APPENDIX

A

GEOTECHNICAL ANALYSIS

Desktop Geotechnical Investigation for Proposed Beveridge North West Precinct Structure Plan

Old Sydney Road,
Beveridge, Sydney

V181662Report01.1

Prepared for
Victorian Planning Authority

March 2019

Cardno
Shaping the Future

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Desktop Geotechnical Investigation for Proposed Beveridge North West Precinct Structure Plan Old Sydney Road, Beveridge, Sydney

Table of Contents

1 Introduction 6
1.1 Purpose 6
1.2 Scope of Assessment 6
2 Limitations of the Report 7
3 Site Description 7
3.1 Road Alignment RD-05 and Intersections IN-15, IN-16, IN-17 and IN-18 8
3.2 Road Alignment RD-03 and Intersections IN-05, IN-06, IN-07 and IN-08 8
3.3 Road Alignment RD-04 and Intersection IN-12 8
3.4 Intersection IN-02 8
4 Site Geology 8
4.1 Road Alignment RD-05 and Intersections IN-15, IN-16, IN-17 and IN-18 8
4.2 Road Alignment RD-03 and Intersections IN-05, IN-06, IN-07 and IN-08 8
4.3 Road Alignment RD-04 and Intersections IN-02 and IN-12 9
5 Aerial Photographs 9
6 Groundwater Review 11
7 Site Walkover 12
7.1 Observations 12
7.2 Road Alignment RD-05 and Intersections IN-15, IN-16, IN-17 and IN-18 12
7.2.1 Road Alignment RD-03 and Intersections IN-05, IN-06, IN-07 and IN-08 20
7.2.2 Road Alignment RD-04 and Intersection IN-12 24
8 Discussion 26
8.1 Roads and Intersections 26
8.2 Erosion Susceptibility 27
8.2.1 Erosion Susceptibility of Siltstone Soils and Alluvial Soils 27
8.2.2 Erosion Susceptibility of Basaltic Soils 27
8.3 Drainage 27
9 Summary of Conclusions 29

Text Figures

Figure 1-1 Proposed SUP to the west of Old Sydney Road 6
Figure 3-1: Site Location 7
Figure 5-1: Historical Aerial Photograph (Nearmap, 24 December 2018) 9
Figure 5-2: Tunnel erosion adjacent to Kalkallo Creek 10
Figure 6-1: Depth to Groundwater (Visualising Victoria's Groundwater) 11

Photographs

Photograph 7-1 Erosion adjacent to Old Sydney Road Pavement at Intersection IN-18 (looking north) 13
Photograph 7-3 Erosion on the unsealed track adjacent to an existing culvert and a natural low point 13
Photograph 7-4 Siltstone bedrock observed on the swale drain between Old Sydney Road and the unsealed track to the west. 14
Photograph 7-5 Proposed Intersection IN-17 (looking south-west) 14
Photograph 7-6 Siltstone observed at the surface adjacent to the proposed intersection IN-17 15
Photograph 7-7 Erosion on the unsealed track adjacent to an existing culvert and a natural low point 15
Photograph 7-8 Wet soil material observed as a result of ponding water in the eroded area 16
Photograph 7-9 Siltstone observed at the surface of the unsealed track 16
Photograph 7-10 Erosion on the unsealed track 17
Photograph 7-11: Proposed Intersection IN-16 (looking north) 17
Photograph 7-12 Erosion on the unsealed track 18
Photograph 7-13: Tunnel erosion at the western edge of the unsealed track 18
Photograph 7-14 Intersection IN-15 (looking east) 19
Photograph 7-15 Tunnel erosion on the western edge of the unsealed track at a natural low point and an existing culvert 19
Photograph 7-16 Erosion on the eastern edge of the unsealed track at a natural low point and an existing culvert 20
Photograph 7-17 RD-03 road alignment start point (looking north) 21
Photograph 7-18 Intersection IN-05 (looking north) 21
Photograph 7-19 RD03 road alignment between intersections IN-05 and IN-06 (looking north) 22
Photograph 7-20 RD03 road alignment between intersections IN-06 and IN-07 (looking north-east) 22
Photograph 7-21 Intersection IN-07 (looking south-west) 23
Photograph 7-22 End of RD-03 road alignment (looking south) 23
Photograph 7-23 Intersection IN-12 and basalt boulders on the surface (looking south) 24
Photograph 7-24 Road alignment RD-04 and basalt boulders on the surface (looking north-west) 25
Photograph 7-25 Road alignment RD-04 and basalt boulders on the surface (looking north) 25

Appendices

Appendix A..... 2 Pages
Figures
Figure 1: Proposed Beveridge North-West PSP
Figure 2: Geology Along Road Alignments
Figure 3: Observation On Site

Appendix B..... 1 Page
Limitations of the Report

List of Abbreviations and Units

Technical Terms

1H:2V	Slope Ratio of 1 Horizontal to 2 Vertical
AHD	Australian Height Datum
AADT	Average Annual Daily Traffic
AC	Asphalt Cement
AMG	Australian Map Grid
Base Course	Upper Layer of the pavement
CBR	California Bearing Ratio (%)
CCL	Compacted Clay Liner
CQA	Construction Quality Assurance
CTCR	Cement treated crushed rock
DCP	Dynamic Cone Penetrometer
DTL	Daily Traffic Loading
EC	Electrical Conductivity
ESA	Equivalent Standard Axles
FoS	Factor of Safety
GCL	Geosynthetic Clay Liner
GPS	Global Positioning System
HDPE	High Density Polyethylene
HV	Heavy Vehicles (Usually a %)
LF	Loading Factor
LLDPE	Linear Low Density Polyethylene
MDD	Maximum Dry Density
MQA	Manufacturers Quality Assurance
NATA	National Association of Testing Authorities
PMB	Polymer Modified Binder
Prime	Application of a primer to a prepared base
QA	Quality Assurance
QC	Quality Control
RL	Reduced Level
Sub-Base Course	Lower layer of the pavement
Subgrade	Foundation material for the pavement
TDS	Total Dissolved Solids (salinity of water)

Desktop Geotechnical Investigation for Proposed Beveridge North West Precinct Structure Plan Old Sydney Road, Beveridge, Sydney

1 Introduction

Cardno was provided an amended brief (VPA Reference No.1059_Beveridge North West PSP)) by Victorian Planning Authority (VPA) on the 19th of December 2019 with regards to providing transport infrastructure design and costing services for the Beveridge North-West Precinct Structure Plan (PSP). Cardno submitted a fee proposal, reference V181662 dated 18 January 2019 to VPA which was accepted in VPA's Purchase Order letter reference COR/19/715 dated 7 February 2019.

The area of the PSP is bounded by Camerons Lane in the south, Hume Freeway in the east and Old Sydney Road in the west. The northern boundary of the site is approximately 3km from Camerons Lane.

This desktop geotechnical assessment includes approximately 6.8km of road alignment (3No. alignments) with 9No. intersections and a Shared User Path (SUP). The majority of the road alignments and intersections are located on farm paddocks with the exception of the proposed upgrade to Old Sydney Road. The SUP will be created along the existing unsealed track to the west of Old Sydney Road as presented in Figure 1-1.

Figure 1-1 Proposed SUP to the west of Old Sydney Road

1.1 Purpose

The purpose of the desktop geotechnical assessment is to undertake a site walkover, identify localised erosion and geology along the road alignment and intersections. The desktop geotechnical assessment is expected to inform the design and costings for the transport infrastructure components of the PSP.

1.2 Scope of Assessment

The scope of the desktop geotechnical assessment of the site covered in this report includes the following:

1. Sub-surface ground profile and geological setting;
2. A discussion of the site features with respect to proposed developments;

3. The likely issues relating to the construction of the roads and intersections;
4. The likely issues relating to the construction of the Shared User Path (SUP); and
5. Other geotechnical issues that may impact the suitability of the site for the proposed development.

2 Limitations of the Report

The report is limited to the desktop review of the proposed site and specifically covers the proposed development and the issues discussed in the project scope identified in Section 1.2. No environmental conclusions or recommendations are made in this report.

The report is specifically for due diligence purposes and as such does not provide detailed design parameters for any buildings, pavements or other infrastructure. No laboratory testing was conducted as part of this assessment. Detailed geotechnical investigations will be required prior to the construction of the development.

The limitations of geotechnical reports are appended in Appendix B

3 Site Description

The site comprised 3No. road alignments and 9No intersections. The site is located at Old Sydney Road, Beveridge and extends approximately 4km to the west to the Hume Freeway. The road alignments and intersection are shown on the Nearmap aerial photograph in Figure 3-1.

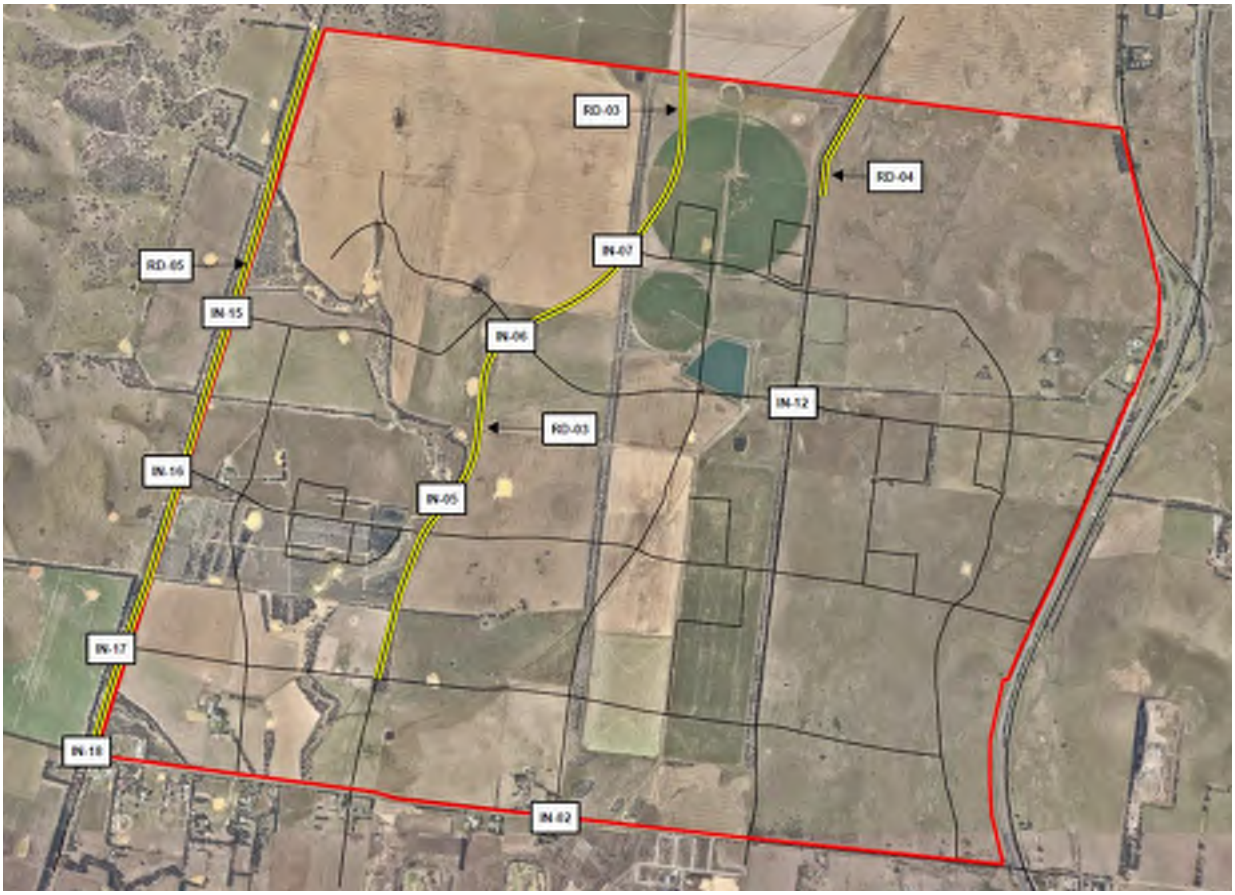

Figure 3-1: Site Location

3.1 Road Alignment RD-05 and Intersections IN-15, IN-16, IN-17 and IN-18

The road alignment RD-05 follows the existing Old Sydney Road alignment bounded by neighbouring rural farming land to the east and the west. An unsealed track is present to the west of Old Sydney Road. Aerial imagery indicates the existing road alignment generally increases in elevation as you progress north and the maximum slope of the road is approximately 1V:10H. The neighbouring farmland to the west of the unsealed track slopes gradual to moderate towards the unsealed track. The neighbouring farmland to the east encompasses a slight slope away from Old Sydney Road.

3.2 Road Alignment RD-03 and Intersections IN-05, IN-06, IN-07 and IN-08

The road alignment RD-03 passes through various farm paddocks and cultivations areas separated by farm fences. The road alignment south of intersection IN-05 follows an existing farm road and is bounded by the Kalkallo Creek to the west. The slope to the east of the alignment has a slight slope towards the road alignment. Numerous farm dam features are also identified adjacent to the road alignment used for farming activities. The farm paddocks predominantly appear to be well grassed and largely free of trees, however, patches of trees are observed in certain area of the alignment (e.g. south of intersection IN-05 and intersectionIN-07).

3.3 Road Alignment RD-04 and Intersection IN-12

The road alignment RD-04 is located within farm paddocks bounded by the cultivation area to the west and dense patch of trees immediately to the east.

The intersection IN-12 is located in an area of dense trees with a large dam present to the west of the intersection. A farm shed is also observed to the east of the intersection.

3.4 Intersection IN-02

The intersection IN-02 is a proposed intersection with a new road and Camerons Lane. A large farm dam is observed north-west of the intersection with flat ground east present north-east of the intersection.

4 Site Geology

Figure 2 attached in Appendix A presents the geological map of the area (Kilmore Sheet, 1:50,000), overlain with the proposed road alignments and intersections of the Beveridge North-West PSP.

4.1 Road Alignment RD-05 and Intersections IN-15, IN-16, IN-17 and IN-18

The alignment of RD-05 and its associated intersections appear to be underlain with a combination of:

- Silurian aged Kilmore Siltstone formation (Smk) generally consisting of siltstone with regularly interbedded thin to very thin beds of fine sandstone often with ripple marks.
- Quaternary Age “gully” alluvium, hillwash and fan deposits (Qpc) consisting of various mixtures of gravel, sand, silt and clay are shown in gullies crossing Old Sydney Road at various locations. This geological unit is stated to be moderately consolidated to firm.

It is noted that all 4No. proposed intersections along Old Sydney Road are underlain with Qpc deposits.

4.2 Road Alignment RD-03 and Intersections IN-05, IN-06, IN-07 and IN-08

The section of the RD-03 road alignment south of intersection IN-05 appears to be underlain with Quaternary aged alluvial floodplain deposits (Qpj) comprising of silt, sand and gravel.

The section of the RD-03 road alignment north of intersection IN-06 in underlain with a combination of Qpc and Smk geological units. The RD-3 road alignment encroaches on Quaternary aged Newer Volcanics formation (Qvnb) described as blue-black olivine basalt flows with broad stony rises at intersection IN-07. The northern most section of the RD-03 road alignment is underlain by Quaternary aged swamp deposits (Qrm) comprising unconsolidated silt and clay.

4.3 Road Alignment RD-04 and Intersections IN-02 and IN-12

The RD-04 road alignment and intersections IN-02 and IN-12 are all underlain with Quaternary aged Newer Volcanics formation (Qvnb) described as blue-black olivine basalt flows with broad stony rises

5 Aerial Photographs

Figure 1 attached in Appendix A presents the most recent publicly available aerial image (Nearmap, December 2018), overlain with the proposed road alignments and intersections of the Beveridge North-West PS. Areas of erosion are highlighted in Figure 5-1 below.

The aerial image indicates areas of significant erosion is present along the unsealed track to the west of the RD-04 rood alignment. Surface water appears to be ponding in these areas of erosion.

Figure 5-1: Historical Aerial Photograph (Nearmap, 24 December 2018)

The aerial image indicates areas of significant erosion is present along the unsealed track to the west of the RD-04 road alignment. Surface water appears to be ponding in some of these areas of erosion. Areas of tunnel erosion are also identified adjacent to Kalkallo Creek near the southern portion of RD-03 road alignment and intersection IN-05 as presented in Figure 5-2. Minor erosion was also identified

adjacent to the far dam located in the vicinity of the RD-03 road alignment between intersections IN-05 and IN-06.

Figure 5-2: Tunnel erosion adjacent to Kalkallo Creek

6 Groundwater Review

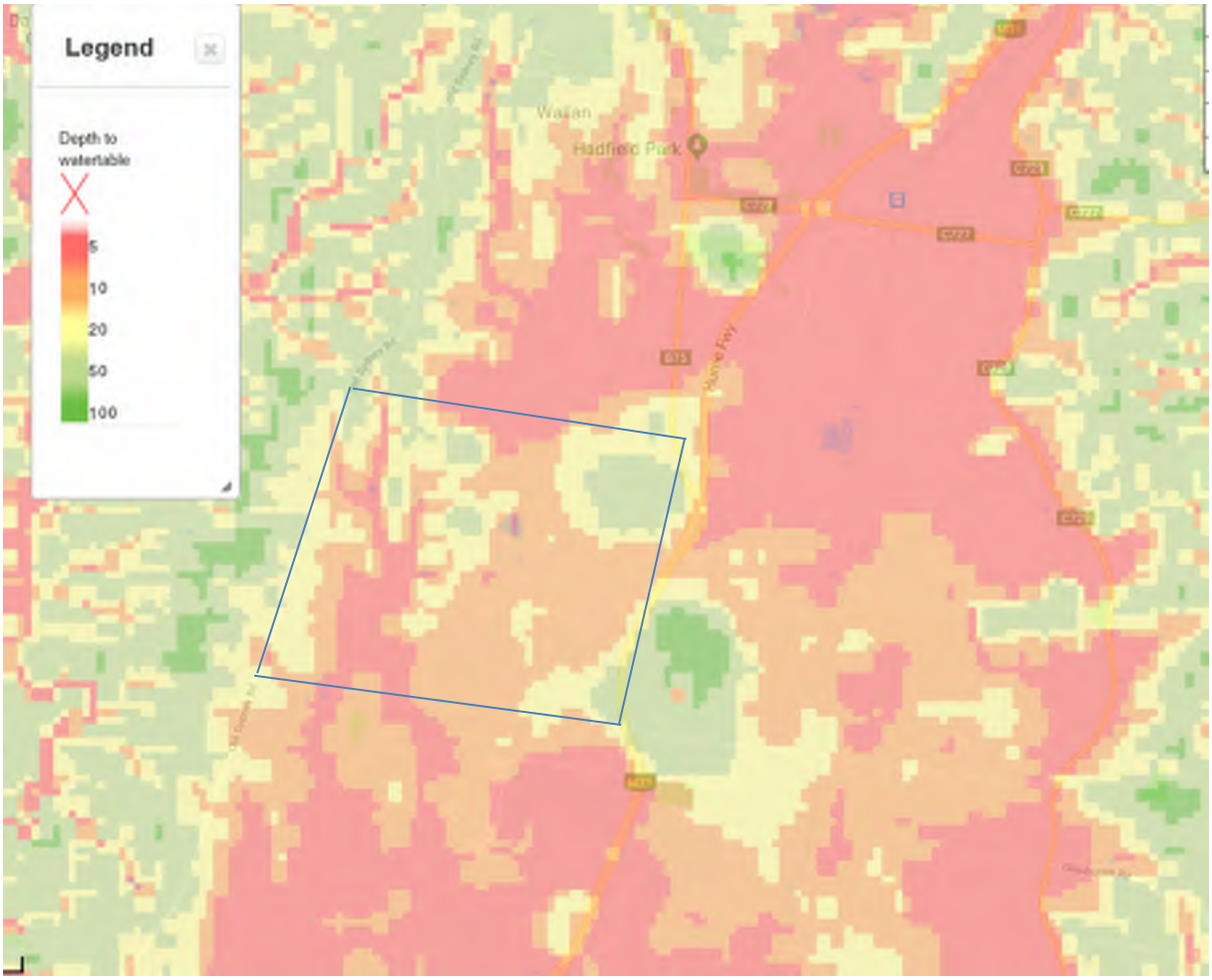

Figure 6-1: Depth to Groundwater (Visualising Victoria's Groundwater)

Depth to groundwater contours available from 'Visualising Victoria's Groundwater' indicate the depth to groundwater within the site is in order of less than 5m to 50m as shown in Figure 6-1. The shallower groundwater appears to be typically in the vicinity of Kalkallo Creek.

7 Site Walkover

The site inspection was carried out on 6 March 2019 and involved a walkover study by a team comprising an experienced geotechnical engineer and 2No. experienced civil engineers. The experienced geotechnical engineer inspected the road alignments and intersections and photographed the site features. The inspection was undertaken to identify geomorphological features that may impact upon the construction of the roads and intersections.

A *Safe Work Method Statement (SWMS)* was prepared to help identify and mitigate potential hazards. The site walkover was conducted in accordance with the prepared SWMS.

The site walkover commenced at the intersection of Old Sydney Road and Camerons Lane and continued north on Old Sydney Road along the RD-05 road alignment. The site walkover then continued along road alignment RD-03 and RD-04 (including intersection IN-12) in a south north direction. It is noted that due to time constraints the team did not visit the intersection IN-02 site. The location of the photographs along with features observed during the site walkover are recorded in Figure 3.

7.1 Observations

7.2 Road Alignment RD-05 and Intersections IN-15, IN-16, IN-17 and IN-18

Localised erosion and subsidence was observed on the western and eastern edges of the Old Sydney Road at the proposed intersection IN-18 as shown in Photograph 7-1. The erosion appears to have been caused by wheel ruts.

At the proposed intersection IN-17, siltstone bedrock was observed adjacent to the existing Old Sydney Road pavement as shown in Photograph 7-5. Similarly, adjacent to the proposed intersection IN-17 siltstone bedrock was also observed at the base of the existing swale drain as shown in Photograph 7-3.

Significant erosion was observed along the unsealed track as depicted in Photograph 7-2, Photograph 7-6, Photograph 7-9, Photograph 7-11, and Photograph 7-15. The erosion appeared to most severe in low points along the unsealed track where natural gullies within the topography to the west of the unsealed track were conveying surface water to. These area also encompassed culverts which were facilitating the surface water flow path under the Old Sydney Road. The erosion appears to have been initiated by wheel ruts and then subsequently exacerbated by surface water flows.

As shown in Photograph 7-12 and Photograph 7-14 significant tunnel erosion was also observed on the northern end of the unsealed track. Most tunnels within the unsealed track appeared to have collapsed and led to further erosion.

The unsealed road varied in elevation progressing south to north direction. The Old Sydney Road gradually increased in elevation progressing south north direction. It was observed that the Old Sydney Road was constructed by cutting into the hillside while the unsealed track followed the natural topography. At various locations where the unsealed track was at a peak siltstone bedrock was observed at the surface as shown in Photograph 7-8.

Photograph 7-1 Erosion adjacent to Old Sydney Road Pavement at Intersection IN-18 (looking north)

Photograph 7-2 Erosion on the unsealed track adjacent to an existing culvert and a natural low point

Photograph 7-3 Siltstone bedrock observed on the swale drain between Old Sydney Road and the unsealed track to the west.

Photograph 7-4 Proposed Intersection IN-17 (looking south-west)

Photograph 7-5 Siltstone observed at the surface adjacent to the proposed intersection IN-17

Photograph 7-6 Erosion on the unsealed track adjacent to an existing culvert and a natural low point

Photograph 7-7 Wet soil material observed as a result of ponding water in the eroded area

Photograph 7-8 Siltstone observed at the surface of the unsealed track

Photograph 7-9 Erosion on the unsealed track

Photograph 7-10: Proposed Intersection IN-16 (looking north)

Photograph 7-11 Erosion on the unsealed track

Photograph 7-12: Tunnel erosion at the western edge of the unsealed track

Photograph 7-13 Intersection IN-15 (looking east)

Photograph 7-14 Tunnel erosion on the western edge of the unsealed track at a natural low point and an existing culvert

Photograph 7-15 Erosion on the eastern edge of the unsealed track at a natural low point and an existing culvert

7.2.1 Road Alignment RD-03 and Intersections IN-05, IN-06, IN-07 and IN-08

The topography along the RD-03 road alignment was observed to be flat. As displayed in Photograph 7-17 the first portion of the road alignment followed an existing farm track after which it transitioned to farm paddocks with grass cover as presented in Photograph 7-18, Photograph 7-19 and Photograph 7-20. The end portion the road alignment RD-03 meandered around a hill and through a cultivated area as shown in Photograph 7-21. The area adjacent to Kalkallo Creek identified to have tunnel erosion based on the aerial image was inaccessible during the site walkover. No other visible erosion was observed along this alignment.

Photograph 7-16 RD-03 road alignment start point (looking north)

Photograph 7-17 Intersection IN-05 (looking north)

Photograph 7-18 RD03 road alignment between intersections IN-05 and IN-06 (looking north)

Photograph 7-19 RD03 road alignment between intersections IN-06 and IN-07 (looking north-east)

Photograph 7-20 Intersection IN-07 (looking south-west)

Photograph 7-21 End of RD-03 road alignment (looking south)

7.2.2 Road Alignment RD-04 and Intersection IN-12

As evident from the geology map presented on Figure 2, the RD-04 road alignment is underlain by basalt. As depicted in Photograph 7-22, Photograph 7-23 and Photograph 7-24 basalt boulders were present at the surface of road alignment RD-04 and intersection IN-12.

Photograph 7-22 Intersection IN-12 and basalt boulders on the surface (looking south)

Photograph 7-23 Road alignment RD-04 and basalt boulders on the surface (looking north-west)

Photograph 7-24 Road alignment RD-04 and basalt boulders on the surface (looking north)

8 Discussion

Based on the information available and limited site observations, the site is generally considered suitable for the proposed transport infrastructure elements of the PSP. Nonetheless, there are a number of potential issues and geotechnical conditions that may influence the development of the site.

8.1 Roads and Intersections

The design subgrade CBR of the pavements is likely to vary across the site depending on the geology.

Where there are residual soils weathered from the siltstone present along RD-05 and RD-03 road alignments the design subgrade CBR is likely to vary between 2.5% and 4.0%. However, these soils are more prone to erodibility which will also need to be considered, especially with regard to the interface between the pavement and the natural soils at the base and sides of the pavement as well as the pavement drains. This is discussed more in Section 8.2.

Where there are residual soils weathered from the basalt present along RD-04 road alignment, intersections IN-02 and IN-12, the design subgrade CBR is likely to vary between 1.0% and 3.0%. These soils are less prone to erosion.

Where there are alluvial soils are present along RD-05 and RD-03 road alignments the design subgrade CBR will be similar to the parent soil. That is alluvial soils derived from erosion of siltstone soils will behave similar to the residual siltstone soils while alluvial soils derived from basalt soils will behave similar to the residual basalt soils. As both siltstone and basalt residual soils exist upslope of the site it is likely that the alluvial soils will be highly variable with regard to subgrade CBR possibly varying from 1.0% to as high as 4.0%. The alluvial soils will also be highly erodible.

These CBR values are based on knowledge of CBR tests conducted on materials of similar properties for nearby road pavements. The upper clayey silt, where encountered, is not suitable as a subgrade and should be stripped from the areas of the proposed pavements.

The above values are indicative only and CBR testing that satisfies the requirements of the appropriate authorities requirements will need to be carried out prior to construction of the roads. Higher CBR's will be able to be adopted where rock forms the pavement subgrade, specifically along RD-04 road alignment and at various locations of RD-05 road alignment.

The expansive nature of the clays is likely to be moderate to high and as such, the clay subgrade is likely to require the minimum cover over expansive material declared in Figure 5.1 of VicRoads Code of Practice RC500.22.

The low subgrade CBR may result in substantial pavements to be constructed within the development, depending on the traffic requirements. Deep asphalt pavements could be required for areas of the site subjected to significant traffic loading. Pavements subjected to car traffic only may be able to adopt thin asphalt pavements.

In RD-04 road alignment the pavement profile excavations are likely to encounter a considerable amount of basalt rock which may require rippers and rock breaking equipment to extract due to the likely strength of the rock. At intersection IN-17, the pavement profile excavations may encounter siltstone which may require which may require rippers and rock breaking equipment to extract due to the likely strength of the rock

As depicted in Figure 2, the northern portion of RD-03 road alignment may be underlain by swamp deposits which may be susceptible to consolidation settlement. If the design level of the road is above natural level (i.e. not at grade) fill placement has the potential to induce consolidation settlement leading to pavement issues. Solutions may include stripping out these deposits down to the underlying stronger underlying materials or preloading of the area to induce settlement in advance of the development. A

more detailed assessment of this area is recommended to determine whether this is a significant issue or not.

8.2 Erosion Susceptibility

8.2.1 Erosion Susceptibility of Siltstone Soils and Alluvial Soils

Significant surface channel erosion and tunnel erosion was identified during the site walkover along the unsealed track west of RD-05 road alignment where siltstone soils or alluvial soils are present. This unsealed track is anticipated to be developed as a SUP. Based on the aerial imagery significant surface and tunnel erosional are observed along the banks of Kalkallo Creek where siltstone soils or alluvial soils are present.

Surface channels and tunnel erosion are caused by the removal of soil by surface and subsurface groundwater flow respectively. The channels and tunnels typically have an inlet at the top of the slope with an outwash further down the slope. The inlet size can vary from a few millimetres to about 1m in diameter and depends on the density and type of the soil cover, the soil characteristics, the water quality and the intensity and rate of the water flow.

Tunnel erosion is similar to the piping failures that occur in dams. Dispersive soils are also more prone to tunnel erosion. The clay fraction of the soils is first eroded with the soil removal starting at the outlet end of the tunnel structure. With continued flow, the tunnel regresses upstream and a continuous tunnel is formed. Once the complete tunnel is formed, the flow rate increases significantly as does the volume of soil removed and the coarser particles such as sands and gravels can be eroded. While for dams, this erosion process can be quite rapid and continuous, for natural slopes the erosion events are limited to rainfall and runoff and the tunnels can grow either slowly, with limited rain, or quickly, during storm events, and some take many years to fully develop. The potential for unpredictable surface collapse of the tunnels is increased in this situation.

Road pavements that are cut into the siltstone soils can also cause erosion issues. This is due to the presence of an area of high permeability immediately adjacent the erodible soils, i.e. the subbase drainage layers of the pavement. Use of a geotextile alone to minimise erosion is not considered sufficient to prevent this erosion as the fine soils that start the tunnel erosion process can migrate through geotextiles. Instead it is typically required that the subgrade of the pavements be stabilised. In addition, it is recommended that the sides of the pavement box also be stabilised in the vicinity of where the pavement drainage will be present.

Laboratory testing conducted by Cardno on similar materials has shown that both the upper soils and the weathered siltstone are highly erodible and susceptible to erosion when used without stabilisation. However, the testing also indicated that similar materials have significantly reduced erodibility when stabilised.

The low points along the unsealed track where the natural gullies exist are considered to be area of high susceptibility to erosion. It is likely that development of the SUP with significant erosion or tunnelling risk will require the deep ripping and stabilisation of the soils down to rock and re-compaction of the materials following stabilisation.

8.2.2 Erosion Susceptibility of Basaltic Soils

No surface or tunnel erosion was identified along the RD-04 road alignment or intersection IN-12. Basaltic high plasticity clays present in this area are less prone to erosion.

8.3 Drainage

With regards to the design of the SUP, RD-05 road alignment and RD-03 road alignment drainage management is critical for the function of these infrastructure alongside stabilisation of erodible on site soils.

The potentially dispersive and erodible nature of the on-site siltstone clays are likely to have an impact on the design and construction of open drainage channels and could result in further surface and tunnel erosion if used un-treated. Care will be needed that significant volumes of water are not discharged onto erodible areas of the site.

It is likely that the on-site clays will be usable as a clay liner for drainage channels provided they are treated to reduce the erodible nature of the soils although further assessment will be required as part of a detailed investigation. Methods such as lime or gypsum stabilisation of the soils is likely to be required as a minimum to reduce the erodibility.

Use of Geosynthetic Clay Liners (GCL) may be considered as an alternative of re-use of these clays. Use of basalt boulders available on site as rock armour to reduce flow rates in area where surface water flows are concentrated should also be considered as an erosion mitigation measure.

9 Summary of Conclusions

The desktop geotechnical assessment on the site has identified significant issues with erosion related geotechnical concerns to the SUP, RD-05 road alignment and the RD-03 road alignment development. The shallow rock at surface in the RD-04 road alignment should provide sufficient support for pavement subgrades but may be difficult to excavate.

Nevertheless, the land is considered suitable for development the infrastructure components of the PSP provided the appropriate engineering advice is sought to address site issues.

Appendix A

3 Pages

Figures

Figure 1: Proposed Beveridge North-West PSP

Figure 2: Geology Along Road Alignments

Figure 3: Observation On Site

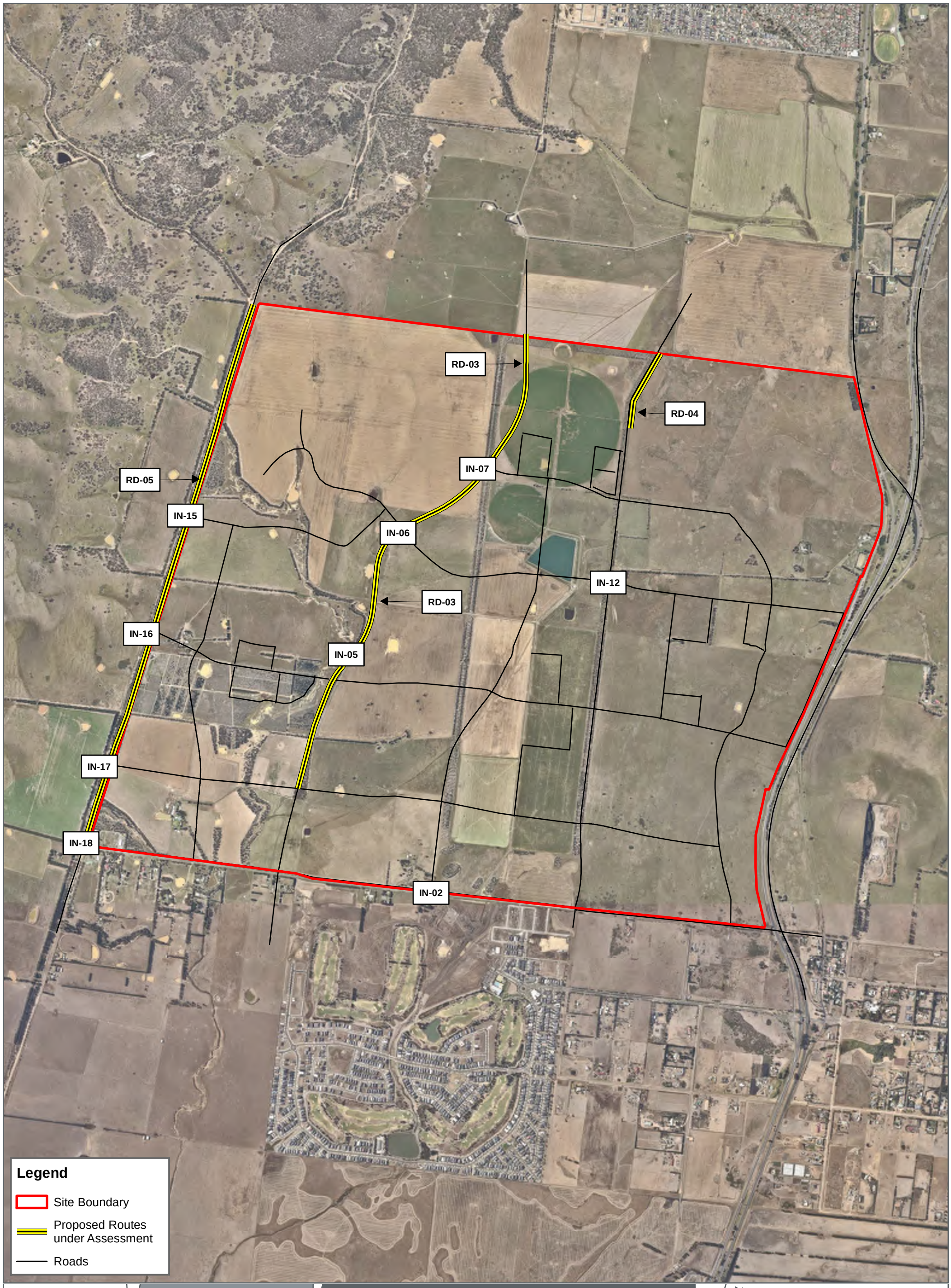

FIGURE 1

1:20,000 Scale at A3

Metres

0 250 500 750

Proposed Beveridge North-West PSP

VICTORIAN PLANNING AUTHORITY

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Map Produced by Cardno
Date: 2019-03-29 | Project: V181662
Coordinate System: GDA 1994 MGA Zone 55
Map: V181662-GS-002-SitePlan.mxd 01
Aerial Imagery Supplied by Nearmap (February, 2019)

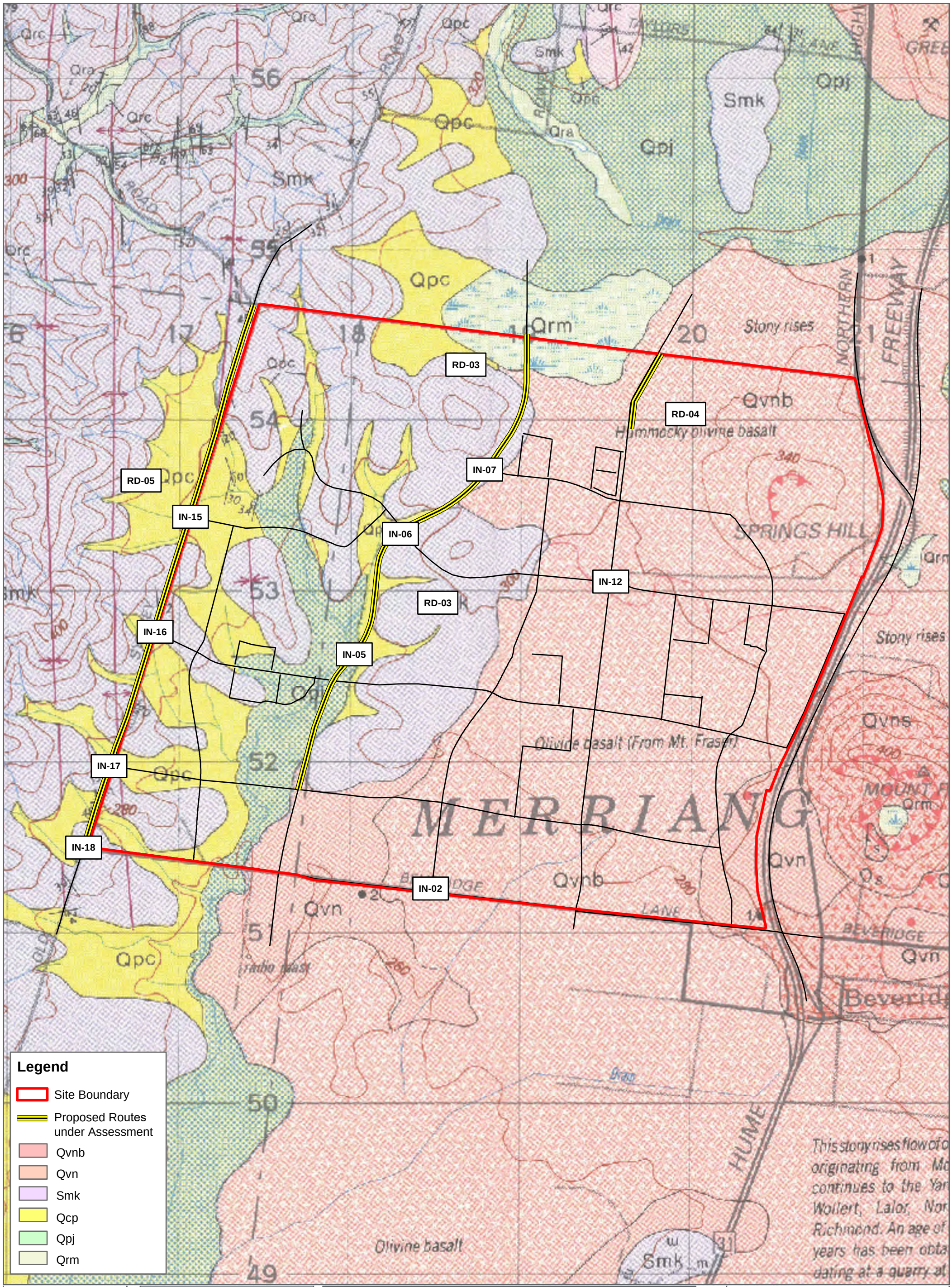

FIGURE 2

1:20,000 Scale at A3

Metres

0 250 500 750

Geology Along Road Alignments

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Date: 2019-03-28 | Project: V181662
Coordinate System: GDA 1994 MGA Zone 55
Map: V181662-GS-003-Geology.mxd 01
Map provided by GeoVIC, (Kilmore - 1:50,000)

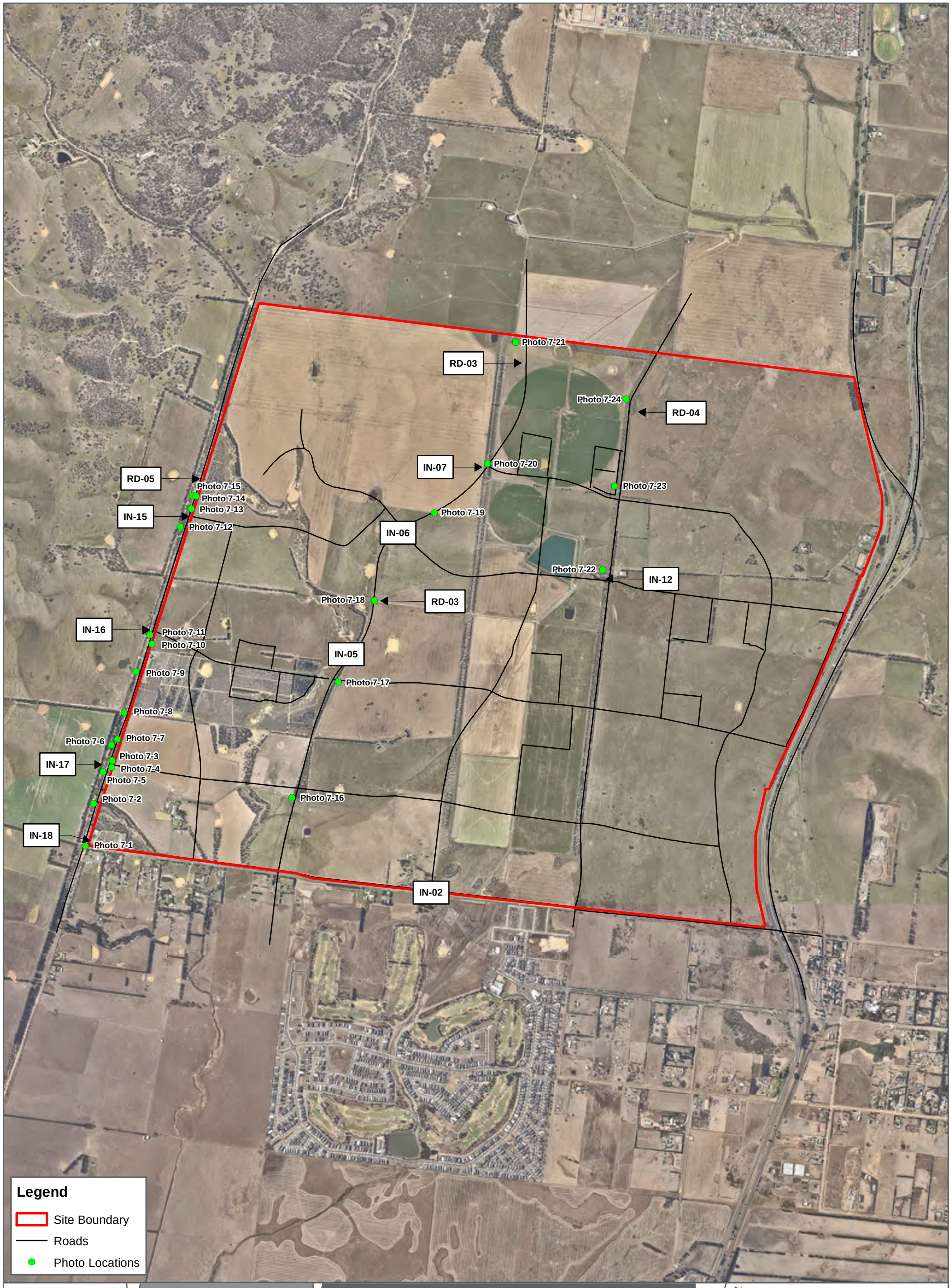

FIGURE 3

1:20,000 Scale at A3

Metres

0 250 500 750

Site Observations

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Map Produced by Cardno
Date: 2019-03-29 | Project: V181662
Coordinate System: GDA 1994 MGA Zone 55
Map: V181662-GS-004-SiteObservations.mxd 01
Aerial Imagery Supplied by Nearmap (February, 2019)

Appendix B
1 Page

Limitations of the Report

LIMITATIONS OF GEOTECHNICAL REPORTS

The purpose of this report is to provide a geotechnical assessment of the sites examined. The information provided herein will reduce the exposure to risks, but no geotechnical assessment can eliminate them. Nonetheless, even a rigorous assessment may fail to detect all of the geotechnical conditions on a site. Site variations may have occurred in areas not investigated or sampled.

This geotechnical report should not be used when the nature of the proposed site usage changes, when the size, layout, or location of the development is modified, when the site ownership changes nor should it be applied to a nearby area. No environmental assessment has been undertaken nor is implied.

This site geotechnical assessment identifies actual subsurface conditions where the samples were taken and at the time they were taken. Any soil tests completed, were carried out in Cardno's NATA accredited soil laboratory. Geotechnical engineers then interpreted the laboratory results and field data and rendered an opinion about the overall subsurface conditions, including the soil type, extent of the soil layers, and their likely impact on the proposed development, with a discussion of the implications considered likely. The actual conditions may differ from the inferred conditions, as no person (no matter how qualified) or even the most detailed subsurface investigation can predict with confidence what may be hidden by soil or water or may have altered with time. Often the interface between different geotechnical areas may be more abrupt or gradual than anticipated. The actual conditions in an area may differ from those predicted.

Site assessments are limited by time, and natural processes such as erosion, or mankind altering the ground conditions, including the site levels or filled areas, may affect a site assessment. This geotechnical assessment is prepared in response to a client's specific requirements. No person other than the client should apply the report without first conferring with Cardno.

Costly problems can occur if the report is misinterpreted. To avoid these problems, Cardno should be retained to work with the appropriate design professionals and to review the adequacy of their plans and specifications relative to the geotechnical matters.

This report should only be reproduced in its entirety. Reproduction of borehole or testpit logs alone without the entire report should not be permitted. Redrafting of the borehole or testpit logs for inclusion in drawings or other reports should not be allowed as errors in the drafting can occur. It is recommended that the report be made available in entirety to persons and organisations involved in the project such as contractors. Simply disclaiming responsibility for the accuracy of the subsurface or geotechnical information does not insulate the organisation from liability. The more information a contractor has available to him, the better able he is to avoid costly construction problems and costly adversarial situations.

Finally, geotechnical reports are based extensively on opinion and judgment and are less exact than other sciences. The report may contain a number of explanatory clauses or limitations on the results to inform the client about the restrictions of the report. These clauses are not meant to be exculpatory clauses to foist liability onto another person, but to identify where Cardno's and the client's responsibilities start and finish. Their use is to clarify where individual responsibilities lie and to allow the individual to take appropriate actions.