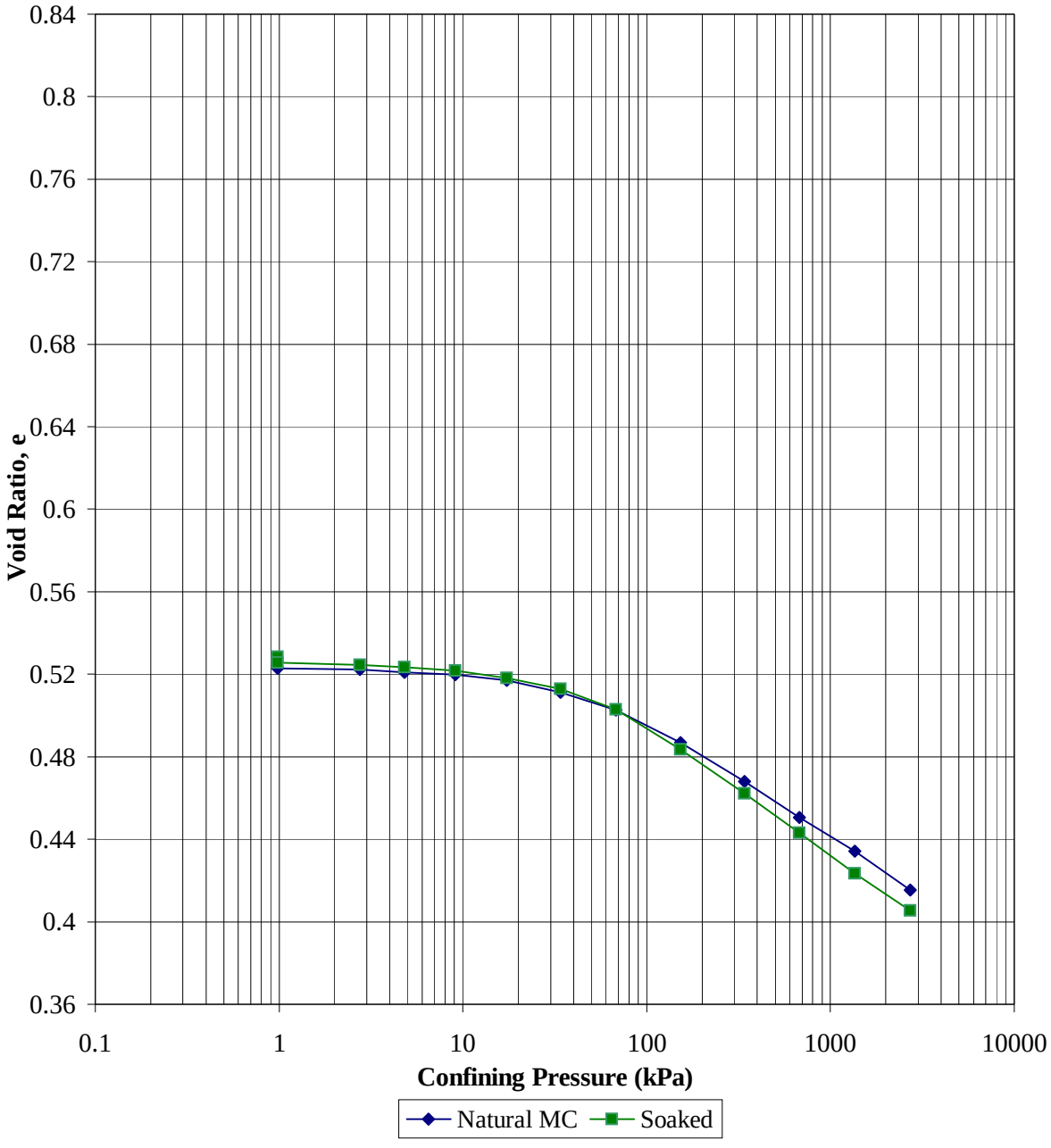
TRICON TESTING
Geotechnical Engineering Laboratory

ONE-DIMENSIONAL CONSOLIDATION TEST
-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT :	Port Village Accommodation Pty Ltd (Job # 76319)	**JOB NO :**	1011471
PROJECT :	Lot 2 & 3 Gt Northern Hwy	**LOCATION :**	Port Hedland
Sample Id :	TP14, Depth : 2.9 - 3.1m	**Lab No. :**	TT 06474002

VOID RATIO Vs CONFINING PRESSURE PLOT



Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP15, Depth : 1.6 - 1.8m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474003A
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	17.97
Dry Density (t/m^3) :	1.710	1.902
Moisture Content (%) :	16.9	15.7
Void Ratio :	0.585	0.425
Degree of Saturation :	78.2	100.2

Sample Description :
Mod Brownish Orange, Clayey Sand with Gravel (med. - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Natural Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.5849
1.0	19.986	0.004	0.02	0.5845
2.8	19.952	0.038	0.19	0.5818
4.8	19.916	0.074	0.37	0.5790
9.1	19.872	0.118	0.59	0.5755
17	19.804	0.186	0.93	0.5701
34	19.701	0.289	1.45	0.5619
68	19.535	0.455	2.28	0.5488
153	19.226	0.764	3.82	0.5243
340	18.910	1.080	5.40	0.4992
679	18.581	1.409	7.05	0.4731
1358	18.268	1.722	8.61	0.4483
2716	17.970	2.020	10.11	0.4247

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP15, Depth : 1.6 - 1.8m

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.76
Dry Density (t/m^3) :	1.707	1.818
Moisture Content (%) :	3.2	3.2
Void Ratio :	0.588	0.490
Degree of Saturation :	14.6	17.5

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474003B
Date Tested : Feb-2012
Sample Description : Mod Brownish Orange, Clayey Sand with Gravel (med. - coarse Gr.)
Sampling Details : nom. 150mm Ø tube sample

CONSOLIDATION DATA (Air-Dried Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.5879
1.0	19.988	0.002	0.01	0.5877
2.8	19.983	0.007	0.04	0.5873
4.8	19.968	0.022	0.11	0.5861
9.1	19.941	0.049	0.25	0.5840
17	19.898	0.092	0.46	0.5806
34	19.846	0.144	0.72	0.5764
68	19.770	0.220	1.10	0.5704
153	19.656	0.334	1.67	0.5613
340	19.518	0.472	2.36	0.5504
679	19.370	0.620	3.10	0.5386
1358	19.106	0.884	4.42	0.5177
2716	18.763	1.227	6.14	0.4904

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] Ph: [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP15, Depth : 1.6 - 1.8m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474003C
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.00
Dry Density (t/m^3) :	1.708	1.896
Moisture Content (%) :	16.9	15.8
Void Ratio :	0.587	0.429
Degree of Saturation :	78.0	100.0

Sample Description :
Mod Brownish Orange, Clayey Sand with Gravel (med. - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Soaked)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.985	0.000	0.00	0.5867
1.0	19.973	0.012	0.06	0.5858
1.0 **	19.918	0.067	0.34	0.5814
2.8	19.902	0.083	0.42	0.5801
4.8	19.878	0.107	0.54	0.5782
9.1	19.842	0.143	0.72	0.5754
17	19.782	0.203	1.02	0.5706
34	19.696	0.289	1.45	0.5638
68	19.574	0.411	2.06	0.5541
153	19.292	0.693	3.47	0.5317
340	18.966	1.019	5.10	0.5058
679	18.665	1.320	6.60	0.4819
1358	18.338	1.647	8.24	0.4559
2716	18.004	1.981	9.91	0.4294

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client
** Specimen was inundated at the start of this stage

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory

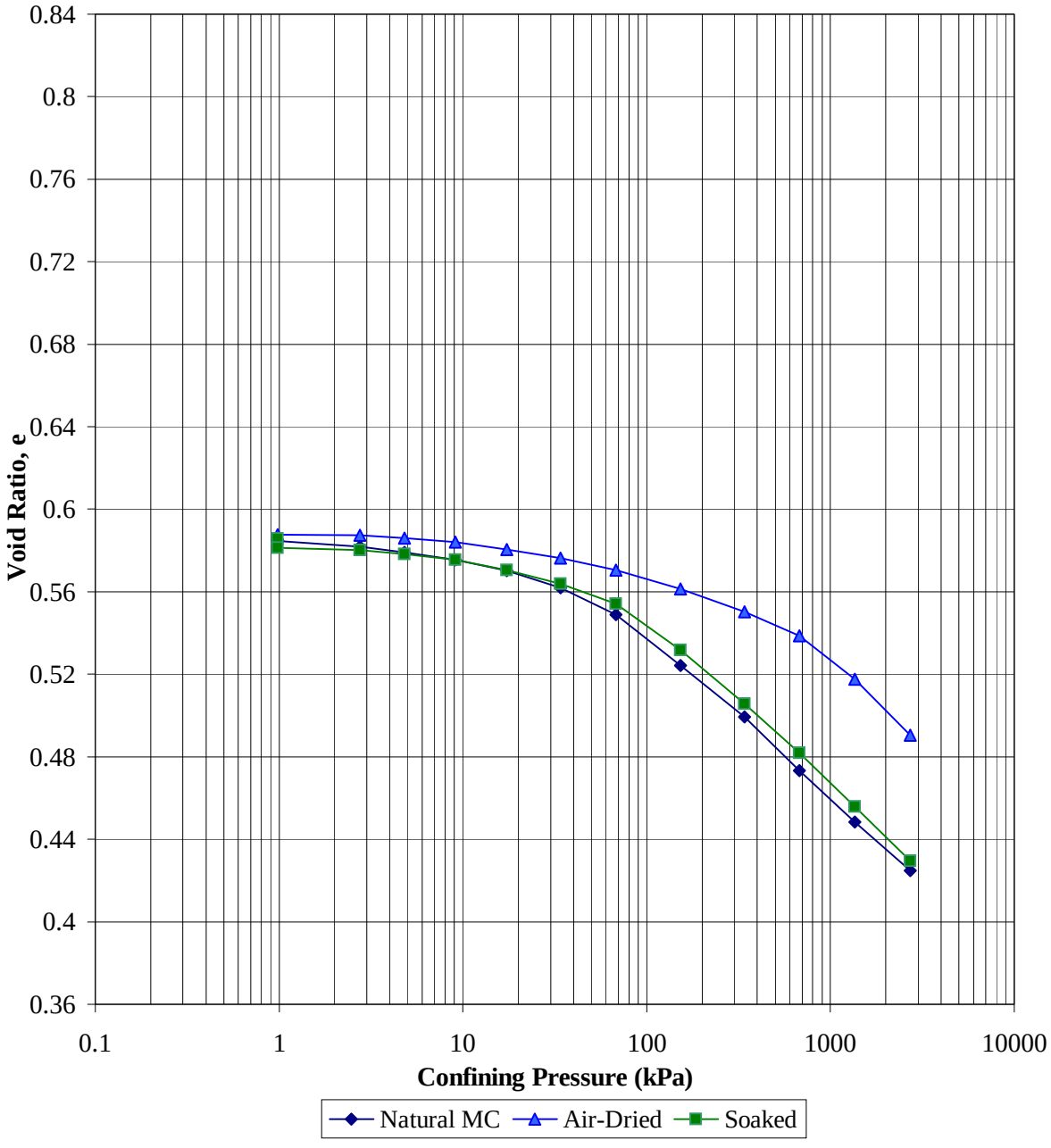
ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT :	Port Village Accommodation Pty Ltd (Job # 76319)	**JOB NO :**	1011471
PROJECT :	Lot 2 & 3 Gt Northern Hwy	**LOCATION :**	Port Hedland
Sample Id :	TP15, Depth : 1.6 - 1.8m	**Lab No. :**	TT 06474003

VOID RATIO Vs CONFINING PRESSURE PLOT



Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP15, Depth : 2.6 - 2.8m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474004A
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	17.77
Dry Density (t/m^3) :	1.592	1.791
Moisture Content (%) :	17.6	17.6
Void Ratio :	0.703	0.513
Degree of Saturation :	68.1	93.2

Sample Description :
Mod Brownish Red, Clayey Silty Sand (med. - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Natural Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.7026
1.0	19.986	0.004	0.02	0.7023
2.8	19.955	0.035	0.18	0.6997
4.8	19.926	0.064	0.32	0.6972
9.1	19.885	0.105	0.53	0.6937
17	19.829	0.161	0.81	0.6889
34	19.729	0.261	1.31	0.6804
68	19.548	0.442	2.21	0.6650
153	19.233	0.757	3.79	0.6382
340	18.892	1.098	5.49	0.6091
679	18.551	1.439	7.20	0.5801
1358	18.173	1.817	9.09	0.5479
2716	17.766	2.224	11.13	0.5132

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP15, Depth : 2.6 - 2.8m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474004B
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.23
Dry Density (t/m^3) :	1.589	1.742
Moisture Content (%) :	3.3	3.3
Void Ratio :	0.705	0.555
Degree of Saturation :	12.6	16.0

Sample Description :
Mod Brownish Red, Clayey Silty Sand (med. - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Air-Dried Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.7053
1.0	19.987	0.003	0.02	0.7051
2.8	19.977	0.013	0.07	0.7042
4.8	19.958	0.032	0.16	0.7026
9.1	19.933	0.057	0.29	0.7005
17	19.889	0.101	0.51	0.6967
34	19.836	0.154	0.77	0.6922
68	19.746	0.244	1.22	0.6845
153	19.626	0.364	1.82	0.6743
340	19.409	0.581	2.91	0.6558
679	19.151	0.839	4.20	0.6338
1358	18.736	1.254	6.27	0.5984
2716	18.233	1.757	8.79	0.5554

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP15, Depth : 2.6 - 2.8m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474004C
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	17.10
Dry Density (t/m^3) :	1.598	1.867
Moisture Content (%) :	17.6	16.6
Void Ratio :	0.696	0.452
Degree of Saturation :	68.7	100.0

Sample Description :
Mod Brownish Red, Clayey Silty Sand (med. - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Soaked)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.985	0.000	0.00	0.6961
1.0	19.973	0.012	0.06	0.6951
1.0 **	19.904	0.081	0.41	0.6892
2.8	19.873	0.112	0.56	0.6866
4.8	19.828	0.157	0.79	0.6828
9.1	19.745	0.240	1.20	0.6757
17	19.641	0.344	1.72	0.6669
34	19.466	0.519	2.60	0.6520
68	19.236	0.749	3.75	0.6325
153	18.852	1.133	5.67	0.5999
340	18.436	1.549	7.75	0.5646
679	18.043	1.942	9.72	0.5313
1358	17.586	2.399	12.00	0.4925
2716	17.104	2.881	14.42	0.4516

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client
** Specimen was inundated at the start of this stage

Authorised Signatory : _ [redacted]

Date : 22/02/2012
Form No AS1289.6.1.1/1 05/1R

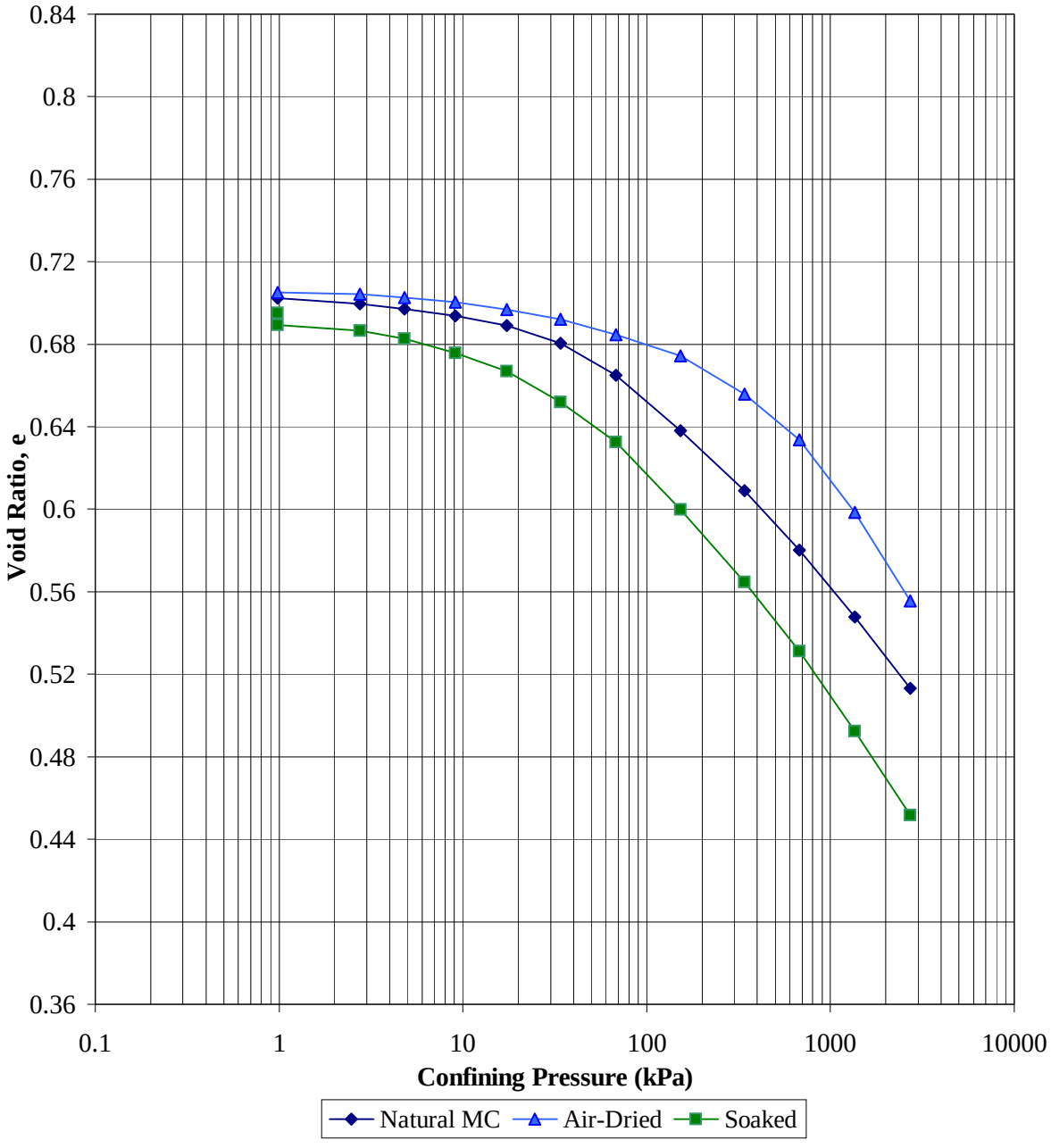
TRICON TESTING
Geotechnical Engineering Laboratory

ONE-DIMENSIONAL CONSOLIDATION TEST
-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT :	Port Village Accommodation Pty Ltd (Job # 76319)	**JOB NO :**	1011471
PROJECT :	Lot 2 & 3 Gt Northern Hwy	**LOCATION :**	Port Hedland
Sample Id :	TP15, Depth : 2.6 - 2.8m	**Lab No. :**	TT 06474004

VOID RATIO Vs CONFINING PRESSURE PLOT



Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP17, Depth : 1.1 - 1.4m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474005A
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	17.27
Dry Density (t/m^3) :	1.512	1.749
Moisture Content (%) :	16.5	16.5
Void Ratio :	0.793	0.549
Degree of Saturation :	56.3	81.3

Sample Description :
Mod Yellowish Brown, Clayey Silty Sand (med. - coarse Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Natural Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.7926
1.0	19.986	0.004	0.02	0.7922
2.8	19.962	0.028	0.14	0.7901
4.8	19.939	0.051	0.26	0.7880
9.1	19.902	0.088	0.44	0.7847
17	19.841	0.149	0.75	0.7792
34	19.746	0.244	1.22	0.7707
68	19.578	0.412	2.06	0.7557
153	19.253	0.737	3.69	0.7265
340	18.806	1.184	5.92	0.6864
679	18.316	1.674	8.37	0.6425
1358	17.794	2.196	10.99	0.5957
2716	17.274	2.716	13.59	0.5490

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP17, Depth : 1.1 - 1.4m

Specimen Details :	**Placement**	**Final**
Height :	19.99	16.31
Dry Density (t/m^3) :	1.511	1.852
Moisture Content (%) :	16.4	17.1
Void Ratio :	0.793	0.463
Degree of Saturation :	56.2	100.1

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474005B
Date Tested : Feb-2012
Sample Description :
Mod Yellowish Brown, Clayey Silty Sand (med. - coarse Gr.)
Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Soaked)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.985	0.000	0.00	0.7933
1.0	19.973	0.012	0.06	0.7922
1.0 **	19.832	0.153	0.77	0.7796
2.8	19.774	0.211	1.06	0.7744
4.8	19.712	0.273	1.37	0.7688
9.1	19.607	0.378	1.89	0.7594
17	19.436	0.549	2.75	0.7440
34	19.186	0.799	4.00	0.7216
68	18.846	1.139	5.70	0.6911
153	18.336	1.649	8.25	0.6453
340	17.758	2.227	11.14	0.5935
679	17.263	2.722	13.62	0.5490
1358	16.753	3.232	16.17	0.5033
2716	16.308	3.677	18.40	0.4633

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client
** Specimen was inundated at the start of this stage

Authorised Signatory : [redacted]

Date : 22/02/2012
Form No AS1289.6.1.1/1 05/1R

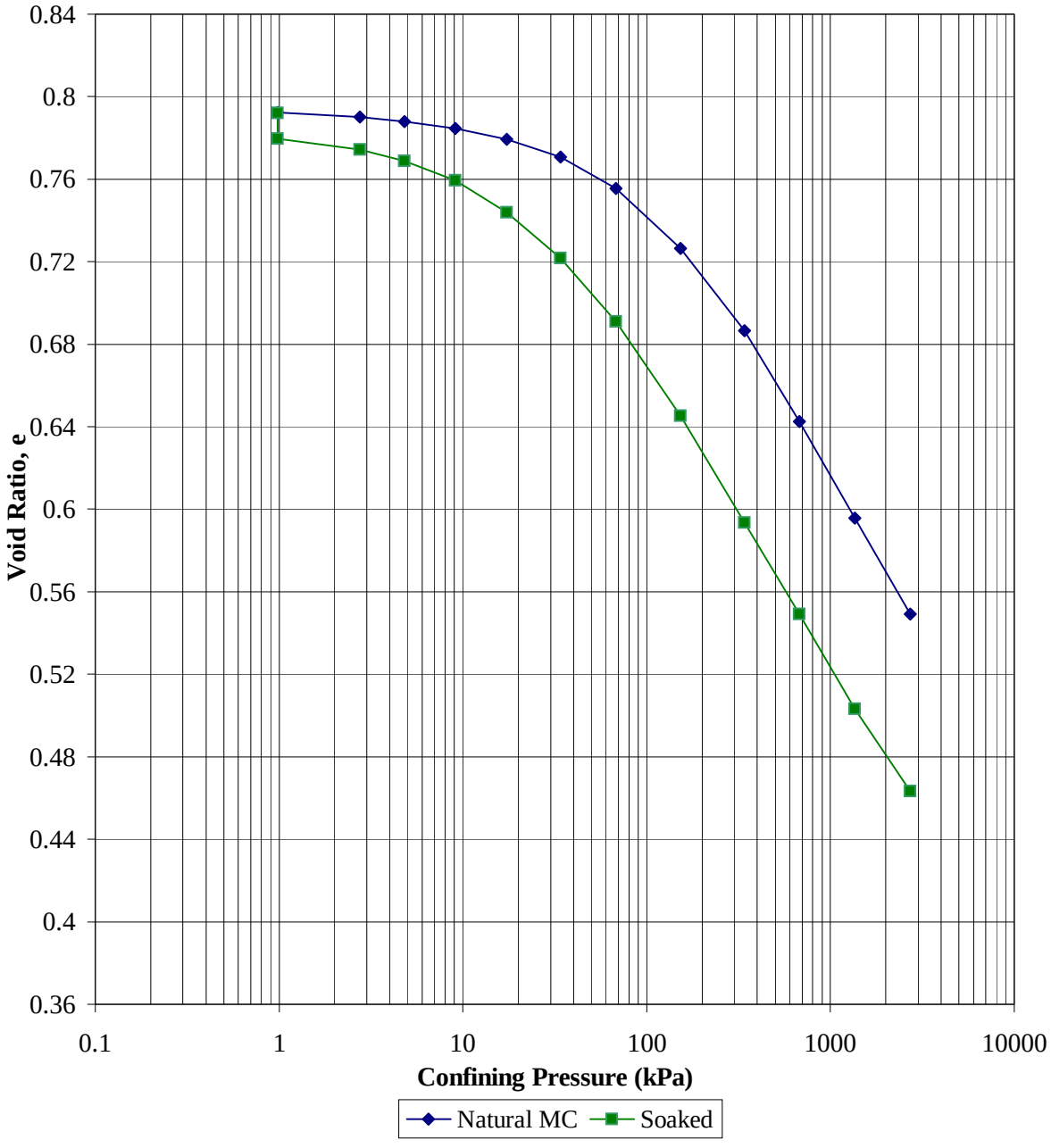
TRICON TESTING
Geotechnical Engineering Laboratory

ONE-DIMENSIONAL CONSOLIDATION TEST
-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT :	Port Village Accommodation Pty Ltd (Job # 76319)	**JOB NO :**	1011471
PROJECT :	Lot 2 & 3 Gt Northern Hwy	**LOCATION :**	Port Hedland
Sample Id :	TP17, Depth : 1.1 - 1.4m	**Lab No. :**	TT 06474005

VOID RATIO Vs CONFINING PRESSURE PLOT



Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP19, Depth : 0.7 - 0.9m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474006A
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.37
Dry Density (t/m^3) :	1.722	1.875
Moisture Content (%) :	16.0	16.0
Void Ratio :	0.573	0.446
Degree of Saturation :	75.9	97.6

Sample Description :
Dark Reddish Brown, Clayey Sand (fine - med. Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Natural Moisture Content)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.990	0.000	0.00	0.5735
1.0	19.988	0.002	0.01	0.5733
2.8	19.981	0.009	0.05	0.5728
4.8	19.971	0.019	0.10	0.5720
9.1	19.955	0.035	0.18	0.5707
17	19.914	0.076	0.38	0.5675
34	19.842	0.148	0.74	0.5618
68	19.726	0.264	1.32	0.5527
153	19.506	0.484	2.42	0.5354
340	19.256	0.734	3.67	0.5157
679	18.960	1.030	5.15	0.4924
1358	18.671	1.319	6.60	0.4697
2716	18.366	1.624	8.12	0.4456

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client

Authorised Signatory : [redacted]

Date : 22/02/2012

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
[redacted] [redacted] Fax: (08) 9240 1044

ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT : Port Village Accommodation Pty Ltd (Job # 76319)
PROJECT : Lot 2 & 3 Gt Northern Hwy
Sample Id : TP19, Depth : 0.7 - 0.9m

JOB NO : 1011471
LOCATION : Port Hedland
Lab No. : TT 06474006B
Date Tested : Feb-2012

Specimen Details :	**Placement**	**Final**
Height :	19.99	18.16
Dry Density (t/m^3) :	1.723	1.896
Moisture Content (%) :	16.0	15.8
Void Ratio :	0.573	0.429
Degree of Saturation :	76.0	100.1

Sample Description :
Dark Reddish Brown, Clayey Sand (fine - med. Gr.)

Sampling Details :
nom. 150mm Ø tube sample

CONSOLIDATION DATA (Soaked)

Confining Pressure kPa	Specimen Height (mm)	Specimen Deflection (mm)	Specimen Settlement (%)	Void Ratio e
Initial	19.985	0.000	0.00	0.5727
1.0	19.975	0.010	0.05	0.5719
1.0 **	19.916	0.069	0.35	0.5673
2.8	19.892	0.093	0.47	0.5654
4.8	19.873	0.112	0.56	0.5639
9.1	19.828	0.157	0.79	0.5604
17	19.765	0.220	1.10	0.5554
34	19.667	0.318	1.59	0.5477
68	19.520	0.465	2.33	0.5361
153	19.268	0.717	3.59	0.5163
340	18.956	1.029	5.15	0.4917
679	18.685	1.300	6.50	0.4704
1358	18.416	1.569	7.85	0.4492
2716	18.159	1.826	9.14	0.4290

Notes : An assumed particle density of 2.71 t/m3 has been used to determine void ratio
Sample supplied by client
** Specimen was inundated at the start of this stage

Authorised Signatory : [redacted]

Date : 22/02/2012
Form No AS1289.6.1.1/1 05/1R

TRICON TESTING
Geotechnical Engineering Laboratory

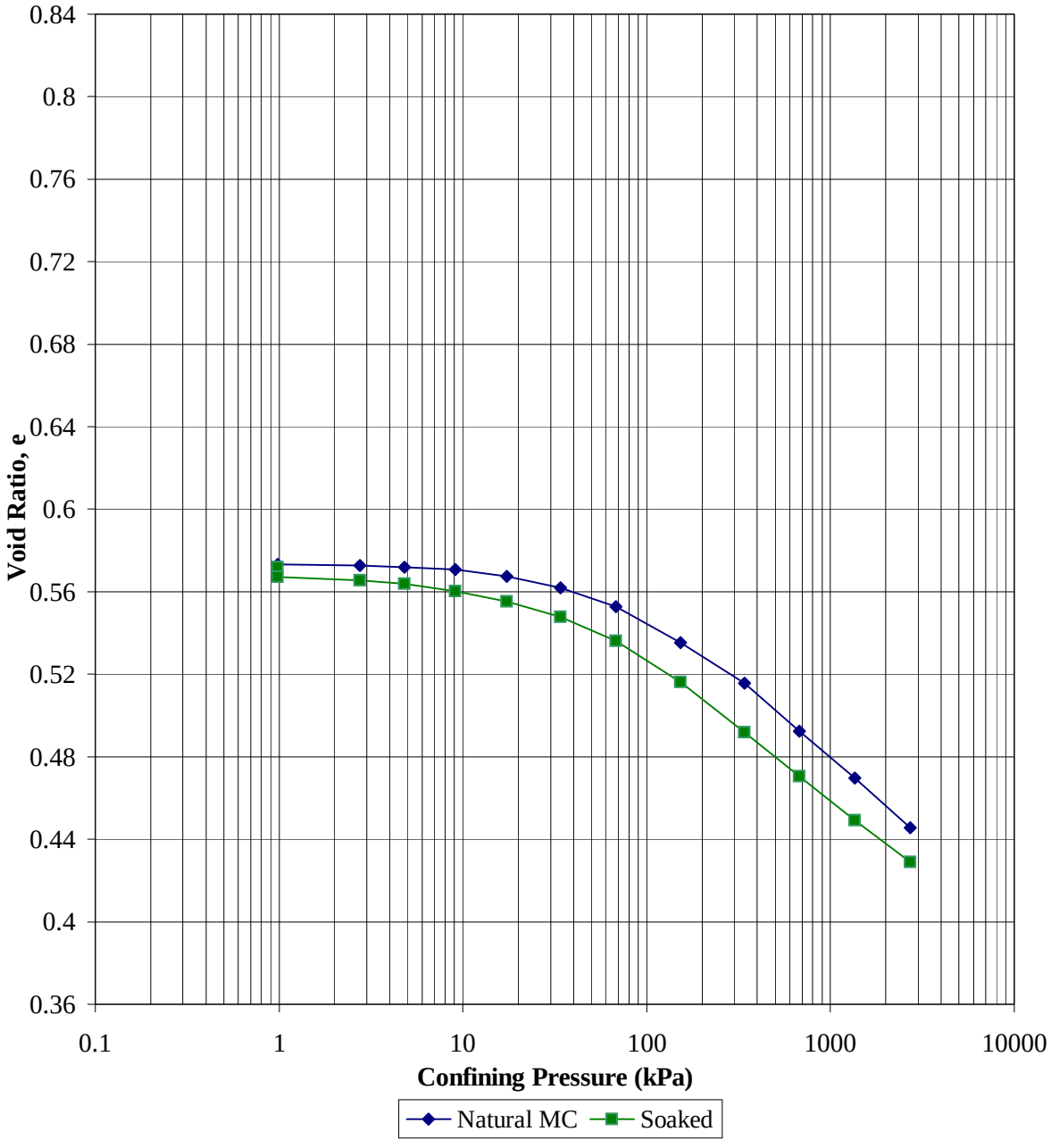
ONE-DIMENSIONAL CONSOLIDATION TEST

-Collapse Potential method - SMFE(SA)

REPORT CERTIFICATE

CLIENT :	Port Village Accommodation Pty Ltd (Job # 76319)	**JOB NO :**	1011471
PROJECT :	Lot 2 & 3 Gt Northern Hwy	**LOCATION :**	Port Hedland
Sample Id :	TP19, Depth : 0.7 - 0.9m	**Lab No. :**	TT 06474006

VOID RATIO Vs CONFINING PRESSURE PLOT



Authorised Signatory : [redacted]

Date : 22/02/2012

Form No AS1289.6.1.1/1 05/1R