PROVINCIAL GEOTECHNICAL PTY. LTD.

CONSULTING GEOLOGISTS

A.B.N. 88 090 400 114

GEOTECHNICAL SITE INVESTIGATION REPORT

COMMISSION:
i. Site Classification to AS2870-2011: Residential slabs and footings.
ii. Geotechnical Design Parameters

Site Address:	Apollo Bay Harbour Precinct 1 Trafalgar Street APOLLO BAY, VICTORIA
Client:	CARDNO TGM PO BOX 563W GEELONG VIC 3220
Proposed Development:	Harbour Precinct Redevelopment
Date:	24th November 2021
File No:	18185J
Author:	Andrew P Redman
Contact:	admin@pgvic.com.au

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i. INTRODUCTION

Provincial Geotechnical Pty Ltd has been commissioned to provide a Geotechnical Site Investigation report for the nominated address. We understand that redevelopment of the infrastructure on the existing site is proposed.

The provided Plan of Survey is appended (Appendix i).

The site investigation hereby reported has been carried out with regard to the information supplied to us by our client or client's agents at the date of our commission. Should the client or his agent have omitted to supply us with relevant information or make significant changes to the building type, building envelope, or site our report may be irrelevant and/or inappropriate. No responsibility will be accepted by us for the consequences of such action. The client should acknowledge that this is a Geotechnical Site Investigation report specifically prepared for the proposed building development at the identified location and does not extend beyond that brief.

All site works related to the building project must be undertaken to comply with the relevant Codes and Standards and must not potentially adversely impact upon building envelopes.
Provincial Geotechnical Pty Ltd accepts no liability or responsibility for any site works outside of our specific commission.

All parties must recognize that this report is not sufficient for any building permit application for any proposed construction on this site.

ii. SITE CLASSIFICATION

The scope of AS2870-2011 allows for the classification of sites for some light commercial and institutional building sites. However, the proposed subdivision development appears to fall outside the scope of the code and the design should be based on engineering principles.

This site would normally be classified as CLASS P due to the presence of deep filling, noting the underlying soil profile is non-reactive (CLASS A – STABLE SAND).

Site Classification is based upon Section 2 Clauses 2.2 of AS2870 - 2011. The method adopted for clay sites primarily includes 2.2.1 (a). Clause 2.2.1 (b) can be adopted under instruction from the client.

Classification of the site has taken into account the following:

- Identification of the sub soil profile.
- Field classification of the soil type and plasticity.

iii. SITE SOIL CHARACTERISTICS SUMMARY

SITE FILLING: Up to 1900mm present.

UNSUITABLE FOUNDATION CONDITIONS: The fill present is not considered a suitable foundation material.

GROUND WATER: None encountered.

PERCHED WATER: None encountered.

BEDROCK: None encountered.

FLOATERS: None encountered.

ABNORMAL MOISTURE CONDITIONS: Existing infrastructure on site. Abnormal Moisture Conditions not present.

GEOLOGY: Quaternary sediments (Mapcode Qa1/-Pwd)
Identification assisted by reference to appropriate geological survey map. This report contains a geology map obtained from the Department of Natural Resources Geovic website including the site under investigation. It is provided as a guide to mapping of the local geology only and not to be used as a basis for design (Appendix ii).

SOIL TYPES:

NATURAL: Sands, typical of area's geology. Soils of the above sedimentary origin are generally considered non-reactive.

FILLING: Sand mix.

iv. TERRAIN EVALUATION SUMMARY

CLIMATIC ZONE: CZ 1

SITE LOCATION: West side of Trafalgar Street.

SLOPE: Slight gradient over site.

DRAINAGE: SURFACE: Good/Fair.
SUB-SURFACE: Good/Fair. Installation of cut off drains will be required.

iv. TERRAIN EVALUATION SUMMARY - continued

EARTHQUAKE CLASS: Australian Standard AS1170.4-2007, 'Minimum Design Loads on Structures, Part 4: 'Site Sub-Soil Class' outlines the methods for assigning the site's Sub-soil Class. Based on the anticipated stratigraphy, Table 4.1 'Maximum Depth Limits for Sub-Soil Class C' and Table 3.2 'Hazard Factor (Z) For Specific Australian Locations' of the standard, we recommend the following Hazard Factor and Sub-Soil Class are adopted:
SUB-SOIL CLASS: Class C_e – Shallow soil site
HAZARD FACTOR (Z): 0.10

PROXIMATE VEGETATION:

GRASSES: None present.
SHRUBS: None present.
TREES: None present.

INFRASTRUCTURE WITHIN OR IN PROXIMITY TO SITE: Yes: Developed university campus. Existing vegetation and infrastructure on site. Abnormal Moisture Conditions present.

NOTE: The designing engineer should review available aerial mapping data and/or available site context information to assess the current or pre-existing conditions in respect to design considerations for Abnormal Moisture Conditions.

This report provides photographic evidence of either existing or pre-existing site context (Refer to Appendix iii).

v. TESTING PROGRAMME

Four (4) test sites were established and excavated using a 100mm direct drive drilling rig at the approximate locations shown on the appended Test Site Location Plan (Appendix iv).

Where soil conditions dictated, investigation was assisted by the use of a penetrometer to confirm profile depth and condition. Where penetrometer testing is not undertaken the soil profile depths and conditions may be extrapolated from our knowledge of the geology and soils in this area.

Disturbed samples were collected and hand classified.

A vane shear apparatus was used to determine the strength of all cohesive soils in conjunction with tactile assessment.

Site history: The client is advised that site classification can be altered by past activities on this site not known at the time of our site investigation and report preparation. The client is advised that failure to investigate and report past history may invalidate the report.

vi. FINDINGS

The soil profiles encountered are shown on the appended borelog sheet (Appendix v).

The cohesion value obtained is quoted on the log sheet.

The sedimentary nature of the Quaternary aged soils indicates a negligible soil reactivity and seasonal heave potential.

The client should recognise that the soil profiles encountered during our testing are deemed representative of the building envelope for the purpose of classifications. The client should be aware however that in some cases soil conditions can change dramatically over short distances and although all effort is made to determine possible soil profile variations, no responsibility is taken for any undetected variations. The most careful exploration programme may not locate all soil profile variations due to time and economic restraints.

If footing excavations reveal soil conditions differing from those shown on the log sheet in this report, we recommend that Provincial Geotechnical be contacted immediately to carry out further testing to confirm or revise our conclusions and recommendations.

vii. CONCLUSIONS AND RECOMMENDATIONS

1. STRUCTURAL RECOMMENDATIONS:

1.1 RESIDENTIAL STYLE STRUCTURES

The use of stiffened raft slab construction is recommended for residential proportioned buildings constructed on a residual clay profile. An Allowable Bearing Pressure of 100kPa may be considered for preliminary proportioning of stiffened raft slab edge beams and internal load bearing ribs a minimum of 100mm into natural medium dense sand.

Minimum dimensions and reinforcement of footings will need to meet the minimum requirements of Australian Standard AS2870-2011, 'Residential Slabs and Footings – Construction' for a CLASS A site classification.

Where the depth of fill exceeds 0.3 metres, as is predominantly the case on this site, it will be necessary to adopt suspended raft slab construction. All edge beams and internal ribs will need to be founded in natural medium dense sand at the base of any fill and silty topsoils, and the slab panels will need to be designed as fully suspended.

1.2 LOW RISE STRUCTURES:

Strip and pad footings founded within residual clay are routinely adopted for flexible commercial style structures constructed on a clay foundation. The use of pad and strip footings founded on a sand foundation may be considered for any proposed low rise structures subject to:

- The superstructures being flexible and well-articulated. Steel portal framed construction and precast concrete panel construction normally satisfies this criteria.

- The superstructures not being sensitive to footing movements.

Minimum dimensions and reinforcement of footings founded on clay will need to meet the minimum requirements of Australian Standard AS2870-2011, 'Residential Slabs and Footings – Construction' for a CLASS A site classification.

Allowable Bearing Pressures of 100kPa and 150kPa may be considered for preliminary proportioning of strip and pad footings respectively where founded a minimum of 300mm into natural medium dense sand, subject to a minimum founding depth of 600mm.

During our investigation a suitable foundation level was found at the following depths:

SITE	FOUNDATION DEPTH	FOUNDATION MATERIAL	ALLOWABLE BEARING PRESSURE
1	2200mm	Natural medium dense sand	100kPa/150kPa
2	700mm	Natural medium dense sand	100kPa/150kPa
3	600mm	Natural medium dense sand	100kPa/150kPa
4	700mm	Natural medium dense sand	100kPa/150kPa

1.3 RETENTION OF SITE EXCAVATIONS:

a. Retention Systems

Should a lower level be proposed and safe batters can be accommodated behind the proposed retention systems, the use of conventional precast concrete panel or reinforced blockwork retaining walls will be suitable. Safe batters of approximately 30° in fill and sandy soils are anticipated under favourably dry conditions.

Where safe batters cannot be accommodated or are not preferred, the use of a soldier pile retention system with infill panels is recommended. A soldier pile retention system is recommended where bulk excavation is proposed adjacent to an existing structure.

If a retained height of more than approximately 3.0 metres is proposed it may be necessary to progressively prop or anchor retention systems as excavation proceeds.

In any case, walls should be designed for the minimum requirements of the appropriate Codes of Practice, e.g. Civil Engineering Code of Practice No. 2, Earth Retaining Structures. The effects of surcharge behind the wall should be calculated using the methods presented in the Code of Practice CP2.

b. Lateral Earth Pressures

Permanently cantilevered retaining walls may be considered where deformation and movement behind the walls can be tolerated, such as for garden or grassed areas. A triangular lateral earth pressure distribution and an active earth pressure coefficient (Ka) of approximately 0.3 could be adopted for preliminary design. The active earth pressure coefficient should be used to calculate lateral earth pressures generated by surcharge loads.

For minimal deflection of progressively propped walls where there are movement sensitive structures or buried services within the zone of influence of the excavation, a uniform earth pressure distribution of 8HkPa, where H is the total retained height in metres, could be adopted for preliminary design. An at rest earth pressure coeffient (Ko) of 0.6 could be used to calculate lateral earth pressures generated by surcharge loads.

A preliminary unit weight of 16 kN/m^3 may be adopted for sand soil.

Sloping backfill should be incorporated as surcharge loading. Any temporary or permanent surcharge loads such as nearby high level footings, traffic loading and compaction stresses, will also need to be included in the design of retention structures.

Retention structures must be designed such that the soil behind the wall is completely and permanently drained. If this cannot be ensured, then hydrostatic pressure must be superimposed on the lateral earth pressure distributions.

Conservatively, the ultimate lateral toe resistance of retaining walls in clay may be estimated based on the following soil parameters:

		SAND
1	**Friction angle of soil Φ**	34° – 38°
2	**Cohesion of soil C**	N/A
3	**Density**	1800kg / m^3
4	**Unit Weight**	16kN / m^3

Construction of pavements may be problematic during the wetter months of the year. Pavement construction should be undertaken during the drier months of the year to avoid the need for additional subgrade improvement and delays in construction.

Any structural fill must be placed in uniform layers no exceeding a loose thickness of 200mm and compacted to at least 98% of the standard maximum dry density value as determined in accordance with Australian Standard AS1289 5.1.1-1993.

Australian Standard AS3798, 'Guidelines on Earthworks for Commercial and Residential Developments' provides guidance on the specification, execution and control of earthworks relevant to the subject site. Level 1 supervision in accordance with Australian Standard AS3798 is recommended for all proposed earthworks at the site.

viii. SITE CONSTRAINTS

EXCAVATION/CONSTRUCTION DIFFICULTIES

SITE VEHICLE ACCESS: Good.

SITE VEHICLE MANEUVERABILITY: Good to Fair. Site may become slippery. During summer and early autumn when evaporation rates are typically high and rainfall levels low, the trafficability of the stripped ground surface is anticipated to be quite good. Other than dust suppression, no significant difficulties are anticipated. During winter and spring it is probably that only tracked machinery will be able to access the site once the surface has been stripped and is exposed to rain.

EXCAVATION CONDTIONS: The fill soils and clays should be readily excavated using a 20 tonne capacity hydraulic excavator.

If site access is to be provided for trucks once the ground surface is saturated it will be necessary to construct access tracks formed using non-descript crushed rock (75mm minus), recycled brick and concreter rubble or equivalent. Under extreme conditions, it will necessary to incorporate a layer of geogrid or geotextile fabric at the base of the crushed rock.

EXISTING STRUCTURES AROUND CONSTRUCTION AREA: Yes.

VEGETATION AROUND CONSTRUCTION AREA: No.

WET WEATHER IMPACT: Possible.

Sites without good natural or installed drainage can be adversely impacted upon during construction. The client should be aware that the following impacts can occur after wet weather.

* Site may become slippery and boggy.
* Foundation soils may become inundated and unworkable.
* Site drainage may need to be installed.
* Site may need to be abandoned for a period.
* Deeper footings or additional earthworks may be required.

ix. CONSTRUCTION REQUIREMENTS

1. CONSTRUCTION ADJACENT TO EASEMENTS, EXCAVATIONS AND SERVICE PIPE TRENCHES

Buried services should be located adjacent to footings. Where this cannot be avoided, the trench should be backfilled in such a way as to prevent moisture ingress. Any footings located adjacent to easements, excavations or backfilled service trenches should be founded below a line drawn up at 40° above horizontal from the base of the easement or excavation. If the angle of repose is to be intersected, a piled footing will be required.

2. SITE DRAINAGE AND MAINTENANCE OF FOOTINGS

Effective drainage of the site should be maintained at all times. Water run-off should be collected and diverted away from all structures during construction. Water should not be allowed to pond against footings during or after construction. The ground adjacent to footings should be graded to provide a permanent fall of 1(V):50(H) away from the footings over the first two metres. Water supply and drainage infrastructure should be maintained so that no leakage occurs.

3. ARTICULATION OF STRUCTURE

Adequate articulation should be provided in accordance with The Cement and Concrete Association of Australia – Technical Note TN61. In addition to the requirements of TN61, a full height articulation joint should be provided at the following locations:

- At the junction where two different footing types intersect.
- Where new structures adjoin existing structures.

4. INSPECTION OF FOOTING EXCAVATIONS

All footing excavations should be inspected by a suitably qualified geotechnical consultant to ensure that the required founding stratum has been achieved. The presence of any unusual features or conditions should be brought to the attention of this office before construction proceeds.

For shallow footing and trench excavations, based on the ground conditions information obtained, it appears excavations will be predominantly in natural clays. Personnel should not be permitted to enter confined excavations in excess of 1.5 metres deep unless such excavations are appropriately battered or shored. Shallower excavations, particularly in loosely compacted fill, may also need to be battered or shored and will need to be assessed at the time of construction.

5. BATTER SLOPES

It is recommended that temporary batter slopes should be steeper than 1H:1V, but flatter slopes may need to be considered within fill materials. Permanent batter slopes should not be steeper than 2H:1V and should be protected from erosion by vegetation or proprietary protection systems. Drainage should be provided at the top of batter slopes to divert run-off away from the slope face. The above recommendations are provided for batter slopes up to 3 metres in height; further geotechnical advice should be sought where higher batter slopes are proposed.

x. REPORT LIMITATIONS

This report is for the use of the party to whom it is addressed only and has been produced for consideration of a proposed subdivision development as described by the client and for no other purpose. It has been assumed that the conditions encountered by the limited number of boreholes are representative of the site in general. Some variation from the conditions encountered by the boreholes is expected over the site.
It is beyond the scope of this report to comment on any possible contamination of the site.

ANDREW REDMAN BSc.
GEOLOGIST.
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APPENDICES

i. Plan of Survey

ii. Geovic Map

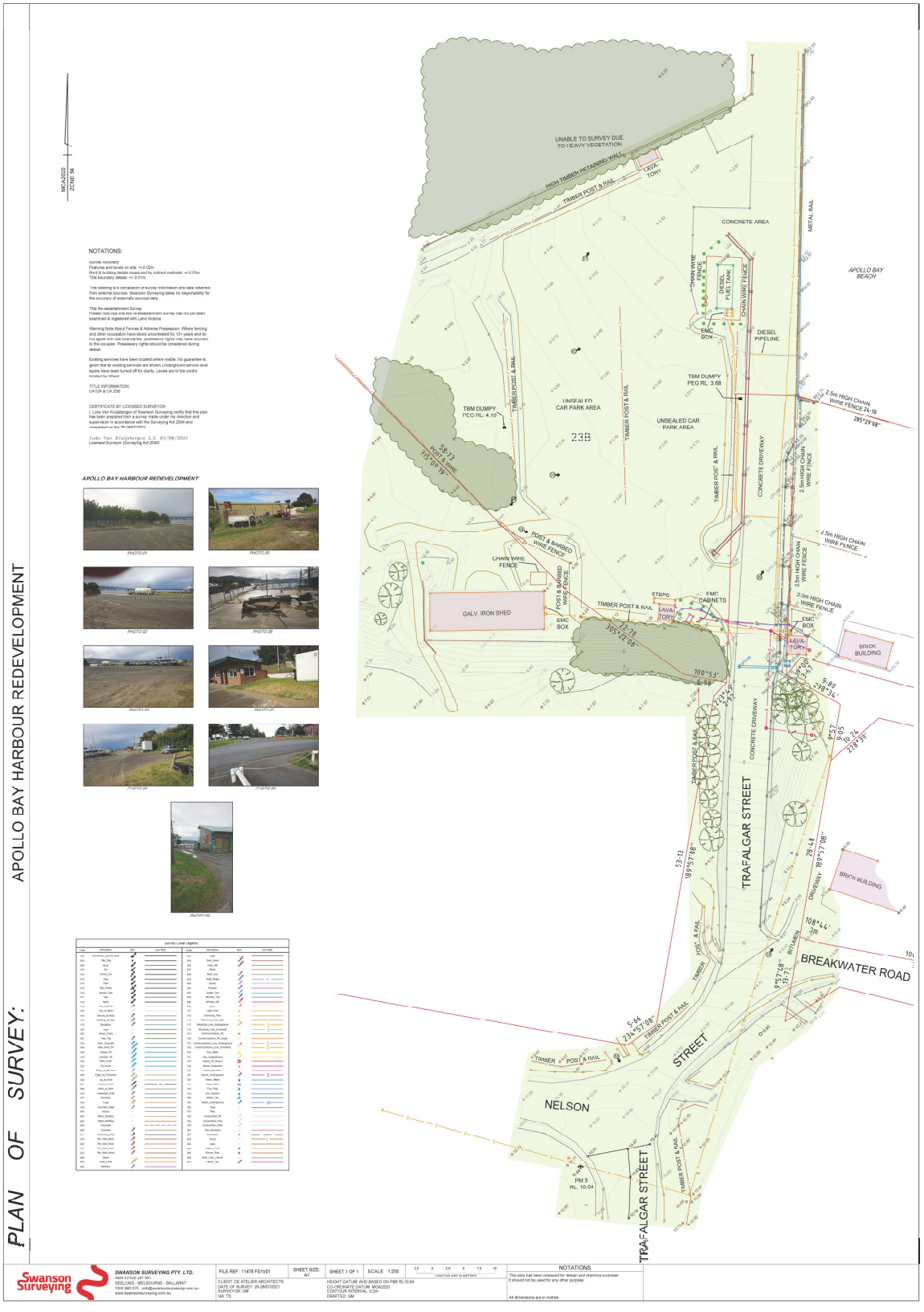
iii. Photographic Evidence

iv. Test Site Location Plan

v. Borelog Descriptions

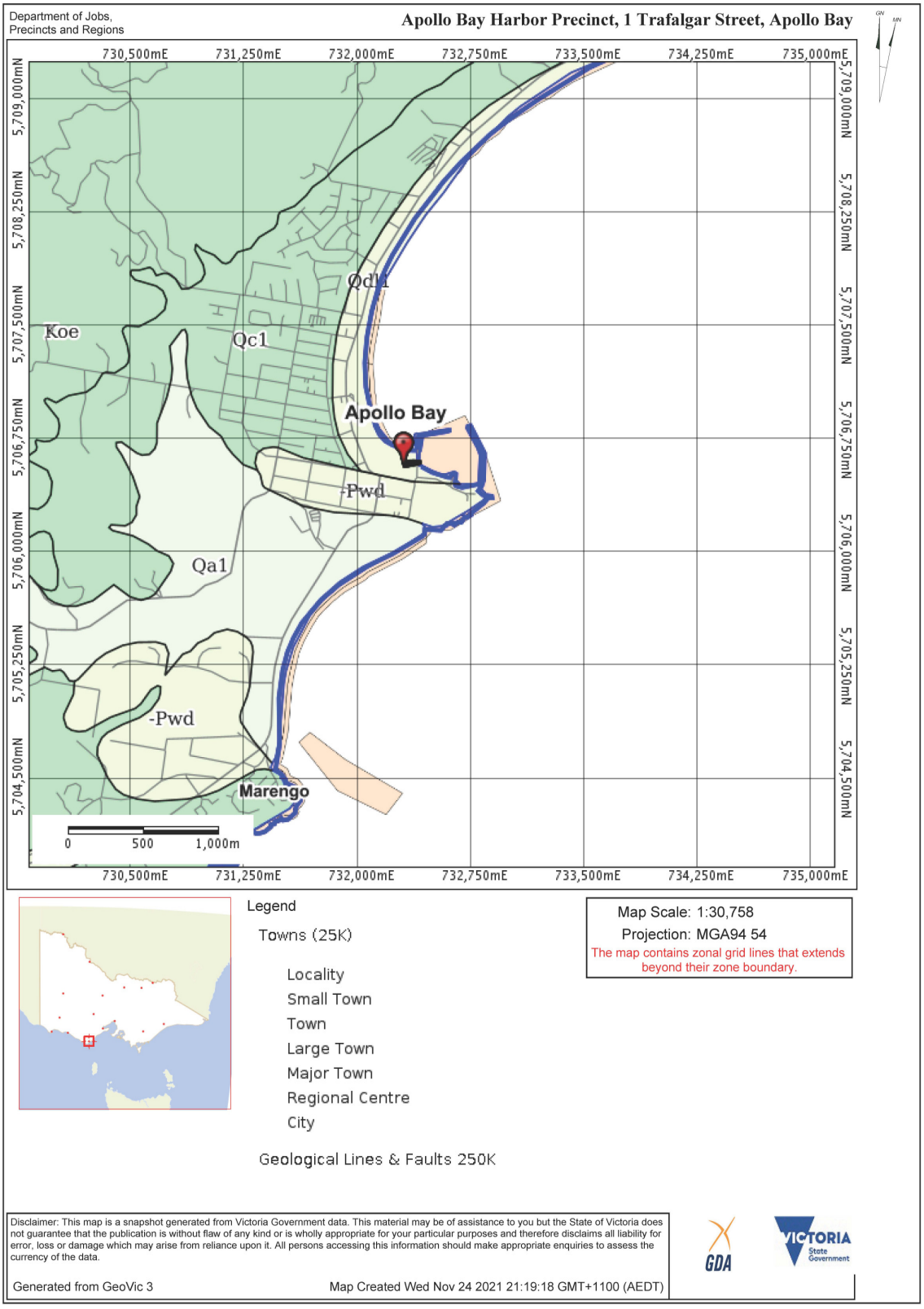
PLAN OF SURVEY

APPENDIX i



GEOVIC MAP

APPENDIX ii



APPENDIX iii

AERIAL PHOTOGRAPH

(Approximate Location)

Client: CARDNO TGM
Ref. Number: 18185J
Date: 22/11/2021
Site: Apollo Bay Harbour Precinct, 1 Trafalgar Street, APOLLO BAY

SUBJECT SITE

SITE PHOTOGRAPHS APPENDIX iii

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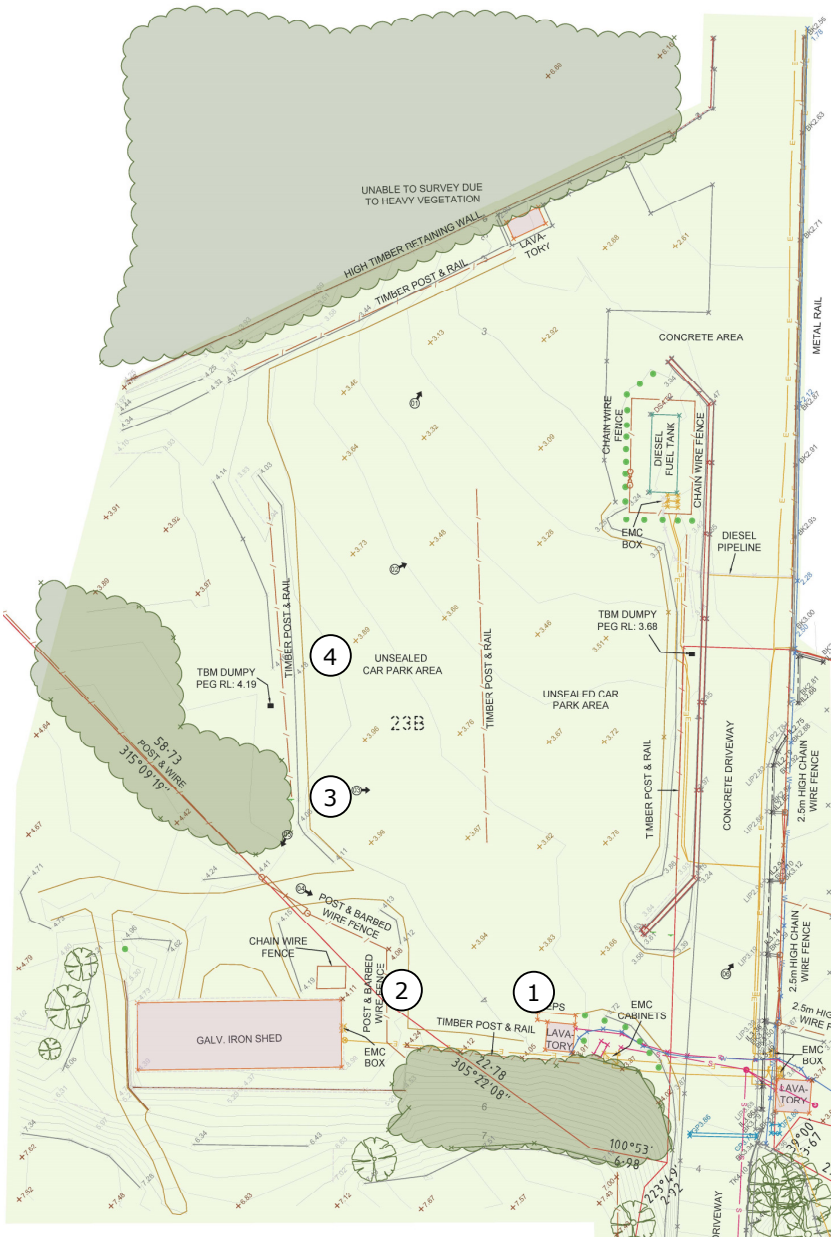
APPENDIX iv

TEST SITE LOCATION PLAN

◯-Approximate borehole locations

Client: CARDNO TGM
Ref. Number: 18185J
Date: 22/11/2021
Site: Apollo Bay Harbour Precinct, 1 Trafalgar Street, APOLLO BAY



BORELOG DESCRIPTIONS APPENDIX v

Client: CARDNO TGM
Ref. Number: 18185J
Date: 22/11/2021
Site: Apollo Bay Harbour Precinct, 1 Trafalgar Street, APOLLO BAY

TEST SITE 1 EXCAVATION METHOD: HYDRAULIC DRILLING RIG					TEST SITE 2 EXCAVATION METHOD: HYDRAULIC DRILLING RIG				
Depth mm	FILL	SOIL PROFILE	"C"	ABP	Depth mm	FILL	SOIL PROFILE	"C"	ABP
100		**FILL: SAND MIX**			100		**FILL: SAND MIX**		
200		**grey brown**			200		**grey brown**		
300		**moist; moderately**			300		**moist; moderately**		
400		**compacted**			400		**compacted**		
500					500		**SAND**		**100**
600					600		**yellow grey**		
700					700		**moist; dense**		
800					800				
900					900				
1000					1000				
1100					1100				
1200					1200				
1300					1300				
1400					1400				
1500					1500				
1600					1600				
1700					1700				
1800					1800				
1900					1900				
2000		**SAND**		**100**	2000				
2100		**yellow grey**			2100				
2200		**moist; dense**			2200				
2300					2300				
2400					2400				
2500					2500				
2600					2600				
2700					2700				
2800					2800				
2900					2900				
3000					3000				
3100		**END BORE HOLE**			3100		**END BORE HOLE**		
3200					3200				
3300					3300				
3400					3400				
3500					3500				
3600					3600				
3700					3700				
3800					3800				

BORELOG DESCRIPTIONS

APPENDIX v

Client: CARDNO TGM
Ref. Number: 18185J
Date: 22/11/2021
Site: Apollo Bay Harbour Precinct, 1 Trafalgar Street, APOLLO BAY

TEST SITE 3 EXCAVATION METHOD: HYDRAULIC DRILLING RIG					TEST SITE 4 EXCAVATION METHOD: HYDRAULIC DRILLING RIG				
Depth mm	FILL	SOIL PROFILE	"C"	ABP	Depth mm	FILL	SOIL PROFILE	"C"	ABP
100		**FILL: SAND MIX**			100		**FILL: SAND MIX**		
200		**moderately comp.**			200		**grey brown**		
300		**SAND**		**100**	300		**moist; moderately**		
400		**yellow grey**			400		**compacted**		
500		**moist; dense**			500		**SAND**		**100**
600					600		**yellow grey**		
700					700		**moist; dense**		
800					800				
900					900				
1000					1000				
1100					1100				
1200					1200				
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2700					2700				
2800					2800				
2900					2900				
3000					3000				
3100		**END BORE HOLE**			3100		**END BORE HOLE**		
3200					3200				
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3400					3400				
3500					3500				
3600					3600				
3700					3700				
3800					3800				