LINDEMAN GREAT BARRIER REEF RESORT PROJECT

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX F - GEOTECHNICAL ASSESSMENT

Addendum: *This EIS was initially prepared assuming that the safe harbour was to be part of the Lindeman Great Barrier Reef Resort Project. With the commencement of the Great Barrier Reef Marine Park Authority's (GBRMPA) Dredging Coral Reef Habitat Policy (2016), further impacts on Great Barrier Reef coral reef habitats from yet more bleaching, and the recent impacts from Tropical Cyclone Debbie, the proponent no longer seeks assessment and approval to construct a safe harbour at Lindeman Island. Instead the proponent seeks assessment and approval for upgrades to the existing jetty and additional moorings in sheltered locations around the island to enable the resort's marine craft to obtain safe shelter under a range of wind and wave conditions. Accordingly, remaining references to, and images of, a safe harbour on various figures and maps in the EIS are no longer current.*

PRELIMIINARY GEOTECHNICAL ASSESSMENT

LINDEMAN ISLAND REDEVELOPMENT

HRP15078

Prepared for
White Horse Holdings Limited

7 September 2015

Note: Minor updates dated 11/06/2017 to remove references to safe harbour.

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Document Information

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Contact Information

Cardno (Qld) Pty Ltd
Trading as Cardno Ullman & Nolan Geotechnic
ABN 57 051 074 992

71 Connors Road
Mackay Qld 4740
Australia

Telephone: 61 7 4952 5255
Facsimile: 61 7 4952 5455

soils@cardno.com.au
www.cardno.com.au

Document Control

Version	Date	Author	Author Initials	Reviewer	Reviewer Initials
1	3/9/15	Andy Williams	AW	Trudie Bradbury	TB
2	7/9/15	Andy Williams	AW	Trudie Bradbury	TB
3	11/06/17		CF		

Letter of Transmittal

White Horse Holdings Limited
c/- Cardno Group
Level 11 St Pauls Terrace
FORTITUDE VALLEY QLD 4006

Attention: Dave Perkins & Catherine Fleming

Dear Sir/Madam,

PRELIMIINARY GEOTECHNICAL ASSESSMENT
LINDEMAN ISLAND REDEVELOPMENT

At the request of the White Horse Holdings Limited (the client) Cardno has undertaken a preliminary geotechnical assessment of the existing resort area and the proposed areas for redevelopment on Lindeman Island. The aim of the assessment was to inspect critical areas of development namely the steeper slope areas for future development, the existing dam wall, potential quarry site and sewerage irrigation areas.

This report contains the findings of the inspection and provides general recommendation for conceptual design and further work. This study is not meant to be used for design of structures or other infrastructure. A separate report is being compiled to assist with input to an ongoing environmental impact assessment

We hope you find this report of interest and look forward to any clarifications you may have on this assessment.

Yours faithfully,

Andrew Williams
Senior Principal Engineering Geologist
MS.Env.Mgmt., BSc.(Hons), Pg.Dip., CGeol
for **Cardno Ullman & Nolan Geotechnic**

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1 SCOPE OF WORK

The scope was outlined to the client in a proposal dated 6 July to the client with an explanatory email (Fleming to Williams) on the 29 July 2015. The scope included a two day inspection by a Senior Principal Engineering Geologist from our Mackay office. Andrew Williams has 30 years geotechnical experience and for the last 15 years he has been based in the Whitsunday area working on all the developed islands, so has good local knowledge of island resort development. The inspection was augmented by a test pitting programme at eight accessible locations where new development is likely. The pits were planned to be excavated by a backhoe provided by the client, but this was not available so manual methods were utilised. The soils are generally thin across the island so this restriction was not considered too significant and most of the pits got to depths where rock was encountered. The locations of the pits are shown in **Figure 1**.

A dynamic cone penetrometer (DCP) test was conducted in accordance with AS 1289.6.3.2, within 2m of each test pit. The results of which are attached in **Appendix A** along with the test pit logs. The test pits were logged onsite with reference to AS1726 and photographed before being backfilled. Representative disturbed samples were taken from the soil and rock strata. These samples were transported back to our NATA accredited facilities in Mackay for laboratory testing.

The development areas were walked over and the visible geology mapped. The existing infrastructure including the sewerage treatment plant, water tanks, beach and landing slipway/jetty and the workshop area were all inspected during this walkover. Photographs of the inspection are provided in **Appendix B**.

Laboratory testing of representative samples were undertaken on soil and rock samples as follows:

Table 1-1 Summary of Laboratory Testing

Test Pit	Location	Tests	General Purpose of Testing
1	Airstrip	Atterberg, Grading, Moisture Density Relationship and Emerson	Classification, reuse as fill, erodability and dispersion, reactivity
2	Airstrip	Atterberg, Grading & Emerson	Classification, reuse as fill, erodability and reactivity
4	Black Water Dam	Atterberg, Grading & Emerson	Classification, reuse as fill, erodability and reactivity
7	Fairway	Atterberg, Grading, Emerson & Point Load	Classification, reuse as fill, erodability and reactivity, strength of rock

The results of the laboratory tests are provided in **Appendix C**.

2 SITE DESCRIPTION AND SITE HISTORY

Lindeman Island is approximately 637 hectares in area with the resort lease being 71.2 hectares of the southern part of this island The island is located in the southern most area of the Whitsunday Islands.

The island was established as a sheep grazing lease in 1905 with a camp for visitors established there in 1923. In 1992 a major investment was undertaken by Club Med of France to construct the existing resort. Following damage by Cyclone Yasi the island was sold to White Horse (Holdings) Australia in 2011. The client is now looking at scenarios to redevelop the existing infrastructure, much of which is no longer functional and also to construct low impact developments in new areas.

The island shows the typical geomorphology of the Whitsunday Group; well vegetated, high relief, with a steep coast line and significant rock outcrop. The land form is a function of the ancient sea level rise that has effectively 'drowned' this area of volcanic rock hills to form the existing island group.

There are significant parts of the island where slopes are less than 15% (see **Figure 2**) such as the area where the two orientations of airstrip occur in the central part of the client's lease. The steeper areas are mostly confined to the slopes around the coastlines and the more elevated areas.

The vegetation on the island comprises grasslands in the flatter areas with dry bushland and mature trees in the undeveloped areas. The resort area and golf course is mostly gardens or maintained grass lawns.

3 REGIONAL AND SITE GEOLOGY

3.1 REGIONAL GEOLOGY

The Whitsunday Volcanic Province has been defined as comprising the Early Cretaceous volcanic and intrusive rocks exposed in the Whitsunday, Cumberland and Northumberland Island groups, as well as onshore exposures to the east of Proserpine. A within-plate, silicic-dominated pyroclastic belt developed along the eastern Australian plate margin, with the volcanic activity caused by the onset of continental breakup of Gondwana during the Cretaceous.

Volcanic and intrusive rocks show a broad range of compositions from basalt through to rhyolite, although intermediate-silicic rock types dominate. Generally the rock types of the Whitsundays are dacitic to rhyolitic ignimbrites, with minor basic to acid lavas and phreatomagmatic deposits, though notably, Lindeman and Hamilton Islands comprise mainly lithic breccias, and coarse lithic ignimbrites. These rock types are indicative of large-volume explosive volcanism with a significant contribution from water either in the form of groundwater or shallow surface water.

Two major faults cross-cut the Volcanic sequence locally; the Whitsunday and Molle Faults are both NNW-trending and show opposing steep and shallow dipping strata on opposite sides of the faults. The Craig and Conway faults trend SSW and are indicative of a later phase of strike-slip faulting in the Mid-Late Cretaceous.

3.2 SITE GEOLOGY

The majority of Lindeman Island comprises pyroclastic deposits, under petrological examination this is resolved into a tuff comprising pale green hornblende, plagioclase, fine grained volcanic rock fragments and quartz set in a devitrified and recrystallised matrix. Tuffaceous cobble conglomerate is found with andesite and pyroclastics on the south coast, and small outcrops of andesite, welded crystal tuff and trachyte are found along the north-northeast coast.

Soils tend to be thin and are either the product of colluvial processes or residual weathering. These occur as clayey gravels or gravelly clays up to 0.3m thick with an organic-rich topsoil. The boundary between the soils and rock tends to be abrupt and well defined.

The geology is not one that is conducive to the formation of aquifers. If groundwater does occur, it will be limited to areas of intense fracturing of the rock.

4 ENGINEERING DISCUSSION

This preliminary investigation has covered the whole development area at a concept level. No detailed structural specific investigation has been undertaken, hence the recommendations below need to be treated as general and not for design purposes.

4.1 SLOPE STABILITY

The slopes on the island in the areas of proposed new and redevelopment appears to be suitable for the proposed structures and infrastructure. The slopes greater than 15% see Figure 2 , will need to be developed in a manner of best practice (see guidelines in **Appendix D**) for construction of sloping areas. This will include minimising cut and fill earthworks, socketing or anchoring footings into bedrock, ensuring drainage does not concentrate overland flow and revegetating strip areas as soon as possible.

The soils are generally thin and less than 1.0m deep before strong volcanic rock is encountered. There was little evidence of large scale 'global' slips other than gullying caused by concentrated overland flows. Boulders up to 4.0m in size tend to form sporadically at the surface and were observed all across the development area. These will have the potential to be a risk and may need to be stabilised or removed.

The natural soils, from the laboratory testing and inspection; have not proved to be particularly dispersive (emerson class 5 to 7) hence they should not require special management.

4.2 DAM WALL

The main water storage dam has a dam wall that appears to be an earthen wall with an armourstone facing (see photographs). The dam wall has a 10-15m wide spillway located in cut rock on the western end of the main wall. This spillway is some 1.8m lower than the crest of the wall. There is some seepage in the central area of the dam wall toe, but no flow was visible at the surface with the pond level understood to be 70-80% full at the time of inspection.

There were trees and shrubs growing on the downstream embankment wall at a low level near the toe. There was also slope fall debris (boulders up to 1.0m) and vegetation in the spillway channel that could obstruct any flow. We recommend the trees are cut and poisoned with follow up visual monitoring to see if there is any increased seepage or piping in the areas where the tree roots exist. The spillway channel needs to be cleaned out.

The performance of the dam seems satisfactory but we recommend a dam break analysis is conducted to confirm the extent of any flooding caused by such an event. If there was a risk to existing or future development areas this could be instigated by the construction of low level levees that would channel any flows to the creek to the south of the dam that drains to the sea on the west of the island.

The dam also has the potential to increase capacity. The option of draining then over excavating seems challenging as we understand that the valley was previously used as a quarry when the resort was first constructed. Given the shallow nature of the soils, we would therefore assume that much of the easily excavatable material has already been taken. We therefore consider dam wall raising to be the most likely option. This will require further investigation and modelling and may affect the People at Risk hazard rating for the dam and therefore its regulatory status.

4.3 POTENTIAL QUARRY SITES

The island has several sites that could be considered for a quarry for construction materials namely;

- Existing valley of the dam;
- Old quarry area;
- New cut in airstrip;
- Other new areas.

The existing dam option has been discussed in 4.2 and is not considered feasible.

The use and extension of the old quarry seems much more favourable both from a planning and technical/commercial perspective. The area is shown on Figure 1 around test pit 8. It appears the quarry has been used as a disposal area for green waste for many years which may now need removal prior to quarrying. The rock in the area seems to be of a quality that may produce aggregate for use in concrete and pavement materials subject to petrographic analysis and durability testing. The quantity of rock and accessibility also seems to be favourable. There is existing aggregate bin and track access into the area. Also this area is secluded by the vegetation and landscape meaning it is not easily visible from surrounding areas. The quarry was previously blasted and no doubt would require blasting to work it in future and to extend the resource.

The airstrip is quite undulating and one aim of future development is to flatten this surface and extend for use by larger aircraft. In the higher areas around test pit 1 there are near surface strong rock outcrops. These could be quarried to produce aggregate or armourstone with the combined benefit of creating a flatter airstrip. The quantity and quality of the rock seems feasible. The adjacent areas may however have ecological sensitivity which could restrict the extent of cut. Also regulatory requirements for airstrip geometrics may make steep side cut gradients prohibitive.

The other areas are somewhat restricted as most would create a visible ‘scar’ on the landscape. However, the flat areas around the intersection of the runways could be investigated. There is also the potential to create more water storage in an excavated quarry in this area for resort use and recreational purposes.

4.4 POTENTIAL SEWERAGE DISPOSAL AREAS

We understand the effective population of the new resort will actually decrease from the existing resort and that there is a new system of effluent disposal planned. Any new areas for disposal will need detailed investigation to AS1527 and modelling (MEDLI) to confirm their suitability. The island does have large areas of flatter ground in the central area that could be utilised. It will be important to avoid using steeper coastal areas.

The soils are quite fine grained with 30-50% clays or silts. The underlying rocks are volcanoclastic ignimbrites with occasional igneous intrusions. The permeability of these rocks is very low. The groundwater is mostly either perched near the surface or transmitted along joint of fault planes within the rock. Springs do exist and would be fracture zone or fault related. The wells that do exist are understood to frequently dry up in the dry season and some have been decommissioned.

We consider that using the golf fairways would be sustainable for irrigation for treated effluent. However, the proximity of the water supply dam would need to be considered in the design of the system.

5 LIMITATIONS

This report is based solely on the data available at the time of writing. Geotechnical services are provided by Cardno UNG in accordance with generally accepted professional engineering and geologic practice in the area where these services are rendered. The client acknowledges that the present standard in the engineering and geologic and environmental profession does not include a guarantee of perfection, and no other warranty, expressed or implied, is extended by Cardno UNG.

It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein. Cardno UNG assumes no responsibility for misunderstandings or improper interpretations that result is unsatisfactory or unsafe work products. It is the reader's further responsibility to acquire copies of any supplemental reports, addenda or responses to public agency reviews that may supersede recommendations in this report.

The findings presented in this report have been based on the assessment described herein. There are always some variations in subsurface conditions across a site, which cannot be fully defined by investigation. It is unlikely that the measurements and values obtained from sampling and testing during the investigation will represent the extremes of conditions that may exist within the site. Hence it is recommended that if any ground conditions significantly different to those described in this report are encountered during construction, further advice should be immediately sought from Cardno Ullman & Nolan Geotechnic.

This report has been prepared specifically for White Horse Group and their planning teams. Information contained in this report should not be construed as appropriate for any other purposes or for other users.

Figure 1 - Aerial Photograph with Test Pit Location Map

Job No. HRP15078	**UNG DWG No.** HRP15078-1A	**Date** 18/08/2015	**Checked** AW **Date** 18/08/2015	**Notes** 	Cardno Ullman & Nolan Geotechnic Pty Ltd ACN: 103 205 205 71 Connors Road, Mackay 4740 P.O Box 5630, Mackay 4741 Email: soils@cardno.com.au Phone (07) 4952 5255 Fax (07) 4952 5455	**White Horse Group** **Borehole Location Plan** **Linderman Island Resort Proposed Redevelopment**	**Scale at A4** NTS **Drawing No.** Figure 1

Figure 2 – Location of Slopes Greater than 15%

Cardno HRP

LEGEND

- Location of Slopes Greater Than 15%
- Proposed Site Boundary
- Proposed Safe Harbour Lease Boundary
- Existing Site Boundary
- Existing Cadastral Boundary

Note: Safe harbour no longer proposed.

N
W E
S

0 80 160 240 320 400
1:8,000 (metres)

DRAWING TITLE	FIGURE 2: Location of Slopes
DRAWING DATE	14 SEPTEBMBER 2015
DRAWING VERSION	1.0
COORDINATE SYSTEM	GDA 94; MGA ZONE 55
MAP PRODUCED BY	CARDNO HRP
JOB NUMBER	HRP15078

PRELIMINARY GEOTECHNICAL ASSESSMENT

LINDEMAN ISLAND REDEVELOPMENT

Location of Slopes Greater than 15%

FIGURE 2

APPENDIX A

Test Pit Logs & DCP Results

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TEST PIT LOG
Test Pit No. : TP01
Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : Airstrip

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			SC	D	D	**Gravelly Clayey Sand**; dark brown mottled grey, fine to medium grained, fine to coarse grained, angular to sub-angular gravel, with rootlets (TOPSOIL) MPS 20 LL 40 P75 40	0.15m	
0.15			GC	M	VSt	**Clayey Sandy Gravel**; brown mottled grey, fine to coarse grained, angular to sub-angular, fine to medium grained sand, rock outcrop 5m to west MPS 50 LL 45 P75 35	B-1	
0.40						TEST PIT TP01 TERMINATED AT 0.40 m Refusal DCP undertaken within 1.0m of test pit location No ground water encountered at surface, although soils were visibly moist and ground was greener than other areas Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

TEST PIT LOG

Test Pit No. : TP02

Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : Intersection of Airstrip

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			GC	M	St	**Clayey Sandy Gravel**; dark brown, fine to coarse grained, angular to sub-angular, fine to medium grained sand MPS 85 LL 55 P75 40	B-1	
0.45						TEST PIT TP02 TERMINATED AT 0.45 m Refusal DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

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TEST PIT LOG
Test Pit No. : TP03
Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : High Water Tower

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			SC	D	St	**Gravelly Clayey Sand**; dark brown mottle dgrey, fine to medium grained, fine to coarse grained, angular to sub-angular gravel, trace silt (TOPSOIL / COLLUVIUM) MPS 40 LL 40 P75 40	B-1	
0.25						TEST PIT TP03 TERMINATED AT 0.25 m Refusal DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

TEST PIT LOG

Test Pit No. : TP04

Sheet : 1 of 1

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Client : White Horse Group	Hole Commenced : 8.5.15	Contractor : Cardno UNG
Project : Geotechnical Investigation	Hole Completed : 8.5.15	Machines : Shovel
Job No : HRP15078	Logged By : AW	Excavation Method : Hand
Site : Lindemen Island Redevelopment	Checked By : TB	Dimensions : 0.50 m L 0.50 m W
Location : Black Water Down Area	Surface R.L. (m) : AHD	Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			CH	M	St / F	**Gravelly Sandy Clay**; dark brown mottled grey, fine to medium grained sand, medium to coarse grained, sub-rounded to sub-angular gravel (TOPSOIL / COLLUVIUM) MPS 20 LL 50 P75 60	B-1	
0.25			CL		St / VSt	**Sandy Gravelly Clay**; dark brown-red, medium to coarse grained, sub-rounded to sub-angular gravel, fine to medium grained sand (RESIDUAL) MPS 40 LL 30 P75 60		
0.40						TEST PIT TP04 TERMINATED AT 0.40 m Refusal DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

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TEST PIT LOG
Test Pit No. : TP05
Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : New Villas

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			SC	D	St	**Gravelly Clayey Sand**; dark brown mottledgrey, fine to medium grained, medium to coarse grained, sub-rounded to sub-angular gravel (TOPSOIL / COLLUVIUM) MPS 25 LL 40 P75 40	B-1	
0.20						TEST PIT TP05 TERMINATED AT 0.20 m Refusal Refused on Rock DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

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TEST PIT LOG
Test Pit No. : TP06
Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : New Villas

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			SC	M	St	**Gravelly Clayey Sand**; dark brown, fine to medium grained, medium to coarse grained, sub-angular gravel (TOPSOIL / RESIDUAL) MPS 25 LL 45 P75 40	B-1	
0.35						TEST PIT TP06 TERMINATED AT 0.35 m Refusal Refused on Rock DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

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TEST PIT LOG
Test Pit No. : TP07
Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : Fairway/New Villas

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			SC	M	St	**Gravelly Clayey Sand**; dark brown mottled grey, fine to coarse grained, sub-angular gravel, rock outcrop 10m to north (TOPSOIL / COLLUVIUM) MPS 40 LL 45 P75 40	B-1	
0.25						TEST PIT TP07 TERMINATED AT 0.25 m Refusal Refused on Rock DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture		Consistency		Visual Description		Sampling	
D	Dry	VS	very soft	MPS	maximum particle size	U	Undisturbed Sample & Size in mm
M	Moist	S	soft	LL	Liquid Limit	D	Disturbed Sample
W	Wet	L	loose	P75	% passing 75um sieve	PP	Pocket Penetrometer Value
		VL	very loose			ES	Environmental Sample
		D	dense			LAB	Sample sent to Lab
		MD	medium dense			DUP	Duplicate Sample
		VD	very dense			SPLIT	Split Sample
		St	stiff			B	Bulk Sample
		VSt	very stiff				
		F	firm				
		H	hard				

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Shaping the Future

TEST PIT LOG
Test Pit No. : TP08
Sheet : 1 of 1

Client : White Horse Group
Project : Geotechnical Investigation
Job No : HRP15078
Site : Lindemen Island Redevelopment
Location : Old Quarry

Hole Commenced : 8.5.15
Hole Completed : 8.5.15
Logged By : AW
Checked By : TB
Surface R.L. (m) : AHD

Contractor : Cardno UNG
Machines : Shovel
Excavation Method : Hand
Dimensions : 0.50 m L 0.50 m W
Coords : MGA94 56

STRATA				VISUAL SOIL DESCRIPTION			SAMPLING	TESTING
Depth (m)	RL (m AHD)	Graphic Log	Classification	Moisture	Consistency	Description (SOIL NAME; plasticity/grain size, colour, particle shape, secondary components, minor constituents) (ROCK NAME; grain size, colour, minor constituents)	Sampling	Testing
			GC	D	D	**Clayey Sandy Gravel**; dark brown mottle dgrey, medium to coarse grained, angular, fine to coarse grained sand, fill of old crush aggregate and topsoil (FILL) MPS 25 LL 25 P75 30	B-1	
0.20						TEST PIT TP08 TERMINATED AT 0.20 m Refusal Refused on Rock DCP undertaken within 1.0m of test pit location No ground water encountered Surface had been stripped of vegitation TP excavated by hand tools to refusal TP walls stable throughout		
0.5								

Moisture	
D	Dry
M	Moist
W	Wet

Consistency	
VS	very soft
S	soft
L	loose
VL	very loose
D	dense
MD	medium dense
VD	very dense
St	stiff
VSt	very stiff
F	firm
H	hard

Visual Description	
MPS	maximum particle size
LL	Liquid Limit
P75	% passing 75um sieve

Sampling	
U	Undisturbed Sample & Size in mm
D	Disturbed Sample
PP	Pocket Penetrometer Value
ES	Environmental Sample
LAB	Sample sent to Lab
DUP	Duplicate Sample
SPLIT	Split Sample
B	Bulk Sample

APPENDIX B

Site Photographs

Photo 1: Looking north-east over the southern part of the island

Photo 2: Tank and workshop area

Photo 3: Old sewage treatment plant

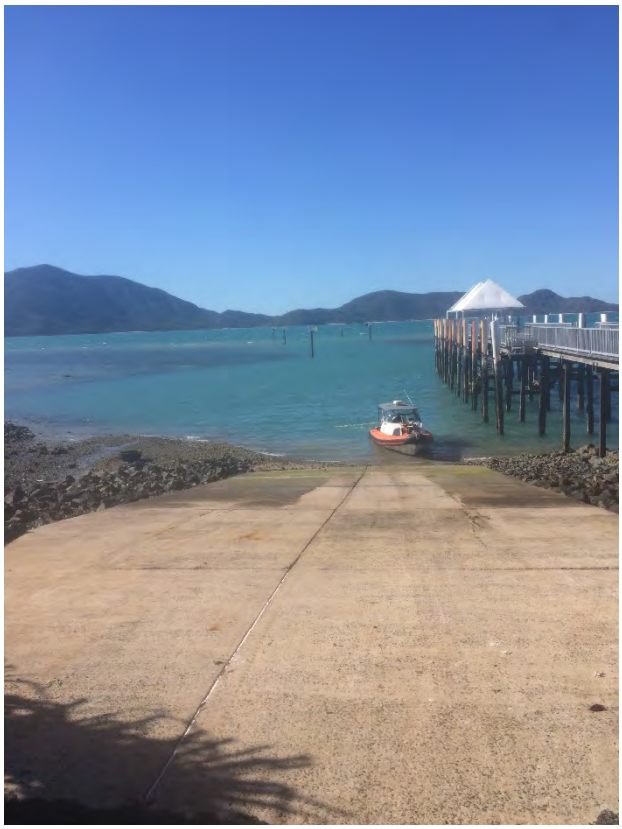

Photo 4: Slipway and jetty at near low tide level

Photo 5: Burst water storage tank

Photo 6: Fuel tanks in bunded area

Photo 7: Boulder and vegetation in dam spill way

Photo 8: Main dam pond looking north

Photo 9: Dam upstream well

Photo 10: Spill wall lip on dam

Photo 11: Dam downstream wall with seepage area

Photo 12: Downstream dam wall with tree growing

Photo 13: Fairway looking South

Photo 14: Main resort beach

Photo 15: Beach rock exposed at low tide on resort beach

Photo 16: Downstream wall of blackwater dam

Photo 17: New slope development areas above main resort

Photo 18: Turbidity in the sea near resort

Photo 19: Old disused well

Photo 20: Panoramic view of south facing slope above the main resort

APPENDIX C

Laboratory Test Results

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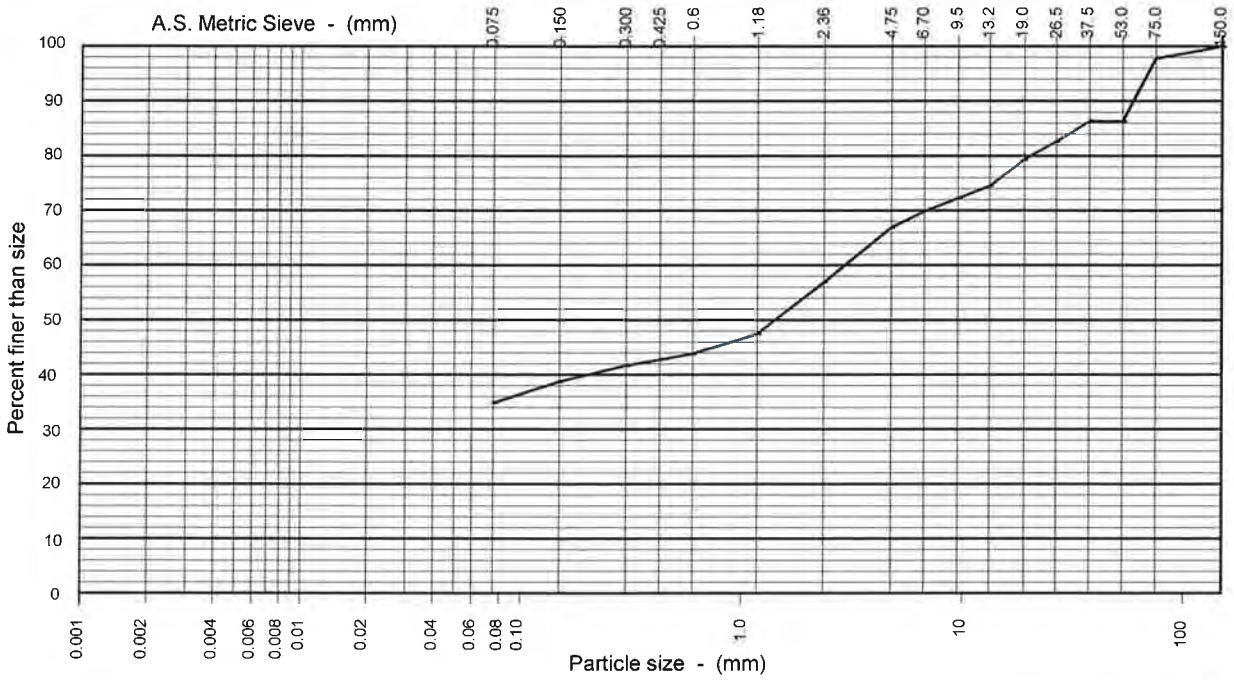
(-/1/14)

REPORT ON SOIL CLASSIFICATION

Mackay Laboratory

CLIENT:	**White Horse Group**	**JOB NO:**	HRP15078	**LAB REF NO:**	15-1790ABC
PROJECT:	**Lindeman Island Redevelopment**	**SAMPLED BY:**	CUNG	**DATE:**	5.8.15
LOCATION:	**Test Pit 1, Depth 0.10-0.30m**	**TESTED BY:**	GM,BD	**DATE:**	20-24.8.15
MATERIAL:	Clayey Sandy Gravel	**CHECKED BY:**	DH	**DATE:**	26.8.15
TEST PROCEDURES:	AS 1289.3.1.1,3.2.1,,3.3.1,3.4.1,3.6.1,3.8.1	**CLIENT REF:**	-		



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	
35				5	4	13	12	11	14	6

Particle Size (mm)	Percent Passing (%)	Particle Size (mm)	Percent Passing (%)
150.0	100		
75.0	98		
37.5	86		
19.0	79		
9.5	72		
4.75	67		
2.36	57		
1.18	48		
0.600	44		
0.425	43		
0.300	42		
0.150	39		
0.075	35		

Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Soil Particle Density (g/cm^3)
37	30	7	6.0	-

Classification: Clayey Sandy Gravel

Emerson Class No.: 7 Temp of Water Used: 24°C Type of Water Used: Distilled

Preparation History of Atterberg Limits

Sample : ~~Natural~~/Air Dried/~~Oven~~

Sieved: ~~Wet~~/dry

Linear Shrinkage Data

Length of Mould (mm) : 250

Sample: -

NATA

Accredited No 910

Certificate No 15-1790A

Date of Issue 27 8 15

Accredited for compliance with ISO/IEC 17025. The results of the tests calibrations and/or measurements included in this document are traceable to Australia/national standards

Authorised Signatory N.J. Richardson

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REPORT ON CALIFORNIA BEARING RATIO OF A SOIL

Sheet 2 of 2 ..... Laboratory

CLIENT:	**White Horse Group**	**JOB NO.:**	HRP15078	**LAB REF NO.:**	15-1790CD
PROJECT:	**Lindeman Island Redevelopment**	**SAMPLED BY:**	CUNG	**DATE:**	5.8.15
LOCATION:	**Test Pit 1, Depth 0.10-0.30m**	**TESTED BY:**	BD DH CD	**DATE:**	20-26.8.15
MATERIAL:	Clayey Sandy Gravel	**CHECKED BY:**	DH	**DATE:**	26.8.15
TEST PROCEDURES:	AS 1289.6.1.1, 5.1.1, ~~5.2.1~~ (Delete One)			**CLIENT REF:**	

Compaction Data	
Maximum Dry Density (t/m^3)	1.66
Optimum Moisture Content (%)	18.0
Material Retained 19 mm sieve (%)	29
M.D.D. Certificate No.	15-1790C
Mass of Compaction Hammer (kg)	2.67
Drop of Compaction Hammer (mm)	301
No. of Layers	3
No. of Blows per Layer	47
Laboratory Density Ratio Specified (%)	98.0
Laboratory Density Ratio Achieved (%)	98.0
Specimen Dry Density (t/m^3)	
i) At Compaction	1.63
ii) After Soaking	1.64
Specimen Moisture Content (%)	
i) At Compaction	18.0
ii) Top 30 mm Layer after Penetration	22.7
iii) Remaining Depth after Penetration	20.9
Laboratory Moisture Ratio (%)	100.0
Soaking Period (days)	4
Swell (%)	-1.0
Penetration (mm)	5.0
California Bearing Ratio (%)	11.0

REMARKS:
Unless specified surcharge of 4.5 kg used

Compactive Effort: standard / ~~modified~~ (delete one)

NATA

Accredited No 910

Certificate No 15-1790C

Date of Issue: 26 8 15

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Authorised Signatory: N.J. Richardson

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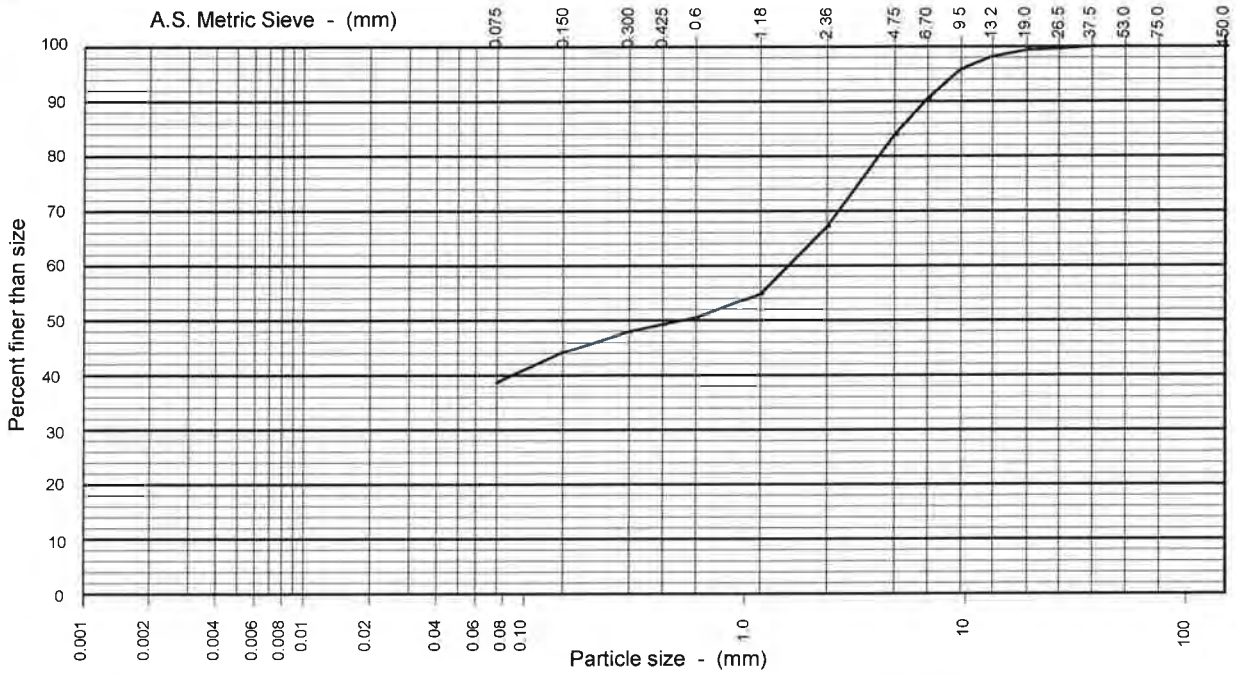
REPORT ON SOIL CLASSIFICATION

Sheet 1 of 1

Mackay Laboratory

CLIENT:	**White Horse Group**	**JOB NO:**	HRP15078	**LAB REF NO:**	15-1791ABC
PROJECT:	**Lindeman Island Redevelopment**	**SAMPLED BY:**	CUNG	**DATE:**	5.8.15
LOCATION:	**Test Pit 2, Depth 0.00-0.20m**	**TESTED BY:**	GM,DH	**DATE:**	20-24.8.15
MATERIAL:	Clayey Sandy Gravel	**CHECKED BY:**	DH	**DATE:**	26.8.15
TEST PROCEDURES:	AS 1289.3.1.1,3.2.1,,3.3.1,3.4.1,3.6.1,3.8.1	**CLIENT REF:**	-		



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	
39				7	5	16	21	11	1	0

Particle Size (mm)	Percent Passing (%)	Particle Size (mm)	Percent Passing (%)
150.0	100		
75.0	100		
37.5	100		
19.0	99		
9.5	96		
4.75	84		
2.36	67		
1.18	55		
0.600	51		
0.425	49		
0.300	48		
0.150	44		
0.075	39		

Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Soil Particle Density (g/cm^3)
38	25	13	6.0	-

Classification: Clayey Sandy Gravel

Emerson Class No.: 7 Temp of Water Used: 24°C Type of Water Used: Distilled

Preparation History of Atterberg Limits

Sample : ~~Natural~~/Air Dried/~~Oven~~

Sieved: ~~Wet~~/dry

Linear Shrinkage Data

Length of Mould (mm) : 250

Sample: -

NATA

Accredited No. 910

Certificate No. 15-1791A

Date of Issue 27 8 15

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Authorised Signatory: N.J. Richardson

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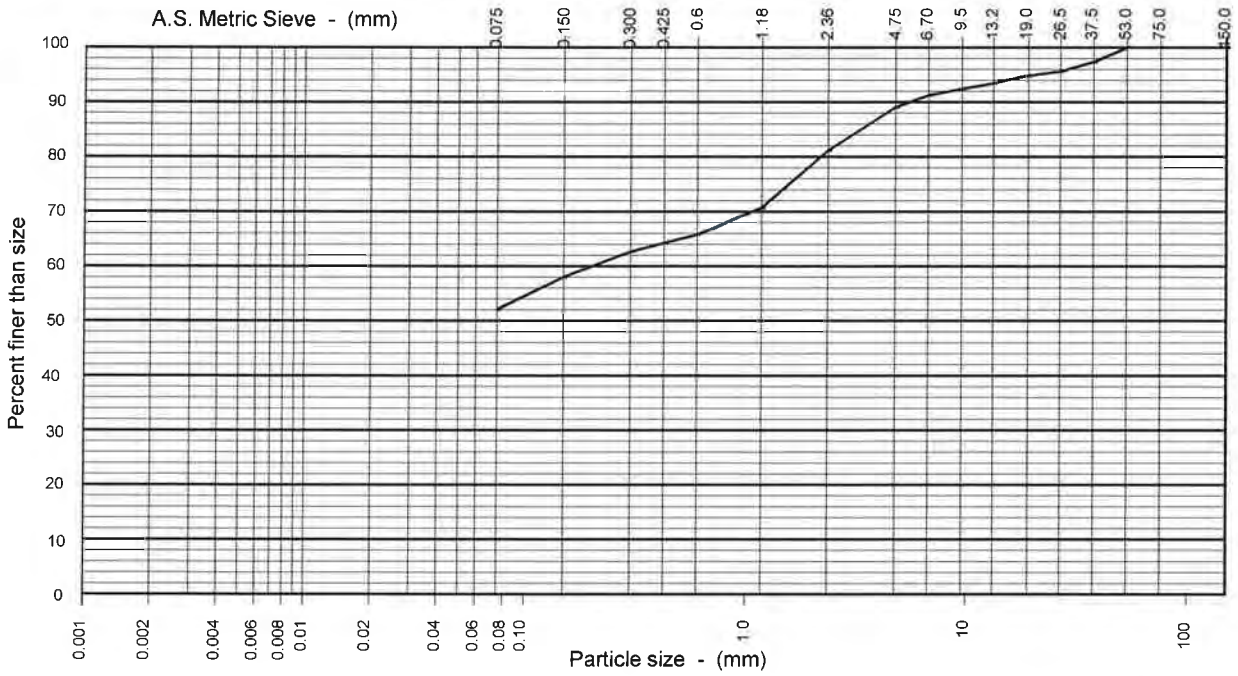
REPORT ON SOIL CLASSIFICATION

Sheet 1 of 1 — Mackay Laboratory

CLIENT:	**White Horse Group**	**JOB NO:**	HRP15078	**LAB REF NO:**	15-1792ABC
PROJECT:	**Lindeman Island Redevelopment**	**SAMPLED BY:**	CUNG	**DATE:**	5.8.15
LOCATION:	**Test Pit 4, Depth 0.10-0.30m**	**TESTED BY:**	GM,DH	**DATE:**	20-24.8.15
MATERIAL:	SandyGravelly Clay	**CHECKED BY:**	DH	**DATE:**	26.8.15
TEST PROCEDURES:	AS 1289.3.1.1,3.2.1,,3.3.1,3.4.1,3.6.1,3.8.1	**CLIENT REF:**	-		



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	
52				8	6	15	9	5	4	1

Particle Size (mm)	Percent Passing (%)	Particle Size (mm)	Percent Passing (%)
150.0	100		
75.0	100		
37.5	97		
19.0	95		
9.5	92		
4.75	89		
2.36	81		
1.18	71		
0.600	66		
0.425	64		
0.300	63		
0.150	58		
0.075	52		

Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Soil Particle Density (g/cm^3)
39	25	14	7.0	-

Classification: **Sandy Gravelly Clay**

Emerson Class No.: 5 — Temp of Water Used: 24°C — Type of Water Used: Distilled

Preparation History of Atterberg Limits

Sample : ~~Natural~~/Air Dried/~~Oven~~

Sieved: ~~Wet~~/dry

Linear Shrinkage Data

Length of Mould (mm) : 250

Sample: -

NATA

Accredited No 910

Certificate No 15-1792A

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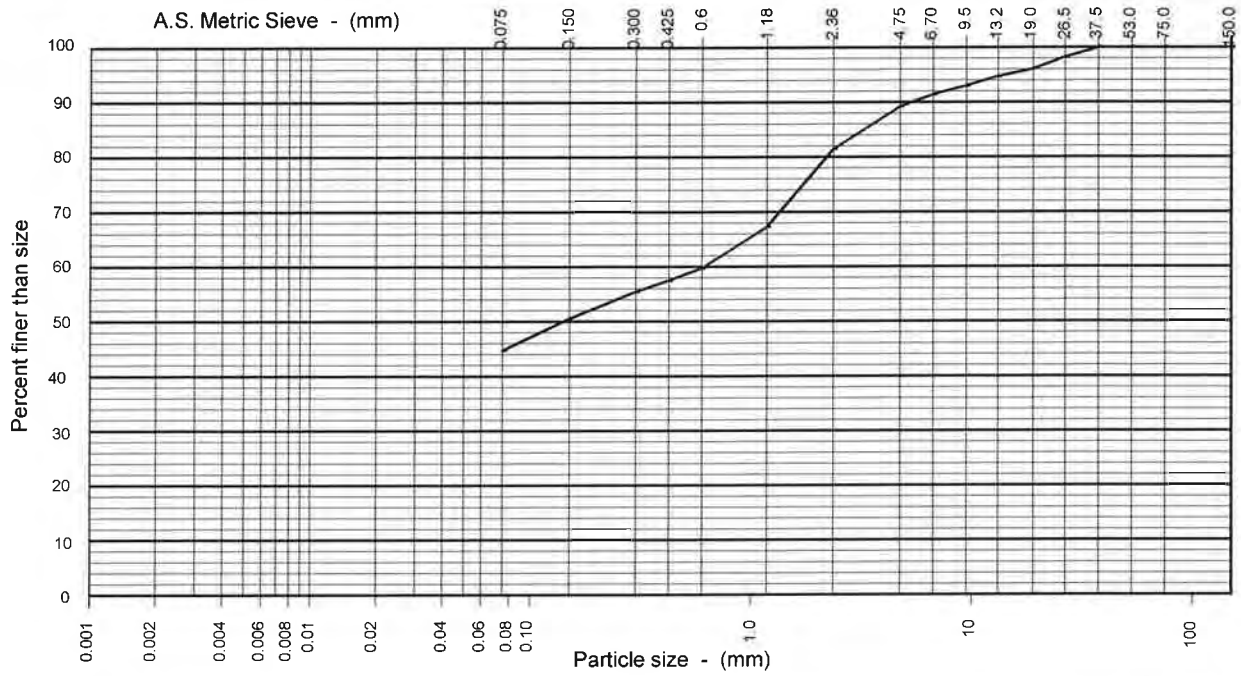
REPORT ON SOIL CLASSIFICATION

Sheet 1 of 1

Mackay Laboratory

CLIENT:	**White Horse Group**	**JOB NO:**	HRP15078	**LAB REF NO:**	15-1793ABC
PROJECT:	**Lindeman Island Redevelopment**	**SAMPLED BY:**	CUNG	**DATE:**	5.8.15
LOCATION:	**Test Pit 7, Depth 0.00- 0.20m**	**TESTED BY:**	GM,DH	**DATE:**	20-24.8.15
MATERIAL:	Clayey Gravelly Sand	**CHECKED BY:**	DH	**DATE:**	26.8.15
TEST PROCEDURES:	AS 1289.3.1.1,3.2.1,,3.3.1,3.4.1,3.6.1,3.8.1	**CLIENT REF:**	-		



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	
45				8	7	22	9	5	4	0

Particle Size (mm)	Percent Passing (%)	Particle Size (mm)	Percent Passing (%)
150.0	100		
75.0	100		
37.5	100		
19.0	96		
9.5	93		
4.75	89		
2.36	82		
1.18	67		
0.600	60		
0.425	58		
0.300	55		
0.150	51		
0.075	45		

Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Soil Particle Density (g/cm^3)
49	34	15	8.0	-

Classification: Clayey Gravelly Sand

Emerson Class No.: 7 Temp of Water Used: 24°C Type of Water Used: Distilled

Preparation History of Atterberg Limits

Sample : ~~Natural~~/Air Dried/~~Oven~~

Sieved: ~~Wet~~/dry

Linear Shrinkage Data

Length of Mould (mm) : 250

Sample: -

NATA

Accredited No 910

Certificate No 15-1793A

Date of Issue 27 8 15

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REPORT ON POINT LOAD

Sheet 1 of 1 Mackay Laboratory

CLIENT:	White Horse Group	**JOB NO.:**	HRP15078	**LAB REF NO:**	Refer below
PROJECT:	Lindeman Island Redevelopment	**SAMPLED BY:**	Cardno	**SAMPLE DATE:**	5.8.15
LOCATION:	Lindeman Island	**TESTED BY:**	CD,DH	**TEST DATE:**	26.8.15
TEST PROCEDURE:	AS4133.4.1	**CHECKED BY:**	DH	**CHECK DATE:**	27.8.15

Lab Ref No	Borehole	Material	Depth From (m)	Depth To (m)	Test Type	D (mm)	P (kN)	$I_{s\ (50)}$ (Mpa)	Rock Strength
15-1793D	TP7	Clayey Gravelly Sand	0.00	0.20	Lump	80	87.20	6.79	VERY HIGH

Notes: Moisture contents of each specimen was not determined.

Signature:  Date: 27.8.15

Andrew Williams

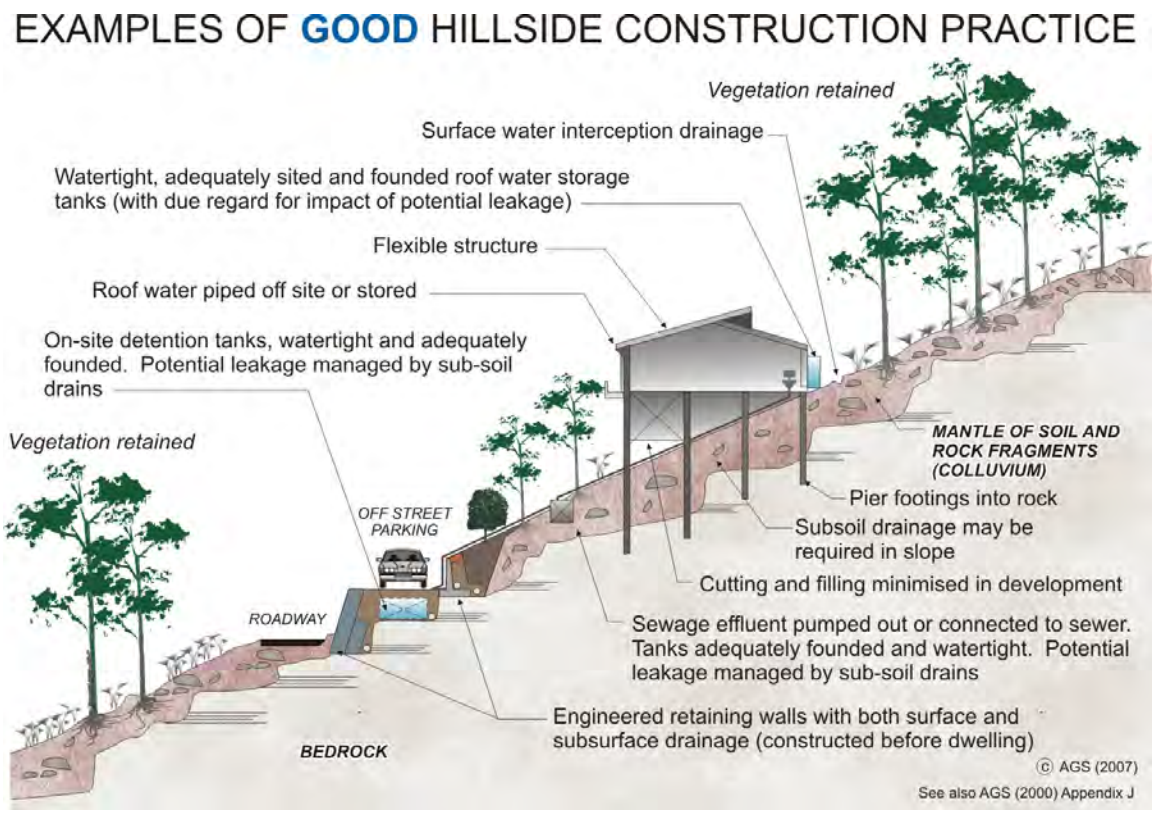
APPENDIX D

Best Practices for Construction on Slopes

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

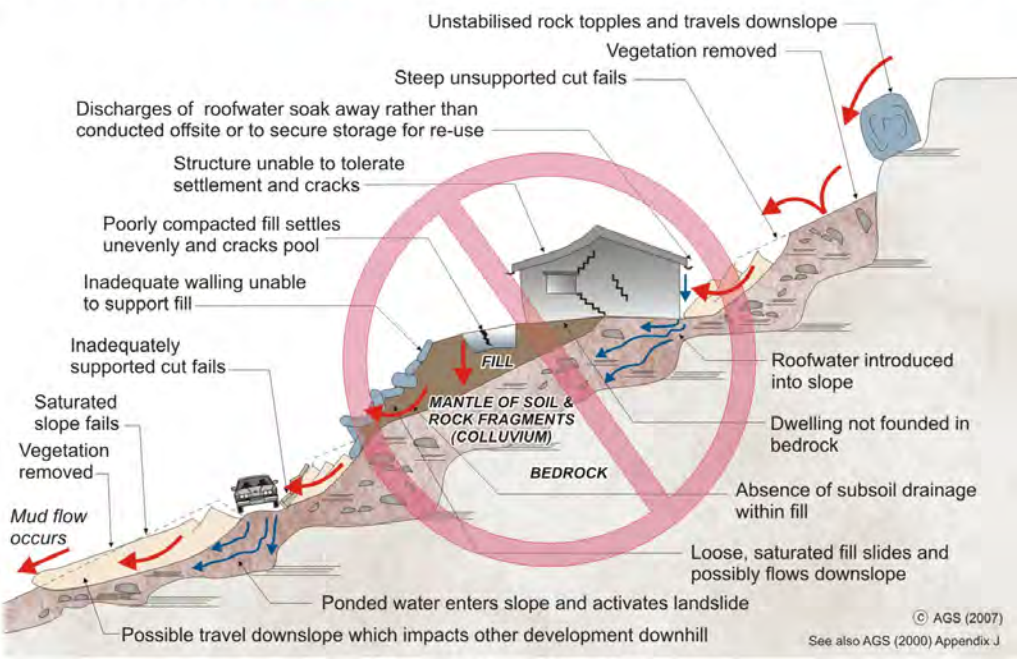
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF **POOR** HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.