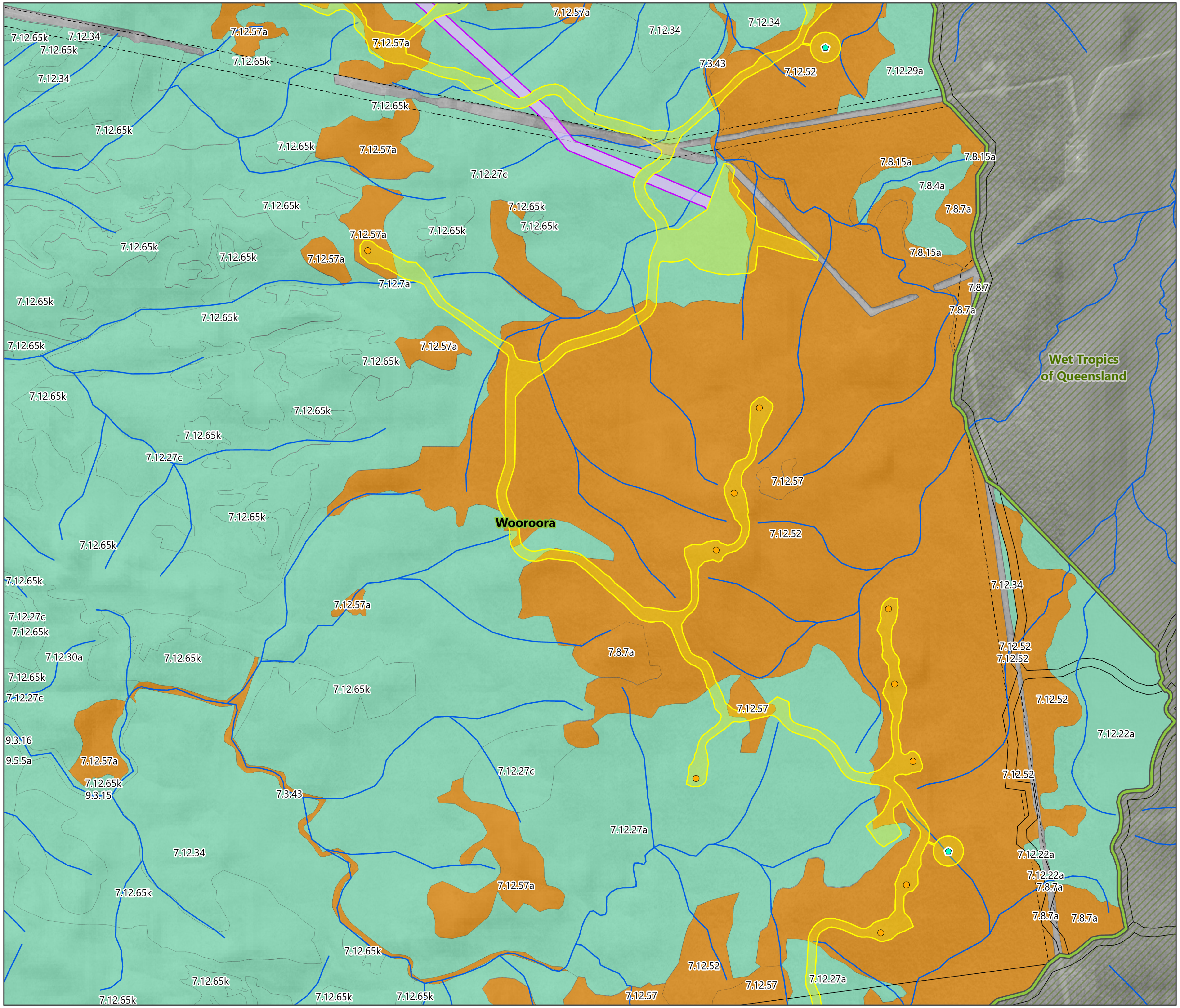

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Chalumbin Wind Farm

Ground-Truthed Regional Ecosystem Mapping

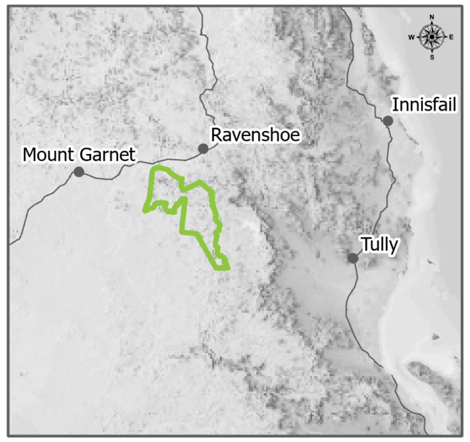
Figure 4.3 Sheet 6 of 8

- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope
- Stage 1
- Stage 2

Regional Ecosystem Mapping (Attexo 2021)
- Remnant vegetation containing endangered regional ecosystem
- Remnant vegetation containing of concern regional ecosystem
- Remnant vegetation containing least concern regional ecosystem
- Non Remnant
- Watercourse
- WTQ Boundary
- Lot Boundary
- Easement

Date: 15/10/2022 Author: TOD
Project: EPU-004 Reviewed: NOD



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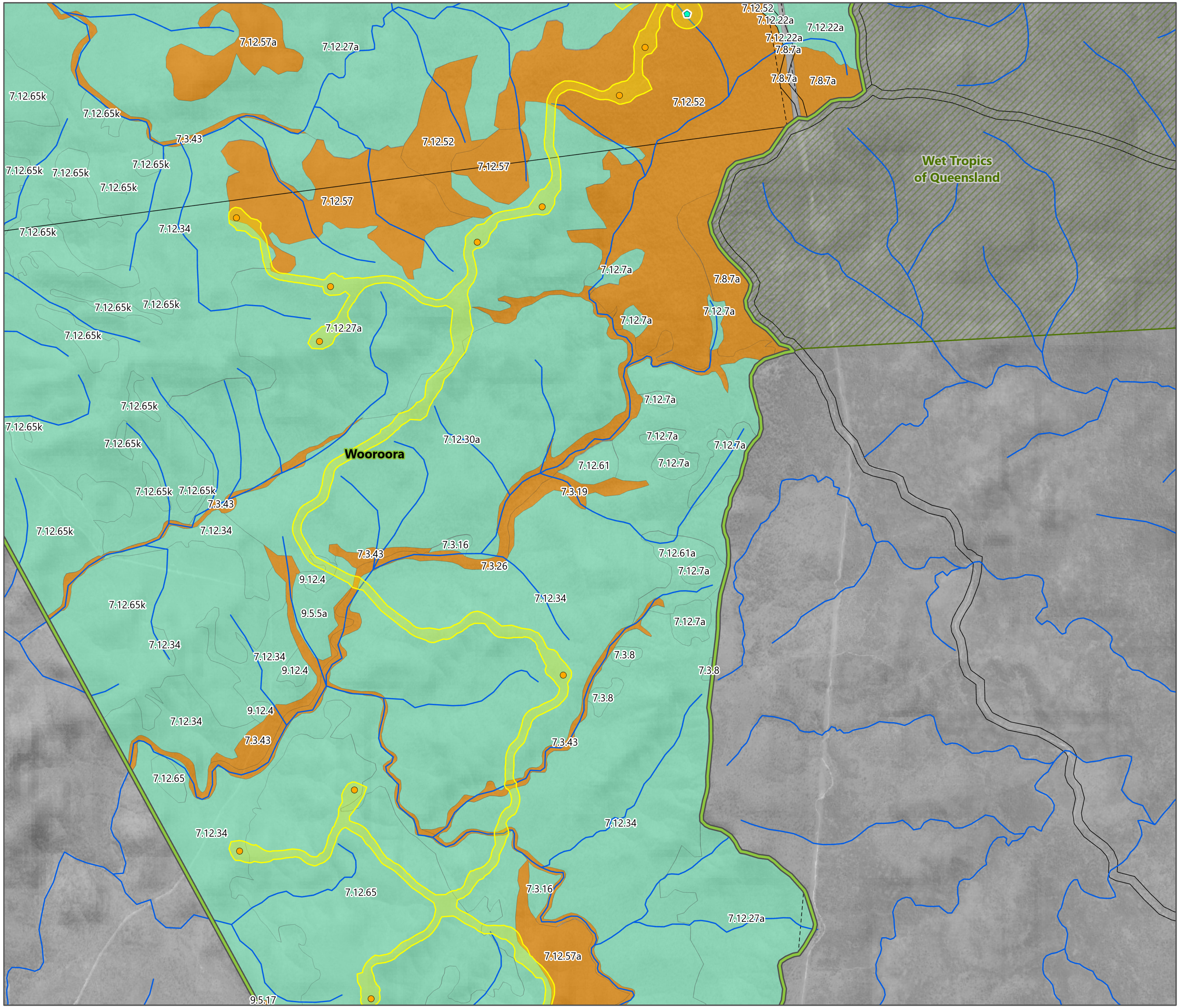

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Chalumbin Wind Farm

Ground-Truthed Regional Ecosystem Mapping

Figure 4.3 Sheet 7 of 8

- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope

- Stage 1
- Stage 2

Regional Ecosystem Mapping (Attexo 2021)

- Remnant vegetation containing endangered regional ecosystem
- Remnant vegetation containing of concern regional ecosystem
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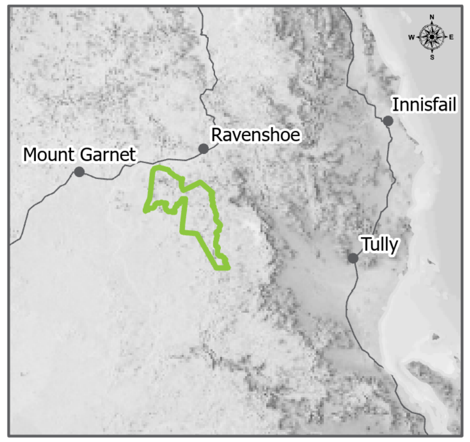
- Non Remnant
- Watercourse
- WTQ Boundary
- Lot Boundary
- Easement

Date: 15/10/2022 Author: TOD
Project: EPU-004 Reviewed: NOD



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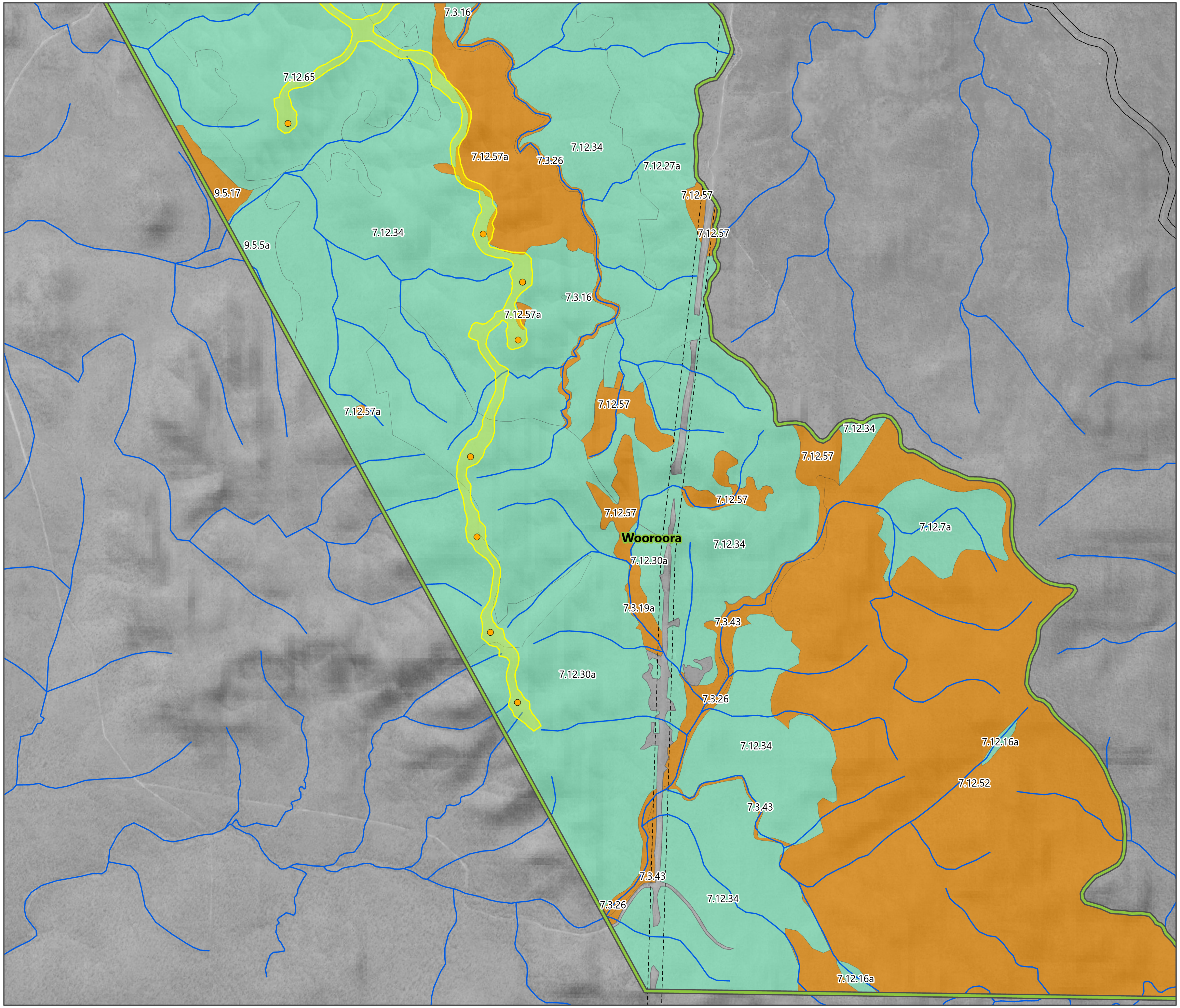

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Chalumbin Wind Farm

Ground-Truthed Regional Ecosystem Mapping

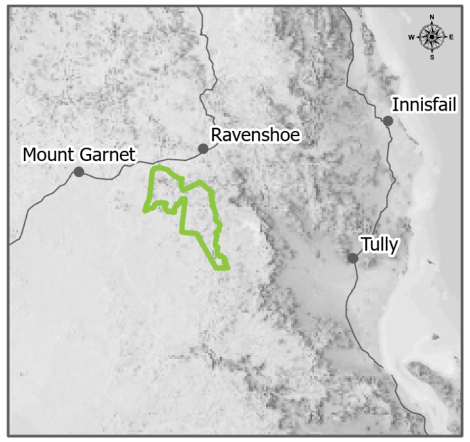
Figure 4.3 Sheet 8 of 8

Project Area Boundary
Study Area
Turbine
Met-mast

Clearance Envelope
Stage 1
Stage 2

Regional Ecosystem Mapping (Attexo 2021)
Remnant vegetation containing endangered regional ecosystem
Remnant vegetation containing of concern regional ecosystem
Remnant vegetation containing least concern regional ecosystem
Non Remnant
Watercourse
WTQ Boundary
Lot Boundary
Easement

Date: 15/10/2022 Author: TOD
Project: EPU-004 Reviewed: NOD



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Data Source(s):
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Plate 4-1 ***Corymbia citriodora* woodland on ridgeline**

Plate 4-2 **Rocky pavement shrub complex**

Plate 4-3 Mixed Eucalypt woodland

4.1.5 Hydrology

The Project area is located on the north-eastern edge of the Herbert River catchment, the largest catchment of the Wet Tropics region (**Figure 4-4**). The Herbert River flows in a generally south-eastern direction intersecting 15 major tributaries before discharging into the Coral Sea near Lucinda, Queensland. The Herbert River catchment averages rainfall of 1,222 mm per year, and discharges approximately 5,081 GL annually into the ocean (DES 2019b). The upper section of the catchment has primarily been developed for grazing, with the central section predominantly reserved for conservation, and the lower floodplains dominated by sugarcane farming (DES 2019b). The Herbert River is a contributor of both dissolved inorganic nitrogen and fine sediments being released into the Great Barrier Reef Marine Park and is therefore managed under the Reef 2050 Water Quality Improvement Plan to reduce the amounts of fine sediments, nutrients (nitrogen and phosphorus) and pesticides flowing to the Great Barrier Reef (DES 2019b).

Blunder Creek is the largest waterway to traverse the Project area (**Plate 4-4**) with a catchment of 142 km^2 (Heiner & Grundy 1994). Blunder Creek flows east to west across both Wooroora and Glen Gordon before joining the Herbert River approximately 9 km to the west. Blunder Creek is identified as a stream order 4 where it traverses the Wooroora property and becomes a stream order 5 waterway within Glen Gordon. The riparian vegetation associated with this waterway, and the waterway itself, provide habitat for a range of native species. Having permanent water available in various stretches of the creek, this waterway provides refuge habitat for wildlife during drier periods. The majority of infrastructure associated with the Project will avoid direct and indirect impacts to Blunder Creek.

In addition to Blunder Creek, there is a series of stream orders 1, 2 and 3 across the site, including within the Project footprint. Third order streams present include Lily, Pandanus, Oaky and Kara Creeks; all of which are tributaries to Blunder Creek. Waterways include creeks with a soft substrate bottom, and rocky gullies with distinct water holes and densely vegetated riparian vegetation.

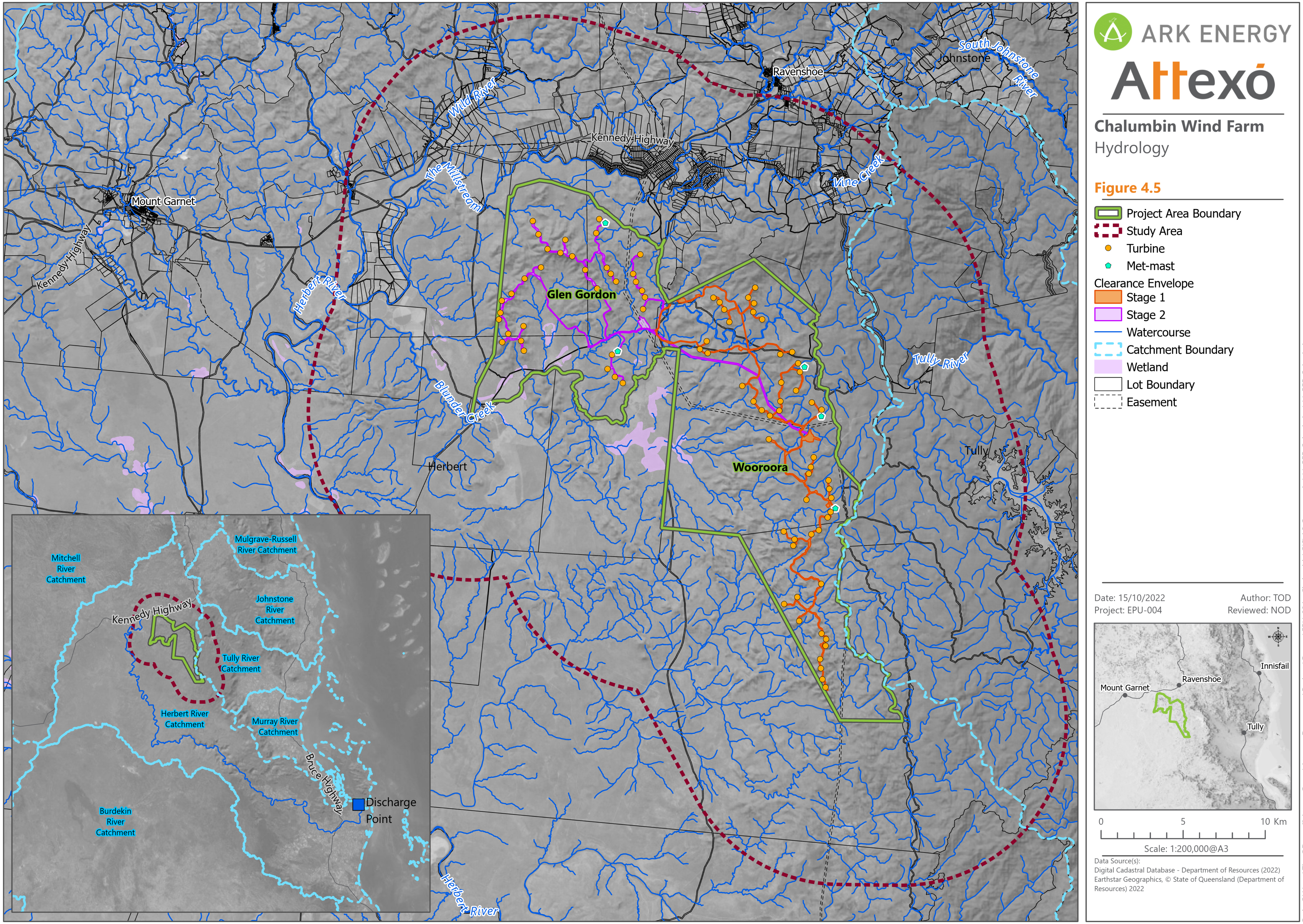
The majority of the lower order waterways within the Project area were not running or were holding stagnant water at the time of the dry-season flora surveys (October 2020). During the wet-season fauna surveys (January-March 2021), all waterways were at the upper limit of their capacity with scattered flooding events. Based on conversations with landholders, this seasonal and episodic inundation is considered typical for the area.

There are a number of small man-made farm dams across both properties, with evidence of frequent use by cattle (low to no vegetation cover, high turbidity).

There are no nationally important wetlands within the Project area; however, there are a number Great Barrier Reef Wetland Protection Areas (Qld) as illustrated in **Figure 4-4**. None of these are intersected by proposed Project infrastructure.

Wetlands of International Importance are those listed under the Ramsar Convention. The nearest Ramsar wetland to the Project area is Bowling Green Bay, located approximately 250 km south-east. The Great Barrier Reef Marine Park is located approximately 60 km east of the Project area. The nearest Commonwealth Marine Area, the Coral Sea Marine Park, is beyond the Great Barrier Reef Marine Park. The Project is not expected to impact these sites directly or indirectly.

Plate 4-4 Blunder Creek within the Glen Gordon Property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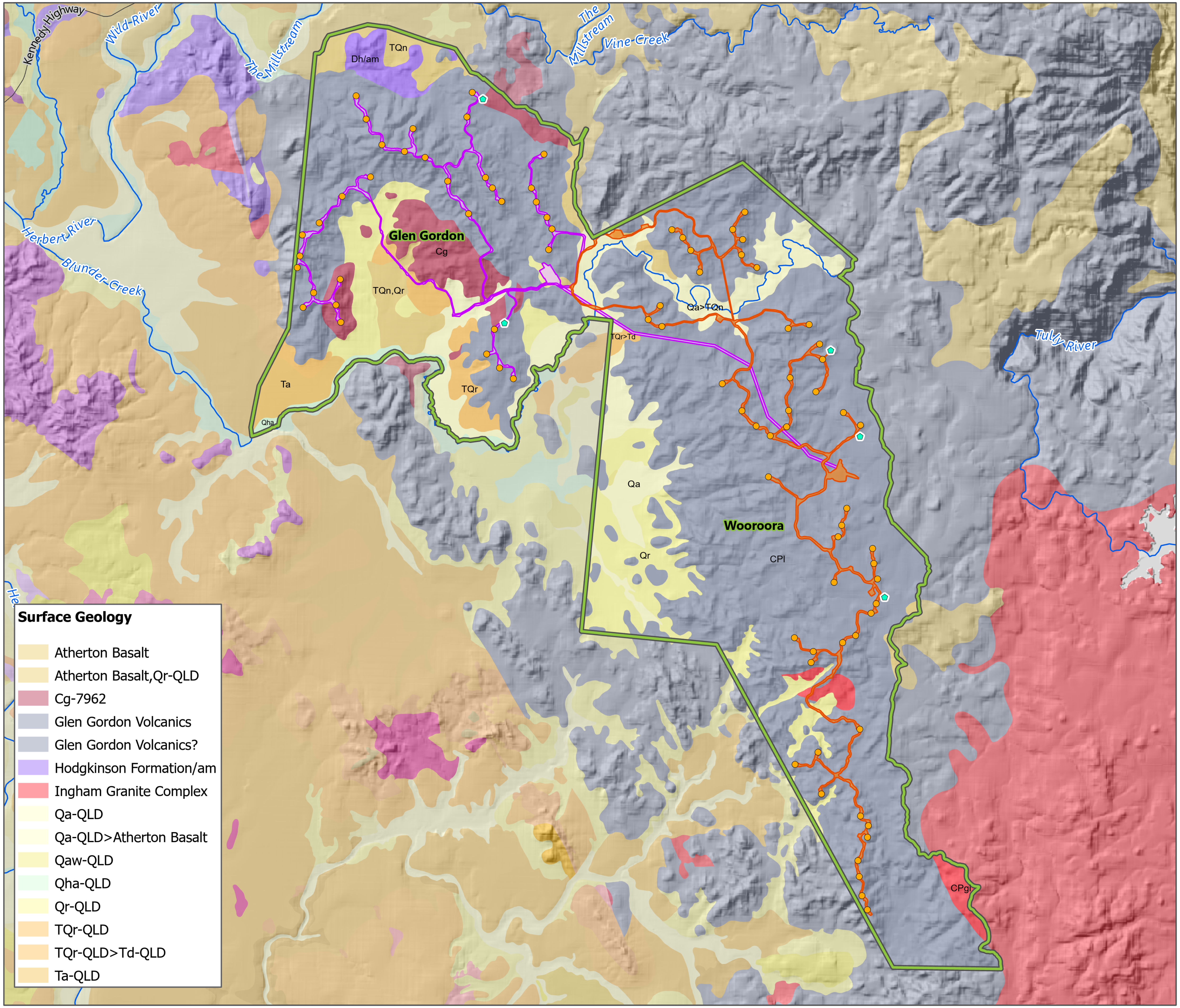
Chalumbin Wind Farm
Hydrology
Figure 4.5
Project Area Boundary
Study Area
Turbine
Met-mast
Clearance Envelope
Stage 1
Stage 2
Watercourse
Catchment Boundary
Wetland
Lot Boundary
Easement
Date: 15/10/2022
Author: TOD
Project: EPU-004
Reviewed: NOD
Mount Garnet
Ravenshoe
Innisfail
Tully
0
5
10 Km
Scale: 1:200,000@A3
Data Source(s):
Digital Cadastral Database - Department of Resources (2022)
Earthstar Geographics, © State of Queensland (Department of Resources) 2022
Ravenshoe
Johnstone
South Johnstone River
Wild River
Kennedy Highway
The Millstream
Vine Creek
Mount Garnet
Kennedy Highway
Herbert River
Glen Gordon
Tully River
Blunder Creek
Herbert
Wooroora
Tully
Herbert River
Mitchell River Catchment
Mulgrave-Russell River Catchment
Johnstone River Catchment
Kennedy Highway
Tully River Catchment
Herbert River Catchment
Murray River Catchment
Bruce Highway
Discharge Point
Burdekin River Catchment

4.1.6 Soils and Geology

The Project area displays characteristics associated with both the Wet Tropics and Einasleigh Uplands bioregions, with a mix of soils and REs. The higher hills and ranges within the landscape are predominantly granite and occasionally rhyolite formations associated with Land Zone 12. Soils within this land zone are mainly tenosols on steeper slopes with chromosols and sodosols on lower slopes and gently undulating areas (Wilson and Taylor 2012). The Project's proposed wind turbines are exclusively located on these formations (**Figure 4-5**).

Lower areas within the Project area range from the imperfectly or poorly drained soils in the north, to the non-sodic soils on alluvia that dominate the central and southern extent. Glen Gordon is defined by broad areas of weakly to moderately pedal yellow and grey soils formed after sediments from the Glen Gordon acid volcanics covered a basaltic plain. The soils have a pale or bleached A2 horizon grading to a D horizon of heavy clay over decomposing basalt (Heiner & Grundy 1994). Organic carbon and total nitrogen levels in these soils are generally low, and carbon/nitrogen ratios generally tends to be high (Heiner & Grundy 1994). By contrast, Wooroora has a much broader coverage of soils associated with alluvia. This is generally described as an acidic duplex humic gley formed from quaternary alluvium with a thin organic surface and grey or gleyed B horizon formed by seasonal swamps. The higher organic carbon and nitrogen levels in these soils also reflect the surface texture and the generally lower position in the landscape (Heiner & Grundy 1994). Some infrastructure, such as access roads, will be located within these lower areas (**Figure 4-5**).



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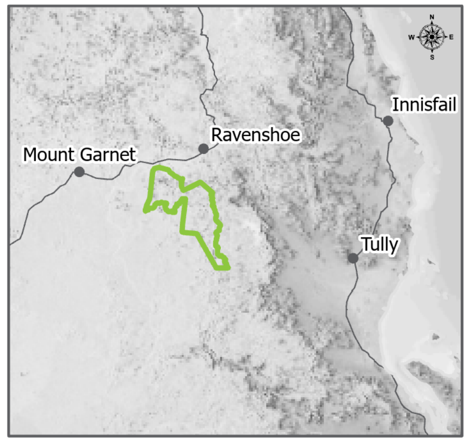
Surface Geology

Figure 4.5

Project Area Boundary
Turbine
Met-mast
Clearance Envelope
Stage 1
Stage 2
Watercourse

Date: 15/10/2022
Author: TOD
Project: EPU-004
Reviewed: NOD



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Data Source(s):
Digital Cadastral Database - Department of Resources (2022)
Earthstar Geographics, © State of Queensland (Department of Resources) 2022

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4.1.7 Groundwater

Turbines are proposed to be located on ridges and elevated features of the landscape where rainfall typically runs off with limited infiltration and storage below the ground as a homogenous water table. Water beneath the ground in these locations may be stored in pockets fractured bedrock (heterogeneous) deep below the ground.

As discussed further below, intersection of the water table for turbined foundations is considered unlikely and therefore a groundwater management plan is not required. Incidental rainfall collected in excavations will be managed in accordance with the Preliminary Erosion and Sediment Control Plan (see **Appendix I**). This includes diversion of clean stormwater around turbine excavations, minimising the duration of disturbance (turbine foundation excavations are typically open for approximately 1 month) and collection and treatment (e.g. sediment basin) of stormwater runoff from disturbance areas. In accordance with the Best Practice Erosion & Sediment Control (IECA, 2008).

The geological characteristics of the Project area are described in **Section 4.1.6** and mapped in **Figure 4-5**. The majority of the proposed wind turbine locations are shown to be underlain by the Glen Gordon Volcanics (mapped as grey) and a smaller number located on the Ingham Granite Complex (red and maroon) and the Atherton Basalt (light brown). The Glen Gordon Volcanics are described as Late Carboniferous to Early Permian age rhyodacitic to rhyolitic ignimbrite; minor bedded tuff, volcanic breccia; tuffaceous sandstone and siltstone. There are a number of interpreted fracture lineaments mapped within the Glen Gordon Volcanics outcrop across the Project area.

The locations of registered groundwater supply bores in the vicinity of the Project area are shown in **Plate 4-5**.

Almost all groundwater bores in the area are utilised for stock and domestic supply. A smaller number are utilised for irrigation. There are no registered groundwater supply bores within the Project area or within 3km of a proposed turbine location. The closest registered bore to the site located on the same mapped geology as the majority of the wind turbines (Glen Gordon Volcanics) is bore Registration Number RN126462 which is located approximately 1.4k m from the northern boundary of the Project area site and approximately 3.3 km from the closest proposed turbine.

The following information is known about the bore from the Queensland Groundwater Database and through discussions with the driller:

- The bore was drilled in 2005 by local drilling company Serra Drilling using air rotary drilling methods.
- The bore was drilled to 74 m depth.
- The geology logged during the drilling of the bore included 54m of basalt overlying sandy clay and sand alluvium.
- The standing water level in the bore was 10m below ground level.
- The electrical conductivity of the bore was 512 micro-siemens/cm which would characterise the water quality as “fresh”.
- The estimated yield (likely measured by the driller during air-lifting) was 0.75L/s.

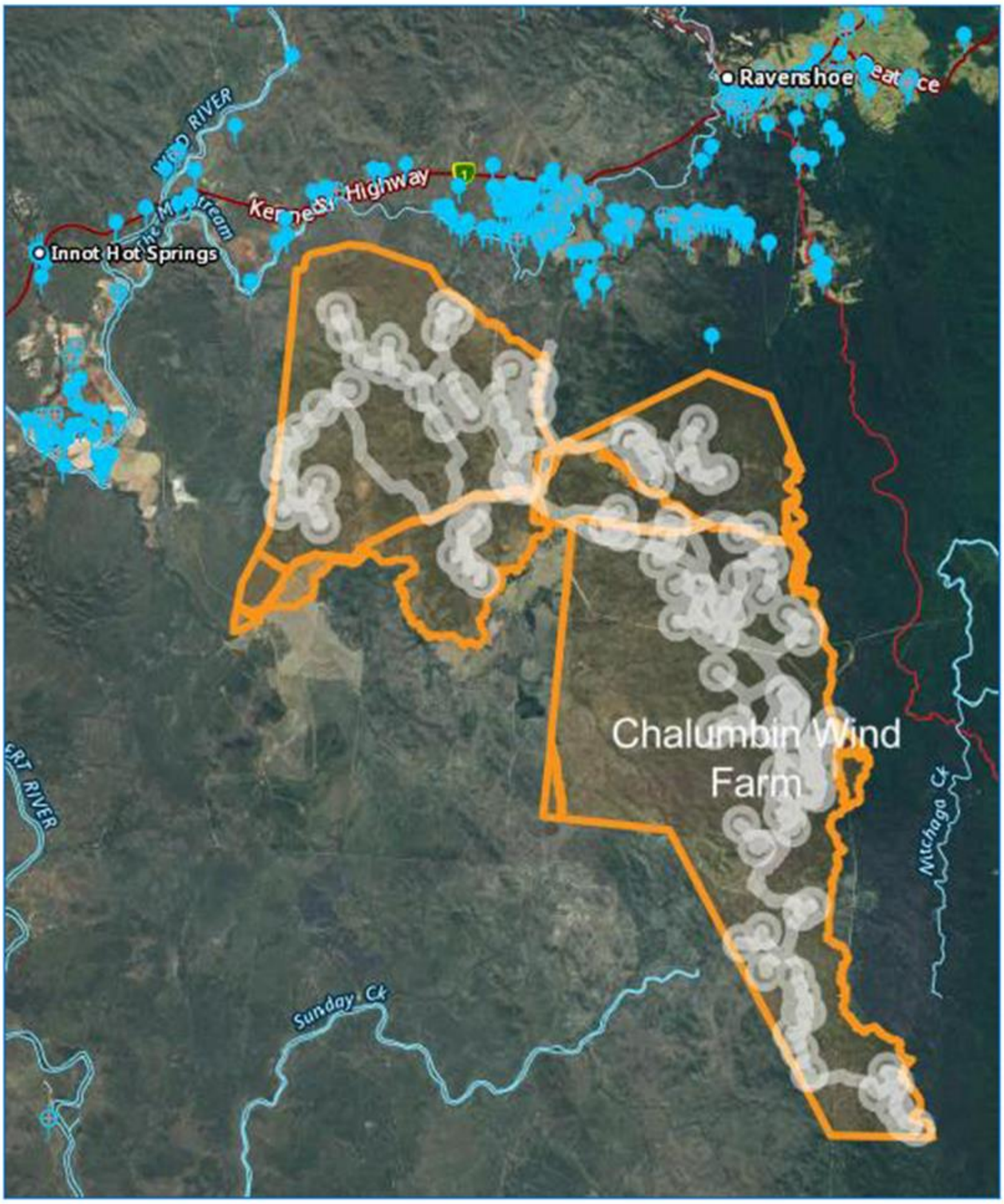


Plate 4-5 Registered groundwater supply bores (blue placemarks) in the vicinity of the Project area

Relevant information was reviewed for surrounding registered groundwater bores collated from a search of the Queensland Groundwater Database within 2 km of the Project area. Apart from a cluster of bores located 8-11 km from the Project area which are drilled into the same geology that underlies the wind farm (discussed further below), bores located further away are not considered to be useful for inferring groundwater conditions beneath the Project.

The following range of relevant groundwater parameters was established:

- Drilled depth: 15-74 m
- Standing Water Level: 10-23 m below ground level.
- Yield: 0.09 – 40 L/s
- Aquifers: predominantly basalt, also alluvium, rhyolite, shale and sandstone.

It should be noted that most of these bores are drilled in lower-lying and flatter areas, most of which are located close to the Millstream tributary of the Herbert River. These areas are not directly comparable with the wind farm hydrogeological setting in particular wind turbine and associated excavations located on elevated ridges. The previously mentioned localised alluvium and basalt flow-filled channels are considered much more prospective for groundwater supply and are recognised targets for stock, domestic and irrigation water supplies.

A cluster of five bores drilled into the mapped Glen Gordon Volcanics, which may be more comparable with the likely geology beneath the Project, is located approximately 8-11 km to the north-east of the Project area as shown in **Plate 4-6**. A summary of relevant data collated from these bores is as follows:

- Drilled depth: 36-114 m
- Standing Water Level: 9-20 m below ground level.
- Yield: 0.52 – 1 L/s
- Aquifers: rhyolite.

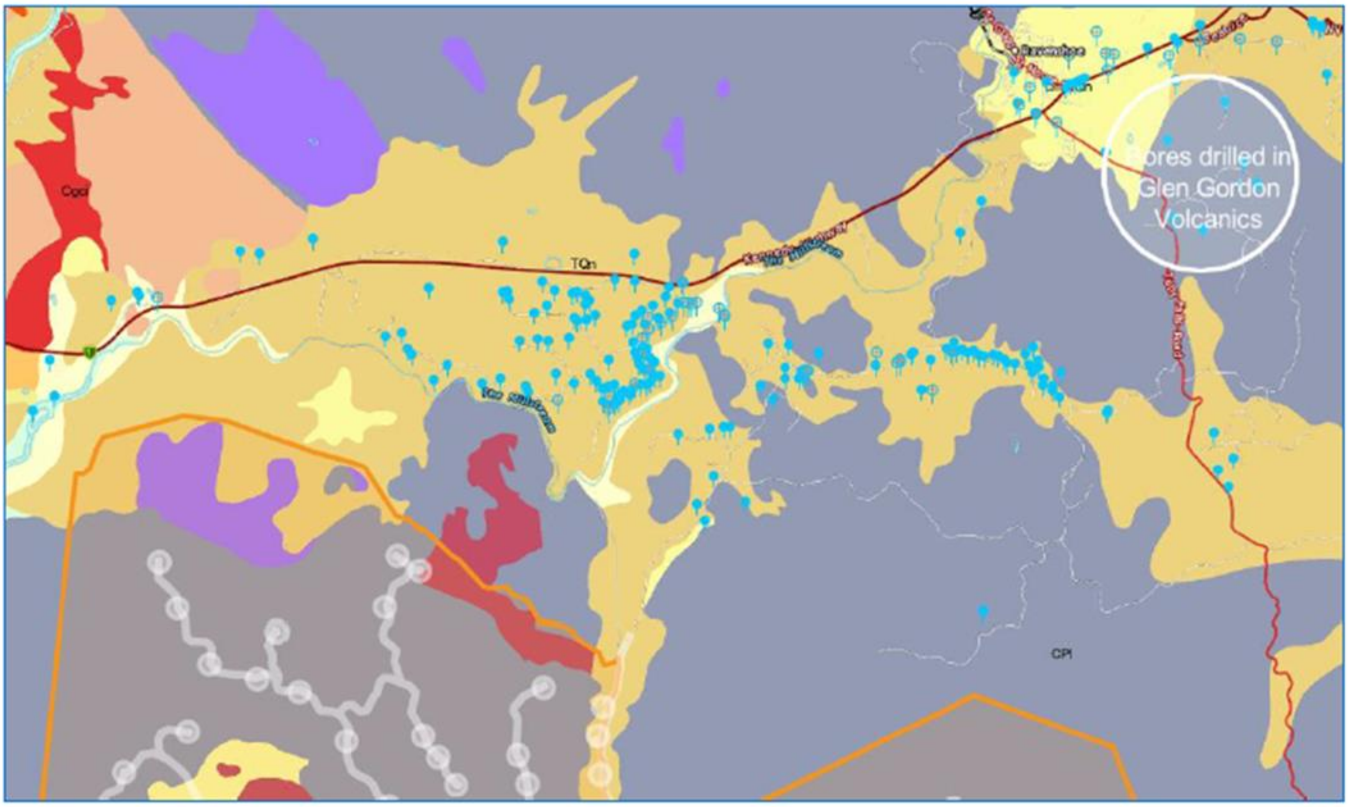


Plate 4-6 Cluster of bores drilled within the same mapped geology (Glen Gordon Volcanics) as the Project

Additional anecdotal information provided by a local drilling company on groundwater presence and geology in the general area includes:

- Bores drilled into the granite are typically poor yielding.
- Bores drilled into the basalt are typically higher yielding, and bores drilled into rhyolite/tuff can be moderately yielding, although yields are highly variable.
- Bores drilled on ridge lines and escarpments typically have much deeper groundwater tables (depth to first water strike).

- It is expected that any excavations for windfarm turbine foundations into granite bedrock will likely encounter limited seepage/inflows, particularly along ridge lines.
- Excavations into rhyolite and tuff bedrock are likely to yield low to moderate to yields, with higher yields in valleys and lower elevation areas.
- Excavations into basalt bedrock are likely to yield moderate to high yields.
- Localised old alluvial channels ("palaeo-channels) are also known to exist in the area, sometimes beneath younger thin basalt flow cover-rock. While typically localised, these features can be prolific water producers. Turbine foundations located on higher ground are considered unlikely to intersect these features.
- Most bores in the area occur approximately 5-6 km to the north of the Project (between the Project area and Ravenshoe) and tap the shallow basalt flows and localised alluvium aquifers (associated with current and palaeo-tributaries of the Herbert River), with a lesser number in rhyolite/tuff and granite aquifers.

Depth to groundwater (water table) contours generally follow the topography in unconfined fractured volcanic rock aquifers as a "muted" (lower relief) expression of the land surface. The piezometric surface typically approaches ground level in valleys and topographical low points and falls away (deepens) beneath hills and high points in the landscape.

Groundwater flow is therefore largely controlled by topography, with flow driven along piezometric gradients from high to lower elevation areas.

Groundwater in volcanic rock aquifers is typically hosted within "secondary permeability" structures such as fractures, cooling joints and flow surfaces, particularly in extrusive volcanic lava rocks such as basalt and rhyolite. The volcanic rock matrix is typically impermeable unless highly vesicular. The yields of fractured volcanic rock aquifers are therefore dependant on the presence and nature of these secondary permeability structures, including fracture aperture widths, spacing (fracture frequency) and orientation. Variability in the volcanic rock mass structure therefore typically results in highly variable yields.

4.1.8 Geochemistry

Based on feedback on the draft PER, a geochemical risk assessment was undertaken on the likelihood of encountering naturally occurring elevated levels of arsenic (and other metal(loid)s) and potential for release into the receiving environment from the excavation of turbine foundations.

The geochemical risk assessment focusses primarily on the risk of contamination of the receiving environment by the generation of acid and metalliferous drainage (AMD[10]) with elevated arsenic and other metal(loid) concentrations) associated with the excavation of wind turbine footings and other excavation activities for the Project.

The geochemical assessment is based on the available geological (**Section 4.1.6**), hydrogeological (**Section 4.1.7**) and geochemical information for the Project to assess the risk of the generation of AMD.

The risk of the generation of AMD is increased where specific geological processes have occurred that concentrate elements such as sulfur, metals, and metalloids.

The underlying geology of the Project area which is predominantly the Glen Gordon Volcanics and the rocks excavated for the wind turbine foundations are expected to be ignimbrites. An ignimbrite is a type of rock formed when a volcano erupts and the ash and pumice solidify while still in the air and fall to the ground as a thick deposit, or from a pyroclastic flow. Ignimbrites are made up of a mixture of ash, pumice, and other volcanic fragments. They

[10] Acid and metalliferous drainage referred to in this report collectively includes acidic, saline, and metalliferous (containing metals and/or metalloids) drainage.

are typically characterised by a fine-grained, glassy texture and a uniform, layered structure. The mineralogy of the ignimbrite is described as rhyodacitic to rhyolitic. This means that in an unaltered state the rocks are expected to be low in sulfide. The primary mineralogy is expected to be plagioclase, feldspar, and quartz with lesser amounts of biotite, mica, and hornblende which are considered environmentally benign from an AMD perspective.

Three foundations are proposed to be placed outside the Glen Gordon Volcanics in the Cp-7962 granite. The granite is also expected to be low in sulfide, with the major minerals present being quartz, plagioclase, feldspar, and biotite. It should be noted that granitic intrusions may also alter the host rock where the intrusion contacts the host rock, potentially leading to sulfide mineralisation. As nearly all the proposed foundation locations are away from the intrusion margins it is considered unlikely that if sulfides were generated by the intrusions of the Ingham Granite Complex and the Cp-7962 granite that these mineralised areas would be encountered during the excavation of the wind turbine foundations.

Acid sulfate soils (ASS) are soils, sediments, or other materials containing iron sulfides. Based on data retrieved from the Atlas of Acid Sulfate Soils (Fitzpatrick, et al., 2011) the occurrence of ASS in the project area is considered unlikely (they typically occur at elevations of less than 5 m Australian Height Datum).

Based on the groundwater assessment in **Section 4.1.7**, it considered unlikely that foundation excavations will intercept the groundwater table. Therefore, it is likely that any materials excavated from these areas have already been subjected to weathering process and any sulfur is likely to be present as non-acid forming sulfate rather than sulfide. Given the geology and mineralogy of the Project area, coupled with the relatively shallow excavation depths likely for most wind turbine foundations the risk of AMD generation and potential for leaching of arsenic (and other metal(loid)s) from the Project into the receiving environment is considered low.

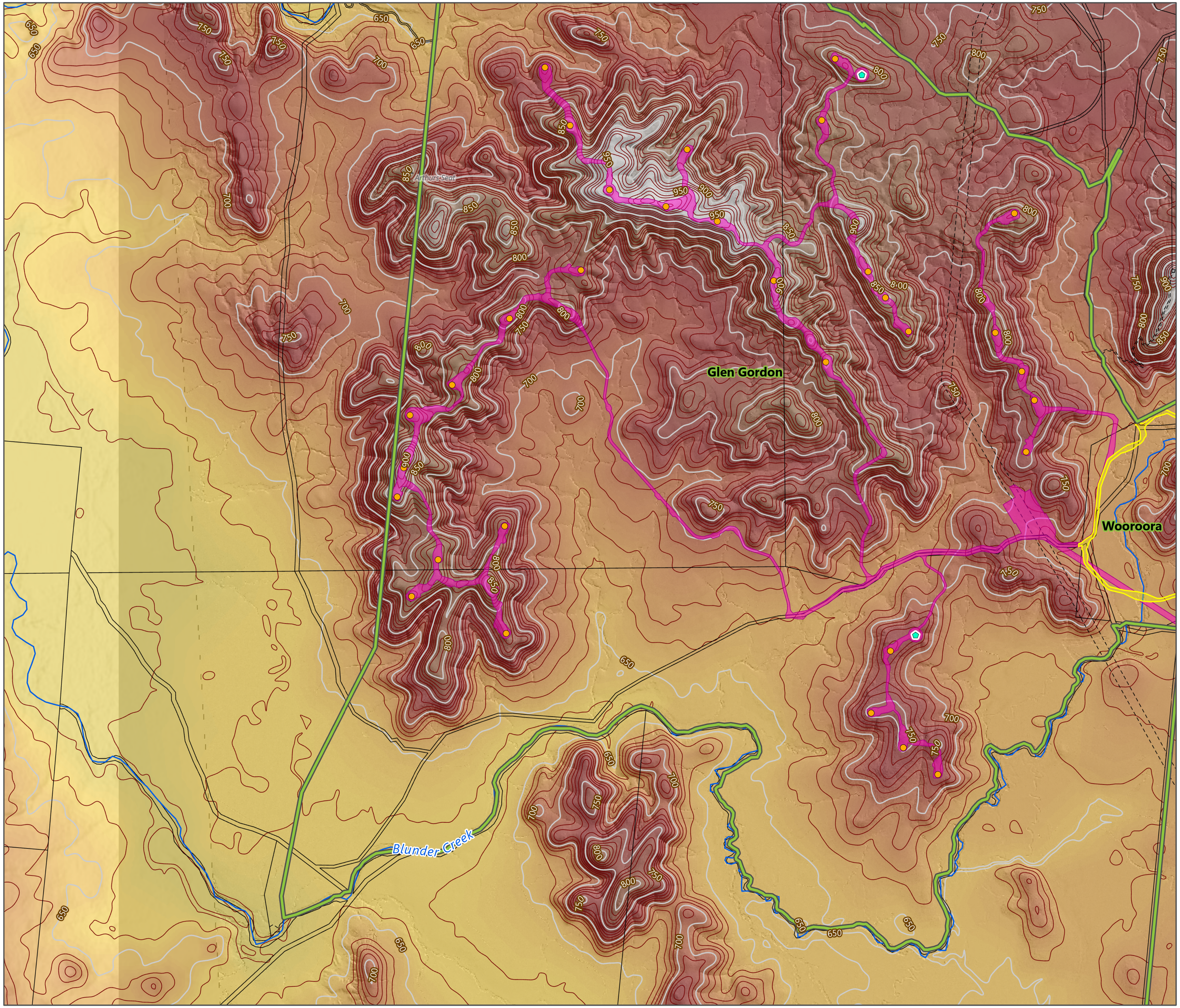
4.1.9 Elevation

The Project area is located on the southern edge of the Atherton Tablelands, a fertile plateau forming part of the northern extent of the Great Dividing Range in Queensland. This plateau sits at an average of 600 m Australian Height Datum (AHD), rising to 800 m AHD in the west and reaching over 1,000 m AHD on the tops of the remnants of shield volcanoes (Whitehead 2003). Landscape formations across the Atherton Tablelands are derived from a range of lithologies but the most important are rhyolite, granite and fine-grained sedimentary rocks (Heiner & Grundy 1994).

The Project area is defined by a taller series of hills forming ridgelines, connected by numerous saddles or knolls, that extend along the eastern edge of the Wooroora property, and across the north of Wooroora and Glen Gordon **(Plate 4-7**). These ridges form the boundary of the local watershed formation, draining southwest through low plains and alluvial areas towards the Herbert River. The majority of the hills are associated with emergent granite formations rising to approximately 990 m AHD in the north of Glen Gordon, with the alluvial plains in the south of Wooroora being the lowest point within the Project Area at approximately 671 m AHD.

The proposed wind turbine locations are predominantly situated on the eastern and northern ridgelines described above, or occasionally located on other isolated scattered hills within the properties, with elevations ranging from 730 m to 990 m (**Figure 4-6**).

Plate 4-7 Glen Gordon ridgeline



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Elevation

Figure 4.6 Sheet 1 of 4

- Project Area Boundary
- Turbine
- Met-mast

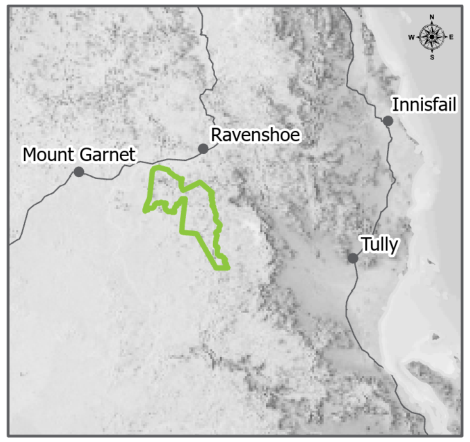
Clearance Envelope

- Stage 1
- Stage 2
- Watercourse
- Lot Boundary
- Easement

Elevation (mAHD)

- <200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 1,100
- 1,100 - 1,200

Date: 15/10/2022 Author: TOD
Project: EPU-004 Reviewed: NOD



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