REPORT

Delburn Wind Farm, Gippsland Victoria

Desktop Assessment of Potential Geotechnical, Contaminated Land and Hydrogeological Constraints

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Executive Summary

Golder Associates Pty Ltd has been engaged by Delburn Wind Farm Pty. Ltd. (an OSMI Australia Pty Ltd Company) (OSMI) to undertake an assessment of potential geotechnical, contaminated land and hydrological constraints associated with the proposed Delburn Wind Farm (DWF) located in the vicinity of Delburn, about 5 km to south east of Moe in Victoria.

Based on the results of our assessment (summarised below) we consider the site to be suitable for development as a Wind Farm. Further investigation will be required (in general accordance with typical practice for wind farm developments in Victoria) as the design of the proposed Wind Farm progresses and to provide information to inform site specific design.

The proposed DWF (Version 2.2) comprises 35 wind turbine generators (WTGs) and associated infrastructure including access roads, hardstand areas, temporary and permanent site offices and a substation. Access to the site is expected to be via the Strzelecki Highway which runs through the central part of the site.

The site of the proposed wind farm development typically comprises areas that are currently used for forestry purposes. Most of the terrain is an incised plateau, with low angle slopes at higher elevations and relatively steep slopes in the vicinity of water courses. The proposed DWF is on a surface water divide, draining towards the north west and south east.

Published information indicates that the eastern part of the site is underlain by Pliocene to Miocene age dense sands and hard clays of the Latrobe Valley Group and the western side of the site is underlain by weathered Eocene age basalt of the Thorpdale Volcanics. The Thorpdale Volcanics weather to a high plasticity clay, which is expected to be encountered near the ground surface, but to be underlain by high strength basalt rock. The depth to rock is uncertain and likely to vary significantly across the project site. Site specific investigation will be required to assess the depth to basalt rock at any particular location. Due to past forestry activities on the site, there may be some areas underlain by uncontrolled fill.

The following key development considerations were identified:

Geotechnical

- Founding conditions for WTG footings, which may require foundations that extend below near surface high plasticity clay material into underlying rock.
- Founding conditions for lightly-loaded structures such as the proposed substation and temporary/permanent site offices which could comprise high plasticity clays.
- Excavation conditions for site earthworks, noting that high plasticity clays are expected to be an unfavourable material in which to undertake earthworks.
- Subgrade conditions and pavement construction requirements for access roads and hardstand areas on high plasticity clays.
- Earthworks issues such as the availability of fill for construction purposes (including the potential to reuse material generated from site excavations as engineered fill), the potential for slope instability in cut or fill batter slopes and the availability of water for construction purposes.
- Natural geological hazards including landslide and earthquake noting that the site is in one of the most seismically active areas in Victoria and that the Thorpdale Volcanics are susceptible to landslide.
- The influence of human activity, i.e. previous construction of logging tracks and the backfilling of excavations, underground services and other structures.

Contaminated land

- Presence of contaminated soils where excess soil is likely to be created.
- Presence of uncontrolled buried waste where soils will be disturbed.

Hydrological

- Availability of groundwater for construction purposes and yield of groundwater wells.
- Potential impact to surface water.
- Potential to encounter groundwater in some WTG excavations.

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1.0 ENGAGEMENT

Delburn Wind Farm Pty. Ltd. (an OSMI Australia Pty. Ltd. Company) (OSMI) has engaged Golder Associates Pty Ltd (Golder) to undertake an assessment of potential geotechnical, contaminated land and hydrological constraints associated with the proposed Delburn Wind Farm (DWF) in the Gippsland region of Victoria. We understand that this work will form part of supporting documents for a pending planning application.

This report presents the results and findings of our assessment, which was performed in general accordance with the scope of services presented in our proposal (ref: P19130636-001-L-Rev0) dated 19 September 2019. Approval to proceed with the assessment was provided by OSMI in an email (Marriot/Annan) dated 7 October 2019.

2.0 BACKGROUND

2.1 Site description

The proposed Delburn Wind Farm project area is located about 5 km to the south of Moe, with the windfarm centred around Delburn as indicated in Figure 1.The site has maximum dimensions of about 16 km (north-south) and 6 km (east-west) with a total area of about 5000 ha.

The project area is mostly used for forestry and comprises a mixture of vegetated and recently cleared forestry areas with some adjacent open paddocks. The Strzelecki Highway passes through the site and access within the site is provided by unsealed logging tracks off the Strzelecki Highway. There are several minor water courses within the area, including Stony Creek which is a tributary to the Morwell River which runs to the east of the site.

2.2 Proposed Delburn Wind Farm

Based on information provided to us via OSMI online GIS, 35 wind turbine generators (WTGs) are currently proposed (Version 2.2) at the site along with associated infrastructure including access roads, hardstand areas, batching and laydown areas, monitoring masts transmission infrastructure and a substation. Access to the site is expected to be via tracks branching off the Strzelecki Highway.

The approximate locations of the proposed WTGs and associated infrastructure, based on the information provided to us by OSMI via their online GIS platform are shown on Figure 1. Note that the WTGs are not labelled sequentially from 1 to 35.

3.0 AIMS OF THE ASSESSMENT

The aims of the assessment were as follows:

- Assess the surface topography, surrounding land use and likely subsurface conditions at the site, relevant to the proposed DWF.
- Identify past uses of the site that may have impacted upon its contamination status.
- Comment on key geotechnical, contamination and hydrological considerations for the proposed development and identify potential geotechnical, contamination or hydrological constraints on development.
- For the constraints identified, provide preliminary advice on mitigation of adverse impacts (e.g. preliminary footing advice for the expected subsurface conditions).

- Comment on the potential impact of earthworks associated with the DWF on surface water flow and groundwater salinity considerations.

Please note that consideration of cultural heritage and biodiversity protection were outside the scope of this assessment.

4.0 METHODOLOGY

4.1 General

The assessment comprised a desktop review together with a site walkover undertaken by a Principal Engineering Geologist.

4.2 Documents reviewed

As part of the desktop review we reviewed relevant aspects of the following documents.

Historical information

- Historical aerial photographs of the site from 1945, 1965 and the 1980s.

Environmental Protection Authority Database

- EPA Environmental Audit database.
- EPA Priority Sites Register.
- Post Closure Pollution Abatement Notices
- Victorian Landfill Register

Published geological information

- Geological Survey of Victoria (GSV) 1:63,360 scale 'Mirboo North' mapsheet.
- CSIRO – ASRIS Acid Sulfate Soils Probability Maps.

We also reviewed information on the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) 'Geovic' and the Visualising Victoria's Groundwater (VVG) websites, and the results of investigations undertaken by the Kennedy Haulage quarry located near the centre of the site.

As part of the desktop review and site visit we spoke to Ross Kennedy of Kennedy Haulage quarries and were taken on a site visit to view rock and soil exposures within existing quarries.

4.3 Site walkover

The site walkover was performed on 22 October 2019 by a principal engineering geologist from Golder accompanied by Mr Peter Marriot of OSMI. During the walkover the proposed sites of WTG07, WTG09, WTG38, WTG39, WTG41, WTG43, WTG45, WTG46 and WTG48 were visited and photographs taken of site features. In addition, the Kennedy Haulage quarry was visited and a tour provided around the quarry site by the quarry management.

Selected photographs taken during the site visit are presented in Appendix A. The WTG locations visited and Kennedy Quarry location are indicated in Figure 1. A summary of observations made during the site walkover is presented in Appendix A.

5.0 DESKTOP REVIEW

5.1 Topographic setting

The topographic setting of the site is presented on Figure 1. The following comments relate to the topography of the site:

- The WTG locations are predominantly located on a remnant plateau formed by the Thorpdale Volanics. The plateau has been incised, with predominant drainage direction to the north east. Surface levels range between about 100 m AHD in creek valleys on the eastern side of the site to 260 m AHD on the crest of hills.
- Due to inferred relict landslide features, the site has an irregular, or ‘stepped’ surface over some areas, with several hundred metres separating prominent breaks in slope.
- The drainage courses are valleys with relatively steep sided (20° to 30°) slopes. There is evidence for recent landslide activity on the sides of some of the gullies. Silver Creek and Stony Creek are two prominent drainage courses that flow towards the north east from the site.
- Catchment dams have been constructed in some natural drainage paths for agricultural purposes.
- The Kennedy Haulage quarry is located near the centre of the site and comprises two pits from which materials of the Thorpdale Volcanics are extracted.
- There are numerous forestry roads throughout the area in various states of repair and accessibility.

5.2 Geology and Subsurface Materials

5.2.1 Regional Geology

The 1:63,360 scale geological mapsheet for Mirboo North (GSV, 1967, see Figure 2) shows the surface geology in the project area to consist primarily of Tertiary (Oligocene) age Thorpdale Volcanics (now formally Thorpdale Volcanic Group), described on the mapsheet as comprising basic lava flows, plugs, dykes and pyroclastics, along with interbedded bands of clay and coal. Limited areas of outcropping Tertiary (Oligocene) age Childers Formation has been recorded beneath the Thorpdale Volcanics near the centre of the project area. The Childers Formation consists of sand, clay, conglomerate, gravel, quartzite and thin brown coal seams. The Tertiary (Pliocene to Miocene) age Latrobe Valley Group is mapped in the north and south of the project area, interbedded with the Thorpdale Volcanics and Childers Formation. Minor areas of Quaternary aged alluvium are mapped within creek channels. Basement rock beneath the site is expected to be of the Cretaceous age Wonthaggi Formation, although this is not mapped as outcropping within the project area. This is composed of sandstone and siltstone with minor conglomerate and black coal.

5.2.2 Near Surface Materials

With reference to Figure 2, there are two predominant geological units that are expected to underlie the site. Most of the site, including around Delburn are expected to be underlain by the Eocene to Oligocene Older Volcanics (Thorpdale Volcanics). The eastern and part of the southern part of the site is expected to be underlain by the more recent Pliocene to Miocene age Latrobe Valley Group, although based on the current WTG layout, a maximum of 6 WTG locations are expected to be underlain by this material.

Localised Quaternary alluvium is expected to be present around water courses, although this material is not expected to significantly influence the development of the DWF. A brief description of the main geological units expected at the surface of the site is provided in Table 1. We anticipate there could be local areas of uncontrolled (i.e. non-engineered) fill associated with past activities on the site including works associated with logging activities.

Table 1: Anticipated near surface geological units

Age	Unit reference	Map symbol	Description
Quaternary (Holocene)	Unit 1	Qra	Alluvium – gravel, sand, silt and clay (fluvial deposits)
Latrobe Valley Group (Pliocene to Miocene)	Unit 2	Tph	Sand, silt, gravel and ferruginous sand. Interbedded with sand and clay in varying proportion.
Thorpdale Volcanics (Eocene to Oligocene)	Unit 3	Tvd	Basic Lava and associated pyroclastics, basic plugs, dykes, interbedded clay and coal.

Note that given the Unit 2 (Latrobe Valley Group) materials are expected to overlie the Unit 3 materials (Thorpdale Volcanics), it is possible that near the geological boundaries, will pass through the Latrobe Valley Group and into the Thorpdale Volcanics. Note that the geological map appears to indicate that WTG 48 is to be located on alluvial materials. However, site inspections indicate this is unlikely to be the case.

5.2.3 Weathering

The upper portions of the Unit 3 Thorpdale Volcanics which are expected to underlie most of the proposed WTG are typically deeply weathered to a red-brown high plasticity clay, which is characteristic of the Thorpdale area. This clay is susceptible to volume changes in response to moisture changes. The clay is expected to be underlain by basalt rock, however the depth to basalt can be highly variable.

The Unit 2 Latrobe Valley Group shows some evidence of weathering, including ferruginisation whereby there is some cementation of sand by iron oxides and occasional very high strength ferricretes.

Exposures through the Thorpdale Volcanics observed in the Kennedy Haulage Quarry along with borehole logs provided by quarry management indicate a varied subsurface profile through this material. In general, the profile comprises a 6 m to 7 m thick layer of high plasticity clay inferred to have derived from the in situ weathering of the Thorpdale Volcanics. This is underlain by inferred extremely weathered basalt, which occurs as a hard clay to low strength rock and has a characteristic yellow colour. There appears to be multiple layers and varied distribution of the extremely weathered basalt before basalt rock is typically encountered at a depth of 15 m or more, noting that at some locations in the vicinity of the quarry, the basalt rock is encountered near surface.

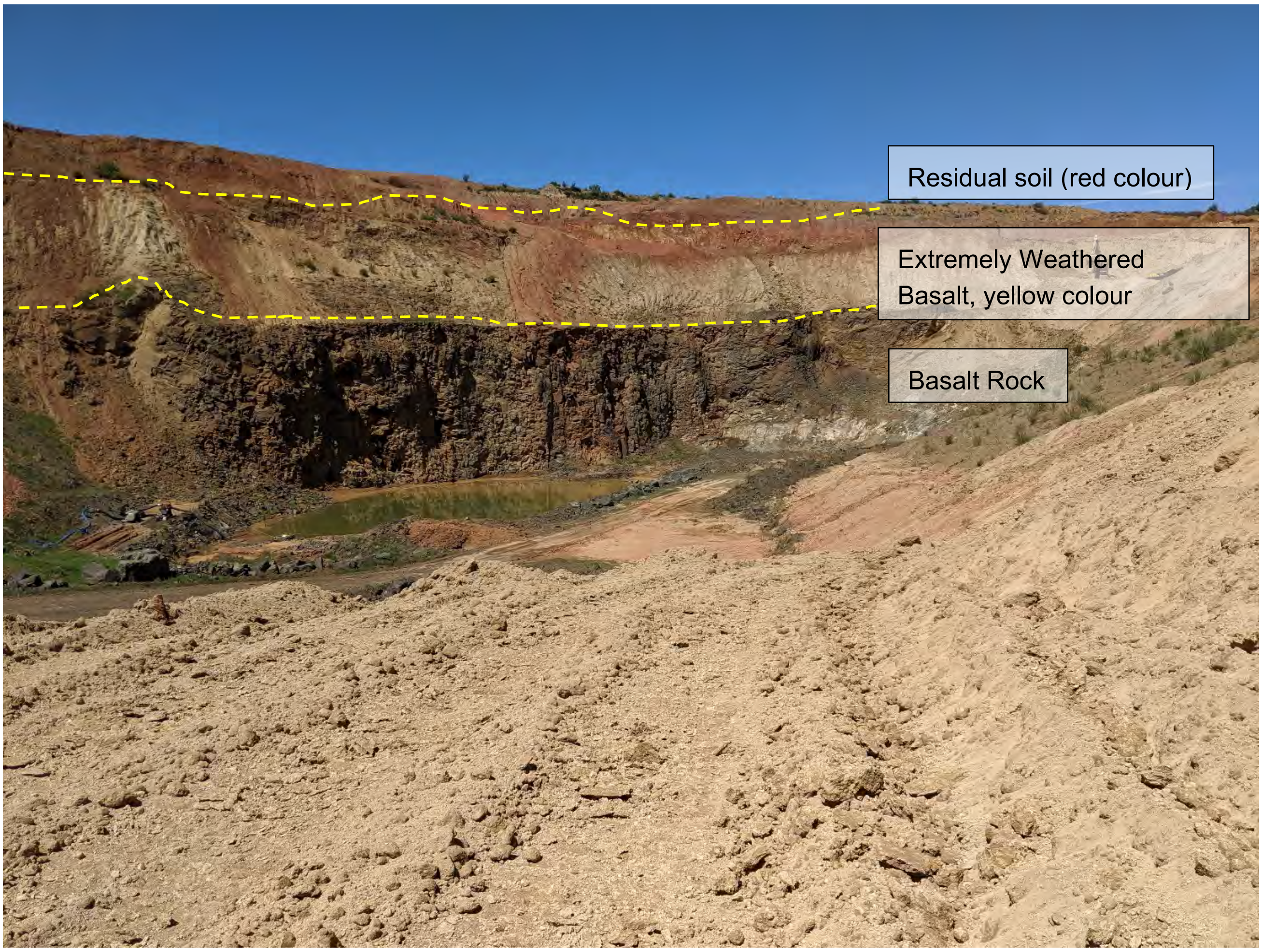

Plate 1: General profile exposed in Kennedy Haulage Quarry

Silcrete rock was observed at one location within the vicinity of the quarry and appears to be present near the top of the extremely weathered basalt.

No exposures were observed through the Latrobe Valley Group. However, past experience with this material indicates that it is typically a dense to very dense sand or hard clay containing a variable proportion of clay to sand.

5.3 Groundwater

5.3.1 Aquifer units

The main hydrostratigraphic units in the project area and their properties are summarised in Table 2.

Table 2: Summary of regional hydrogeological units

Unit	Thickness (m)	Aquifer type	Typical salinity (TDS, mg/L)	Typical bore yield (L/s)
Thorpdale Volcanics	Up to 60	Unconfined and confined fractured basalt aquifer	Less than 1,000	Variable, less than 4
Childers Formation	40 to 50	Confined sand aquifer	Less than 1,000	Less than 5

Unit	Thickness (m)	Aquifer type	Typical salinity (TDS, mg/L)	Typical bore yield (L/s)
Latrobe Valley Group	> 100	Sand and gravel aquifers locally confined by interbedded coal and clay	Less than 900	Up to 150
Wonthaggi Formation	> 100	Fractured rock aquifer,	1,000 to 3,500	Less than 5

Sources:
Nott, 2004. Groundwater Occurrence in the Gippsland Basin. Department of Sustainability and Environment, Note No. 5.
Lakey & Tickell, 1980. Explanatory Notes on the Western Port Groundwater Basin 1:100 000 Hydrogeological Map. Geological Survey of Victoria, Report #69.
Australian Stratigraphic Units Database. https://asud.ga.gov.au/search-stratigraphic-units/

5.3.2 Groundwater Levels

Groundwater levels in the project area estimated as part of state-wide mapping of groundwater levels as part of the Victorian Aquifer Framework are shown in Figure 4. This indicates that depth to groundwater across the project area is likely to range from less than 5 metres below ground level (m bgl), in topographically lower areas close to streams, to over 100 m bgl in areas of higher elevation. Based on this map, depth to groundwater at the eight proposed wind turbine locations (WTG16, WTG 21, WTG 34, WTG 35, WTG 36, WTG 38, WTG 43, WTG 49) may be less than 20 m bgl. Further investigation may be warranted near these locations to confirm actual groundwater levels.

A search of registered boreholes on the Water Management Information System (WMIS) maintained by the Department of Environment, Land, Water and Planning (DELWP) was undertaken to identify the monitoring wells for which long term groundwater level monitoring data may be available. Two monitoring wells with groundwater level information (IDs 110731 and 79784) were identified within 5 km of the site. The groundwater levels observed in these bores are shown in Plate 2, along with the rainfall residual mass curve. Rainfall data was obtained from the Mirboo North Water Board weather station (BOM station #85282), approximately 7 km south-west of the project area.

Bore 110731, located approximately 2.5 km to the east of the project area, is recorded as 200 m deep, but the screened interval and lithology is not reported. Based on the surface geology and depth, this bore is likely to intersect the Latrobe Valley Group. A declining in groundwater level of approximately 9 m was recorded between 1982, when the well was installed, and 2000. Groundwater level then remained relatively stable from 2000 to 2012, declined by approximately 4 m from 2012 to 2013, then remained relatively stable to 2018. The most recent groundwater level recorded (August 2018) indicates a depth to water of approximately 62 m, corresponding to an elevation of approximately 30 m AHD.

Bore 79784, located approximately 4.9 km to the west, is screened from 21 m bgl to 37 m bgl, within the Thorpdale Volcanics. The groundwater level has remained relatively stable over the period of monitoring (from 1975 to 2018). The most recent groundwater level (August 2018) records indicate groundwater to be approximately at the ground surface level, corresponding to an elevation of 226 m AHD.

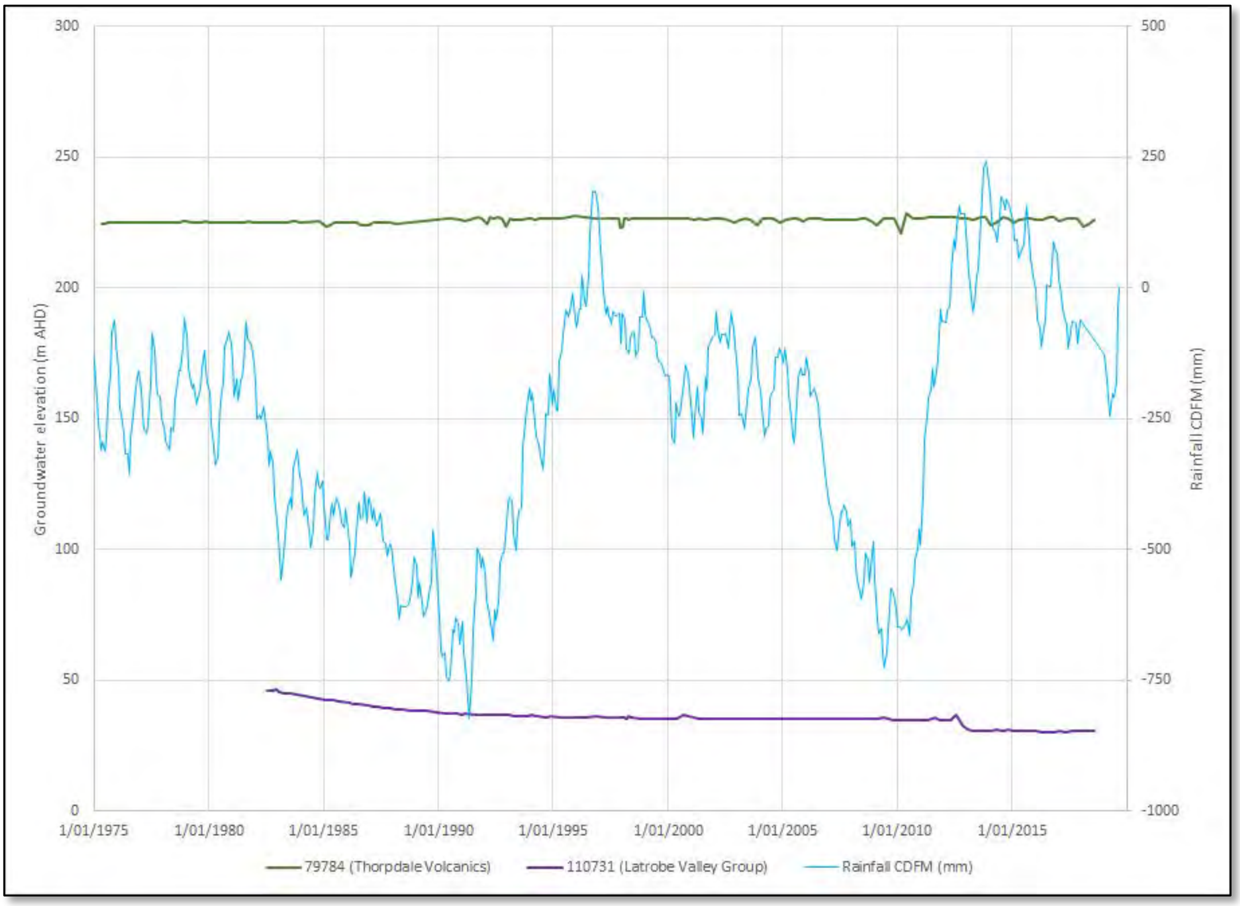

Plate 2: Groundwater level at registered wells

5.3.3 Groundwater flow system and receptors

Surface topography is commonly inferred to be a good indication of a water-table aquifer flow system. Local flow towards streams would be expected, with regional flow to the east or north-east towards the Morwell River. The Morwell River and its tributaries in the project area fall within the Central Foothills and Coastal Plains Segment under the State Environment Protection Policy (SEPP Waters) (2018). Waterways within this segment are considered to be slightly to moderately modified, so a 95% level of protection applies when selecting water quality objectives.

Aquatic groundwater dependent ecosystems are mapped (BOM Groundwater Dependent Ecosystems Atlas) along the various creeks which cross the project area (See Figure 5):

- Little Morwell River,
- Stony Creek,
- Silver Creek,
- Ten Mile Creek,
- Bird's Gully,
- Wilderness Creek.

This indicates that the creeks are likely to be receptors of groundwater discharge, and associated ecosystems rely on the surface expression of groundwater. Terrestrial groundwater dependent ecosystems are mapped in scattered locations across and surrounding the project area. These areas have the potential for vegetation to be reliant on sub-surface groundwater. Much of the GDE mapping is based on remote sensing data, and would require confirmation on the ground.

Regionally, groundwater levels and flow within the Latrobe Valley Group aquifers are known to be influenced by dewatering of the Latrobe Valley coal mines (SRW, 2012). This influence may not extend to the adjacent/overlying Thorpdale Volcanics and Childers Formation. The Morwell open cut is located approximately 4 km to the north-east of the project area, beyond the Morwell River.

5.3.4 Groundwater Quality

State-wide mapping indicates shallow groundwater in the project area is likely to have salinity of less than 1,000 mg/L.

A review of information on groundwater quality in the project area was undertaken using the information provided in the WMIS database. A total of nine wells were identified with chemical data available within 5 km of the site. All available information was collected in the 1970s. A summary of the available data is provided in Table 3. The data indicate that salinity is generally below 500 mg/L, and pH, chloride and sulphate concentrations indicate non-aggressive groundwater conditions, with reference to AS2159-2009: Exposure classification for steel or concrete piles. However, as none of these wells is located within the project area, and the age of the data, it is recommended to confirm groundwater chemistry within the project area if structures are likely to intersect groundwater.

Table 3: Summary of chemistry results from registered wells

Well ID	pH	EC (µS/cm)	Total Soluble Salts (mg/L)	Chloride (mg/L)	Sulphate (mg/L)
76630	8.0	2740	1,670	653	39
79778	8.2	454	326	58.5	15
79779	7.3	305	119	47	3
79784	8.1	660	409	77.5	-
79822	6.6	550	322	139	1
84155	8.1	554.5	392	61.5	10
84156	8.2	466	353	50	7
84157	8.0	795	-	117	-
84274	7.1	322	235	59	3

5.4 Groundwater Use

The results of a search of the WMIS database of registered groundwater wells within 5 km of the site is summarised in Table 4. A total of 77 wells are registered within the project area, but none have an extractive use listed. The realised beneficial uses in the project area identified from the search are domestic use, use for stock watering, industrial (dairy) use and dewatering. A large number of wells are registered as SEC use (State Electricity Commission). The SEC wells are thought to have been drilled for coal exploration prior to 1992, and are not likely to represent ongoing extractive use of groundwater. Dewatering bores are associated with the Yallourn open cut, approximately 4 km to the north of the project area. The location of registered wells along with their use is presented in Figure 4.

Table 4: Registered groundwater wells within 5 km

Groundwater Use	Number of Registered Bores within Project Area	Number of Registered Bores within 5 km of Project Area
Domestic and/or Stock	0	14
Irrigation	0	7
Dairy	0	3
Dewatering	0	53
Investigation/Observation	0	5
SEC	71	2729
Not Known	6	33

The Victorian Mineral Springs Database does not list any mineral springs in the project area. However, spring-fed creeks are common in the Thorpdale area, over the Thorpdale Volcanics (SRW, 2012[1]), so it is possible that groundwater springs other than mineral water are also present in the project area.

5.5 Earthquake

A review of earthquake epicentre records on the Geovic website indicates there have been earthquakes with magnitude up to 5.4 within about 3 kms of the proposed DWF. Figure 3.2(A) of Australian Standard AS1170.4 – 2007 ‘Structural design actions Part 4: Earthquake actions in Australia’ indicates that the hazard factor (z) for the Delburn region is 0.11, which is the highest in Victoria.

[1] Southern Rural Water, 2012. Gippsland Groundwater Atlas.

5.6 Landslide and Slope Instability

Review of the digital terrain model by a principal engineering geologist has been undertaken to identify areas that appear to have been subject to previous slope instability. The residual soils of the Thorpdale Volcanics are known to be susceptible to landslides, with several landslides previously occurring around the Thorpdale area. Relict landslides have been identified based on indications in the digital terrain model, similar to that presented in Plate 3.

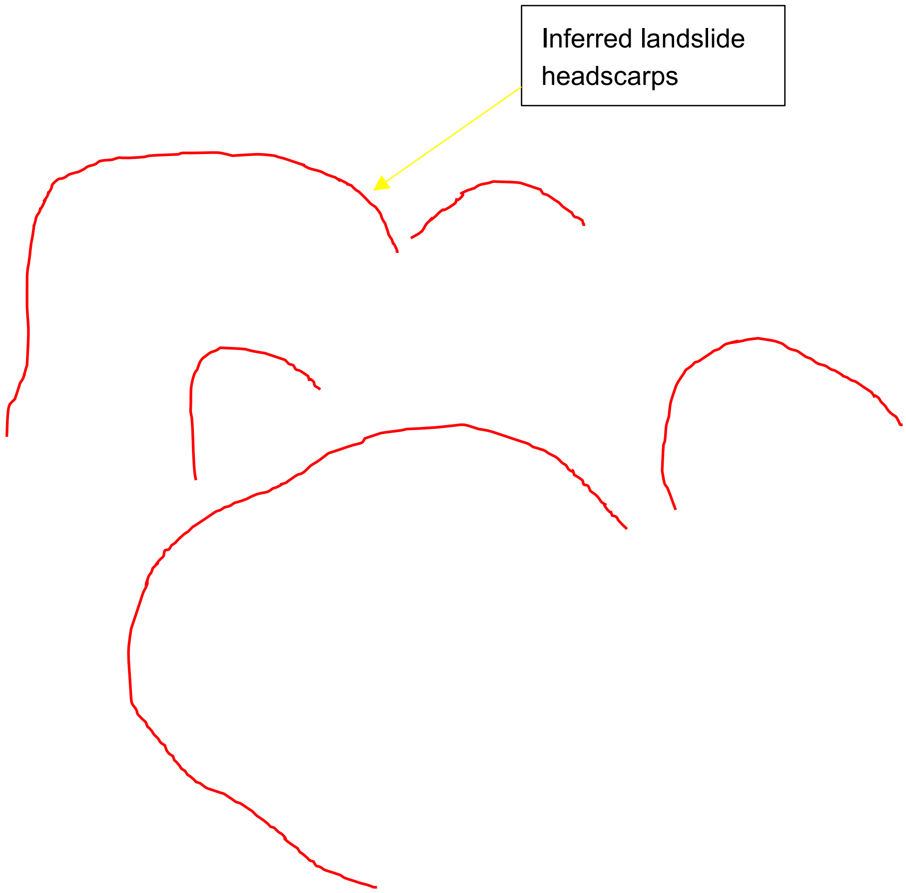

Plate 3: Example of inferred landslide within project area

Figure 3 indicates areas inferred to be subject to landslide and slope instability. These susceptible areas are typically associated with steeper slopes in the vicinity of water courses.

Field visit suggested that whilst there is evidence for past large scale landslide activity, there is no evidence for recent large scale landslide activity. Slightly hummocky and stepped ground observed in some locations appears to be indicative of historical landslides, probably thousands of years old. An example of stepped ground is presented in Plate 4 where the distance between breaks in slope is several hundred metres.

Plate 4: Example of stepped ground, track into WTG41

One example of a recent landslide was observed whilst traversing between WTG 8 and 9, noting that the landslide was not observed to be at a WTG location. The landslide was observed to be about 30 m wide and had occurred on an approximately 30 degree slope, noting that this is one of the steepest slopes within the proposed wind farm area.

Plate 5: Example of recent landslide, traverse between WTG 8 and WTG 9

We note that no evidence for recent landslide activity was observed at any of the WTG locations visited during the site visit.

5.7 Sites of Geological Significance

The GeoVic website does not identify any sites of geological significance within the project boundaries.

5.8 Acid Sulfate Soils

The CSIRO Acid Sulfate Soils Probability map indicate generally a “low probability of occurrence” to “extremely low probability of occurrence” in the vicinity of the site. However, discrete localised areas of “high probability of occurrence” are present in the vicinity of the site located near waterbodies.

5.9 Surface Hydrology

The GeoVic website indicates that the site is not located within a designated catchment area. However, the Narracan Creek Catchment area is located within 1.2 km of the western site boundary. The project site does not appear to be within any declared catchment or groundwater management areas.

5.10 Sources of Select Fill and Aggregate

During the site visit of the Kennedy Haulage quarry, observation was made of the products produced by the quarry. Based on discussions with quarry management, we understand that materials produced in the quarry are typically used for road construction, including most of the logging tracks within the proposed wind farm area. We were also provided with laboratory test results for some of the materials produced by the quarry. The following products are produced at the quarry:

- VicRoads 20 mm and 40 mm Class 3 and Class 4 crushed rock.
- 7 mm and 14 mm concrete aggregates.
- Various 'resheet' mixes, generally derived from extremely weathered basalt and screened to 20 or 40 mm minus.
- Various non-descript crushed rock products and spalls.

Photos of the materials produced in the quarry (as provided by Kennedy Haulage), including photographs of materials after placement on local roads is presented in Appendix A for reference.

Based on our preliminary observations and on the test results viewed, we expect that the Kennedy Haulage quarry will be a feasible source of most of the select fill and aggregate products required for the project, including concrete aggregates and road base materials. However, this preliminary indication is subject to detailed assessment of specific material and volume requirements.

5.11 Historical Aerial Photographs

Commercially available historical aerial photographs were obtained for review. The observations from the review are summarised in Table 5 and copies of the historical aerial photographs are provided in Appendix B.

Table 5: Aerial Photograph Observations

Date of Photograph Run	Notes
1945	The available photograph only covers the central northern portion of the site. This portion of the site mostly consists of tree covered areas with visible paddocks and roadways across the area. Rural residential dwellings and farm sheds are scattered across the area. A disturbed area is located between the proposed locations of WT08 and WT09 and to the west of WT45.
1965	The site mostly consists of tree covered areas with some visible paddocks and roadways. Inferred cropping is evident in the south of the site.
1980s	The available photographs cover limited sections of the site. The visible areas of the site appear to be generally unchanged from the 1965 photographs.
2010s (NearMap)	The site mostly consists of tree covered areas with some visible paddocks and roadways. Some areas have been cleared of trees since the previous photographs. A disturbed area is located in the north of the site. Kennedys Quarry is visible in the centre of the site. There does not appear to be any dwellings on the site however numerous dwellings and farm sheds are located near the boundary of the site. A number of creeks and surface water bodies are evident within the site.

5.12 Environmental Protection Authority Database

5.12.1 Certificates and Statements of Environmental Audit (EPA Victoria)

Certificates and Statements of Environmental Audit are statutory documents that are issued after a statutory environmental audit of a property has been conducted. A *Certificate of Environmental Audit* is issued for property where, following an audit, an environmental auditor believes the environmental condition of the land is suitable for any beneficial use. A *Statement of Environmental Audit* is issued where, following an audit, an environmental auditor believes the land is not suitable for all possible beneficial uses, but is suitable for specific uses or developments; it may contain conditions of clean-up or management of contamination.

A search of the EPA Victoria 'List of Issued Certificates and Statements of Environmental Audit' and Visualising Victoria's Groundwater website did not identify any completed environmental audits within 1 km of the site.

The closest environmental audit to the site boundary is located approximately 7 km east north east from the closest corner of the site and was completed in 2002 (CARMS No. 47803-1).

5.12.2 Groundwater Quality Restricted Use Zones (EPA Victoria website)

A groundwater quality restricted use zone (GQRUZ) is an EPA declared area where, following an environmental audit, groundwater pollution remains, usually as a result of previous industrial activity. A GQRUZ is implemented when attempts have been made to clean up the groundwater and EPA determines that restrictions should remain on how the water can be used without further treatment.

A search of Visualising Victoria's Groundwater website indicates there are no GQRUZs within 1 km of the site.

5.12.3 EPA Priority Sites Register (EPA Victoria)

The Priority Sites Register lists sites for which the EPA has issued a Clean-Up Notice (CUN) or a Pollution Abatement Notice (PAN) pursuant to sections of the *Environment Protection Act 1970*. The condition of these sites is not compatible with the current or approved use of the site without active management to reduce the risk to human health and the environment. Such management can include clean-up, monitoring and/or institutional controls.

The Priority Sites Register (current to 30 September 2019) does not list the site, or any site within 1 km of the site.

5.12.4 Post Closure Pollution Abatement Notices

Following closure, landfills continue to pose risks to the environment. In order to ensure that the risks are appropriately quantified and managed, owners of closed landfill sites are issued with a Post Closure Pollution Abatement Notices (PC PAN) that requires the closed landfill to be managed so there are no unacceptable risks to the environment.

EPA Victoria maintains a database for locating issued PC PAN documents (EPA Interaction Portal). The database was queried 28 October 2019 and did not list any PC PANs within the townships/localities (Boolarra, Darlimurla, Delburn, Driffield, Hernes Oak, Narracan and Yinnar) that intersect the site.

5.12.5 Victorian Landfill Register

Publicly available to all Victorians, the Victorian Landfill Register (VLR) draws information from various sources. It lists all current and known closed landfills in Victoria. Information contained in the VLR is intended to be used only as a guide and is not to be relied upon as being either complete or accurate. The VLR brings together information from:

- EPA landfill licences and post closure pollution abatement notices;
- Regional Waste and Resource Recovery Implementation Plans; and
- Historic landfill records held by EPA.

Sites that are located within 500 m of landfills, or former landfills may require further assessment for potential ground gas risks, such as methane.

The VLR interactive webpage was queried on 28 October 2019 and shows than an operating landfill is located 750 m to the north of the site (at its closest point) and is operated by Energy Australia Yallourn Pty Ltd, the type of waste received was not available on the VLR. No other landfills were listed on the register within a 1 km radius of the site.

An interest search of Energy Australia Yallourn Pty Ltd found that Energy Australia Yallourn submitted a Financial Assurance proposal to the Victorian EPA for three operational landfills located at Yallourn. The three landfills include an ash landfill, a hard waste landfill and an asbestos landfill. The Financial Assurance Proposal was approved by EPA in December 2018.

Additionally, the VLR interactive webpage shows that an operational landfill is located at the Hazelwood Power Complex and receives ceramic-based fibres, asbestos and ash waste, the landfill is located approximately 1.7 km south east of the site at its closest point.

6.0 DISCUSSION - GEOTECHNICAL

Based on the results of our desktop assessment the key geotechnical considerations relevant to potential constraints on development of the proposed DWF are as follows:

- Founding conditions for WTG footings.
- Founding conditions for lightly-loaded structures such as the proposed substation and temporary/permanent site offices.
- Excavation conditions for site earthworks.
- Subgrade conditions and pavement construction requirements for access roads and hardstand areas.
- Earthworks issues such as the availability of fill for construction purposes (including the potential to reuse material generated from site excavations as engineered fill), the potential for erosion or slope instability in cut or fill batter slopes and the availability of water for construction purposes.
- Potential for landslides and slope instability.

Preliminary recommendations relating to these key considerations are presented below. The constraints identified are summarised in Section 9.0. Targeted geotechnical investigation works will be required to address these considerations and to inform the design of the proposed DWF.

6.1 Founding conditions for WTG footings

In our experience the preferred footing alternative for WTGs in Victoria is usually a square or octagonal shallow mass concrete footing, founding at about 1.5 m to 3.5 m depth and with a maximum plan dimension of about 15 m to 20 m. Given the size of the turbines proposed for the DWF, we understand that excavations may need to be advanced up to 7 m below the ground surface. Piled footings are generally only adopted (sometimes in conjunction with shallow footings to reduce settlement) where the ground support conditions are unsatisfactory for shallow footings at the design founding level. The average vertical pressure imposed below the mass concrete footings is usually relatively low. However, higher pressures are imposed beneath the edge of these footings when resisting overturning loads. The mass of the footing also assists to resist the relatively high overturning and tension loads.

The Unit 3 Thorpdale Volcanics on which most of the WTG are proposed to be supported are expected to comprise high plasticity clay at shallow depth which could be the material present at the likely founding level of the proposed WTGs. Depending on the thickness of the residual clay it may be feasible at some locations to found the WTG below the residual clay on weathered basalt rock. However specific investigation will be required at each WTG location to investigate the depth to rock. If rock is present within a depth of about 5 m below the ground surface level, shallow mass concrete footings could be a satisfactory footing alternative. However, if residual basaltic which is expected to have a stiff or softer consistency is present at the proposed founding level, piles may be required, or the dimensions of shallow footings may need to be increased to reduce the pressure imposed at the base of the footing. Alternatively, ground improvement works (e.g. excavation and replacement of weak founding materials with blinding concrete or compacted crushed rock) could be considered.

The Unit 2 Haunted Hill Formation is expected to comprise very stiff clay and dense to very dense sand and gravel. Shallow mass concrete footings may be suitable on this material, However, again site specific investigation will be required to assess the engineering characteristics of the material and it is possible that piles could be required if the material present at the proposed founding depth is not at least very stiff or dense.

There is an increased potential for relatively low strength founding materials to be encountered within surface drainage paths (e.g. near wet or boggy ground) which should be considered in the positioning of the proposed WTGs and designing of access tracks. Notwithstanding this, based on the layout provided to us (Version 2.2) and our site visit there do not appear to be any WTG proposed on alluvial material in the vicinity of water courses.

Excavations for WTG are not expected to encounter groundwater, unless WTG are located in areas within lower elevation, for example in the vicinity of water courses. However, depth to groundwater should be assessed as part of geotechnical investigation works.

6.2 Founding conditions for lightly-loaded structures

The site is generally expected to be underlain by natural soils that are a satisfactory founding stratum for lightly-loaded structures such as substation buildings and temporary or permanent site offices. However, the high plasticity clay soils associated with the Unit 3 Thorpdale Volcanics are potentially highly reactive and significant seasonal shrink-swell movements can be expected due to seasonal deep-seated changes in the moisture content of the soil. These reactive movements (shrink and swell of the soils) can impact lightly-loaded structures and should be considered in developing the scope of future geotechnical investigation works at proposed structure locations.

Australian Standard AS2870 (2011) ‘Residential slabs and footings’ provides guidance and recommendations on the assessment of reactivity for lightly-loaded structures and footing design for various ‘site classifications’ based on the expected reactive ground movements.

Construction requirements for lightly-loaded structures built as part of the proposed DWF will depend on design requirements such as design loads and settlement/ground movement tolerances. For example, we anticipate that temporary site offices will generally have a high tolerance to reactive ground movements but elements of substation buildings may not. Potential alternatives to mitigate the impact of reactive ground movements include the following:

- Increasing the founding depth of footings (as seasonal changes in soil moisture content decrease with increasing depth).
- Increasing the stiffness of the building footing, so that larger reactive movements can be accommodated with less potential for damage or differential movement of the structure.
- Excavating below the design founding level to remove the uppermost layer(s) of reactive clay materials and replacement with select fill of low reactivity.
- Drainage controls and restrictions on landscaping works (e.g. tree planting) to reduce the potential for seasonal moisture content change in the underlying soils.

6.3 Excavation conditions

The natural soils expected to be encountered within about 5 m to 10 m depth below the ground surface are typically expected to be able to be excavated using medium sized excavation plant. If the residual soils of the Thorpdale Volcanics are penetrated and the underlying basalt rock is encountered, excavation of basalt rock using larger excavation plant may be required, depending on the strength of the rock (which could be high strength or stronger rock) and the frequency of defects (e.g. joints) in the cemented layers. We note that near surface, high strength basalt was observed at one location during the site visit, near the Kennedy Haulage quarry. Future geotechnical investigations should include an assessment of likely excavation conditions over the depth of proposed excavations at the site.

If excavation for piles is required in the Unit 3 Thorpdale Volcanics, the pile excavations are likely to penetrate into and socket into weathered basalt rock. Depending on the degree of weathering of the basalt, coring barrels may be needed to effect this excavation.

If high strength basalt rock is encountered at the design subgrade level for pavements and hardstands, ripping may be required to assist in the preparation of a level surface. However, these materials were not observed at the ground surface level at the proposed WTG and access road locations visited during the site walkover and so this is not expected to be a significant construction issue.

6.4 Subgrade conditions and pavements

Highly reactive clays may be exposed at the design subgrade level of access road pavements and hardstand areas, in particular within the Unit 3 Thorpdale Volcanics. The presence of these clays can be problematic for construction works, particularly in wet weather. However, the adverse impact of these clays can be mitigated through careful construction practices that take into account the potential for reactive movement with changes in moisture content, and strength loss of these clays when wet (e.g. the inclusion of a capping layer of low hydraulic conductivity materials as the base layer of pavements, stabilisation with the inclusion of lime and/or cement and performing earthworks during the drier months of the year).

Subgrade preparation is likely to be more problematic where surface drainage paths or ponded water (e.g. shallow gullies and table drains at the edge of road reserves) are present. However, this may be less of an issue for construction in the drier months of the year. The depth of topsoil should be assessed during future geotechnical investigation works to assist in the assessment of likely topsoil strip depths and volumes.

6.5 Earthworks issues

With regards to likely earthworks issues we provide the following general comments:

- The residual soils of the Unit 3 Thorpdale Volcanics are not expected to support long term unsupported batters steeper than about 3H:1V, nor temporary batters steeper than about 2H:1V. If batters higher than about 4 m are required, benches may need to be incorporated into the batter design.
- The soils of the Unit 2 Latrobe Valley Group are not expected to support long term unsupported batters steeper than about 2H:1V, nor temporary batters steeper than about 1H:1V and benches are likely to be necessary where batters are higher than about 4 m.
- The Unit 2 Latrobe Valley Group is expected to be suitable as engineered fill. However, if this material has a high proportion of plastic clay or organic materials, it may be less suitable. Site specific investigation in potential borrow areas will be required to assess the suitability of this material as fill. Topsoil materials are unsuitable for re-use in engineered fill platforms due to their high organic content, but could potentially be stockpiled for re-use in landscaping works
- The residual soils of the Unit 3 Thorpdale Volcanics are a high plasticity clay which is generally a poor material within which to undertake earthworks and is not favourable for use as engineered fill due to expected difficulty in moisture conditioning the material. Careful construction procedures (e.g. stringent controls on moisture conditioning) will be required if high plasticity clay materials are to be reused as fill. It may be possible to treat the high plasticity clays with lime or to blend it with other materials in order to improve its workability as engineered fill. However, ideally use of this material as fill should be avoided.
- The Kennedy Haulage quarry within the project area is a source of select fill including concrete aggregate mined from the Unit 3 Thorpdale Volcanics. This material is expected to be suitable as a crushed rock for road and pavement construction and for use as concrete aggregate. Similar basalt rock is expected to be present elsewhere in the project area that could provide a suitable source of crushed rock if encountered in excavations for WTG. There are also other quarry sites outside of the project site, including at Jeeralang that could also be a suitable crushed rock or aggregate source.
- Assuming the adoption of good construction practices such as erosion protection of exposed cut and fill batter slopes, drainage controls and the implementation of silt fences where required, erosion of cut and fill batters is not considered to be a significant issue for the proposed DWF taking into account the shallow site slopes.
- The availability of water for construction purposes (e.g. moisture conditioning of fill and dust control) is not expected to be a significant issue provided water can economically be obtained from nearby sources. We recommend testing of groundwater wells to assess yields that can be achieved from groundwater bores.

6.6 Landslide

The residual soils of the Unit 3 Thorpdale Volcanics are prone to landslides. Landslides can occur at relatively shallow slope angles, in some cases as low as 11°, however observations made on the site visit indicates recent landslide activity only on slopes steeper than about 20°. As indicated on Figure 3, there is evidence for extensive relict landsliding within the project area, generally in the vicinity of water courses. Although these features appear subdued and are unlikely to have reactivated for thousands of years, there is potential for reactivation to be initiated through inappropriate earthworks or drainage management. It is recommended that wherever possible, WTG construction on sites with slope angles steeper than about 11° and underlain by the Unit 3 Thorpdale Volcanics is avoided and where this cannot be avoided, a site specific landslide risk assessment is undertaken to assess specific landslide risks to the WTG.

We note that based on the WTG layout provided to us, none of the WTG locations currently proposed are within landslide susceptible areas.

6.7 Earthquake

The proposed DWF is located in one of the most active seismic areas in Victoria. Notwithstanding this, the seismic risk is low relative to more active seismic areas elsewhere in the world and Australia. Whilst seismic loading will need to be considered in the engineering design, it is unlikely to preclude the development.

6.8 Human impacts

There has previously been the location of logging and forestry activities within the extent of the proposed DWF. Ground disturbance associated with this activity included the formation of tracks, and potentially other earthworks. There could be areas of the project site which are underlain by uncontrolled fill, including associated with tracks and potentially backfilled dams. We anticipate that maintenance of public roads (e.g. re-grading, and potentially resurfacing of asphalt roads) may need to be undertaken as part of the proposed DWF construction works, in accordance with typical construction practices for wind farms. We consider it would be prudent to perform a dilapidation survey of existing structures and roads prior to construction works commencing so there is a record of the ‘pre-construction’ conditions.

6.9 Future Investigation

We recommend that future investigation for the purposes of informing detailed design include a borehole at each proposed WTG location, with boreholes advanced to a depth of 15 m to 25 m. The principal objective of the borehole will be to assess the strength and stiffness of the underlying soil and rock to assist in foundation design. The boreholes would also assist in assessing the depth to rock beneath the proposed WTG locations, noting that the depth to rock across the DWF is expected to be highly variable. This information will inform the likely footing depth, excavation batter angles and whether piles are required to support the proposed WTG. In addition, we recommend the following:

- The installation of groundwater wells at locations where bore water is expected to be sourced, for the purposes of assessing groundwater bore yields.
- Independent testing of materials provided by the Kennedy Haulage quarry.
- Electrical and thermal resistivity testing of materials within which buried electrical infrastructure is proposed.

7.0 DISCUSSION - CONTAMINATED LAND

The review of historical information has indicated that the risk of potential contamination of soil is likely to be low with a localised risk in the immediate vicinity of dwellings, farm sheds and disturbed areas. However, it is understood that DWF development is not expected to comprise construction near existing areas of residential or agricultural infrastructure, therefore the overall risk of soil contamination to the project is considered to be low. Potential constraints identified in relation to contaminated land are summarised in Table 7.

8.0 DISCUSSION – HYDROGEOLOGY

Based on the desktop review of groundwater conditions, and the wind farm layout as currently proposed, there is limited potential for structures to intersect groundwater. WTG sites with the potential for shallower groundwater include WTG16, WTG 21, WTG 34, WTG 35, WTG 36, WTG 38, WTG 43, and WTG 49.

Indications are that groundwater chemistry is not aggressive to steel or concrete structures, although this is based on old information from beyond the project areas, so should be confirmed if intersection of groundwater is anticipated.

Groundwater quality is indicated to be potentially suitable for any beneficial use, based on salinity. Although low yields would be expected from the Thorpdale Volcanics or Childers Formation within the project area, these aquifers may be considered as a potential water supply for project needs. Supply from the Latrobe Valley Group may also be available, although deeper wells may be required to access this. The entire project area is within both the Rosedale and Stratford Groundwater Management Areas (GMAs: see Figure 3). The Rosedale GMA applies to "Middle Aquifers", nominally from 50 m to 150 m below ground surface. In the project area, this would include the Morwell Formation and Yallourn Formation of the Latrobe Valley Group (i.e. upper part). The Stratford GMA applies to "Lower Aquifers" at greater than 150 m depth. In the project area, this would include the Thorpdale Volcanics, Childers Formation and Traralgon Formation/Burong Formation of the Latrobe Valley Group (i.e. lower part). Permission to extract groundwater would need to be sought from Southern Rural Water, subject to availability within the Permissible Consumptive Volume (PCV). As at 2016, the Rosedale GMA had 99.7% of the PCV allocated and the Stratford GMA had licences issued up to the PCV (SRW, 2016[2]), so approval for additional extraction could only be given by trading with existing licensees. Shallower zones (i.e. less than 50 m depth) are not included within the GMAs, so no PCV is in force. Applications for groundwater extraction are still required, and would be assessed for potential interference to any nearby existing groundwater user. Any application for groundwater extraction would also need to consider potential effects on surface water stream flow and associated ecosystems.

Further investigation would be required to measure the groundwater yield that could potentially be gained from wells.

Constraints associated with hydrological considerations are assessed to be low as indicated in Table 7.

[2] Southern Rural Water, 2016. Catchment Statement for Central Gippsland and Moe Groundwater Catchments. Version 2, August 2016.

9.0 ASSESSMENT OF POTENTIAL CONSTRAINTS

9.1 Definitions

Table 6 defines the qualitative ranking system adopted for our assessment of potential geotechnical, contaminated land and hydrological constraints in Table 7 (Section 9.2 below).

Table 6: Definition of qualitative constraint assessment rankings

Rank	Definition
Low	The potential constraint is expected to be readily addressed using engineering design or construction practices typically adopted for wind farm developments in Victoria.
Medium	The potential constraint is unlikely to preclude development. However, non-standard engineering design or construction practices (in the context of typical wind farm projects in Victoria) would be required to address the constraint.
High	The potential constraint is likely to preclude development unless significant engineering or construction practice controls are implemented. Controls may be costly or impractical.
Unknown	The significance of the potential constraint cannot be assessed without further information.

9.2 Assessment

The constraints identified as part of our assessment, together with recommended mitigation measures, are summarised in Table 7.

Based on the results of our assessment we consider the site can be developed as a wind farm, subject to mitigation measures being implemented for the identified constraints. The constraints identified are typically expected to be readily addressed using standard engineering design or construction practices.

Table 7: Qualitative assessment of potential constraint ranking and potential mitigation measures

Potential Constraint		Potential impact to project	Rank	Mitigation measures
Geotechnical	Weak subsurface materials present at design founding level.	Increased cost of foundation construction (e.g. larger spread footings or requirement for piles).	Medium	Geotechnical investigation required at the infrastructure locations. Address in engineering design, for example ground improvement or piles. Costs may be high depending on the proportion of WTG that require piles or ground improvement.
	Presence of high reactivity clay beneath lightly loaded structures.	Increased cost of foundation construction.	Medium	Geotechnical investigation required at the infrastructure locations. Address in engineering design of footings.
	Presence of high strength or stronger basalt rock within proposed excavations.	Increased cost of excavation works.	Low	Geotechnical investigation required at the infrastructure and WTG locations. Address in engineering design.
	Presence of high reactivity clay in pavement subgrade materials.	Increased cost of pavement construction.	Low	Geotechnical investigation required at the infrastructure locations. Address in engineering design.
	Wet or unstable subgrade materials.	Increased cost of pavement construction.	Low	Locate infrastructure to avoid water courses and drainage paths or areas of ponded water. Implement drainage controls and consider undertaking construction works in the drier months of the year.
	Site generated materials not suitable for reuse as engineered fill.	Increased costs for offsite disposal of unsuitable materials. Increased costs and delays associated with importing suitable fill.	Medium	Geotechnical investigation required at the infrastructure locations. Address in engineering design. Identify potential sources of imported fill.
	Availability of imported fill for construction purposes.	Increased costs and construction delays due to fill importation.	Low	Identify potential material sources during planning/detailed design. Confirm suitability of materials sourced from the Kennedy Haulage quarry.

Potential Constraint		Potential impact to project	Rank	Mitigation measures
	Availability of water for construction purposes	Costs and delays associated with identifying a source of water.	Low	Confirm availability of water from local bores or other local sources, for example Hazelwood Pondage.
	Earthquake	Damage to WTG.	Low	Address in engineering design, undertake appropriate seismic design.
	Landslide and slope instability.	Undermining or damage to WTG and assets.	Medium	Undertaken landslide risk assessment for WTG and infrastructure within areas that have landslide susceptibility.
	Presence of uncontrolled fill.	Increased cost of foundation construction or subgrade preparation.	Low	Geotechnical investigation required at the infrastructure locations. Address in detailed design.
	Damage to public roads due to construction traffic.	Cost of repair or replacement.	Low	Provide appropriate allowance for maintenance. Dilapidation survey prior to construction works.
	Damage to existing structures including services.	Cost of repair or replacement.	Low	Identify service locations that could be impacted by works. Dilapidation survey prior to construction works.
Contaminated land	Presence of contaminated soils where excess soil is likely to be created.	Potential increased cost of off-site disposal of excess soil material.	Low	Undertake a targeted intrusive soil investigation of areas that will likely require off-site disposal.
	Presence of uncontrolled buried waste where soils will be disturbed.	Potential increased cost of off-site disposal of excess soil material.	Low	Undertake a targeted intrusive soil investigation of areas that will likely be disturbed.

Potential Constraint		Potential impact to project	Rank	Mitigation measures
Hydrogeological and Hydrological	Availability of bore water for construction activities.	Requirement to import water from a further source leading to a greater number of road movements.	Low	Undertake hydrological testing within bores to measure yields and estimate volumes of water available for construction.
	Impact to groundwater.	Environmental harm caused by groundwater impact.	Low	Measure groundwater levels at proposed WTG locations through targeted investigation. Establish baseline groundwater quality through site specific measurement.
	Impact to existing surface water.	Environmental harm caused by release of silt or chemicals to the environment including surface or groundwater.	Low	Address through environmental management plan and construction practices. Likely to include silt control and dust suppression measures.

10.0 IMPORTANT INFORMATION

Your attention is drawn to the document 'Important information relating to this report' which is included in Appendix C of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. We would be pleased to answer any questions the reader may have regarding this document.

Signature Page

Golder Associates Pty Ltd

Darren Paul
Principal

DRP-RJ/JMW-DLG/drp

https://golderassociates.sharepoint.com/sites/115925/project files/6 deliverables/19130636-001-r-rev0.docx

LEGEND

- WTG
- ProjectBoundary
- Kennedy Quarry
- VVG Bores
- 10 m elevation contour

Roads

- Freeway
- Highway
- Local Road
- Sealed Road
- Other Road
- Track
- Reticulation

DRAFT

0 1,000 2,000 3,000

1:60,000 METRES

NOTE(S)

1. PROJECTION: GDA 1994 MGA ZONE 55.

REFERENCE(S)

1. KEY MAP AND IMAGERY SOURCED FROM ESRI ONLINE BASEMAPS.
2. ROAD & PROPERTY DATA © THE STATE OF VICTORIA, DEPARTMENT OF ENVIRONMENT, LAND, WATER & PLANNING, 2017.

CLIENT

OSMI AUSTRALIA

PROJECT

DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE

SITE LAYOUT

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-26
DESIGNED	-
PREPARED	MAH
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
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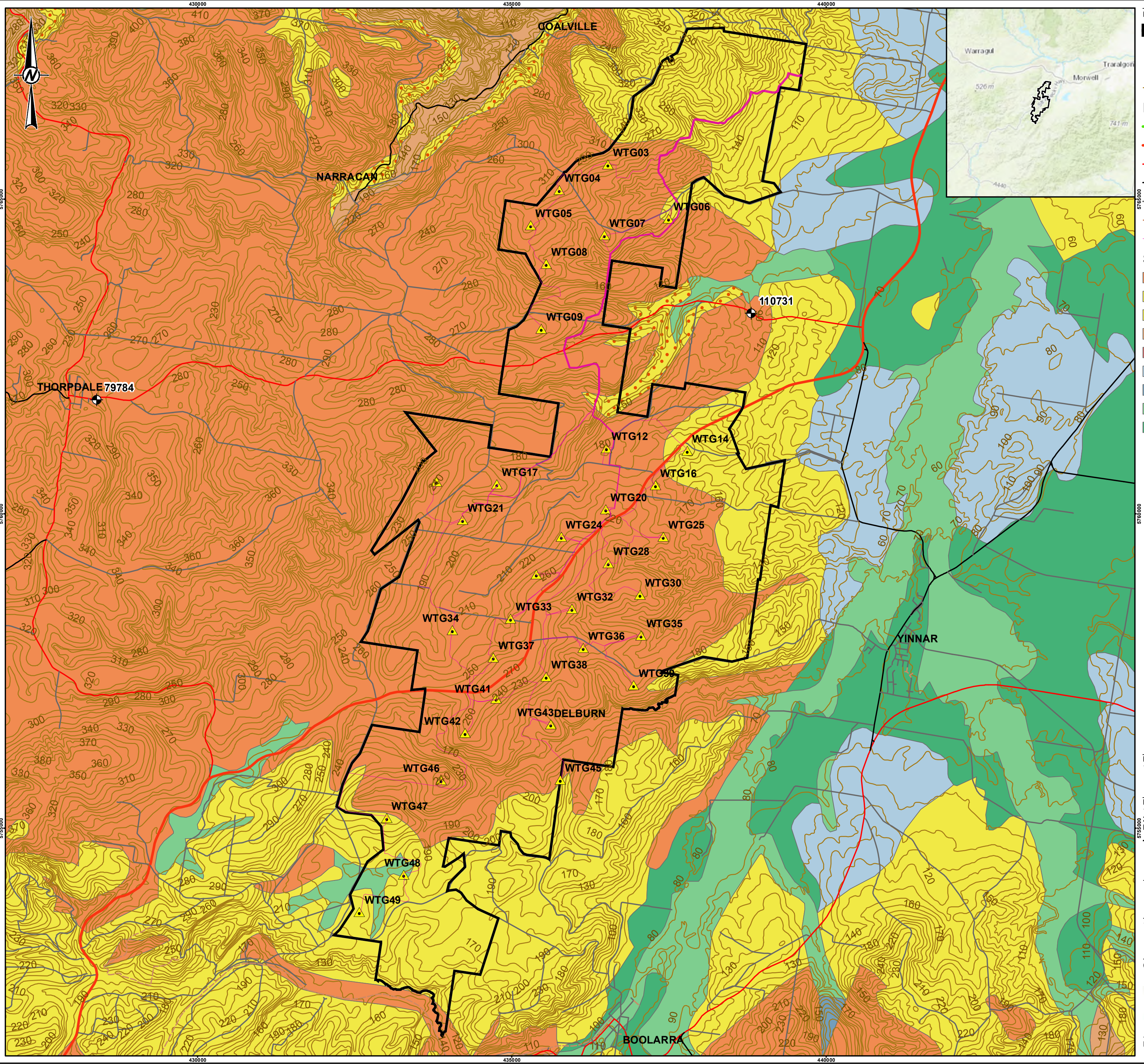

LEGEND

- Project Boundary
- VVG Bores
- WTG
- 10 m elevation contour

Roads

- Freeway
- Highway
- Local Road
- Sealed Road
- Other Road
- Track
- Reticulation

Surface Geology

- Thorpdale Volcanics (-Put)
- Latrobe Valley Group (-Pv)
- Childers Formation (-Pvc)
- Strzelecki Group (Ksw)
- Incised colluvium (Nc1)
- Haunted Hills Formation (Nlh)
- Howqua Chert (Oah)
- Sand, silt, clay, gravel of Recent alluvial flats (Qa1)
- Alluvial terrace deposits (Qa2)

DRAFT

0 1,000 2,000 3,000
1:60,000 METRES

NOTE(S)
1. PROJECTION: GDA 1994 MGA ZONE 55.

REFERENCE(S)
1. KEY MAP AND IMAGERY SOURCED FROM ESRI ONLINE BASEMAPS.
2. ROAD & PROPERTY DATA © THE STATE OF VICTORIA, DEPARTMENT OF ENVIRONMENT, LAND, WATER & PLANNING, 2017.

CLIENT
OSMI AUSTRALIA

PROJECT
DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE
GEOLOGICAL PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-26
DESIGNED	-
PREPARED	MAH
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
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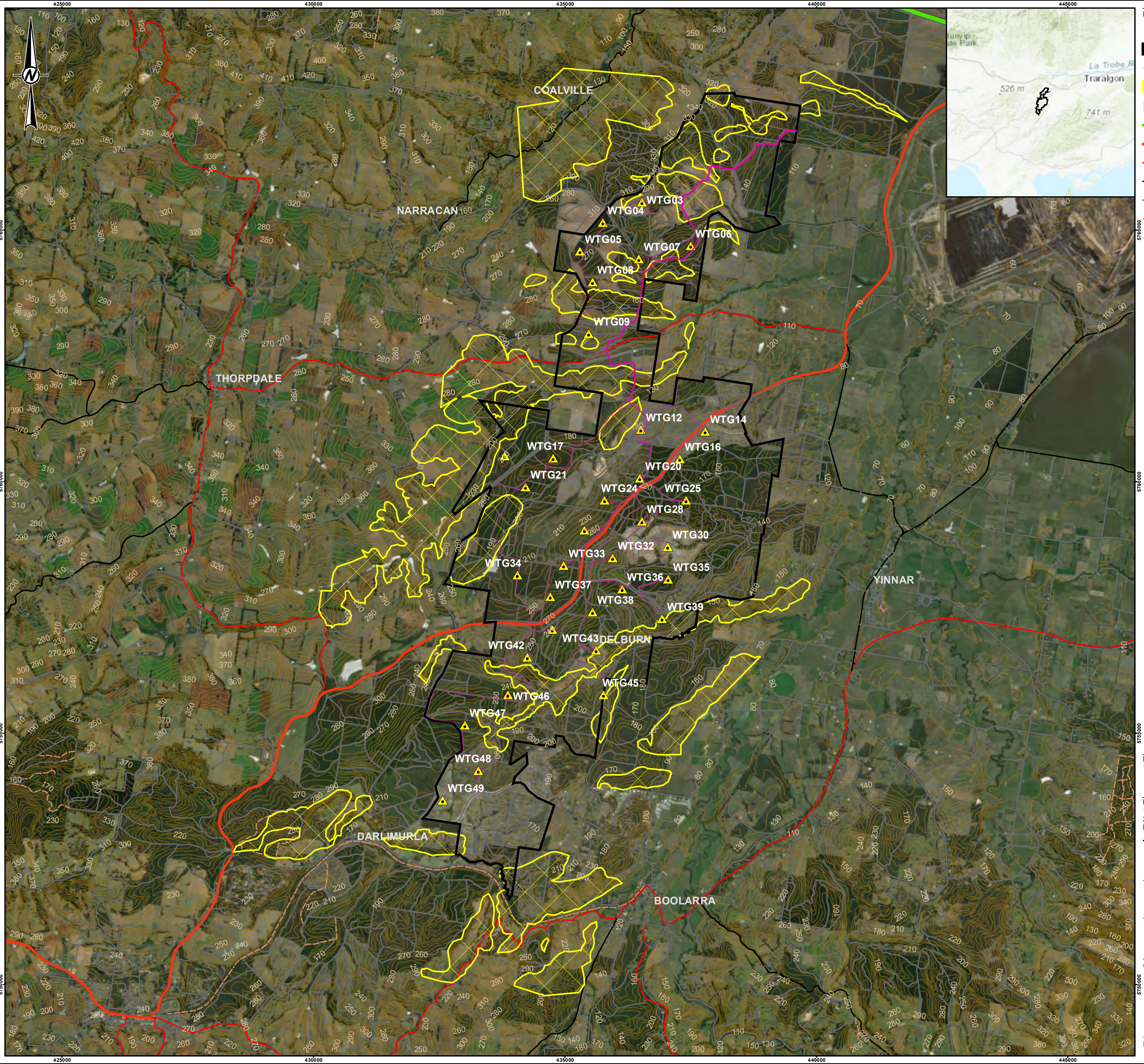

LEGEND

- WTG
- Project Boundary
- 10 m elevation contour
- Landslide Susceptibility

Roads

- Freeway
- Highway
- Local Road
- Sealed Road
- Other Road
- Track
- Reticulation

DRAFT

0 1,000 2,000 3,000 4,000 5,000

1:75,000 METRES

NOTE(S)
1. PROJECTION: GDA 1994 MGA ZONE 55.

REFERENCE(S)
1. KEY MAP AND IMAGERY SOURCED FROM ESRI ONLINE BASEMAPS.
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CLIENT
OSMI AUSTRALIA

PROJECT
DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE
INFERRED LANDSLIDE SUSCEPTIBILITY

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-26
DESIGNED	-
PREPARED	MAH
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
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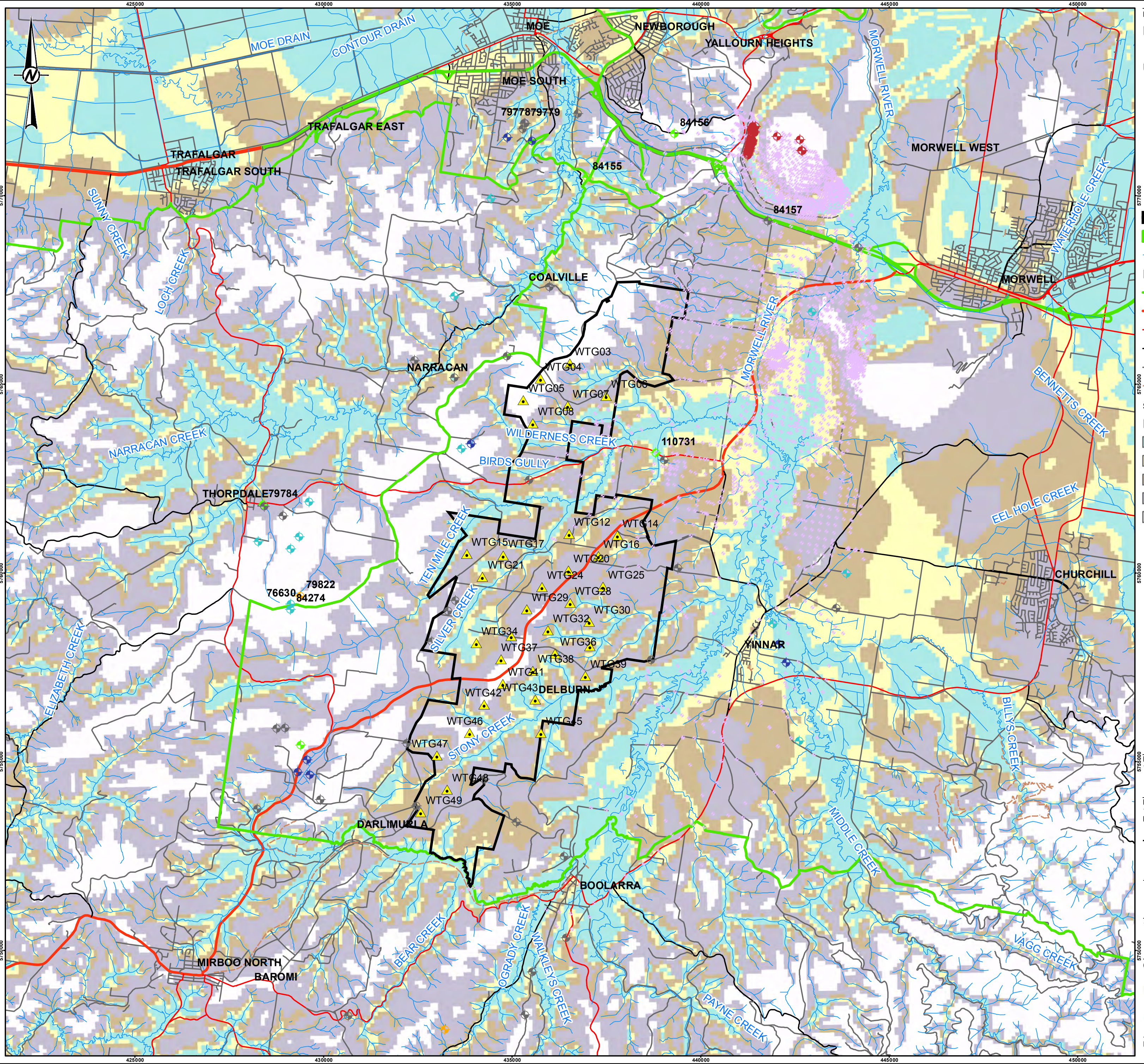

LEGEND

Registered Wells

- Unknown

USE TYPE

- Stock/Domestic
- Irrigation
- Dairy
- Investigation/Observation
- Dewatering
- SEC
- WTG
- ProjectBoundary
- Groundwater Management Areas
- Watercourse

Roads

- Freeway
- Highway
- Local Road
- Sealed Road
- Other Road
- Track

swl100_f

Depth to groundwater (m)

- 0 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- >50

DRAFT

0 1,000 2,000 3,000 4,000 5,000

1:100,000 METRES

NOTE(S)

1. PROJECTION: GDA 1994 MGA ZONE 55.

REFERENCE(S)

1. ROAD & PROPERTY DATA © THE STATE OF VICTORIA, DEPARTMENT OF ENVIRONMENT, LAND, WATER & PLANNING, 2017.

CLIENT

OSMI AUSTRALIA

PROJECT

DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE

DEPTH TO GROUNDWATER AND REGISTERED WELLS

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-26
DESIGNED	-
PREPARED	SM
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
19130636	001-R	0	4

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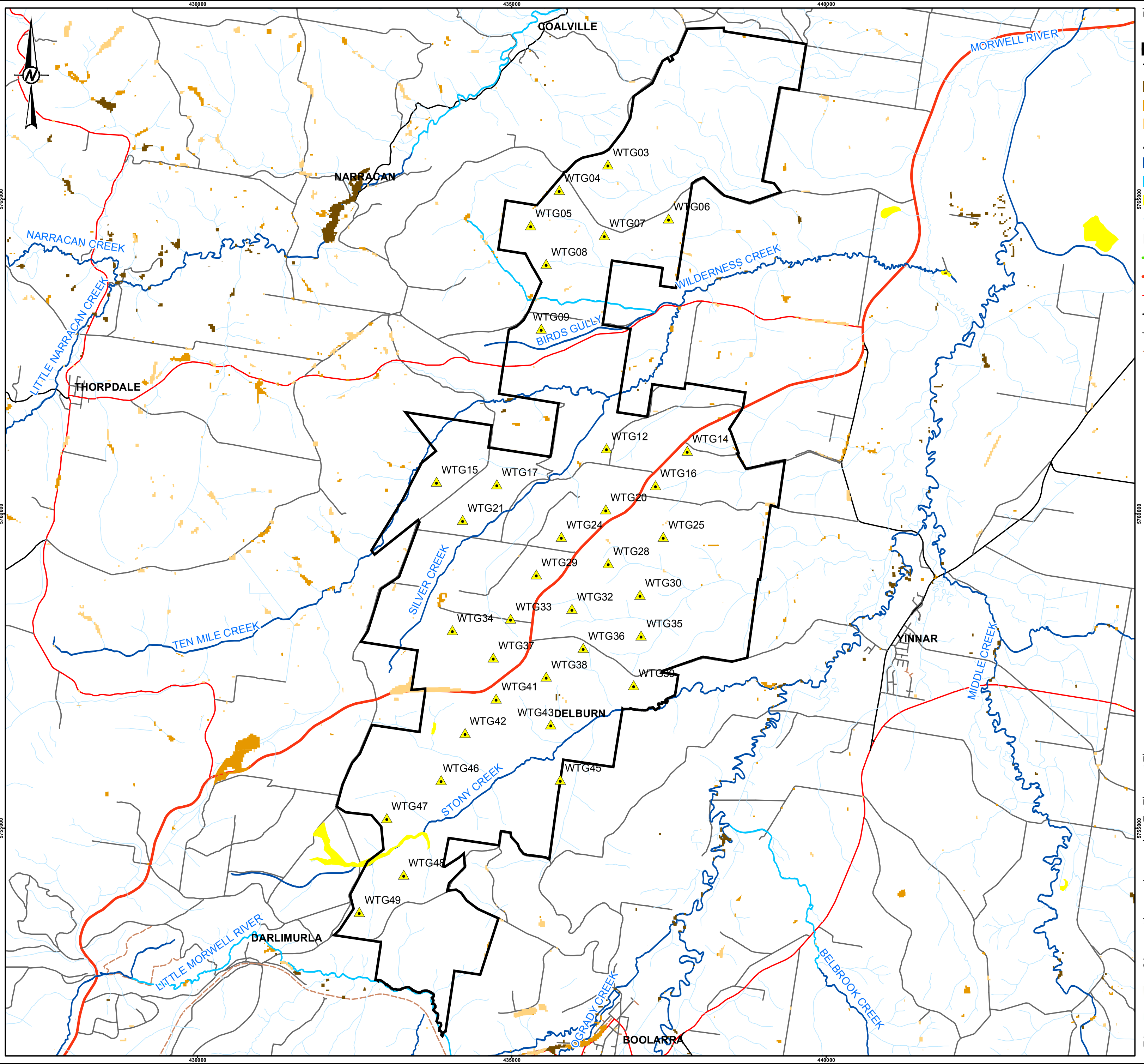

LEGEND

- WTG
- ProjectBoundary

Terrestrial GDEs

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDEs

- High potential GDE
- Moderate potential GDE
- Unclassified potential GDE
- Watercourse

Roads

- Freeway
- Highway
- Local Road
- Sealed Road
- Other Road
- Track

DRAFT

0 1,000 2,000

1:60,000 METRES

NOTE(S)
1. PROJECTION: GDA 1994 MGA ZONE 55.

REFERENCE(S)
1. ROAD & PROPERTY DATA © THE STATE OF VICTORIA, DEPARTMENT OF ENVIRONMENT, LAND, WATER & PLANNING, 2017.

CLIENT
OSMI AUSTRALIA

PROJECT
DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE
GROUNDWATER DEPENDENT ECOSYSTEMS

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-26
DESIGNED	-
PREPARED	SM
REVIEWED	DRP
APPROVED	DRP

PROJECT NO.	CONTROL	REV.	FIGURE
19130636	001-R	0	5

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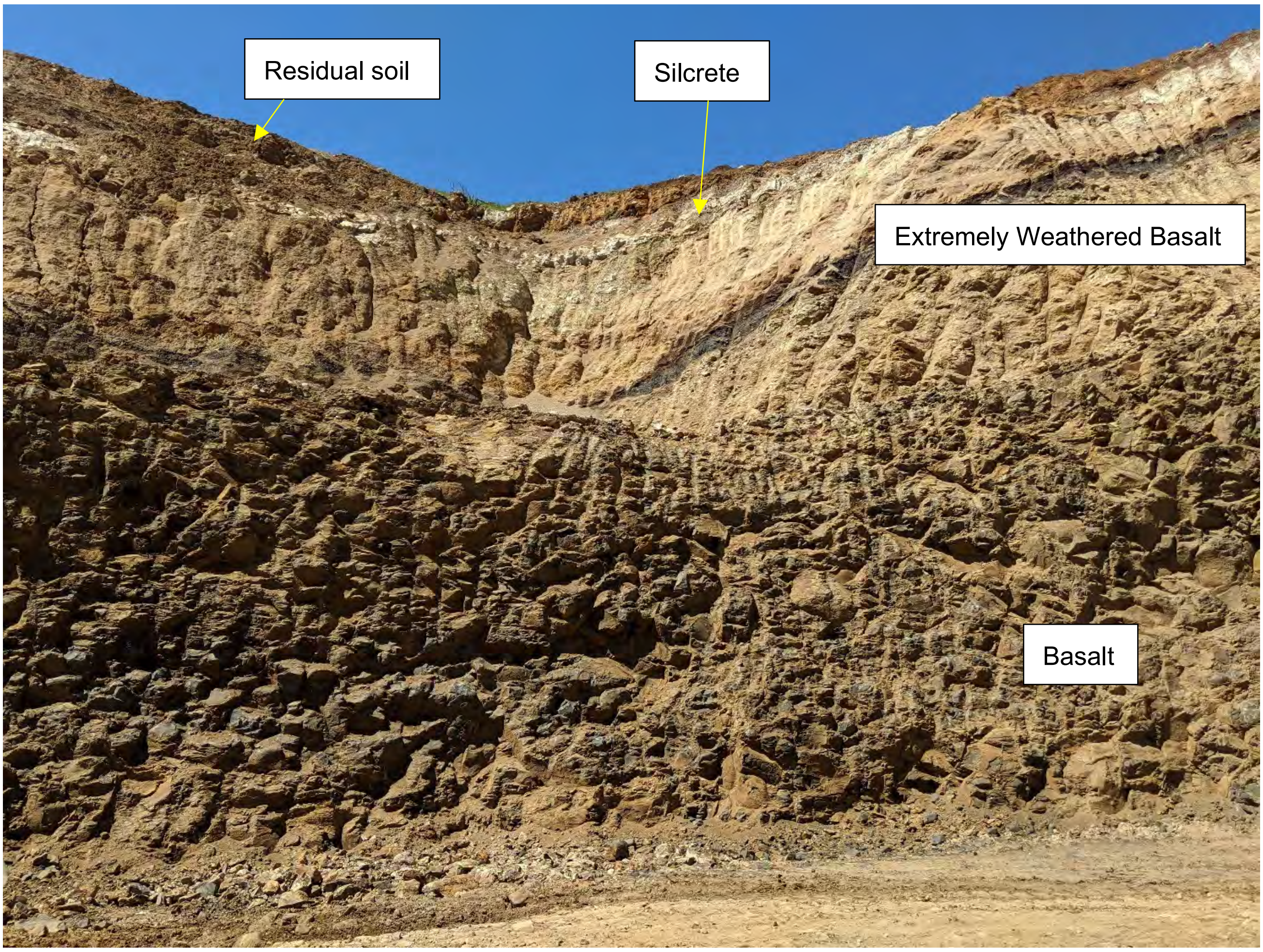
APPENDIX A

Selected Site Photographs

The following sets out a summary of the observations made during our site visit of 22 October 2022.

Kennedy Haulage Quarry

A tour of the Kennedy Haulage Quarry was undertaken during which exposures of subsurface materials were observed. The general profile observed at two quarry pits comprises residual clay to a depth of up to 7 m overlying extremely weathered basalt (sometimes with interbedded silcrete), overlying highly or less weathered basalt.



Exposed face at Kennedy Haulage Quarry

In addition, several stockpiles of processed material were observed at the quarry. Photographs of the various materials were provided by quarry management along with photographs of the materials post placement on local roads.

40 mm Non-Descript Crushed Rock resheet. Photo provided by Ross Kennedy

Construction with 20 mm VicRoads Class 3 crushed rock. Photo provided by Ross Kennedy

40 mm Non-Descript Crushed Rock ‘resheet mix’. Photo provided by Ross Kennedy

40 mm Non-Descript Crushed Rock ‘resheet mix’. Photo provided by Ross Kennedy

Road construction using 20 mm VicRoads Class 2 crushed rock. Photo provided by Ross Kennedy.

Stockpile of 20 mm Non-Descript crushed rock – 'Resheet Mix'. Photo provided by Ross Kennedy.

Stockpile of 20 mm Non-Descript crushed rock – 'Resheet Mix'. Photo provided by Ross Kennedy.

Stockpile of 40 mm Non-Descript crushed rock – 'Resheet Mix'. Photo provided by Ross Kennedy.

Stockpile of 75 mm Non-Descript Crushed Rock. Photo provided by Ross Kennedy.

Stockpile of 20 mm VicRoads Class 3 crushed rock. Photo provided by Ross Kennedy.

Stockpile of 20 mm VicRoads Class 3 crushed rock. Photo provided by Ross Kennedy.

Stockpile of 40 mm VicRoads Class 3 crushed rock. Photo provided by Ross Kennedy.

WTG07

There is some evidence for previous landslide movement about 50 m to the south west of the proposed WTG location, however not within the inferred zone of influence of the proposed WTG. The slope angle in this area is about 10° and there is no evidence for recent landslide movement.

View towards south west of WTG07 showing break in slope and irregular surface characteristic of past landslide movement.

WTG09

There is evidence for past landslide movement to the south of the proposed location of WTG09. Based on the presence of mature vegetation and subdued or 'rounded' morphology of the landscape, the landslide movement is inferred to be relict. No evidence of recent landslide was observed.

View to south from near proposed location of WTG09, showing break in slope due to inferred relict landslide activity.

WTG38

There is irregular and hummocky ground at the proposed turbine location indicative of past large scale landslide movement. However, the slope angle is about 8° and there is no evidence for recent landslide movement. There is also minor evidence of shallow erosion.

View to east from WTG38 location showing irregular ground surface with some evidence of shallow erosion

WTG39

The ground at the location of WTG39 has some irregularity, however has a slope angle of about 6° and does not show evidence for recent slope instability.

View to north showing relatively flat ground near proposed location of WTG39

WTG41

Slightly irregular terrain, possibly indicative of past landslide was observed at the location of WTG41. However the slope angle is 6° to 7° and there is no evidence for recent slope instability.

Slope near WTG41 showing relatively flat, slightly irregular slopes.

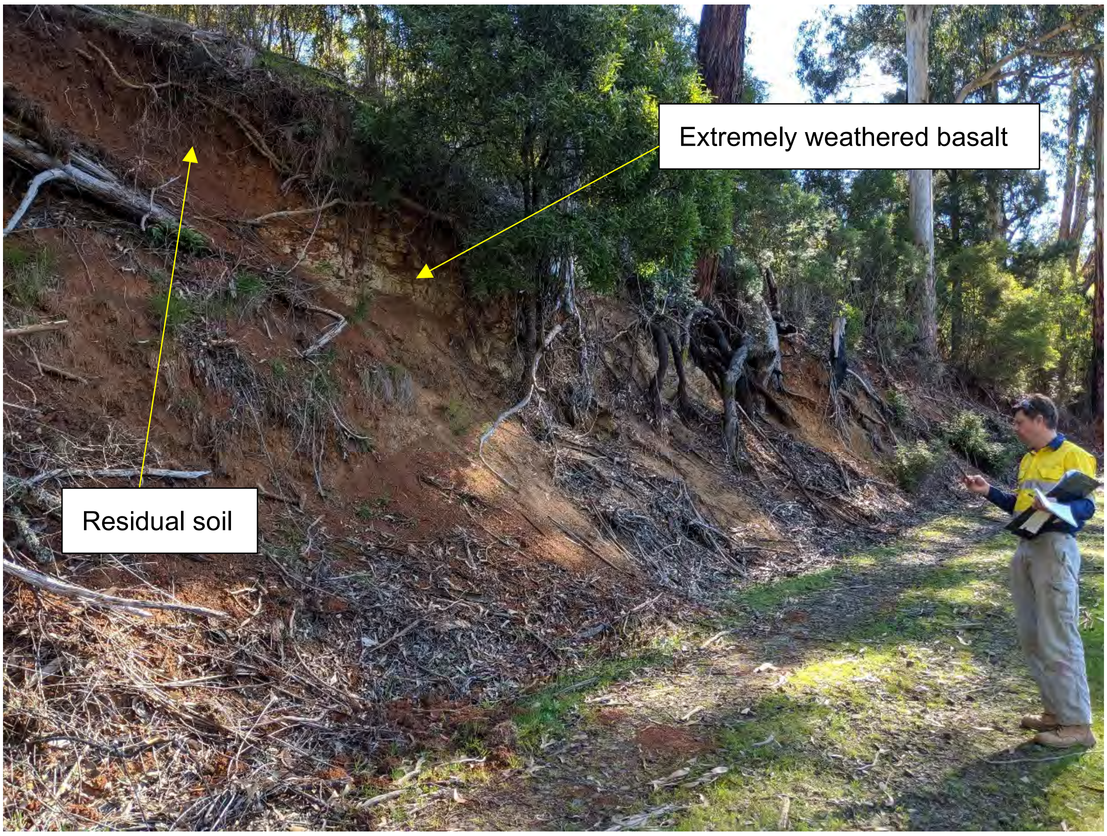
WTG45

Slightly irregular slopes were observed at the location of WTG45. Ground to the east of the proposed WTG location is furrowed. There appears to be no evidence for recent slope instability.

Slope to the east of WTG45 location showing furrowed ground.

WTG46

The location of WTG46 is near the crest of a knoll within highly vegetated terrain and inaccessible at the time of the site visit. However, a road cutting located about 200 m to the north of the proposed WTG location exposed a thin cover of residual soil overlying extremely weathered basalt.



Cutting exposed about 100 m to the north of WTG46

WTG48

Geological maps indicate that WTG48 may be underlain by alluvium. However, observations made at the site are not consistent with the indications of the geological map. The WTG location is near the top of a low rise which is inconsistent with its being underlain by alluvium. It is inferred that this site is underlain by Thorpdale Volcanics.

Low rise at proposed location of WTG48, inconsistent with geological map indications of alluvium.

APPENDIX B

Historical Aerial Photographs

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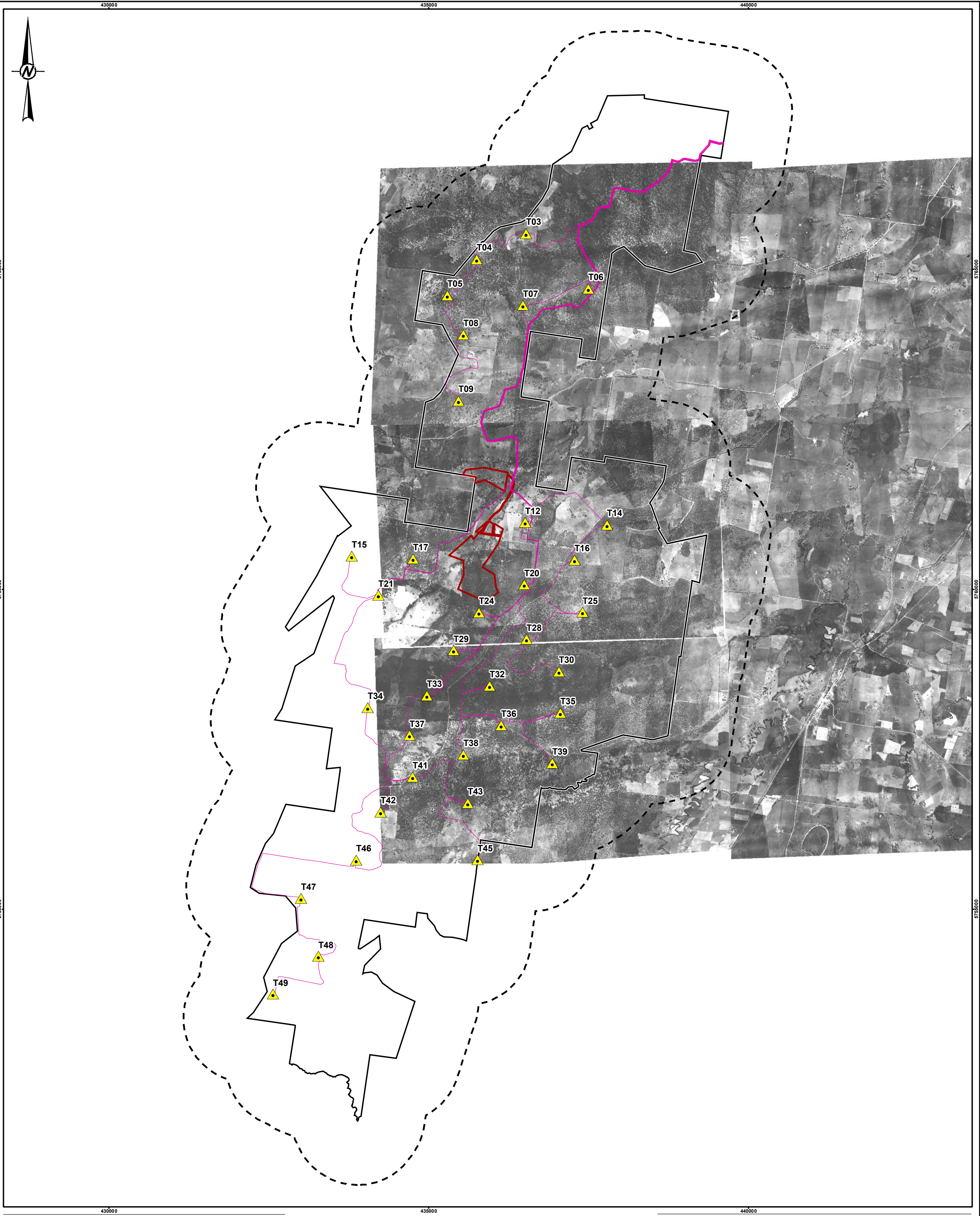


LEGEND

- WTG Location
- Reticulation
- Kennedy Quarry
- Project Boundary
- Project Boundary (1km buffer)

0 1,000 2,000

1:55,000 METRES

DRAFT

NOTE(S)
1. PROJECTION: GDA 1994 MGA ZONE 55

REFERENCE(S)
1. IMAGERY SOURCED FROM GOLDER ARCHIVES.

CLIENT
OSMI AUSTRALIA

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-07
DESIGNED	LMA
PREPARED	JPH
REVIEWED	JMW
APPROVED	JMW

PROJECT
DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE
1945 AERIAL

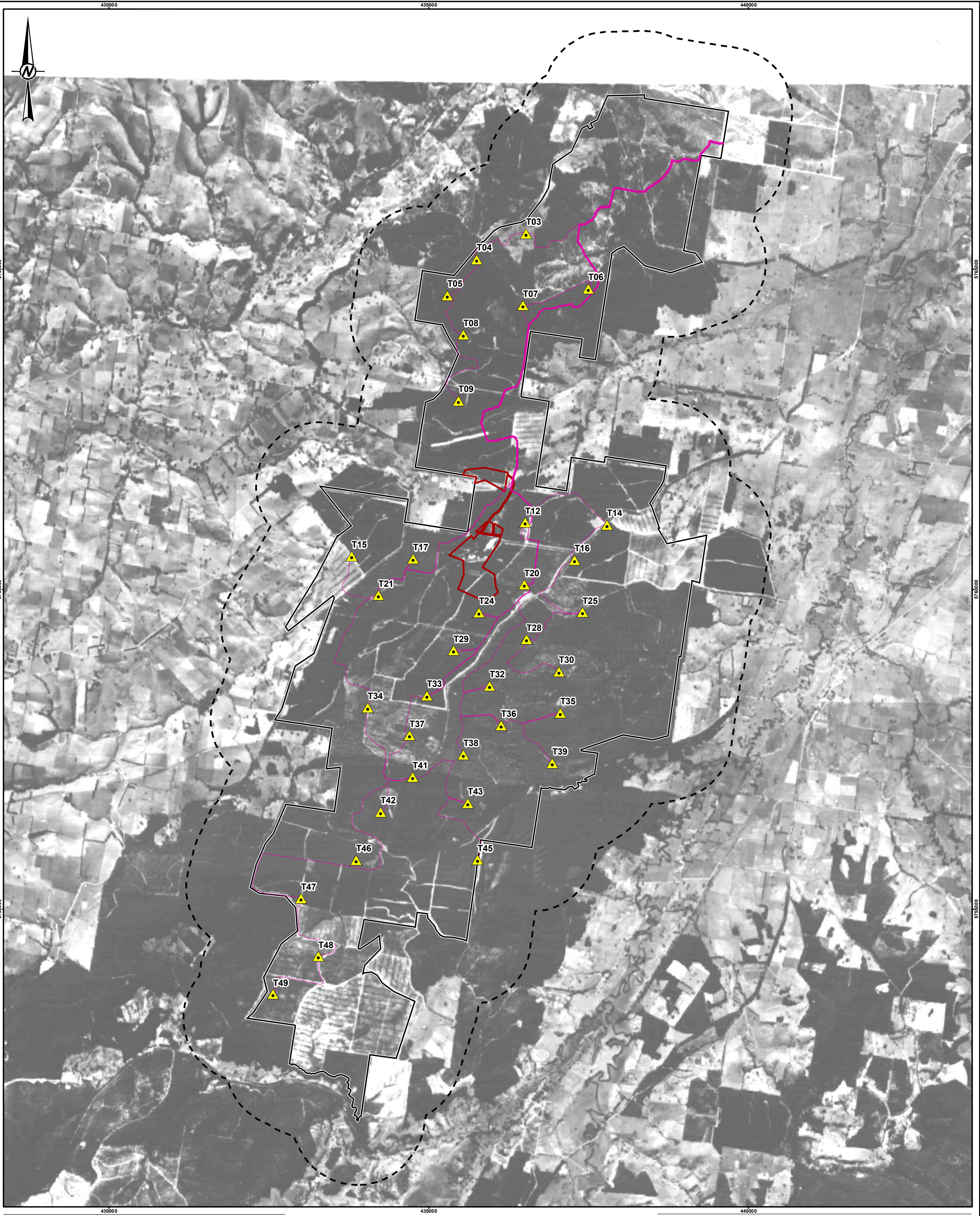
PROJECT NO.	CONTROL	REV.	FIGURE
19130636	001	A	B1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0

PATH: V:\GIS\Jobs\2019\19130636\Project\19130636-001-R-Rev0-F000B1-B3.mxd PRINTED ON: 2019-11-07 AT: 4:36:25 PM



LEGEND

- WTG Location
- Reticulation
- Kennedy Quarry
- Project Boundary
- Project Boundary (1km buffer)

DRAFT

NOTE(S)
1. PROJECTION: GDA 1994 MGA ZONE 55

0 1,000 2,000
1:55,000 METRES

REFERENCE(S)
1. IMAGERY SOURCED FROM GOLDER ARCHIVES.

CLIENT
OSMI AUSTRALIA

CONSULTANT

GOLDER

YYYY-MM-DD	2019-11-07
DESIGNED	LMA
PREPARED	JPH
REVIEWED	JMW
APPROVED	JMW

PROJECT
DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE
1965 AERIAL

PROJECT NO.	CONTROL	REV.	FIGURE
19130636	001	A	B2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

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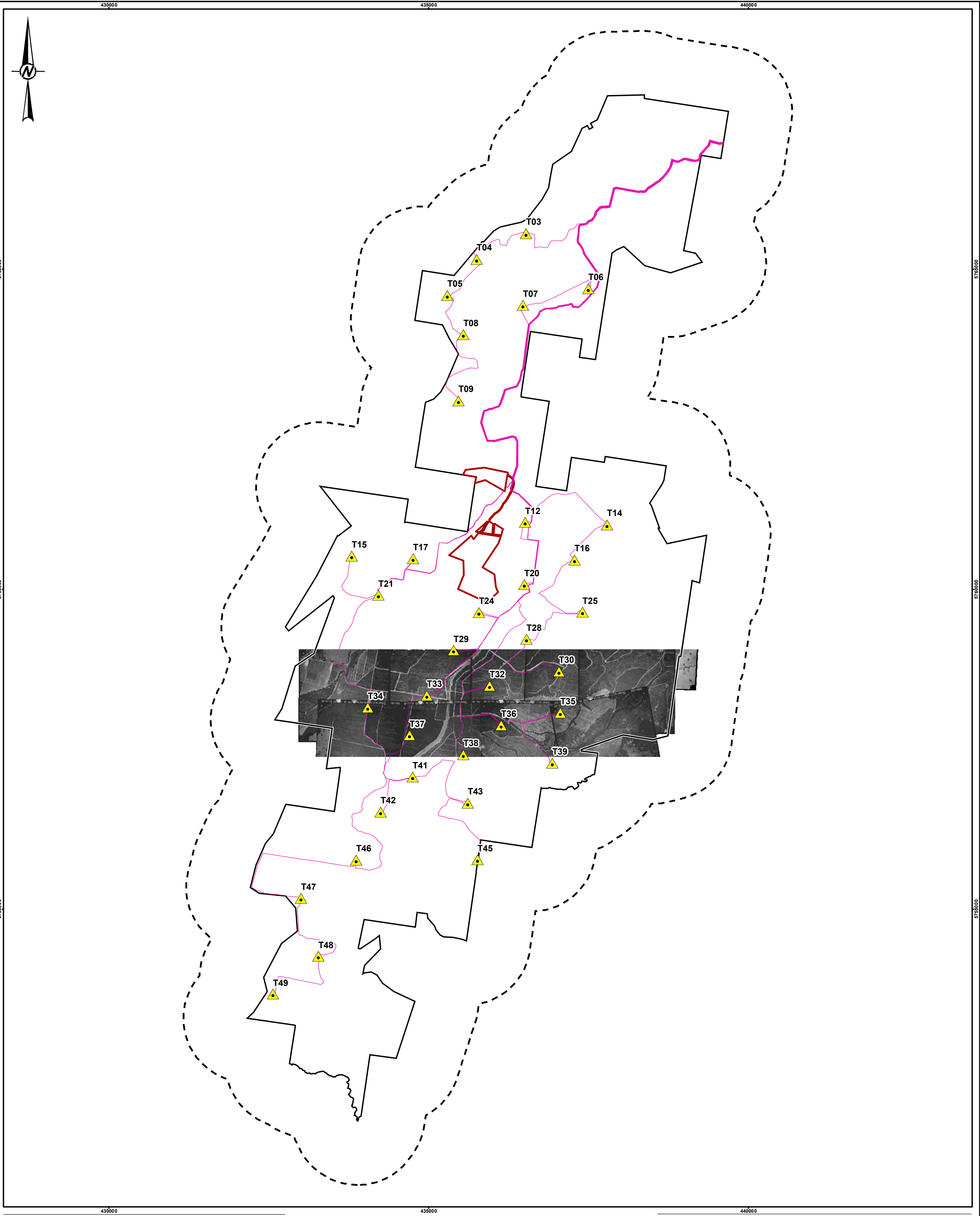

LEGEND

- WTG Location
- Reticulation
- Kennedy Quarry
- Project Boundary
- Project Boundary (1km buffer)

DRAFT

NOTE(S)
1. PROJECTION: GDA 1994 MGA ZONE 55

REFERENCE(S)
1. IMAGERY SOURCED FROM GOLDER ARCHIVES.

0 1,000 2,000
1:55,000 METRES

CLIENT
OSMI AUSTRALIA

CONSULTANT
GOLDER

YYYY-MM-DD	2019-11-07
DESIGNED	LMA
PREPARED	JPH
REVIEWED	JMW
APPROVED	JMW

PROJECT
DESKTOP ASSESSMENT OF GEOTECHNICAL, CONTAMINATED LAND AND HYDROLOGICAL CONSTRAINTS

TITLE
1980 AERIAL

PROJECT NO.	CONTROL	REV.	FIGURE
19130636	001	A	B3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
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APPENDIX C

Limitations

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