PUBLIC NOTICE

Pursuant to Section 382 of the *Water Act 2000* Release of UNDERGROUND WATER IMPACT REPORT

Comet Ridge Limited

In accordance with the requirements of section 381 and section 382 of the *Water Act 2000* (Water Act) **Comet Ridge Limited** has developed an underground water impact report (UWIR) for its **proposed production programs** within **Authority to Prospect (ATP) 744P** located approximately 90km north-east of Aramac and 145km north-east of Barcaldine in central Queensland.

You have the opportunity to review and comment on the UWIR.

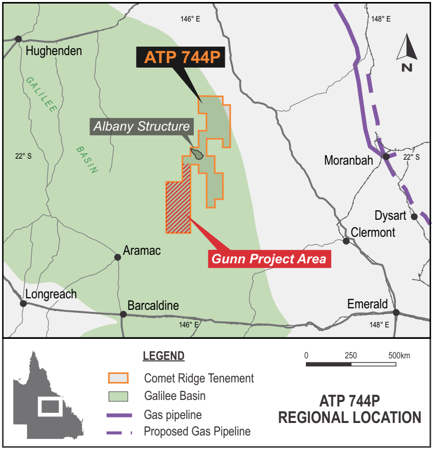
From **Wednesday 11th March 2020** you can access the UWIR for **ATP744P** by visiting **Comet Ridge's** website at: **http://www.cometridge.com.au**

You can also phone **07 3221 3661** to arrange a hard copy of the report to be posted to you.

Written submissions on the UWIR may be made to **Comet Ridge Limited** and mailed to:

Comet Ridge Limited
GPO BOX 798
Brisbane QLD 4001

Your submissions must be:
- In writing; and
- Received by COB **Wednesday 8th April 2020**.



Please note that as required by section 382(d) of the Water Act copies of all received submissions must be provided to the chief executive. The submissions will be part of the assessment process for the UWIR.

For more information please phone **07 3221 3661**

Comet Ridge

UNDERGROUND WATER IMPACT REPORT

AUTHORITY TO PROSPECT ATP744 – GALILEE BASIN

COMET RIDGE

March 2020

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Document Revision History

Date	Version	Author/s	Reviewer/s
10/02/2020	Draft	Dr Przemek Nalecki Dr Grazia Gargiulo	Melanie Fitzell Simon Garnett
14/02/2020	Public consultation	Dr Przemek Nalecki Dr Grazia Gargiulo	Melanie Fitzell
9/03/2020	Public consultation	Dr Przemek Nalecki Dr Grazia Gargiulo	Melanie Fitzell
10/03/2020	Public consultation	Dr Przemek Nalecki Dr Grazia Gargiulo	

Executive Summary

The following is an Underground Water Impact Report (UWIR) completed for the purposes of meeting the requirements of Chapter 3 of the *Water Act 2000* (Qld). The report covers previous and proposed production testing activities on Authority to Prospect 744 (ATP 744) conducted by Comet Ridge. These activities include:

- a short term production testing that occurred during 2013 at the Gunn #2 well (CSG well);
- a proposed five-spot pilot production test which is planned to commence on commission of the five-spot pilot scheme (referred to as Gunn Pilot); and
- A proposed short term production testing of unconventional tight gas wells to occur at the Albany Project site.

Since submission of the initial UWIR for ATP 744 (2014), Comet Ridge has not undertaken any further production testing at the Gunn #2 well. The proposed five-spot pilot has not been drilled at the time of writing this report, however the proposed pilot may be commissioned within the next three year reporting period. The proposed Gunn Pilot design and forecasted production have not changed since the initial UWIR and therefore the modelling undertaken for the initial UWIR remains relevant for the next three year reporting period and is covered in this report.

The Albany Project consists of two deep wells (Albany 1 and Albany 2) drilled respectively in 2018 and 2019 to test tight gas potential in Albany Structure within ATP 744.

The report provides:

- a description of the hydrogeological context of the area including description of the aquifers present and how they interact;
- an estimate of how much underground water will be required to be taken as result of the proposed production testing activities;
- an estimate of the groundwater level impacts as result of the proposed production testing activities as determined through a groundwater flow models;
- a description of the predicted Immediately Affected Area (IAA) generated by the proposed production testing activities;
- a description of environmental values, the impacts that have occurred and the impact that are likely to occur as a results of the exercising of underground water rights;
- a description of springs within the tenure and surrounding area;
- a monitoring strategy to verify modelling predictions and quantify impacts; and
- a reporting strategy back to the Department of Environment of Science (DES) should there have been a material change from predictions.

The key findings of the report for the Gunn Pilot are that:

- the shallow aquifers in the area are separated from the target coal seams by at least 300m of low permeability formation (Rewan Group);
- a small immediately affected area is predicted **only** within the coal seam (C1 seam) being targeted;

- There are no water bores sourcing water from the coal seams of the Betts Creek Beds within the IAA;
- The coal seams are the only formation predicted to have an IAA; as a result, no make good obligations are triggered;
- The C1 coal seam is the only interval predicted to experience drawdown during testing activities and no drawdown was predicted in the overlying or underlying aquifers or aquitards within the project area;
- No impacts on environmental values have been identified as a result of the previous or future exercise of underground water rights associated with the Gunn Pilot based on the current modelling;
- There are two active landowner bores sourcing water from sandstone intervals within the Betts Creek Beds located over 70km from the proposed pilot. The predicted impact from the proposed exercise of underground water rights on these wells is considered negligible due to the spatial separation from the Gunn Pilot;
- There are eight active water bores drilled for the purpose of monitoring water levels and water quality of coal seams within the Betts Creek Beds. These monitoring bores are associated with coal mining operations and are located over 70km from the pilot;
- There are six active landholder bores within a 10km radius of the pilot, where water is being extracted from aquifers at least 440m above the coal seams;
- Only one active landowner bore is located within the IAA where water is sourced from the Moolayember Formation (at least 570m above the coal seams) for the purpose of stock watering; and
- There are no springs within 20km of the pilot, and the nearest springs are not sourced from the coal seams.

The key findings of the report for the Albany Production Test are that:

- The shallow aquifers in the area are vertically separated from the target formation the Lake Galilee Sandstone by over 2000m, within which at least 1000m is considered to be formations of low permeability (Rewan Group, Jericho Formation, silt layers within Betts Creek Beds and Jochmus Formation);
- A small (~100m radius) IAA is predicted **only** within the Lake Galilee Sandstone which is the formation being targeted;
- There are no water bores sourcing water from the Lake Galilee Sandstone within the IAA;
- The Lake Galilee Sandstone is the only formation predicted to have an immediately affected area, meaning no make good obligations are triggered;
- The Lake Galilee Sandstone is predicted to experience drawdown only during testing activities and shortly thereafter. No drawdown was predicted in the overlying aquifers or aquitards within the project area;
- No impacts on environmental values have been identified as a result of the previous or future exercise of underground water rights associated with the Albany Project based on the current modelling;

- There are no monitoring or water bores drilled into the Lake Galilee Sandstone. The only wells that penetrated the Lake Galilee Sandstone in the Galilee Basin are the conventional oil and gas wells;
- There are seven (7) landholder bores within a 10km radius of the Albany Project (3 of them are unregistered bores), where water is being extracted from Moolayember aquifer at least 2000m above the Lake Galilee Sandstone;
- There are no landowner bores located within the IAA where water is sourced from any of the overlying aquifers; and
- There are no springs within 10km of the Albany Project wells, and none of the nearest springs is sourcing water from the Lake Galilee Sandstone.

The initial UWIR which was prepared for ATP744 was submitted and approved by the Department of Environment and Heritage Protection (DEHP) in April 2014. The following UWIR was prepared in 2017 and covered the reporting period between 2017 and 2020. This UWIR is relevant for the next reporting period from 2020 to 2023. As required under the *Water Act 2000 (Qld)*, during this period Comet Ridge will undertake annual reviews of the model drawdown predictions presented in this report. A summary of those reviews will be presented to Department of Environment and Science (DES) and where applicable will provide detail on how actual drawdown (if any) deviates from model predictions presented in this report.

This UWIR presents the actual volume of water that was produced during an extended production test of a single production well (Gunn #2) in 2013 and simulated prediction of the volumes of production water from a proposed five-spot coal seam gas pilot to be located at the Gunn Pilot location. The initial UWIR proposed the five-spot pilot would be operational in late 2014. The proposed future five-spot pilot has not been drilled or constructed at the time of writing this report, however Comet Ridge may commit to the development of the pilot, which may occur within the next three year reporting period. The modelling undertaken for the initial UWIR had an arbitrary start date of production at 1 October 2014. No production testing has occurred in the last three year reporting period. The arbitrary start date for commencement of production of the Gunn Pilot is assumed to be 1 October 2020 for the purposes of this report for the next three year reporting period.

Production testing has not started for the Albany Project at the time of writing this report. The assumed start of the production testing for the reporting purposes has been assumed to be 1 July 2020.

Overall, no material impacts to underground water resources are predicted as a result of the production testing activities on ATP744. The monitoring strategy will ensure that realised groundwater changes align with predictions. As knowledge of the hydrogeology in the area expands, the model will be re-run with updated information and re-submitted to the DES.

Introduction

Comet Ridge is a publicly listed Australian energy company focussed on Coal Seam Gas (CSG) and conventional petroleum exploration and appraisal. Based in Brisbane, the company has three permit interests within the Galilee Basin in Queensland, including 100% equity in Authority To Prospect ATP743, ATP744 & ATP1015. The company also has a suite of other prospective projects in Queensland and New South Wales. Comet Ridge is the tenure holder of ATP744 and is also the operator.

Project Area

ATP744 is located along the eastern margin of the Galilee Basin in central Queensland and is approximately 90km northeast of Aramac (**Figure 1**). ATP744 comprises 54 continuous blocks comprising 1350 sub-blocks.

Project Rationale

The *Water Act 2000* (Qld) (Water Act) requires petroleum tenure holders to manage impacts of extraction of underground water from their production testing or production activities. To assist in achieving this, petroleum tenure holders must prepare an Underground Water Impact Report (UWIR), which is used to proactively predict any possible impacts of the petroleum operations on underground water resources and implement monitoring and mitigation measures if necessary. An UWIR established responsibilities for resource tenure holders and ensures measures and programs are in place to respond to impacts on underground water.

The key aspects of an UWIR are:

- identify aquifers that are predicted to be impacted by resource tenure holders' exercising their underground water rights (immediately affected areas (IAA) and long term affected areas (LTAA));
- establish obligations to monitor impacts on aquifers and springs;
- impose a strategy to mitigate impacts of any spring of interest, where required;
- assist with management of impacts of the exercise of water rights by resource tenure holders; and
- establish underground water obligations (make good obligations of the resource tenure holder for private water bores), where required.

A resource tenure holder is not required to prepare further UWIR's if in the following circumstances apply:

- the resource tenure is not a CMA tenure; and
- the existing approved UWIR;
    - estimated a quantity of water to be taken to be zero; and
    - did not predict a decline in the water level of an aquifer of more than the bore trigger threshold at any time.

This UWIR relates to activities proposed to be carried out within ATP744 and provides information about the relevant underground water extractions and the potential impacts on aquifers within ATP744 in relation to any future production testing of:

- a proposed five well pilot program, to be located around Gunn #2 well, known as the Gunn Pilot, and (**Figure 1**).
- a proposed testing program of two tight gas wells drilled within the Albany structure, known as Albany Project (**Figure 1**).

The initial UWIR prepared for ATP744 was submitted and approved with conditions by the former Department of Environmental and Heritage Protection (EHP) currently known as Department of Environment and Science (DES) in April 2014 and took effect on 3 April 2014. An updated UWIR was submitted in 2017. Each subsequent UWIR is due for submission within 10 business days of the three years anniversary of when the first UWIR took effect.

Objective

The purpose of this document is to satisfy the requirements of section 376 of the Water Act for the proposed future production testing activities of the proposed Gunn Pilot and Albany Project within ATP744 in the Galilee Basin. The proposed production testing will occur in the south western and central parts of Comet Ridge ATP 744 petroleum and gas exploration permit.

Purpose

This UWIR has been prepared to describe the hydro-geological context of the project areas and predict the impacts on underground water associated with the proposed Gunn Pilot and Albany Project. A hydro-geological conceptualisation has been prepared to assist in understanding the aquifers in the project area. Numerical models have been prepared to predict groundwater impacts expected as a result of the proposed production testing at the proposed pilot locations. This UWIR also proposes a monitoring strategy to compliment and verify the groundwater modelling. The monitoring strategy will also be used to quantify any possible impacts and be used to refine future groundwater models.

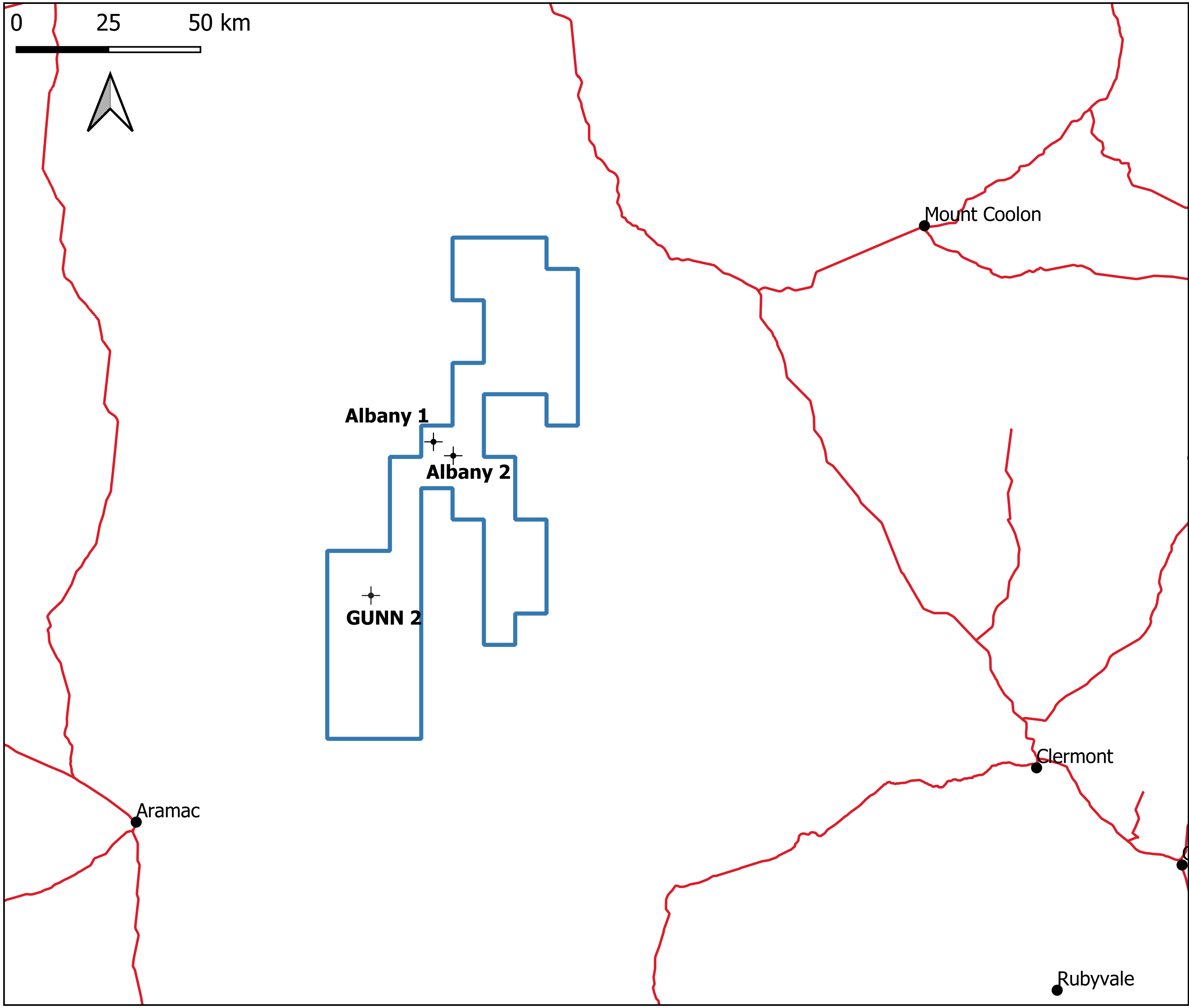


Figure 1:

Locality Plan

Statutory Requirements

An UWIR is developed to document compliance with sections 370 to 383 of the Water Act. This UWIR has also been developed following the requirements outlined in the Guideline: Underground water impact reports and final reports (ESR/2016/2000), Version 3.02, prepared by DES.

Water Act 2000

In terms of the management of impacts on underground water caused by the exercising of underground water rights by petroleum tenure holders, the requirements of the Water Act are achieved by:

- Requiring petroleum tenure holders to monitor and assess the impact of the exercise of underground water rights on water bores and to enter into 'make good' agreements with the owners of the bores
- The preparation of UWIRs that establish underground water obligations, including obligations to monitor and manage impacts on aquifers and springs;
- Establishing a management framework overseen by the Office of Groundwater Impact Assessment (OGIA) which addresses cumulative underground water impacts from multiple tenure holders in an area (e.g. the Surat Cumulative Management Area).

The Water Act gives OGIA other functions and powers for managing underground water. If a water bore has an impaired capacity as a result of gas extraction activities, an agreement will be negotiated with the owner of the bore about the following:

- The reason for the bore's impaired capacity;
- The measures the holder will take to ensure the bore owner has access to a reasonable quantity and quality of water for the authorised use and purpose of the bore; and
- Any monetary or non-monetary compensation payable to the bore owner for impact on the bore. If an agreement relating to a water bore is made the agreement is taken to be a 'make good' agreement for the bore.

The UWIR is required to define the IAA expected to result from gas extraction activities. An IAA is defined as an area where the predicted drawdown within 3 years is at least:

- 5 m for a consolidated aquifer;
- 2 m for an unconsolidated aquifer; or
- 0.2 m for a spring.

UWIRs are published to enable the community, including bore owners and other stakeholders, within the relevant area, to make submissions on the UWIR. Submissions made by bore owners will be summarised by Comet Ridge, addressed as appropriate and provided to the Department of Environment of Science (DES). UWIRs are submitted for approval by DES. The OGIA may also advise DES about the adequacy of these reports. The UWIR must then remain available on the petroleum tenure holder's website.

The OGIA will maintain a database of information collected under monitoring plans carried out by petroleum tenure holders in accordance with approved UWIRs. The database will also incorporate baseline assessment data collected by petroleum tenure holders.

Public Consultation

A full 20 business day consultation process is required to be run. Submissions may be made by bore owners and other stakeholders. Comet Ridge will consider all submissions and prepare a submissions summary to the DES together with the UWIR.

A public consultations notice will be prepared and circulated containing the following information:

- a description of the area to which the report relates;
- where copies of the report may be obtained
- how the copies may be obtained;
- how written submissions on the report may be given;
- that submissions must be given to the responsible entity;
- that a copy of submissions must be given to the chief executive;
- the day by which submissions may be made, that is at least 20 business days after the notice is published; and
- where the submissions may be given.

Consultation will be undertaken for a minimum of 20 business days and the final UWIR will be submitted within 10 days of the three years anniversary date of the initial UWIR. Comet Ridge will provide a copy of the report to any person who requests a copy.

Petroleum and Gas (Production and Safety) Act 2004

Under the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) the petroleum tenure holder may take or interfere with groundwater to the extent that it is necessary and unavoidable during the course of an activity authorised for the petroleum tenure. P&G Act requires tenure holders to comply with underground water obligations specified in the Water Act.

Environmental Protection Act 1994

Potential impacts on groundwater are managed through an adaptive regime through both the *Environmental Protection Act 1994* (EP Act) and the UWIR process under the Water Act.

The requirements of section 126A and 227AA of the EP Act are complimentary to the requirements for the UWIR in section 376 of the Water Act. It is anticipated that the information supplied with the environmental authority application will be utilised and built upon for the responsible entity's submission of the UWIR. Equally, any relevant information contained within an approved UWIR may be utilised as part of an environmental authority application. An environmental authority may be amended in response to the contents of an UWIR. This framework ensures there is sufficient monitoring, collection and review of information for ongoing adaptive management of groundwater impacts due to the resource sector's statutory right to take underground water.

Geological Summary

Galilee Basin Operator's Forum

As the Galilee Basin formations and the overlying Eromanga Basin formations both have broad stratigraphic continuity over a wide area, a number of energy companies with exploration interests in the region formed a group to support a cooperative and coordinated approach to defining the hydrogeology in the area.

The Galilee Basin Operator's Forum (GBOF), of which Comet Ridge was a member, commissioned RPS Australia East Pty Ltd (RPS) to undertake a baseline water assessment report for the Galilee Basin during 2012. The RPS 'Galilee Basin - Report on the Hydrogeological Investigations' (2012) provides a technical review of all existing publicly available data and to ultimately provide the regulator and the community with the core baseline of the existing environment. This baseline information was considered in the development of this UWIR, particularly when designing the proposed monitoring plan and is referred to throughout this report. The baseline assessment report can be accessed via the GBOF website at: www.rlms.com.au/galilee-basin-operators-forum/.

Galilee Basin

The Galilee Basin covers approximately 247,000 km², extending 700 km from Charleville in the south to near Charters Towers in the north and 550 km from Emerald in the east to Julia Creek in the northwest. The major population centre of Longreach is located to the south of the basin centre. Land use within the Galilee Basin is predominantly sheep and cattle grazing. Petroleum exploration permits are located over the eastern portion of the basin between Longreach and Pentland. Coal exploration permits cover the entire eastern margins of the basin. Refer to **Figure 2** for the extents of the Galilee Basin.

Geological Settings

The Late Carboniferous to Middle Triassic Galilee Basin (**Figure 2**) is an intracratonic, dominantly fluvial, basin that extends over an area of approximately 247,000km² in central Queensland. The following structural and depositional overview has primarily been summarised from Hawkins and Green (1993).

The Galilee Basin is generally divided into northern and southern areas by the east-west Barcaldine Ridge. Up to 3,000m of dominantly fluvial sediments have been deposited within three main depocentres; the Koburra Trough in the east, the Lovelle Depression in the west and the Powell Depression in the south. ATP744 lies within the eastern part of the Koburra Trough.

The basin unconformably overlies the Late Devonian – Early Carboniferous Drummond Basin in the east, Devonian Adavale Basin in the south and terminates against shallow basement rocks including the Proterozoic Mount Isa Inlier in the northwest, the Early Palaeozoic Lolworth-Ravensworth Block in the northeast and early Paleozoic Maneroo Platform in the south (Hawkins and Green, 1993). Strata from the Galilee Basin is exposed along the eastern and north-eastern margin. Elsewhere the basin is unconformably overlain by Jurassic-Cretaceous sediments of the Eromanga Basin. The Eromanga Basin is largely absent over the area of ATP744. The Late Permian-Middle Triassic strata of the Galilee Basin is continuous with the Bowen Basin across the Springsure Shelf and Nebine Ridge in the south.

Basin initiation occurred when crustal extension during the Late Carboniferous reactivated older faults in underlying basins. Quartz-rich braided-stream sediments (Lake Galilee Sandstone) were initially restricted to the Koburra Trough in east. By the Early Permian widespread fluvial and lacustrine sedimentation (Jochmus and Jericho Formations) had extended to the other depocentres in the south and west. Widespread development of peat swamps resulted in the deposition of the Aramac Coal Measures in the western part of the Koburra Trough and Lovelle Depression.

E-W compression at the end of the Early Permian resulted in reverse fault movement, uplift and erosion resulting with a basin-wide mid-Permian unconformity. Thermal subsidence and subsequent foreland loading during the Late Permian led to widespread deposition of coal-bearing sediments of the Betts Creek Beds across the northern part of the basin, while distal fluvial-deltaic, coastal plain and shallow marine sediments (Bandanna Formation, Colinlea Sandstone and Black Alley Shale) were deposited in the south. Widespread fluvial sedimentation (Rewan Group) continued to be deposited into the Early Triassic. Uplift during the Middle Triassic led to deposition of quartz-rich braided stream sediments (Clematis Group, Warang Sandstone) and widespread fluvial and lacustrine sediments (Moolayember Formation). Sedimentation ended with an E-W compressional event during the Late-Triassic. Folding, uplift and widespread erosion resulted in a basin wide mid-Triassic unconformity at the top of the Galilee Basin sequence.

Coal development within the Galilee Basin is limited to the Permian. There are two major coal-bearing units within the basin; the Early Permian Aramac Coal Measures and the Betts Creek Beds. The Aramac Coal Measures are restricted to the western Koburra Trough and Lovelle Depression. The Aramac Coal Measures have not been intersected in any exploration wells drilled within ATP744, indicating the extent is restricted to west of the tenure area. The Late Permian Betts Creek Beds are widespread throughout the northern part of the basin. The Betts Creek Beds are equivalent to the Bandanna Formation in the Bowen Basin. The Aramac Coal Measures and Betts Creek Beds are separated by the mid-Permian unconformity. The stratigraphy of the Galilee Basin is shown in **Figure 3**.

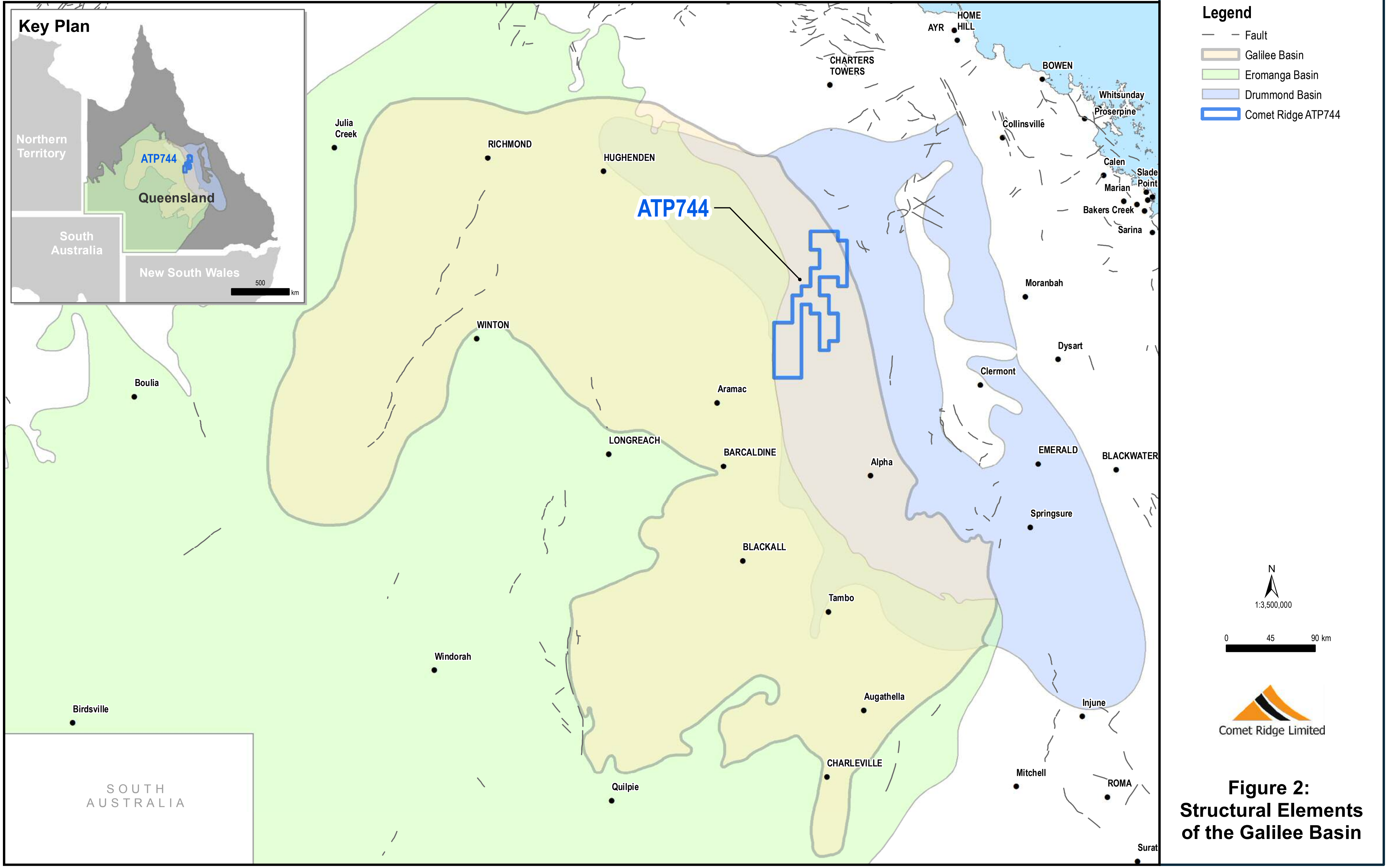


Figure 2: Structural Elements of the Galilee Basin

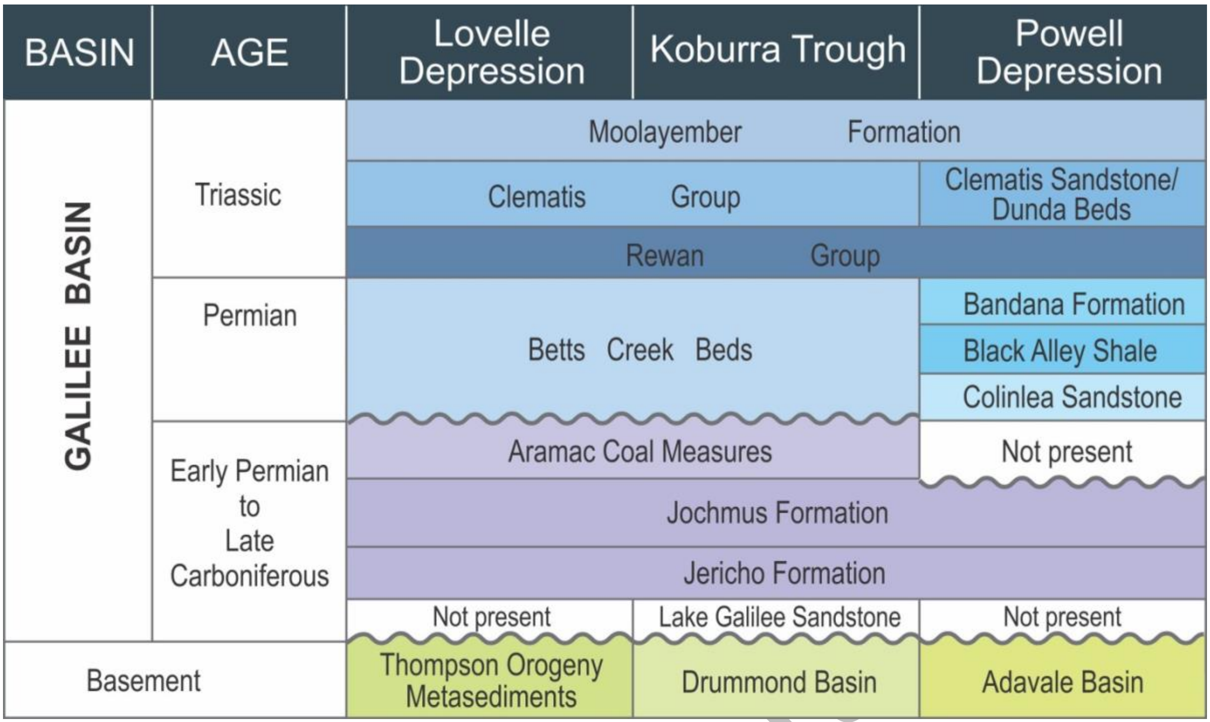


Figure 3: Stratigraphy of the Galilee Basin.

ATP744 Geology

ATP744 is located in a geologically and hydrogeologically diverse area. The tenure area is located across the Koburra Trough, which is the most significant structure in the north eastern part of the basin.

Surface Geology

The surface geology of the permit contains widespread Quaternary alluvium and Tertiary sediments that surround outcropping Triassic aged sediments of the Galilee Basin. The Dundas Beds (correlative equivalent to Clematis Group) crop out along the eastern margin in the south east of ATP744. The Moolayember Formation and Clematis Group crop out along the eastern margin and in the central part of the tenure area. The more extensive Warang Sandstone (basin margin facies) crops out along the western margin in the north of the tenure area. The Betts Creek Beds also crop out over a small area in the north. Drummond Basin sediments crop out in the north-eastern part of the tenure area to the east of the margin of the Galilee Basin. Eromanga Basin sediments are absent from the tenure area and crop out to the west of the tenure area boundary (**Figure 4**)

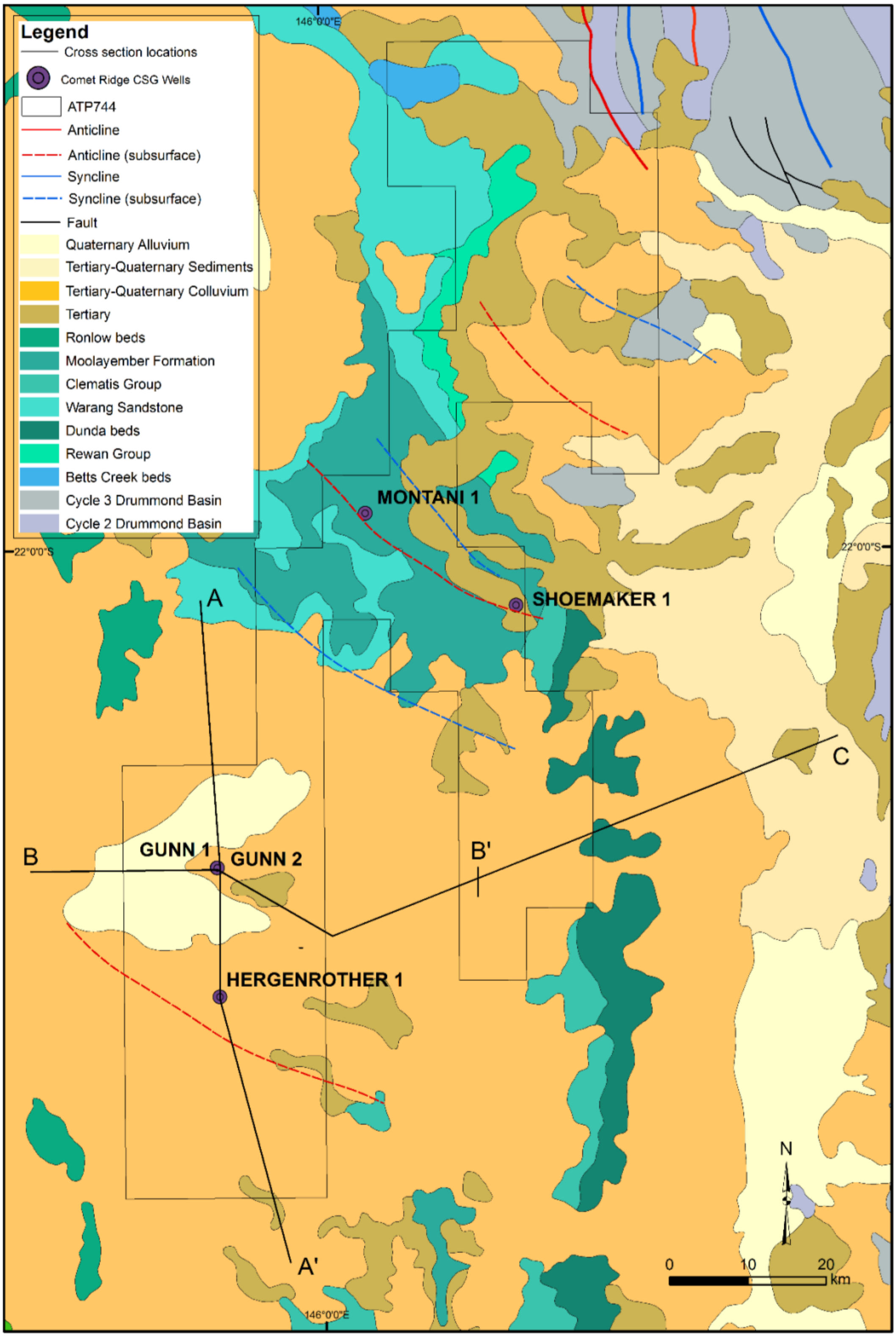


Figure 4: Surface geology map of ATP744, showing locations of schematic cross-sections.

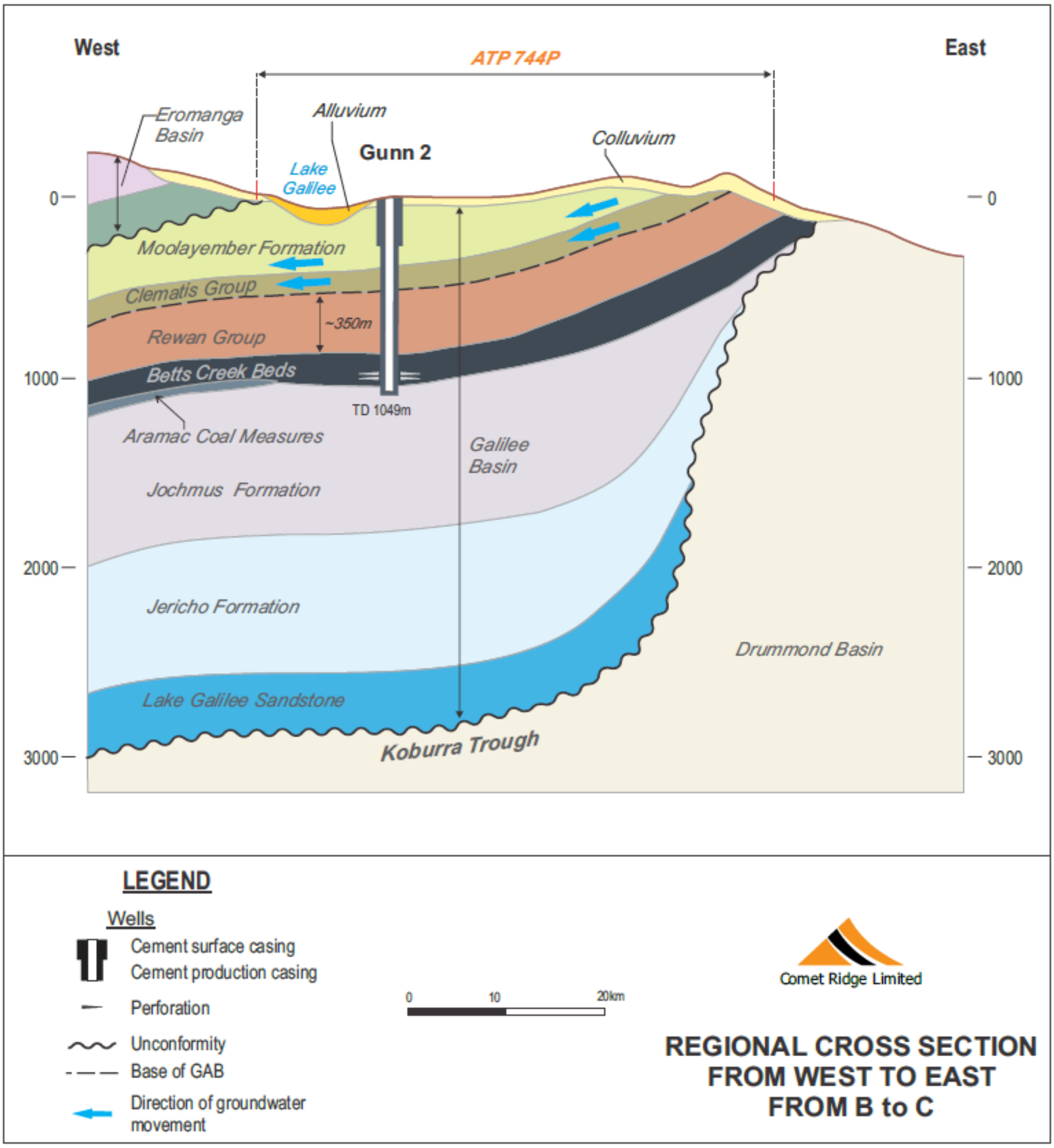


Figure 5: Regional schematic geological cross-section B-B' from west to east across ATP744

Report Structure

This report is divided into two major parts. Each of the parts, addresses separately the proposed pilot projects – Gunn Pilot and Albany Project. The two projects are different in nature and are planned to be developed in distinctively different geological and hydrogeological settings with no known or expected hydraulic connectivity between them. For the ease of addressing UWIR requirements, each section is constructed to form a complete report on its own.

For each part, the report contains:

- A description of the relevant aquifers of the area;
- The quantity of underground water produced or taken from the production testing activities already undertaken;
- An estimate of the volume of water likely to be produced from the production testing activities in the next three years;
- An analysis of movement of underground water as a result of the production testing activities;
- An analysis of likely corresponding water level changes;
- A map showing the Immediately Affected Area (IAA);
- A description of the modelling techniques used to make the predictions;
- A description of how the modelling was used to produce a map of the IAA;
- A description of environmental values;
- An assessment of the likely impacts on environmental values; and
- A groundwater monitoring strategy.

GUNN PILOT

Target Formations for Gunn Project

The target formation for coal seam gas exploration within ATP744 is the Betts Creek Beds. The Betts Creek Beds predominantly comprises high volatile bituminous coal seams that are interbedded with mudstone, siltstone, sandstone and carbonaceous shale. Seven coal seams have been interpreted within the Betts Creek Beds within the tenure area including the A, B, C, C1, D, D1 and E seams (**Figure 6)**. The Betts Creek Beds sub-crop in the north-eastern area of ATP744 and to the east of the south-eastern leg of the permit area. Depth to top of the Betts Creek Beds ranges between 200m to 1000m within the project area. The Betts Creek Beds gradually deepen to the west across the permit area (**Figure 7**). In the vicinity of the proposed pilot program coal seams are greater than 800m in depth. Net thickness of coal seams ranges between 15-24m across the tenure area. The target seam for the Gunn Pilot production program is the C1 seam only. The C1 target seam has a net thickness of 3 to 8m and an average gas content >4.0m^3/t on a dry ash free basis. The Early Triassic aged Rewan Group conformably overlies the Betts Creek Beds. The Betts Creek Beds unconformably overly the Early Permian Jochmus Formation. The Rewan Group mainly comprises red to green mudstone sandstone and minor volcanilithic conglomerate and is a regional significant confining unit (RPS, 2012). The Rewan Group is over 300m in thickness in the vicinity of the proposed pilot program which confines and separates the Permian Betts Creek Beds from the locally significant Triassic aquifers of the Clematis Group and Moolayember Formation. (**Figure 8**)

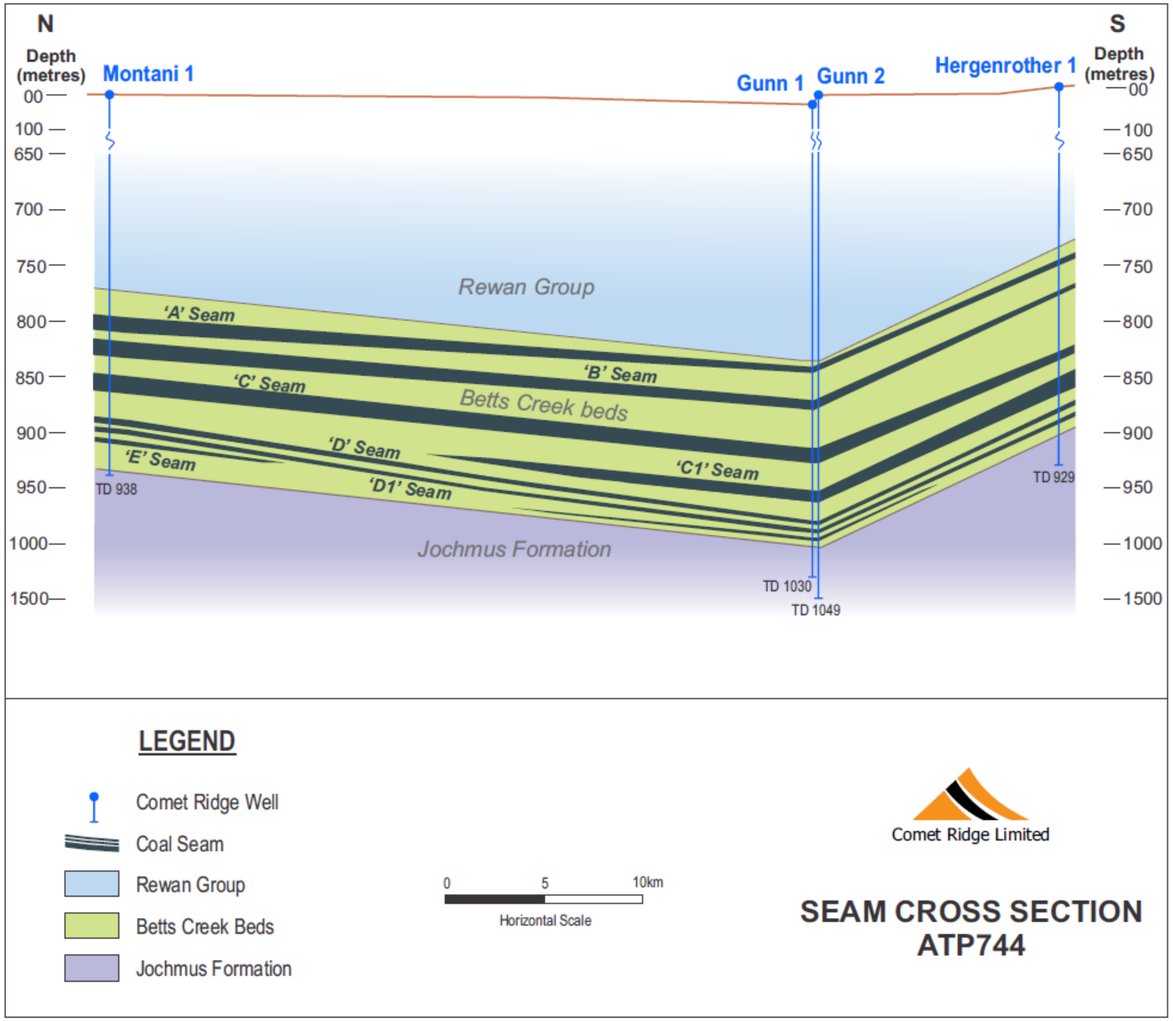
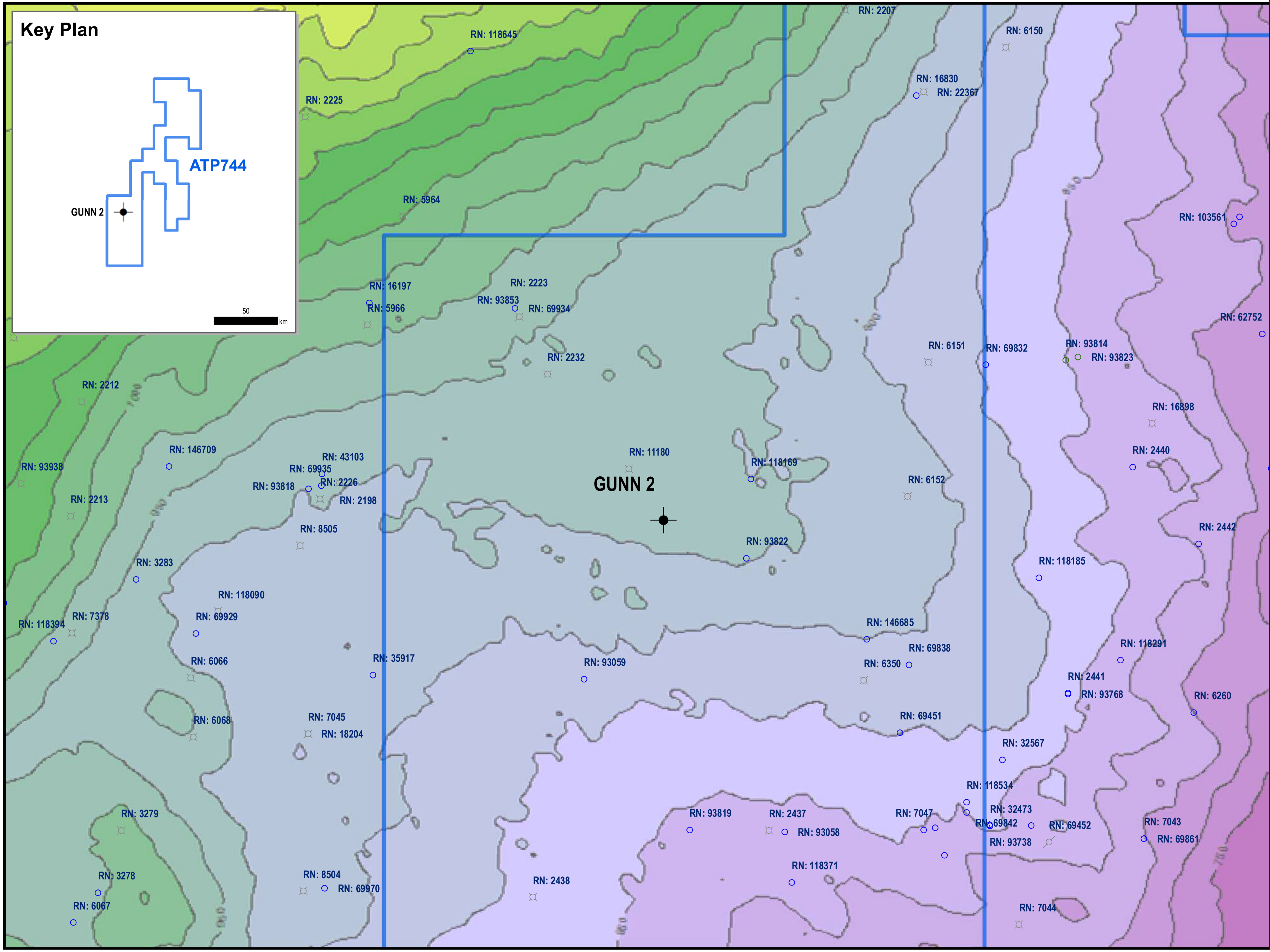


Figure 6: Schematic cross-section of coal seams within the Betts Creek Beds in ATP744



Legend

- Gunn 2

Ground Water Bores

- Abandoned and destroyed
- Abandoned but useable
- Existing
- Proposed
- Comet Ridge ATP744

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Comet Ridge Limited

Figure 7: Depth to Target Formation C1 Seam

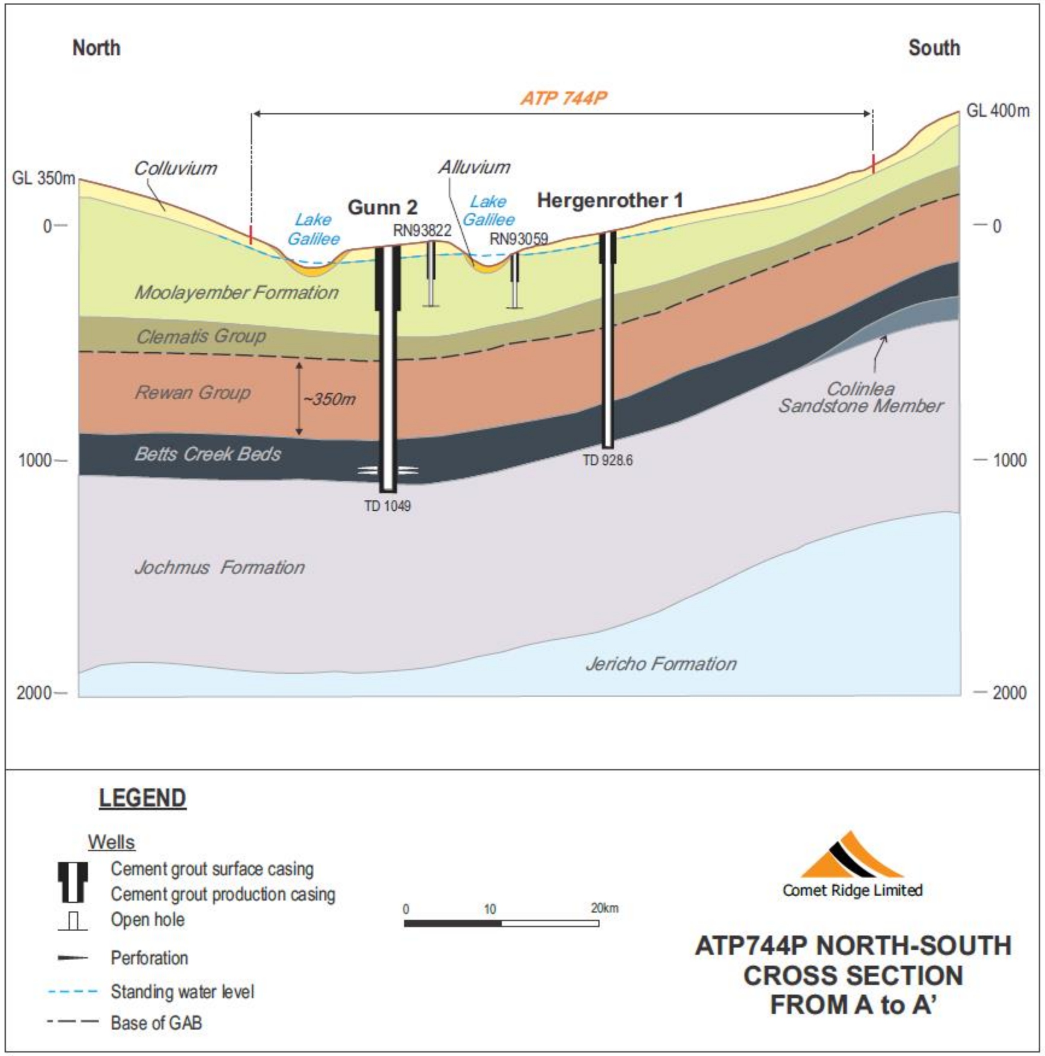


Figure 8: Schematic cross section from north to south across ATP744 showing Rewan Group separating underlying Betts Creek Beds from overlying Clematis Group and Moolayember Formation by >300m

Geological Structure

A series of NW-SE trending anticlines and synclines have been mapped on seismic surveys across the permit area and minimal faulting is observed on surface mapping (**Figure 4**). Faulting interpreted on seismic surveys is primarily associated with basement rocks of the Drummond Basin (**Figure 10**). Significant structural features have been mapped outside the permit area to the north-east (**Figure 4 & Figure 10**).

Structuring associated with the Late Permian coal measures is generally broad and low relief and is associated with compressional events occurring during the mid–late Triassic. The Gunn #2 well is located on the north eastern flank of a broad anticlinal structure named the Hergenrother Nose (**Figure 7**).

In the vicinity of the proposed pilot there is very little structure seen on seismic surveys. Small scale faults are associated with the Betts Creek Beds, however these are interpreted to be confined to the coal seam interval and are not interpreted to extend into the overlying Triassic aquifers or underlying sediments (**Figure 9**).

There are no mapped large scale faults to suggest connection between the Betts Creek Beds interval with overlying Triassic aquifers of the Clematis Group or Moolayember Formations in the vicinity of the proposed Gunn Pilot (**Figure 9**) or within the tenure area (**Figure 10**).

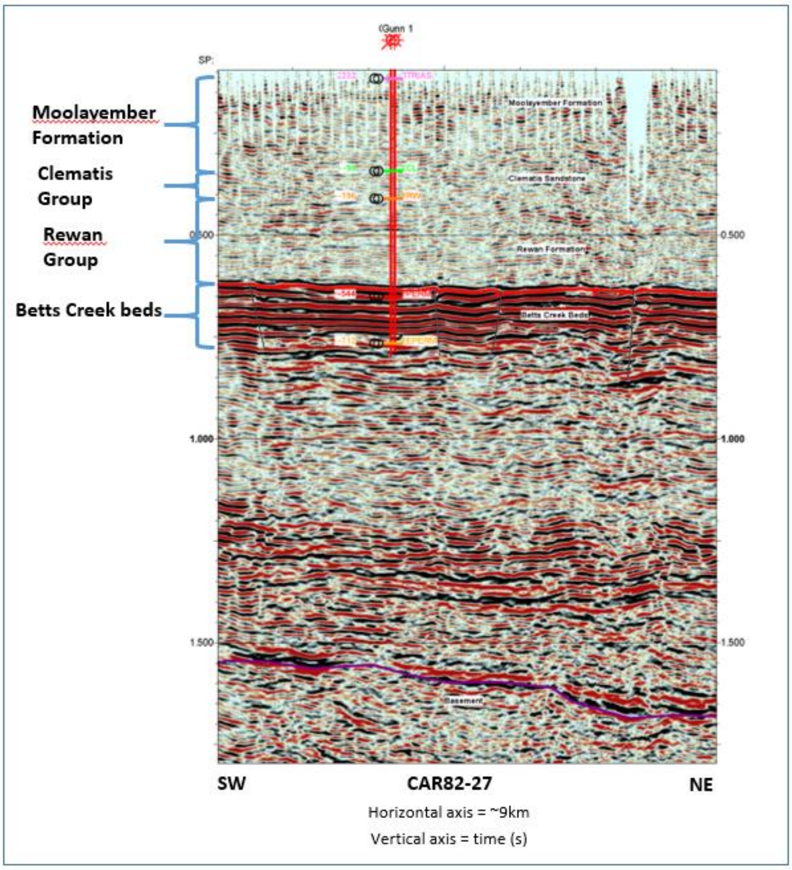


Figure 9: Northeast striking seismic line in vicinity of Gunn # 2 (Carmichael SS CAR82-27)

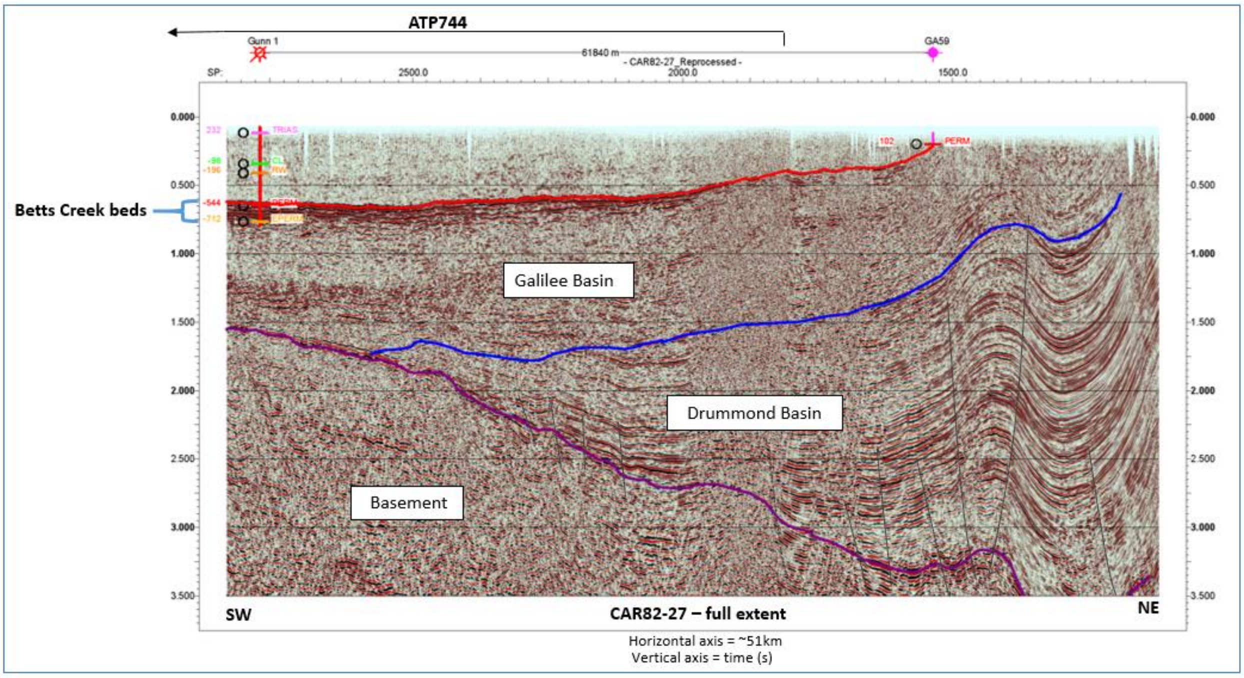


Figure 10: Northeast striking seismic line showing minimal structure and faulting within permit area (Carmichael SS CAR82-72)

Project Information

ATP744 was granted to Comet Ridge for a 12 year period, effective from 1 November 2009. Exploration activities to date have focussed on evaluating and delineating coal seam gas resources within the Betts Creek Beds of the eastern Galilee Basin. Exploration activities have included four exploration wells, one appraisal well and a 252km 2D seismic survey. As a result of this exploration the Gunn Project Area has been defined in the south western leg of ATP744 (**Figure 11**)

In late 2012, Comet Ridge drilled and completed the Gunn #2 appraisal well located approximately 70m west of Gunn #1 exploration well (**Figure 11**). Gunn #2 was drilled as a twin to the Gunn #1 to undertake additional flow testing of coal seams within the Gunn Project Area. Four intervals were tested including two intervals that had not been previously tested. All four intervals demonstrated good to very good permeability.

Gunn #2 was drilled to total depth of 1050m and intersected 16.2m of net coal within the Betts Creek Beds. The depth to the top of the Betts Creek Beds was 835.5mRT. Six (6) individual coal intervals were intersected including A, B, C, C1, D and D1 seams.

The completion style for the well was designed to isolate the coal seams from overlying and underlying permeable sandstones within the Betts Creek Beds and isolate overlying sandstone aquifers within the Clematis Group and Moolayember Formation from the Betts Creek Beds. This completion also allowed perforation of the C1 seam to ensure water was only produced from the C1 seam interval.

The completion diagram for Gunn #2 is shown in **Figure 12**.

Coal seams within the Betts Creek Beds are inter-bedded by sandstones and impermeable mudstones. Some sandstone intervals within the Betts Creek Beds have shown to be permeable and comprise formation water.

The Clematis Group and Moolayember Formation comprise the basal part of the Great Artesian Basin (GAB) in the tenure area. Aquifers within the Clematis Group form the main groundwater source for agricultural and domestic use within the region. The Clematis Group is separated (>300m) from the underlying Betts Creek Beds by a regionally significant confining unit, the Rewan Group (**Figure 8**).

The C1 seam was intersected between 950.2 and 956.8m and is bounded above and below by impermeable mudstone. The well was perforated over a four meter interval from 952.5 to 956.5m to ensure that water was only being produced from the C1 seam reservoir (**Figure 12**).

The well was completed using industry standards and in compliance with Department of Natural Resources, Mines and Energy (DNRME), *Code of practice for the construction and abandonment of petroleum wells and associated bores in Queensland*, with steel casing from surface to 1042.57mDT which has been pressure sealed with cement to surface. Gunn #2 completion technique has allowed:

- Triassic Great Artesian Basin aquifers to be isolated behind steel casing which has been pressure sealed with cement.
- isolation of the C1 coal seam from overlying and underlying intra-bedded permeable sandstone and other coal seams within the Betts Creek Beds and;
- Perforation of the C1 coal seam only to ensure water was only produced from this coal interval.

A cement bond log was run after cementing was completed to evaluate the integrity of the cement with the casing of the well. The cement bond log confirms the cement job in Gunn #2 has resulted in complete isolation of the Betts Creek Beds from the Clematis Group and Moolayember Formation.

An extended production test was carried out on Gunn #2 between January and February 2013 and September and October 2013. The objective of the production test was to provide information on the completion methodology for a full pilot scheme and to obtain good quality water samples from the Betts Creek Beds target coal.

The proposed Gunn Pilot will consist of five vertical wells (Figure 13). All the wells are planned to be completed in the same style as Gunn #2. The C1 seam will be perforated and isolated from all other intervals allowing water and gas production from this interval only. Commissioning and water production from the proposed five-spot production pilot is expected to commence on completion of the drilling and construction of the pilot. Numerical modelling for the proposed future five spot pilot has been assigned an assumed production start date of 1 October, 2020 for this reporting period. The underground water impacts of both the completed production testing on Gunn #2 and the proposed five-spot pilot have been simulated and are considered in this report.

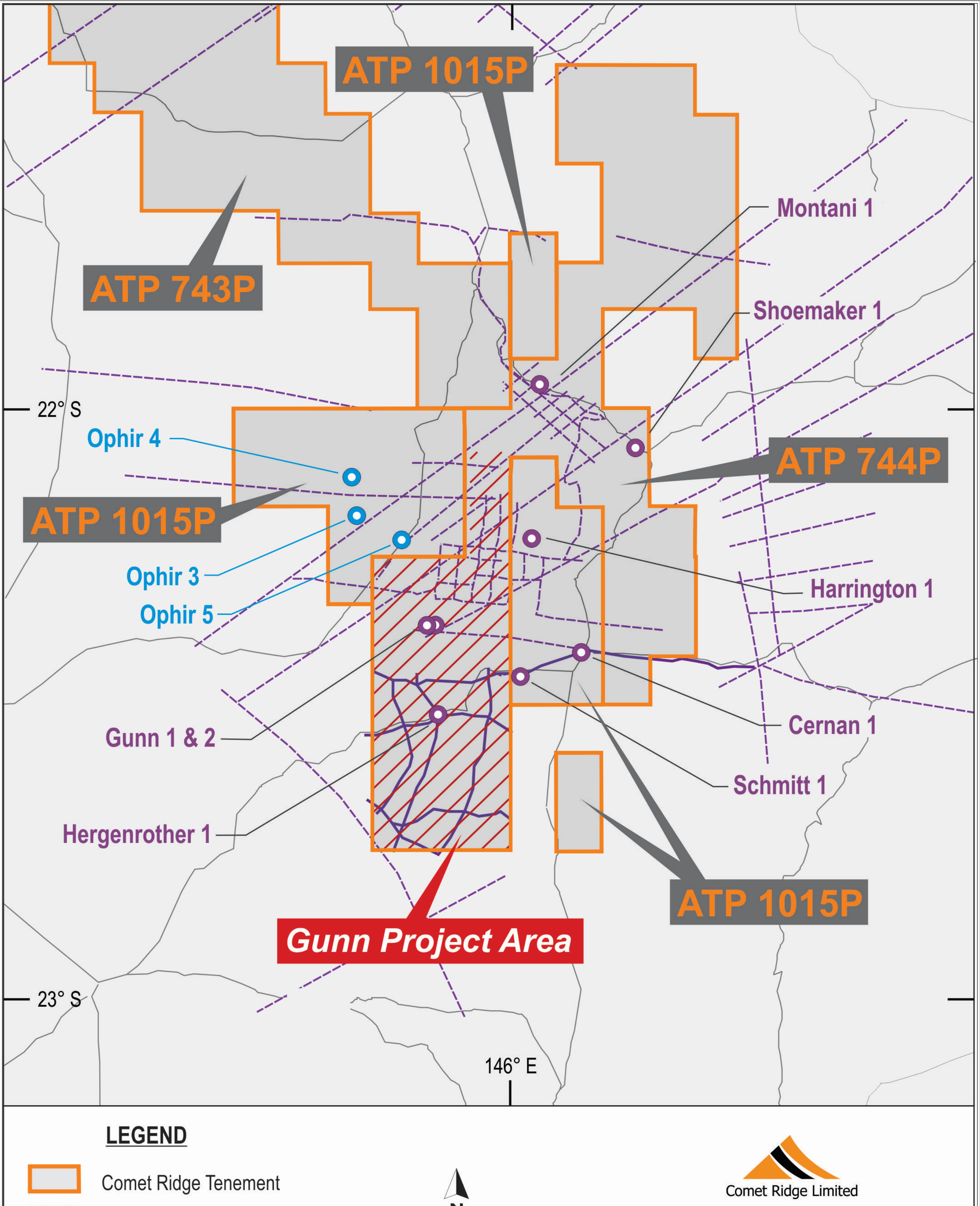


Figure 11

ATP744, ATP743 & ATP1015 TENURE SEISMIC & WELLS

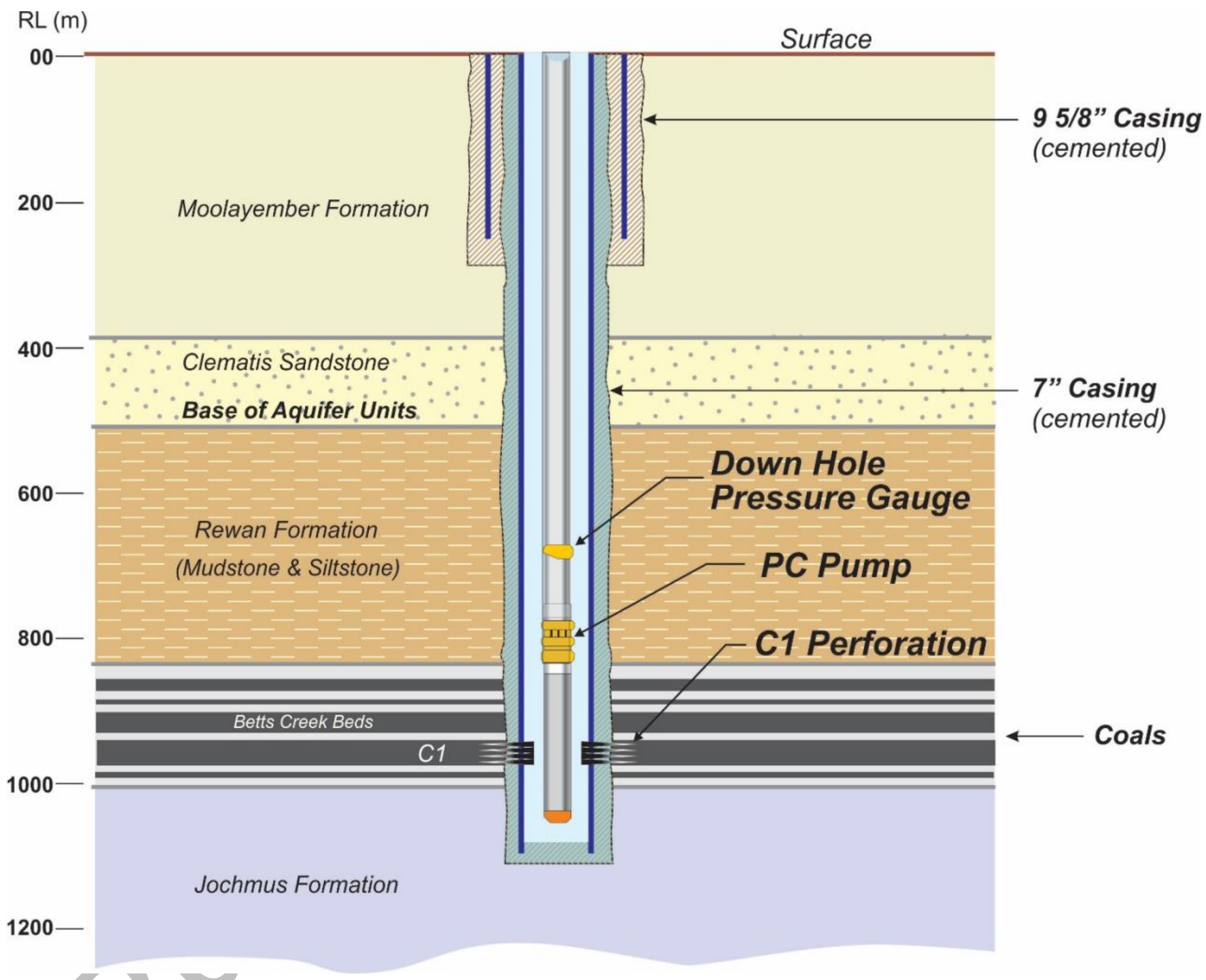


Figure 12: Gunn #2 production well completion design

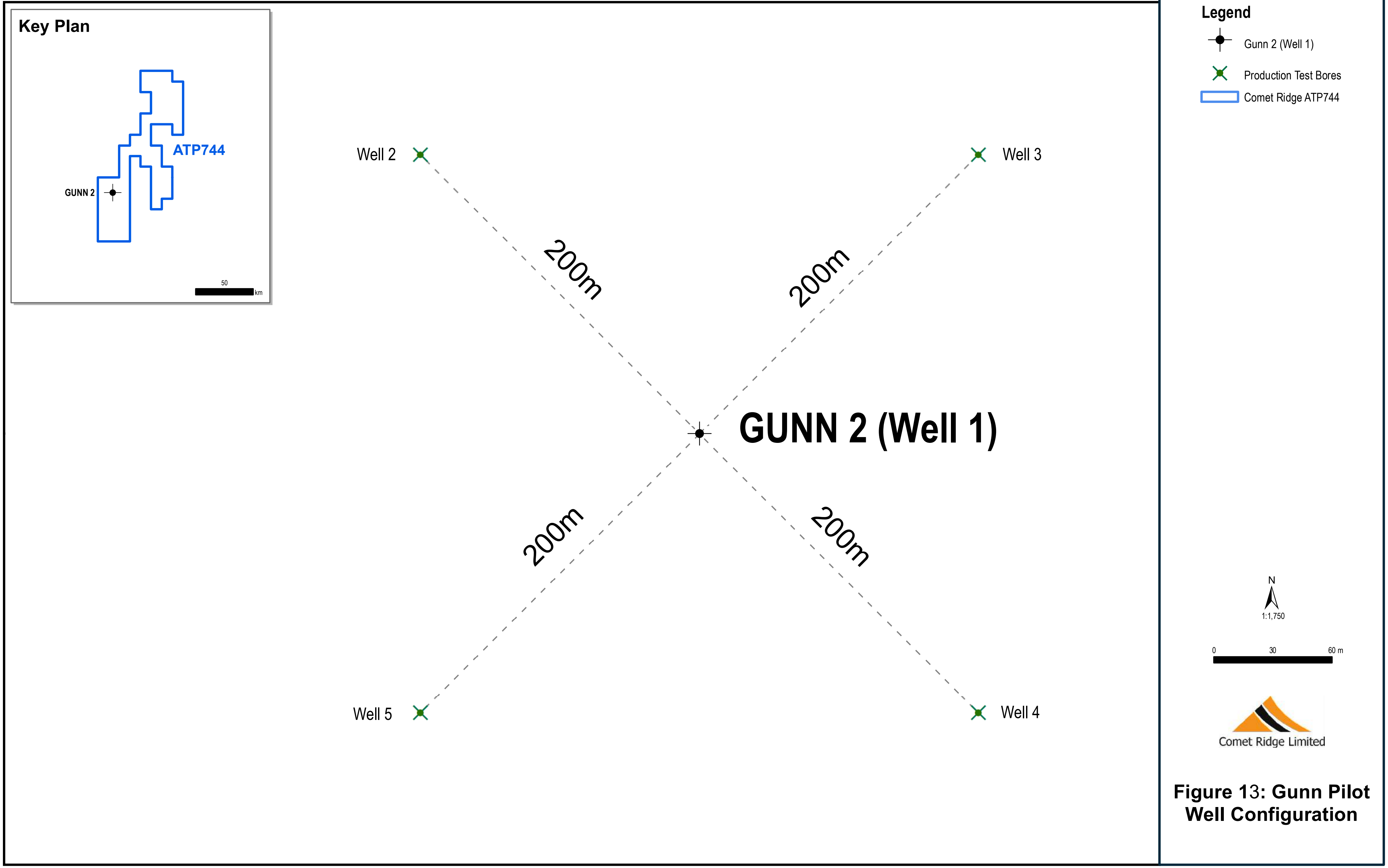


Figure 13: Gunn Pilot Well Configuration

Part A: Underground Water Extraction

Gunn #2 EPT – Quantity of Water Already Produced

To date, production testing from the C1 coal seam of the Betts Creek Beds at Gunn #2 has occurred over two periods. Water was extracted using a progressive cavity pump (PCP) set at 969.95m which was powered by a diesel generator at the surface. The volume of water produced from the well was measured using a magnetic flow meter that measured and recorded volume in barrels per day and provided a cumulative volume. This data was relayed in real time via telemetry. In addition, down hole pressure monitoring was carried out which allowed an accurate understanding of water level and therefore drawdown of the targeted seam.

Total water extracted was as follows:

- 11 January 2013 to 16 February 2013 - 8,609bbls or 1.37ML
- 9 September 2013 to 16 October 2013 - 7,553bbls or 1.2ML

Average water production was 0.034ML per day during the first production period. Total water production over both testing periods (total 81 days) was 2.57ML. During the initial testing period the water rate progressively increased over a period of several weeks, with the well reaching a stabilised production rate of approximately 400bbls/day (0.064ML/day) (**Figure 14**). Down hole pressure mimicked the water level trends during the production test. As the pump speed was increased water produced increased and standing water levels deceased as did bottom hole pressures.

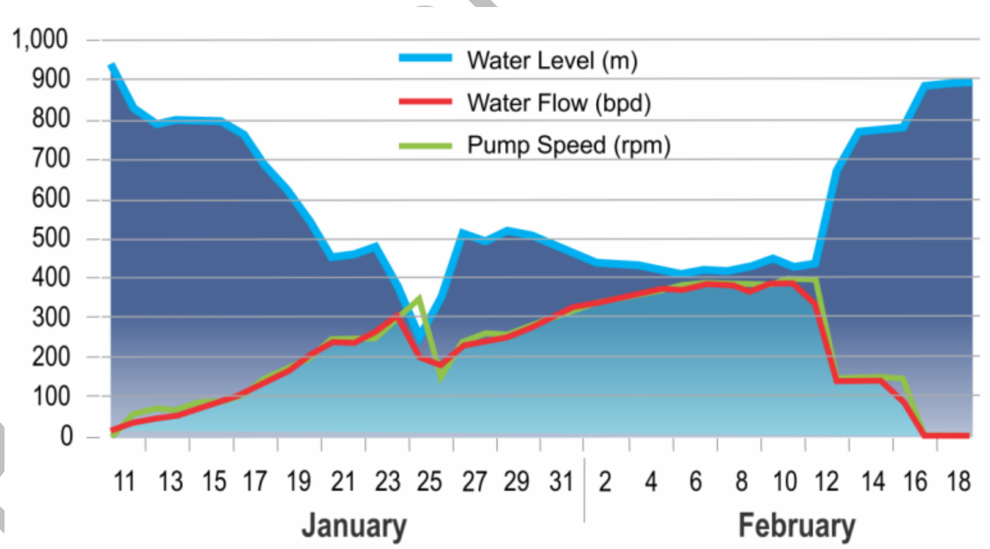


Figure 14: Gunn #2 extended production test 11 January 2013 to 16 February 2013-water level (m), water flow (bpd) and pump speed (rpm).

Gunn Pilot Reservoir Modelling – Quantity of water estimated to be produced over the next three years.

A reservoir simulation model for the proposed Gunn Pilot has been completed by Comet Ridge to forecast gas and water production of the proposed pilot.

The key objectives of the simulation model were twofold:

- History matching of the Gunn #2 extended production test;
- To predict future gas and water production rates for the proposed five-spot Gunn Pilot.

The reservoir modelling was conducted using Computer Modelling Group's (CMG) GEM simulation software. GEM is the industry's leading coal bed methane (CBM) simulator, as it can provide accurate early-time water and methane production predictions, as well as multi-component production predictions for enhanced CBM (ECBM) recovery.

The simulation was based on a 1 km by 1 km numerical model for the proposed vertical wells. Grid cell size for the model was set at 20m. The top of coal was based on the top of coal for the C1 seam in the Gunn Project Area.

The pilot configuration for the modelling comprised 5 wells. The central well (Gunn #2) remains in the middle of the grid with the other 4 wells positioned at 200m spacing's at NW, NE, SW and SE locations (**Figure 13**). Various sensitivities were run on permeability and skin parameters. The well drawdown was restricted and a minimum flowing bottom hole pressure was also set.

Start date of the proposed five spot pilot program has been assumed to be 1 October 2020 for the purposes of this three year reporting period. The simulation predicted water production from the proposed Gunn Pilot over three years from the start date.

Modelled predicted water production and cumulative water production are shown graphically in **Figure 15**. The total volume of water expected to be produced from the five wells after three years of production (1/10/2020-1/11/2023) is approximately 22 ML, refer **Table 2**.

Table 1: Estimated quantity of water to be produced in the next three years.

Year	Estimated produced water in ML per year/well					
	Well 1 (Gunn #2)	Well 2	Well 3	Well 4	Well 5	Total all wells
Oct 2020 to Oct 2021	3.08	3.86	3.96	3.96	3.86	18.70
Oct 2021 to Oct 2022	0.37	0.43	0.44	0.44	0.43	2.10
Oct 2022 to Oct 2023	0.17	0.19	0.20	0.20	0.19	0.94
Total per well	3.61	4.48	4.59	4.59	4.48	21.74

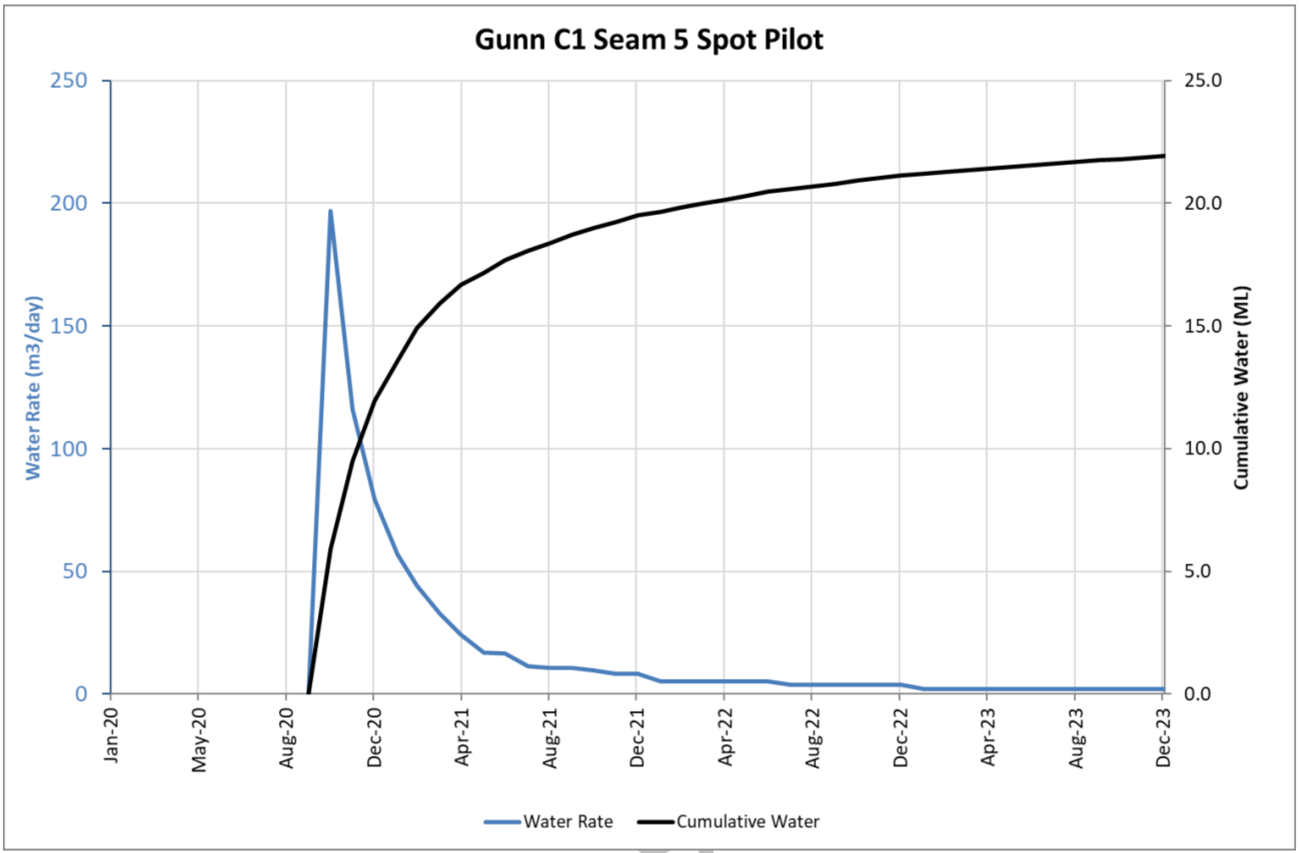


Figure 15: Modelled water rate and cumulative water production of the proposed pilot wells over three years from 1/10/2020

Part B: Aquifer and Underground Water Flow and Levels

Hydrogeology of ATP744

The hydrogeological significant formations of ATP744 included the following:

- the Quaternary Alluvium and Tertiary Sediments;
- Moolayember Formation
- Clematis Group;
- Dunda Beds;
- Rewan Group;
- Betts Creek Beds;
- Jericho Formation and Jochmus Formation.

Refer to **Figure 3** and **Table 1** for additional information on the stratigraphy of these formations. Quaternary alluvium and Tertiary sediments are widespread over the tenure area. Triassic aged units of the upper Galilee Basin including intervals of the Moolayember Formation, Clematis Group and Dundas Beds form part of the basal section of the Great Artesian basin (GAB) within the tenure area. The Early Triassic Rewan Group underlies these units and can be over 300m in thickness over the tenure area. The Rewan Group is considered a regionally significant confining unit (Habermehl, 1980 & Queensland Herbarium, 2017).

In ATP744, the Betts Creek Beds are the target formation for coal seam gas production. The Permian Betts Creek Beds are confined and separated from the overlying Triassic age aquifers of the Great Artesian Basin (GAB) by the Rewan Group, which is a regional aquitard. (**Figure 16**).

The lower Galilee Basin section comprises Late Carboniferous to Early Permian units of the Lake Galilee Sandstone, Jericho Formation and Jochmus Formation, respectively. The Jochmus Formation unconformably underlies the Betts Creek Beds in the tenure area.

The Jericho Formation is over 750m below the Jochmus Formation and no wells within the ATP other than oil and gas exploration wells penetrate this formation. Therefore, the Jericho Formation and the underling Lake Galilee Sandstone are not considered further in this section of the report. Lake Galilee Sandstone is the target formation for the Albany Project conventional wells and it is discussed in the second part of this report (Albany Project).

In the permit area, the Rewan Group separates the GAB aquifers in the upper Galilee Basin from the underlying Permian and Late Carboniferous aquifers and water-bearing units of the lower Galilee Basin (**Figure 16**).

It is considered very unlikely that the proposed five-spot pilot will directly interfere with locally significant aquifers, specifically, the Moolayember Formation and Clematis Group as they are typically separated by at least 300m from the targeted Betts Creek Beds by the Rewan Group, a regionally significant confining unit. Refer **Figure 16**.

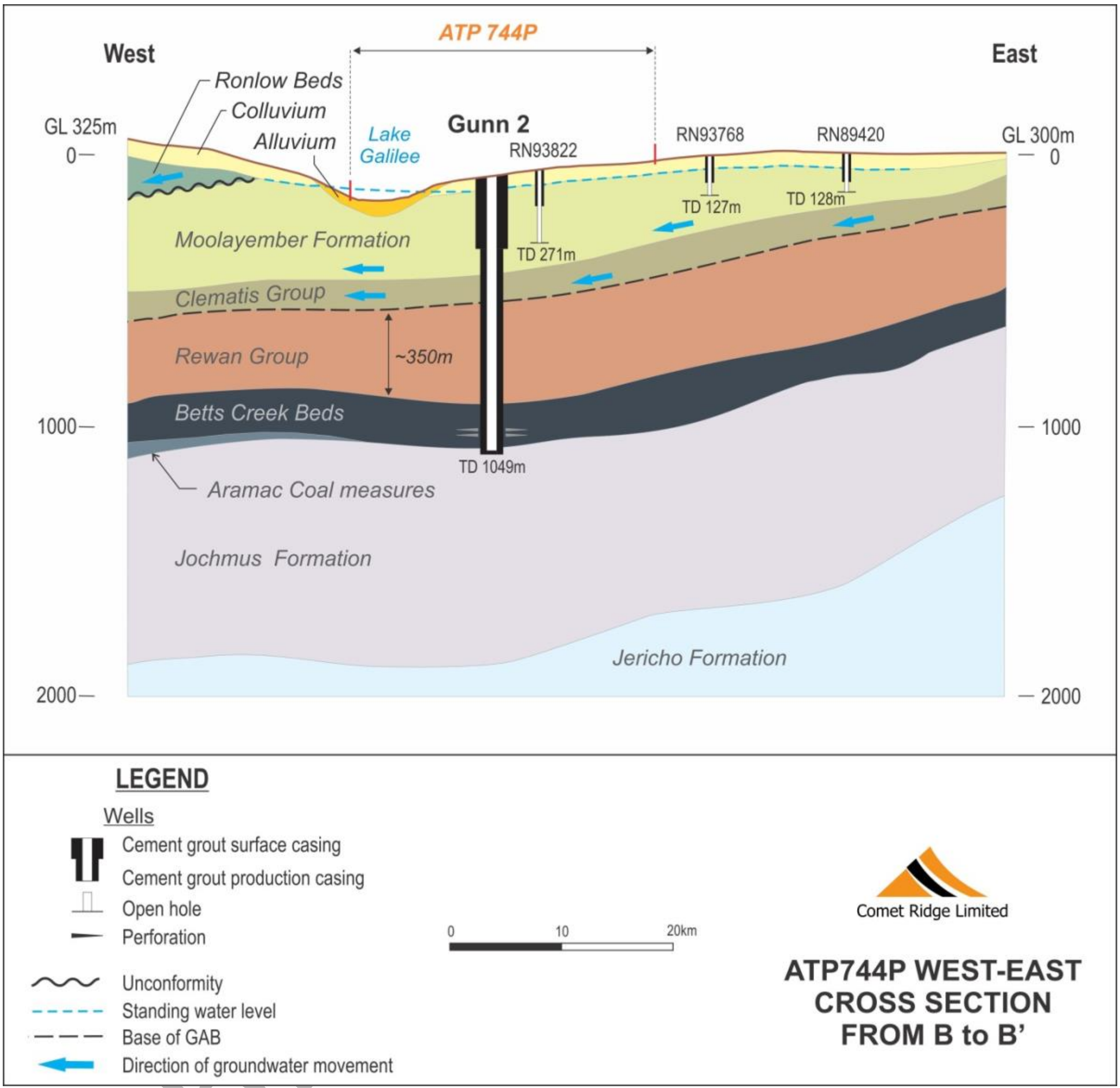


Figure 16: Schematic geological cross-section across ATP744, showing Gunn #2 appraisal well, nearby groundwater bores and groundwater flow direction.

Aquifers

Quaternary Alluvium and Tertiary Sediments

Quaternary alluvium and Tertiary sediments are generally widespread across the permit surface (RPS 2012). however, they are thin relative to the underlying sequences. It should be noted that unconsolidated sediments were not identified in the Gunn #2 log and therefore may not be present at the site of production testing.

Shallow unconfined groundwater is found in the alluvial deposits along the major river systems and creeks that drain the Galilee Basin study area (RPS 2012). Tertiary sediment aquifers host some appreciable individual supplies with both sub-artesian and artesian characteristics on the eastern margin of the Galilee study area (RPS 2012).

Moolayember Formation

The Moolayember Formation is a Middle to Late Triassic aged formation that is commonly present directly beneath the Quaternary alluvium and Tertiary sediments. The Moolayember Formation is dominantly mudstone and siltstone with interbeds of lithic sandstone and quartz sandstone (Olgers 1970). While only a handful of the existing water wells within the region have been assigned a specific aquifer to them in the Groundwater Database – Queensland DNRME, it is believed that the majority of the surrounding groundwater bores are likely tapping into this formation. Refer Tables 3 and 4 below.

Clematis Group

The Clematis Group is an Early to Middle Triassic aged formation that directly underlies the Moolayember Formation. The Clematis Group comprises fine to coarse quartzose sandstone, with conglomerate Beds and interbedded siltstone and mudstone (Vine 1972).

Water can be extracted from the Triassic formations of the Galilee Basin (Moolayember Formation and Clematis Group) at relatively shallow depths (Queensland Department of Natural Resources and Mines 2005). These aquifers are mostly accessed in the eastern portion of Galilee Basin study area where they sub crop beneath thin Quaternary alluvium and Tertiary sediments at shallow depths (RPS 2012). However, as the water quality is very variable, and supplies are dominantly sub-artesian and low yielding (<1L/s), this unit has provided only stock and domestic supplies (Groundwater Database – Queensland DNRME).

Dunda Beds

The Dunda Beds is an Early Triassic formation that comprises lithic to quartz sandstone with thick intervals of mudstone and siltstone (Olgers 1970). The Dundas Beds are considered correlative with the upper Rewan Group and are recognized to be the upper facies of the Rewan Group in the outcrop areas. This formation has only been identified in the stratigraphic records for a few bores and was not identified in the vicinity of production testing.

Rewan Group

The Rewan Group is an Early Triassic aged formation that comprises lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate (at base) (RPS 2012). Available literature (including descriptions of the unit from coal seam gas wells drilled within ATP744) suggest the formation is dominated by fine grained sediments which is generally characterised as an aquitard, separating underlying Permian sediments (including the coal bearing Betts Creek Beds) and the overlying sandstones of the Dundas Beds and Clematis Group (Queensland Herbarium, 2017). This formation is locally more than 300 metres thick. Silicification and clay alteration has significantly reduced the porosity and permeability in this formation and no significant aquifers exist (Queensland Department of Natural Resources and Mines 2005). The Rewan was deposited in a fluvial-lacustrine environment and is considered a regionally significant confining unit.

As a result, this formation is expected to form a barrier between the targeted Betts Creek Beds and overlying significant aquifers of the region.

Betts Creek Beds

The Late Permian Betts Creek Beds comprise carbonaceous interbedded feldspathic lithic sandstone (Olgers 1970). Regionally, the Permian Betts Creek Beds (and its equivalents) yield sufficient groundwater to be classified as water-bearing sediments (RPS 2012). However, fine grained low permeability strata are interspersed within the Betts Creek Beds. Only two water bores have been identified to be sourced from sandstones within the Betts Creek Beds within ATP744 since the initial UWIR was approved, therefore utilisation of this formation as an aquifer is considered minimal. Since the initial UWIR, eight mine monitoring bores have been drilled within coal mining permits which partially overlap the north-eastern part of ATP744. These bores have been drilled to monitor water levels and water quality within the formation. All of the above mentioned wells are located over 70km away from the proposed Gunn Pilot area.

Groundwater Bores

A review of the Groundwater Database – Queensland (formerly Department of Natural Resource and Mine (DNRM) currently knows as DNRME) was undertaken prior to lodgement of the initial UWIR in 2014 (Comet Ridge, 2014) to identify registered bores that have not been abandoned and destroyed within the permit area.

This report has included an update research of the data from the Groundwater Database – Queensland DNRME.

From the total number of 110 registered water bores in ATP744, 87 registered/licensed bores have not been abandoned and destroyed (**Figure 17**) as of current (Jan 2020).

It is believed that groundwater is primarily being used as water supply either for livestock watering or farm supply. It is believed that the groundwater is principally drawn from either Tertiary Sediments, Moolayember Formation or Clematis Group although there is currently insufficient data available to assign an aquifer to more than a handful of groundwater bores (**Appendix 1**). Despite this, the Moolayember Formation and Clematis Group are considered to be the most relevant locally significant aquifers.

Within 20km of the Gunn #2 there are thirty three registered bores which have not been abandoned and destroyed. Excluding Gunn #2 nineteen of these have ground water level data and six have groundwater quality information, refer **Tables 3 and 4**. Of the six bores with groundwater quality data, only three are within ATP744. These are active landholder bores for which a baseline assessment has been completed by Comet Ridge as per requirements of the Baseline Assessment Plan for ATP744. Refer **Table 4 and Appendix 1** for detailed information.

Groundwater Levels

As shown in **Table 3 and Appendix 2**, a limited number of groundwater level observations have been recorded within ATP744. Within 20km of Gunn #2 only a handful of bores with water level data can be assigned to a specific aquifer (**Table 3**).

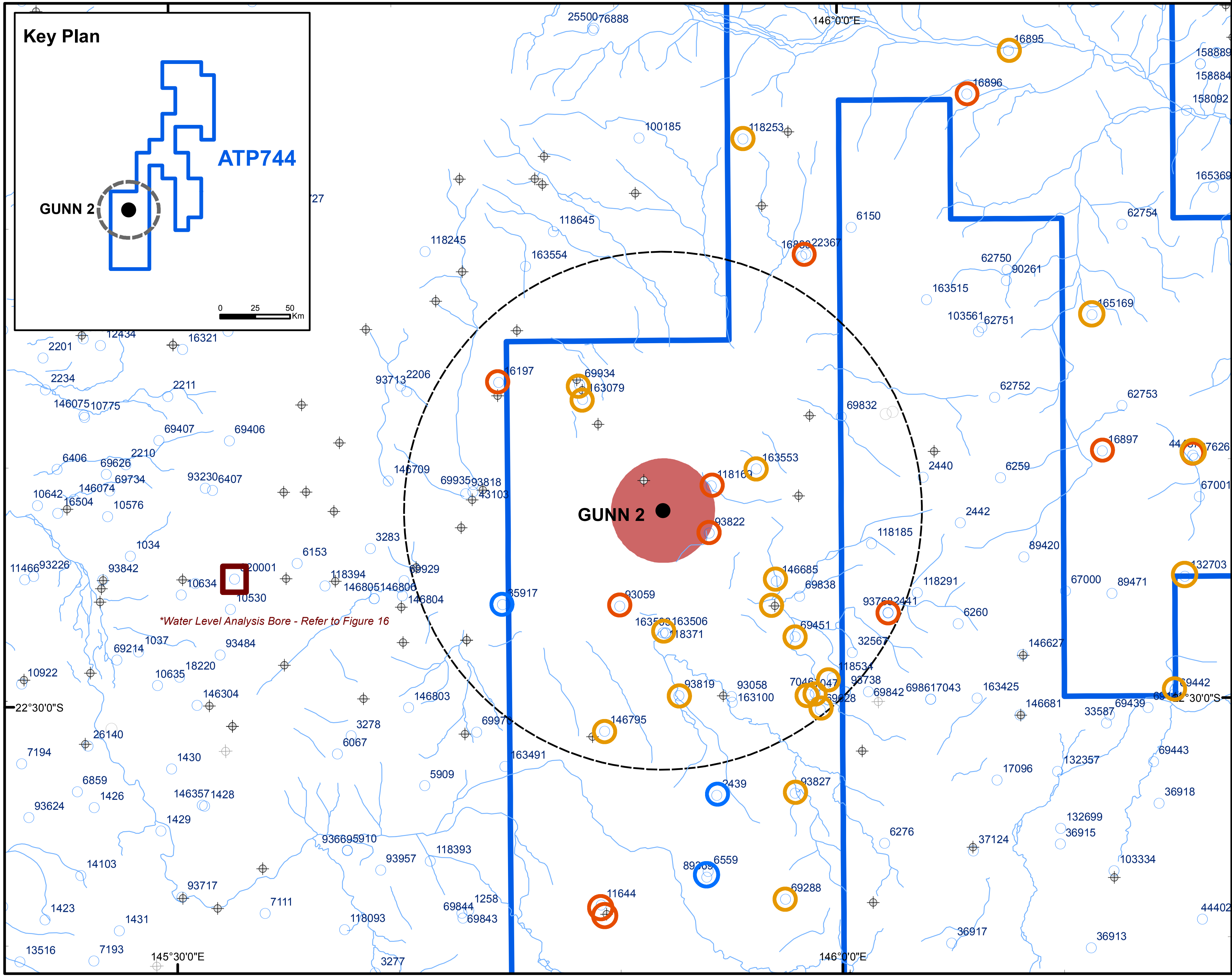
Table 2: Available Groundwater Level Data within 20km of Gunn #2

RN[1]	Formation Name	Date	Groundwater Level (m bGL)	S.W.L (m)[2]
7046	Unknown	10/01/1983	-48.76	NA
7047	Unknown	10/01/1983	-33.52	NA
16197	Unknown	22/10/2012	NA	-59.03
69451	Unknown	18/09/1987	-16.5	NA
69628	Unknown	11/01/1990	-36.58	NA
69934	Unknown	29/02/1992	-12.1	NA
93059	Moolayember Formation	26/05/2013	NA	-9.8
93768	Unknown	09/10/2012	NA	-42.25
93819	Clematis Group	05/07/2001	NA	-8
93822	Moolayember Formation [3]	10/10/2012	NA	-60.71
118164	Unknown	06/04/2004	NA	-54
118169	Moolayember Formation	25/05/2013	NA	-46.95
118371	Unknown	8/06/2004	NA	-7
146685	Clematis Group	13/08/2013	NA	-12.6
146795	Clematis Group	02/10/2013	NA	-30.4
163079	Unknown	12/12/2013	NA	-18
163503	Clematis Group	05/10/2015	NA	-7.9
163506	Moolayember Formation	09/07/2015	NA	-6.8
163553	Clematis Group	15/08/2015	NA	-18

[1] RN = Registration Number

[2] SWL = Static Water Level. Negative values, m below ground level. Positive values, m above ground level

[3] Interpreted aquifer by Comet Ridge



Legend

- Gunn 2

Ground Water

- Abandoned and destroyed
- Abandoned but useable
- Existing
- Proposed
- *Water Level Analysis Bore - Refer to Figure 16
- Water Level Information
- Water Quality Information
- Water Quality & Water Level Information
- Watercourse
- Modelled Drawdown Area (Immediately Affected Area)
- 20km radius from Gunn 2
- Comet Ridge ATP744

N

0 5 10 Km

Comet Ridge Limited

Figure 17: Groundwater Bores

From the available data, a detailed analysis of the movement of water within and between these aquifers is not possible. Additionally, as the existing information has only recorded an individual water level for the different bores, the analysis of change in water level and cumulative departure from average rainfall has not been undertaken. Ongoing monitoring of underground water level will be conducted in the future (refer **Groundwater Monitoring** section below for the proposed monitoring details). As additional information becomes available, further data analysis will be undertaken and information revised.

An analysis conducted by RPS of the available groundwater level data in the general region indicates that the prevailing groundwater flow direction for ATP744 is to the west (RPS 2012). Additionally, the RPS report conducted a cumulative departure from average rainfall analysis for a number of wells within the Galilee Basin but not within ATP744. The nearest data available for the analysis of the change in water level was conducted on RN 100320001 which is outside of ATP744 and approximately 35 km away from Gunn #2. These results are presented in **Figure 18**. It should also be noted that RN 100320001 is completed within the Eromanga Basin, not the Galilee Basin.

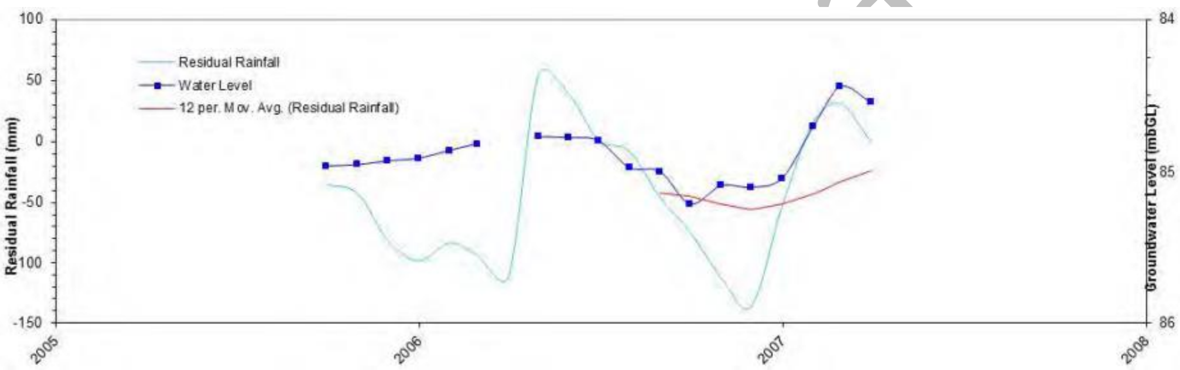


Figure 18: Cumulative departure from average rainfall, a plot of DNRME Rainfall tipping gauge 600306A & (DNRME GWDB bore RN 100320001 - Ronlow Beds)

The hydrograph for tipping gauge 600306A, attributed to the Ronlow Beds, exhibits an increase in groundwater level of 0.42 m between September 2005 and March 2007. The hydrograph for this site indicates an increase in groundwater levels with an increase in residual rainfall between 2005 and 2007. The correlation is not close however, which may indicate that the recharge zones for this aquifer are located some distance away (RPS, 2012).

Table 4: Water Quality data (excluding DST samples) within 20km of Gunn #2

BAP within 20 Km Gunn #2																		
RN	Aquifer	Depth (m)	Conductivity (uS/cm)	pH	Hardness (mg/L Ca)	Alkalinity (mg/L)	SAR	TDS (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Bi- carbonate (mg/L)	Carbonate (mg/L)	Cl (mg/L)	F (mg/L)	Sulphate (mg/L)
16197	Undifferentiated Aquifer	514	462	7.76	<1	164		300	96	6	<1	<1	0.50	164	<1	42	0.2	<1
16197	Unknown	514	500	7.1	12	176		252.97	73.3		4.8	0		214.5		64	0.4	5
35917	Moolayember Formation		5150	7.6	800	150		4607.68	1442		256	39		183		2780	0.7	0
35917	Moolayember Formation		10000	7.2	1361	72		5767.97	1687		500	27		88		3510	0.7	0
35917	Moolayember Formation		10000	7.2	1298	8		5690.62	1682		470	30		10		3510	0.7	0
93059	Moolayember Formation	246	40250	6.9	ND	122	ND	27100	8300	116	1540	1040	3.27	122	ND	14810	0.7	1230
93768	Undifferentiated Aquifer	127	5300	7.81	573	155		3440	902	16	114	70	0.1	155		1480	0.5	119
93822	Clematis Group1 / Moolayember Formation2	271	12600	7.2	1470	61	ND	8632	2080	30	424	100	0.82	61	ND	4540	0.7	2
118169	Moolayember Formation	204	7456	7.4	ND	111	ND	3840	1500	50.5	206	30.7	0.359	111	ND	1912	0.53	78.5
RN	Aquifer	Depth (m)	Conductivity (uS/cm)	pH	Hardness (mg/L Ca)	Alkalinity (mg/L)	SAR	TDS (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	Bi- carbonate (mg/L)	Carbonate (mg/L)	Cl (mg/L)	F (mg/L)	Sulphate (mg/L)
BAP within 20 Km Gunn #2																		
Gunn #2 Sample 1	Betts Creek Beds		1780	8.3	15	846	54.4	1080	484	28	6	<1	0.16	733	113	126	11	<1
Gunn #2 Sample 2	Betts Creek Beds		1770	8.2	15	821	52	1050	463	20	6	<1	1.74	802	19	110	11.9	<1
Gunn #2 Sample 3	Betts Creek Beds		1730	8.2	15	818	52.4	1030	466	14	6	<1	1.76	810	8	97	11.7	<1
Gunn #2 Sample 4	Betts Creek Beds		1700	8.38	12	697	50.7	915	412	9	5	<1	2.5	672	24	99	11.1	<1

(1) DNRME Groundwater Database

(2) Interpreted aquifer by Comet Ridge Limited

Groundwater Quality

Figures 19 and 20 have been produced using the available water quality data from the permit (excluding water quality from DST's).

In the vicinity of the production test wells, the only water quality information available is from the analyses of the Gunn #2 well and the baseline assessments of the nearby landholders bores. Based on this data, the composition of the groundwater from the Betts Creek Beds appears to be much fresher (EC <1780 µS/cm) than the groundwater from the Clematis Group or the Moolayember Formation (EC > 12500 µS/cm). The groundwater from the Betts Creek Beds coal seam is of a Na-HCO_3 water type which is typical for coal seam water chemistry (Van Voast 2003).

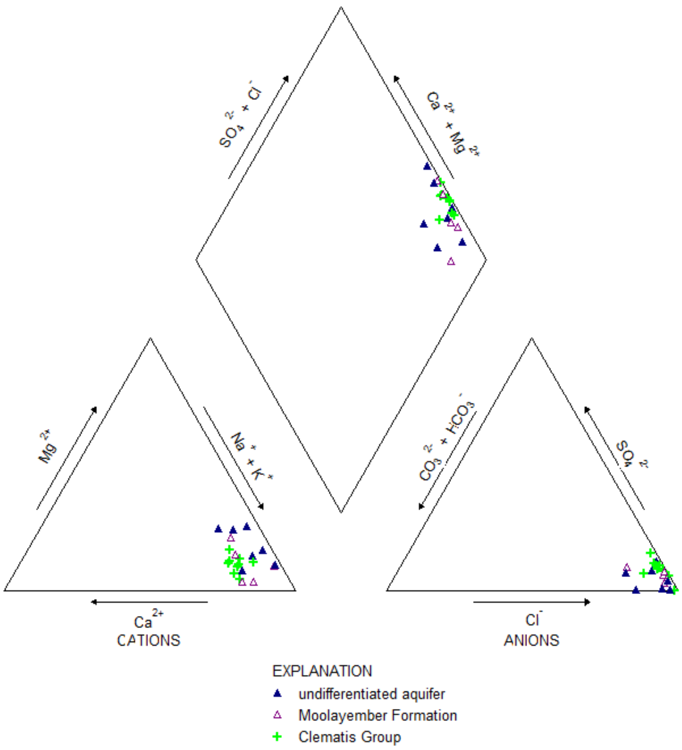


Figure 19: Piper Diagram for all available quality data within ATP 744 (excluding analysis from Gunn #2 and DST's)

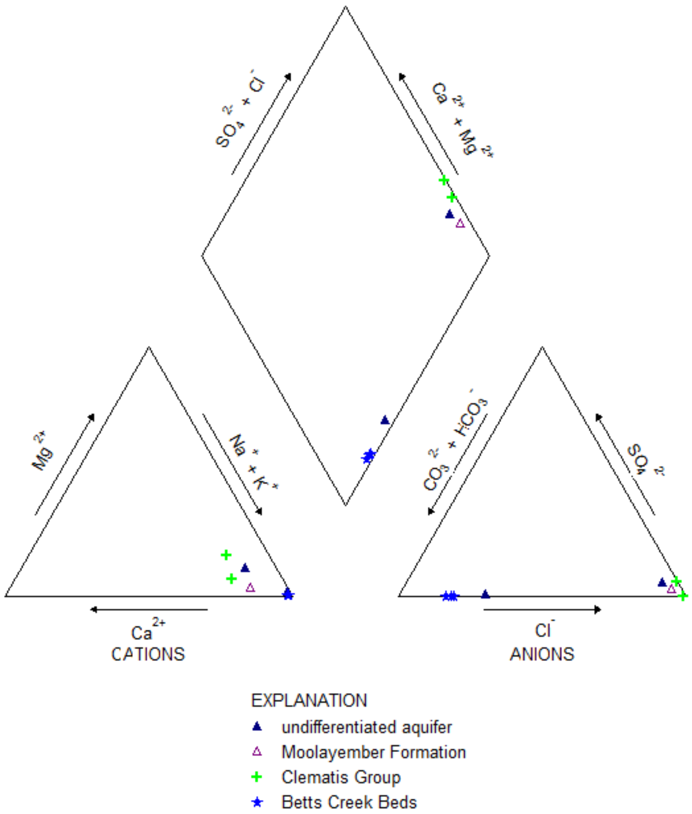


Figure 20: Piper Diagram for all available quality data from Betts Creek Beds at Gunn #2 and within 20km of Gunn #2 (excluding analysis from DST's)

The available groundwater quality data also suggests a possible hydraulic connection between the groundwater in the Moolayember Formation and the Clematis Group, although the Clematis Group samples have a slightly higher salinity than the Moolayember Formation samples (RPS 2012). Further geochemical data from definitive aquifer intervals would be required to confirm the degree of hydraulic connection between these two formations.

Water chemistry of the Betts Creek Beds is quite distinct from the overlying Moolayember Formation, Clematis Group and most undifferentiated aquifers in the vicinity of Gunn #2 and across the entire permit area. One sample from an undifferentiated aquifer plots with a similar water composition to that of the Betts Creek Beds at Gunn #2. The sample from the undifferentiated aquifer is however significantly fresher (EC <500 µS/cm) than the Betts Creek Beds samples. Carbonate and bicarbonate contents are similar to those from the Moolayember Formation and Clematis Group rather than the Betts Creek Beds. Additional geochemical data will be required to confirm the degree of relationship (if any) between these samples.

Springs

A review of the Queensland Springs Database, Queensland Government was undertaken in 2013 prior to the lodgement of the initial UWIR (Comet Ridge Limited, 2014). This report includes a research of the updated Version 5 of the Queensland Wetland Database, Queensland Government. The current mapped locations of springs is shown on **Figure 21**.

Springs located in the eastern Galilee Basin comprise the Barcaldine Supergroup (Queensland Springs Database, research conducted in 2015).

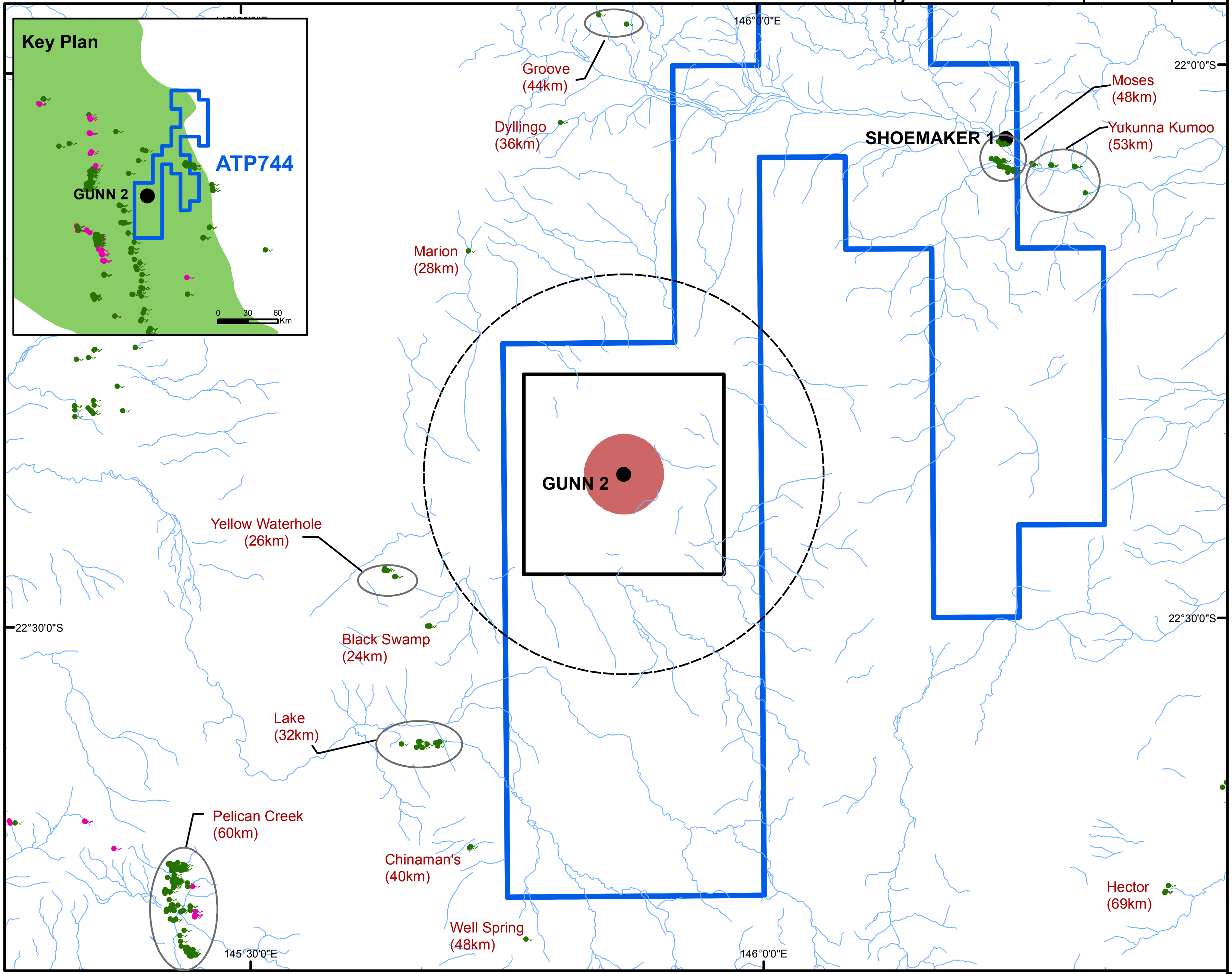
A review of the database found one cluster of springs which are located within the extent of the permit area and are understood to be discharge springs from the Moses complex (Queensland Springs Database, research conducted in 2019). These springs form part of a larger isolated cluster of wetlands, known as the Doongmabulla Spring complex and are associated with the Carmichael River and its tributaries within and adjacent to the permit area. This group of springs is associated with the Galilee Basin, however due to limitations in available data their aquifer source is ambiguous (Queensland Herbarium, 2017). Geological mapping and intersections from Shoemaker #1 coal seam gas well located approximately 600m to the north of the spring complex suggest an association with either the Moolayember Formation or Clematis Group. Shoemaker #1 intersected the Moolayember Formation beneath a thin veneer (3.20m) of Quaternary surficial sediments. The Clematis Group underlies the Moolayember Formation and was intersected at 80.8m depth. The Moses springs comprise approximately 30 individual mound springs and contribute to riverine wetland which are associated with the springs. The Doongmabulla Springs complex is also recognised as a Nationally Important Wetland area (refer, **Figure 23**).

The Moses spring complex is located approximately 50km from the Gunn Pilot area and is considered to be sufficiently separated from the proposed production testing and as such no impacts are expected.

No documented springs are located within 20km of the Gunn Pilot. The nearest springs are understood to be recharge springs from either the Yellow Waterhole or Black Swamp (Queensland Wetland Database, research conducted in 2015). It is expected that these springs are associated with the Hutton Sandstone aquifer or the Cadna-owie Formation / Hooray Sandstone aquifer system (RPS, 2012) and are west of the inferred Hutton - Rand unconformity and part of the Eromanga basin. These springs are not associated with the Betts Creek Beds formation or any of the overlying aquifers.

The Eromanga Basin sequence is absent from the tenure and is not expected to be encountered during the proposed activities. There is currently no evidence of hydrogeological connection between the band of springs to the west of the permit area and the Betts Creek coal seams.

It is considered that the springs are sufficiently separated from the Gunn Pilot site that it is highly unlikely that production testing at the Gunn Pilot will result in a greater than 0.2m decline in water levels of springs and as such no impacts are expected.



Legend

- Gunn 2
- Active Springs
- Inactive Springs
- Watercourse
- Modelled Drawdown Area (Immediately Affected Area)
- Comet Ridge ATP744
- UWIR Model Extent
- 20km radius from Gunn 2

Name of Spring Complex
Distance to Gunn Pilot (Approx)

Moses Springs	26km
Marion Springs	28km
Lake Springs	32km
Chinaman's Springs	40km
Groove Springs	44km
Dyllingo Spring	36km
WellSp Spring	48km
Pelican Springs	60km
Yellow Waterhole Springs	26km
Hector Springs	69km
Black Swamp Springs	24km
Yukunna Kumoo	53km

N

0 5 10 Km

Comet Ridge Limited

Figure 21: Springs Adjacent to Gunn Pilot

Part C: Groundwater Modelling

In order to understand the possible impacts of the underground water extraction associated with the already conducted production testing on the Gunn #2 well and the proposed five-spot pilot, a groundwater numerical model has been developed. This model relies on the groundwater extraction forecasts described in **Underground Water Extraction** section above, data obtained through previous production testing and available literature of the groundwater properties of the area.

Water level data for the Galilee Basin aquifers could not be contoured because there are too few data points for the water bores associated with a formation to contour (RPS 2012). Therefore, the hydraulic heads within the Galilee Basin aquifers were estimated using available data on formation depths, formation pressures and groundwater levels and developing relationships between these formation characteristics. These derived relationships were found to be consistent with equivalent relationships derived previously by (RPS, 2012) and (Dixon et al, 2010). Where measured data were available, these measurements were used to constrain the estimates. The estimated hydraulic heads were then used in the model as the 'initial hydraulic heads'.

Pressure data available for the Joe Joe Group (Aramac Coal Measures, Jochmus Formation, Jericho Formation and Lake Galilee Sandstone) suggests higher pressures than in the Betts Creek Beds. This indicates that the Betts Creek Beds are capable of confining groundwater, but may not be an effective aquifer seals on a regional basis (former Department of Employment, Economic Development and Innovation (DEEDI), 2009). There is, however, evidence that the Rewan Group confines the groundwater that occurs within the Betts Creek Beds and the Moolayember Formation confines the underlying Clematis Group aquifer (RPS 2012). In general, the Clematis Group exhibits higher permeabilities than the Moolayember Formation (Dixon et al., 2010).

Very limited porosity and permeability data presented difficulties for estimating the ranges of model parameters making it difficult to simulate groundwater flow in the basin (Dixon et al., 2010). In addition, data points show few clear trends in the distribution of porosity and permeability, with broad scatter across measurements in most of the stratigraphic units (Dixon et., al 2010). Therefore, measurements of hydraulic properties from the vicinity of the production test site were used where possible. **Table 5** shows the hydraulic conductivity values that were assigned to the formations when the groundwater model was built (these parameters were adjusted during the calibration process).

Table 5: Hydraulic Conductivity Data

Formation	Hydraulic Conductivity (Horizontal)	Hydraulic Conductivity (Vertical)	Reference
Moolayember Formation	2.9×10^{-6} m/s	9.7×10^{-7} m/s	Dixon et al 2010
Clematis Group	3.6×10^{-5} m/s	3.4×10^{-6} m/s	Dixon et al 2010
Rewan Group	4.5×10^{-5} m/s	1.2×10^{-5} m/s	Dixon et al 2010
Betts Creek Beds	9.7×10^{-7} m/s	9.7×10^{-7} m/s	Dixon et al 2010
Betts Creek – Target Coal Seam	5.8×10^{-5} m/s	5.8×10^{-5} m/s	Comet Formation Tests (Gunn #2)
Jochmus Formation	9.7×10^{-7} m/s	9.7×10^{-7} m/s	Dixon et al 2010

Groundwater Flow Model

MODFLOW was used to predict the extent of impacts within the target coal seam and within adjacent aquifers and aquitards. MODFLOW is a finite difference groundwater flow model, where the groundwater flow domain is discretised into rectangular or cubic block elements.

The groundwater flow model was constructed in a transient format to simulate the time period associated with proposed production testing and the proposed five-spot pilot. The time period for the groundwater flow simulations was 01/10/2020 to 01/01/2041 for the purposes of this three year reporting period.

The pumping rates applied in the model were those predicted from the reservoir modelling. These pumping rates were converted to m^3/sec and applied at either a daily or monthly time steps, as per time step resolution in the reservoir model. All pumping was applied to layer 9 (the C1 coal seam).

A 20km by 20km model extent, centred on the Gunn #2 well was used for the groundwater flow model (**Figure 22**). The model grid was constructed with variable grid sizes to incorporate a finer grid in the area surrounding production testing. The grid cells ranged from 50 m by 50 m in the region of production testing to a maximum size of 500 m by 500 m.

12 layers were used in the model, including 7 layers to represent distinct coal seams within the Betts Creek Beds. Where stratigraphic surfaces were available, these were used to create the model layers. As there was not enough information available to map the depths of individual coal seams across the whole model domain, constant thicknesses were selected for layers 5-11 (**Table 6**). The thicknesses for these layers were based on measured stratigraphic data for the Gunn #2 well.

Table 6: Thickness of Model Layers

Layer	Formation	Minimum Thickness (m)	Maximum Thickness (m)	Average Thickness (m)
1	Quaternary/Tertiary	9	70	37
2	Moolayember Formation	274	381	326
3	Clematis Group	98	121	102
4	Rewan Group	312	356	341
5-11	Betts Creek Beds (including the target coal seam)	197	197	197
12	Jochmus Formation	80	183	122

The major groundwater recharge areas for the GAB are located in the north, west and east where the Eromanga and Galilee basin aquifers outcrop or subcrop beneath alluvial sediments. This recharge zone is outside of the model domain. In the absence of more detailed information about recharge rates, constant recharge rates were used in the groundwater flow model. The rates selected were consistent with the GAB resource study (Great Artesian Basin Coordinating Committee (GABCC) 1998) recommendation to use a recharge rate of 1-2% of mean annual rainfall as a basin wide average. This study pointed out that evaporation rates in the GAB typically exceed rainfall rates. Due to the uncertainty associated with this parameter, the recharge rate was varied during the calibration process.

A combination of constant head and constant flux boundary conditions was applied to specific layers in such a way that the general groundwater flow directions were maintained. Assignment of more accurate boundary conditions would require more detailed information about current hydraulic gradients in each aquifer and aquitard.

A transient calibration was carried out for the groundwater flow model using the water production test data. The parameter estimation software, PEST (Doherty 2009), was used to automatically adjust the parameters in order to improve the match between "simulated" and "observed" water levels for the production test. A large range of parameters were included in this calibration process to start with but once the model was found to be insensitive to many of the parameters, the range of parameters was refined to those shown in **Table 7**. Once the drawdown and recovery curves from the production test in 2013 were able to be simulated adequately, the model was used to predict groundwater level responses to the planned production of the five-spot pilot.

Table 7: Calibration Parameters

Parameter	Minimum	Maximum
Horizontal Hydraulic Conductivity – Moolayember Formation (m/s)	2.90×10^{-8}	2.90×10^{-4}
Horizontal Hydraulic Conductivity – Clematis Group (m/s)	3.55×10^{-7}	3.55×10^{-3}
Horizontal Hydraulic Conductivity - Rewan Group (m/s)	4.54×10^{-7}	4.54×10^{-3}
Horizontal Hydraulic Conductivity - Betts Ck (m/s)	9.68×10^{-9}	9.68×10^{-5}
Horizontal Hydraulic Conductivity - Betts Ck A (m/s)	9.68×10^{-9}	9.68×10^{-5}
Horizontal Hydraulic Conductivity - Betts Ck B (m/s)	9.68×10^{-9}	9.68×10^{-5}
Horizontal Hydraulic Conductivity - Betts Ck C (m/s)	9.68×10^{-9}	9.68×10^{-5}
Horizontal Hydraulic Conductivity - Betts Ck C1 (m/s)	5.81×10^{-9}	5.81×10^{-5}
Horizontal Hydraulic Conductivity - Betts Ck D (m/s)	9.68×10^{-9}	9.68×10^{-5}
Horizontal Hydraulic Conductivity - Betts Ck D1 (m/s)	9.68×10^{-9}	9.68×10^{-5}
Horizontal Hydraulic Conductivity – Jochmus Formation (m/s)	9.68×10^{-9}	9.68×10^{-5}
Recharge Rate (m/s)	1.00×10^{-12}	1.00×10^{-8}
Specific Yield - Rewan Group (-)	1.00×10^{-3}	3.00×10^{-1}
Specific Yield - Betts Creek (-)	1.00×10^{-3}	3.00×10^{-1}
Specific Yield - Betts Creek C1 (-)	1.00×10^{-3}	3.00×10^{-1}

Results and Discussion

Simulation results suggest that, only the target C1 coal seam is expected to experience drawdown and therefore the IAA (areas where the drawdown of greater than 5 metres is expected) is only predicted within the C1 seam. The mapped IAA is required to be predicted in January 2020, which is within three years after the consultation day for this report (as required under the requirements of section 376(b)(iv) of the Water Act 2000). The predicted drawdown in January 2020 for the C1 seam of the Betts Creek Beds is 96.5m at the centre of the pilot and decreases to 5m at maximum 4.13km from the centre point. The extent of the predicted 5m drawdown (IAA) in the C1 seam of the Betts Creek Beds in January 2020 is shown in **Figure 22**. This therefore represents the immediately affected area (IAA) for the C1 seam in the Betts Creek Beds.

No drawdown was predicted for any other layers above and below the Betts Creek Beds.

There are no private water bores present within the IAA, which would intersect the coal seams. Therefore no bores are subject to make good obligations as a result of the IAA.

One existing registered water bore (RN: 93822) located within the IAA utilises water from the Moolayember Formation (at least 570m above the coal seams). The bore is used for the purpose of stock watering. A baseline assessment was completed on this water bore on 10 October 2012. This water bore is included in the schedule of monitoring bores, refer to **Groundwater Monitoring** section of this report.

Model simulated drawdown impacts (including IAA) are, predicted to gradually decline by 2029. There is no IAA predicted for any other formation and there is no "long term affected area" predicted for any formation including the C1 coal seam.

The results of the groundwater modelling for this UWIR support other available hydrogeological information in suggesting that there is limited interaction between the Betts Creek Beds and any other formation in the model area.

There are, however, limitations associated with the groundwater simulations performed. These relate primarily to the data availability, assumptions underlying the conceptual model and, the assumption that the water level responses during the production testing are indicative of the longer term impacts that could be expected from a five-spot pilot. For this reason, ongoing monitoring of groundwater levels within the Betts Creek Beds and in the overlying formations is proposed throughout the production test period.

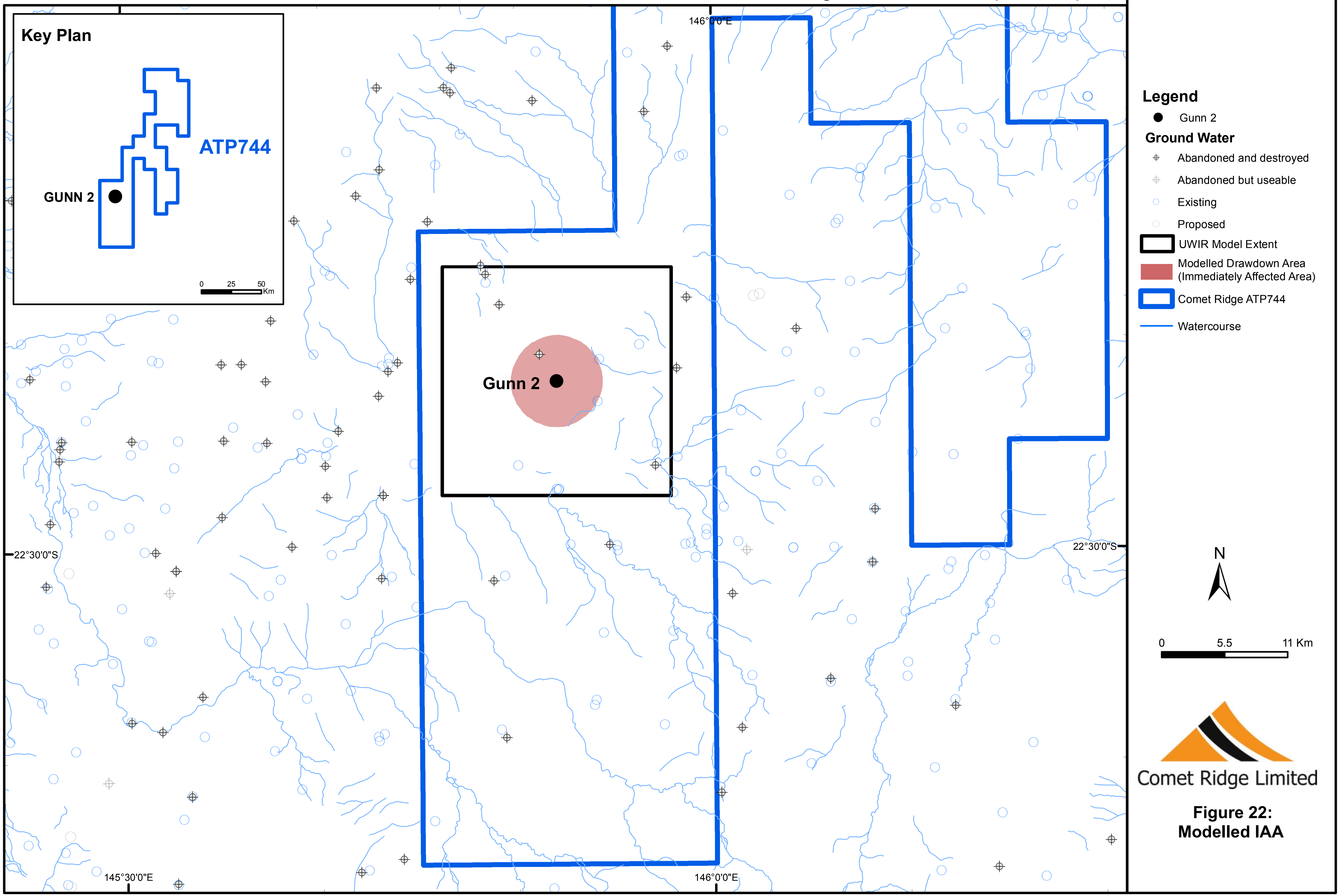


Figure 22:
Modelled IAA

Part D: Environmental Values

Environmental Values

The environmental values of water to be enhanced or protected are outlined in Section 6 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019.*

For waters that are not included in Schedule 1 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019;* environmental values include:

(a) for high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued; or
(b) for slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators; or
(c) for moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree; or
(d) for highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in paragraphs (a) to (c); or
(e) for waters from which aquatic foods intended for human consumption are taken—the suitability of the water for producing the foods for human consumption; or
(f) for waters that may be used for aquaculture—the suitability of the water for aquacultural use; or
(g) for waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes; or
(h) for waters that may be used for recreation or aesthetic purposes—the suitability of the water for—
(i)primary recreational use; or
(ii)secondary recreational use; or
(iii)visual recreational use; or
(i) for waters that may be used for drinking water—the suitability of the water for supply as drinking water having regard to the level of treatment of the water; or
(j) for waters that may be used for industrial purposes—the suitability of the water for industrial use; or
(k) the cultural and spiritual values of the water.

Identified Environmental Values

The following environmental values have been identified in ATP744:

- Farm water supply (i.e. use of groundwater from water bores);
- Stock watering (i.e. use of groundwater from water bores);
- Domestic Use (i.e. use of groundwater from water bores);
- Aquatic ecosystem (i.e. Lake Galilee, Moses Springs and waterways);
- Visual Appreciation (i.e. aesthetic qualities of Lake Galilee and Moses Springs); and
- Cultural Values (i.e. aesthetic qualities of Lake Galilee and Moses Springs)

All of the above listed environmental values are primarily associated with either surface water features (lakes and waterways), springs or Quaternary, Tertiary and Triassic aquifers accessed by registered groundwater bores.

Groundwater Dependant Ecosystems

Groundwater Dependant Ecosystems (GDE's) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. Ecosystem dependency may vary temporally (over time) and spatially (depending on its location in the landscape). GDE's include aquifers, caves, lakes, palustrine, lacustrine and riverine wetlands including springs, rivers and vegetation that access groundwater through their roots.

Maps of the following GDE's are provided to show spatial relationship between the IAA, model extent and 20km radius from the proposed Gunn Pilot with mapped GDE's including wetlands and springs.

- Springs and watercourses adjacent to the Gunn Pilot (**Figure 21**)
- Queensland Wetland Areas – water bodies, regional ecosystems and mapped nationally important wetlands, including springs across ATP744 (**Figure 23**)
- Terrestrial Groundwater Dependant Ecosystems adjacent to the Gunn Pilot (**Figure 24**)
- Surface Groundwater Dependant Ecosystems (area, line and point data) adjacent to the Gunn Pilot (**Figure 25**)
- Potential Groundwater Dependant Aquifers adjacent to the Gunn Pilot (**Figure 26**)

No underground GDE's are mapped across the permit area or surrounding area.

Wetland areas and Nationally Important Wetlands

Wetlands are areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres. To be a wetland the area must have one or more of the following attributes:

- at least periodically the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle, or
- the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers, or
- the substratum is not soil and is saturated with water or covered by water at some time.

The most significant surface feature in the vicinity of the Gunn Pilot project is Lake Galilee which is recognised as a nationally important wetland and comprises both lacustrine wetland system (e.g. lakes 15.8%) and palustrine wetland system (e.g. vegetated swamps – 84.2%) (**Figure 23**). Lake Galilee habitat mainly comprises arid to semi-arid grass, sedge and herb swamp, saline lake and saline swamp and tree swamp. The wetland area is primarily sourced from shallow, unconfined, unconsolidated sedimentary aquifers which are closed alluvial systems with fluctuating and intermittent flow.

Two other nationally important wetland areas are located within and adjacent to the permit including: Doongmabulla Springs and Bingeringo Aggregation (**Figure 23**). For more information on the Doongmabulla Springs complex, refer to section on **Springs**. The Bingeringo Aggregation primarily comprises both riverine wetland system (e.g. river and creek channel - 92.6%) and palustrine wetland system (e.g. vegetated swamps - 7.4%). Both of these wetland areas are between 50 and 105km from the Gunn Pilot area and therefore sufficiently separated from the project area and, as such, no impacts are expected.

Riverine wetlands have also been identified and are associated with waterways traversing the north eastern portion of the permit area. Some areas of remnant regional ecosystem comprising 1-50% wetland by area have also been mapped across the permit area (**Figure 23**).

Terrestrial groundwater dependant ecosystems in the area are primarily associated with either Tertiary Ironstone jump-ups or alluvium and sandy plains and wetlands (**Figure 24**). Tertiary Ironstone jump-ups comprise unconfined intermittent aquifers sourced from local bedrock which primarily support specific melaleuca vegetation. Unconsolidated alluvial and sandy plain systems are primarily sourced from localised shallow alluvial aquifers which generally support specific vegetation ecosystems (such as Bloodwood or Melaleuca) on old loamy and sandy soils with fluctuating or intermittent flow.

Watercourses traversing the permit area are described as either channels on sandstone ranges with fluctuating and intermittent flow sourced from unconfined consolidated sedimentary aquifers or channels on alluvia and sandy plains below 300m in elevation with fresh, intermittent flow sourced from unconfined shallow alluvial aquifers (**Figure 25**).

Mapped springs are discussed further under the **Springs** section of this report.

Potential GDE Aquifers across the permit area comprise primarily either consolidated or fractured sedimentary aquifers (Tertiary Ironstone jump-ups) or unconsolidated sedimentary aquifers (i.e. sandy plains, Quaternary Alluvium) with intermittent groundwater flow (**Figure 26**). Water quality ranges between fresh and brackish.

Impacts Arising from Previous Exercise of UWR

The water that is subject to the underground water rights for ATP744 petroleum activities is within the Betts Creek Beds at the proposed Gunn Pilot. The formation predominantly comprises coal seams that are inter bedded with mudstone, siltstone, sandstone and carbonaceous shale.

Two registered water bores (RN103875 & RN103876) are using water from a sandstone interval in the upper part of the Betts Creek Beds for water supply (likely agricultural use) in the north-eastern part of ATP744. Eight registered groundwater bores have intersected the Betts Creek Beds which are being utilised as mine monitoring bores associated with a mineral (coal) development lease and mining lease partially overlapping the north-eastern part of ATP744. All ten bores accessing the Betts Creek Beds are located over 70km from the Gunn #2 well and are over 66km outside the IAA area and, therefore, activities proposed at the proposed Gunn Pilot are considered to have negligible impact on environmental values at the referenced bores.

The following section provides information supporting the view that a hydraulic discontinuity exists between the Betts Creek Beds and overlying aquifers within the area of the IAA and within 20km from the Gunn #2 well.

The Gunn #2 well was completed using industry standards and in compliance with the *Code of practice for the construction and abandonment of petroleum wells and associated bores in Queensland (2019).* (DNRME).

Gunn #2 completion technique has allowed:

- Triassic GAB aquifers to be isolated behind steel casing which has been pressure sealed with cement.
- isolation of the C1 coal seam from overlying and underlying intra-bedded permeable sandstone and other coal seams within the Betts Creek Beds.
- Perforation of the C1 coal seam only, to ensure water was only produced from this coal interval.

A cement bond log was run after cementing was completed to evaluate the integrity of the cement with the casing of the well. The cement bond log confirms the cement job in Gunn #2 has resulted in complete isolation of the Betts Creek Beds from the Clematis Group and Moolayember Formation aquifers.

The coals within the Betts Creek Beds within the IAA and within 20km from Gunn #2 well and are separated from overlying Triassic aquifers by at least 300m of low permeability formation (Rewan Group), refer **Figure 16**. Available literature (including descriptions of the unit from coal seam gas wells drilled within ATP744) suggest the formation is dominated by fine grained sediments which is generally characterised as an aquitard (Queensland Herbarium, 2017). For further information, refer section **Hydrology of ATP744**.

In support of the above, the results of the groundwater modelling for this UWIR confirm that no drawdown was predicted for any other layers above and below the Betts Creek Beds. The target C1 coal seam is the only layer where drawdown was predicted. Where the drawdown was greater than the 5m threshold for a confined aquifer, an immediately affected area (IAA) was mapped and only applies to the C1 seam. The results of the groundwater modelling for this UWIR support other available hydrogeological information in suggesting that there is limited interaction between the Betts Creek Beds and any other formation in the model area. For more information, refer **Part C: Groundwater Modelling.**

In addition, no faults have been mapped within the IAA or within 20km from the Gunn #2 well that have been interpreted to connect the Betts Creek Beds to overlying Triassic or Cenozoic aquifers or the ground surface (**Figure 2, Figure 4, Figure 9 & Figure 10**). For more information, refer section **Structural Geology.**

The Betts Creek Beds crop out in the far north-east of the permit area and sub crop along and outside the eastern boundary of the permit area (**Figure 4**). These areas are located 50km to 100km from the proposed Gunn Pilot project location. These areas are considered to be sufficiently separated from the proposed production testing and, as such, negligible impacts are expected.

No underground water is being extracted from the C1 coal seam within the Betts Creek Beds, to which this report relates. The actual impacts in the initial UWIR (dated 3 April 2014) were less than predicted as no water has been produced in the six years since the initial UWIR in 2014 and the IAA prediction did not eventuate.

The water within the Betts Creek Beds within the IAA or 20km from the proposed pilot location is not currently used for agricultural purposes, domestic use, drinking water or industrial purposes, and therefore no impact was made on the environmental values with respect to these possible uses (**Table 8**). There are no documented cultural and spiritual values. The water is not used for any recreational purposes.

Table 8: Environmental values associated with the previous exercise of underground water rights.

Previous exercise of underground water right	Environmental Values											
	Aquatic ecosystems	Irrigation	Farm supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary Recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
Betts Creek Beds within the IAA	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

No springs are located within the IAA or within 20km of the Gunn Pilot project. The closest springs are 24km from the Gunn Pilot area and are not sourced from the coal seams and therefore no impact on environmental values has been associated with any springs.

There is also no identifiable connection between the coal seams of the Betts Creek Beds and the surface within the IAA or within 20km of the Gunn #2 well, therefore no known association or connection with any terrestrial or surface GDE's. No subterranean GDE's have been mapped within the IAA in ATP744.

Environmental values identified within or adjacent to the boundary of the permit are not associated with the exercise of underground water rights from the Betts Creek Beds and there are no impacts for any identified environmental values within or adjacent to the permit.

Impacts Likely to Occur for Continued Exercise of UWR

For the water production envisaged in the next three years, the predicted drawdown has not changed. There are therefore no impacts likely on the environmental values in the period covered by this UWIR (April 2020 to April 2023).

Since the Betts Creek Beds are currently not widely used as a water source, the impact on water users is considered to be negligible as previously indicated. However, the necessary monitoring strategies are documented under **Part E: Groundwater Monitoring** section of this document and any necessary baseline assessments on bores have or will be completed as required per ATP744 Baseline Assessment Plan. All active landowner bores within 10km of Gunn #2 well have been nominated as monitoring bores in this report, refer **Figure 27**.

Table 9: Environmental values associated with the future exercise of underground water rights.

Future exercise of underground water rights	Environmental Values											
	Aquatic ecosystems	Irrigation	Farm supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary Recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
Betts Creek Beds within the IAA	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

As, and if, further development on the resource tenure continues, there could be an expansion of the immediately affected area, and there may be a long-term affected area in the future, but this is not possible to predict at this time. Future development of the area is contingent upon results from the production testing that will be carried out. Nevertheless, the impact on environmental values of the water is still considered to be negligible unless the water production increases in the future. A review of the impact of environmental values from the exercise of underground water rights will be undertaken as part of the annual review process for the UWIR.

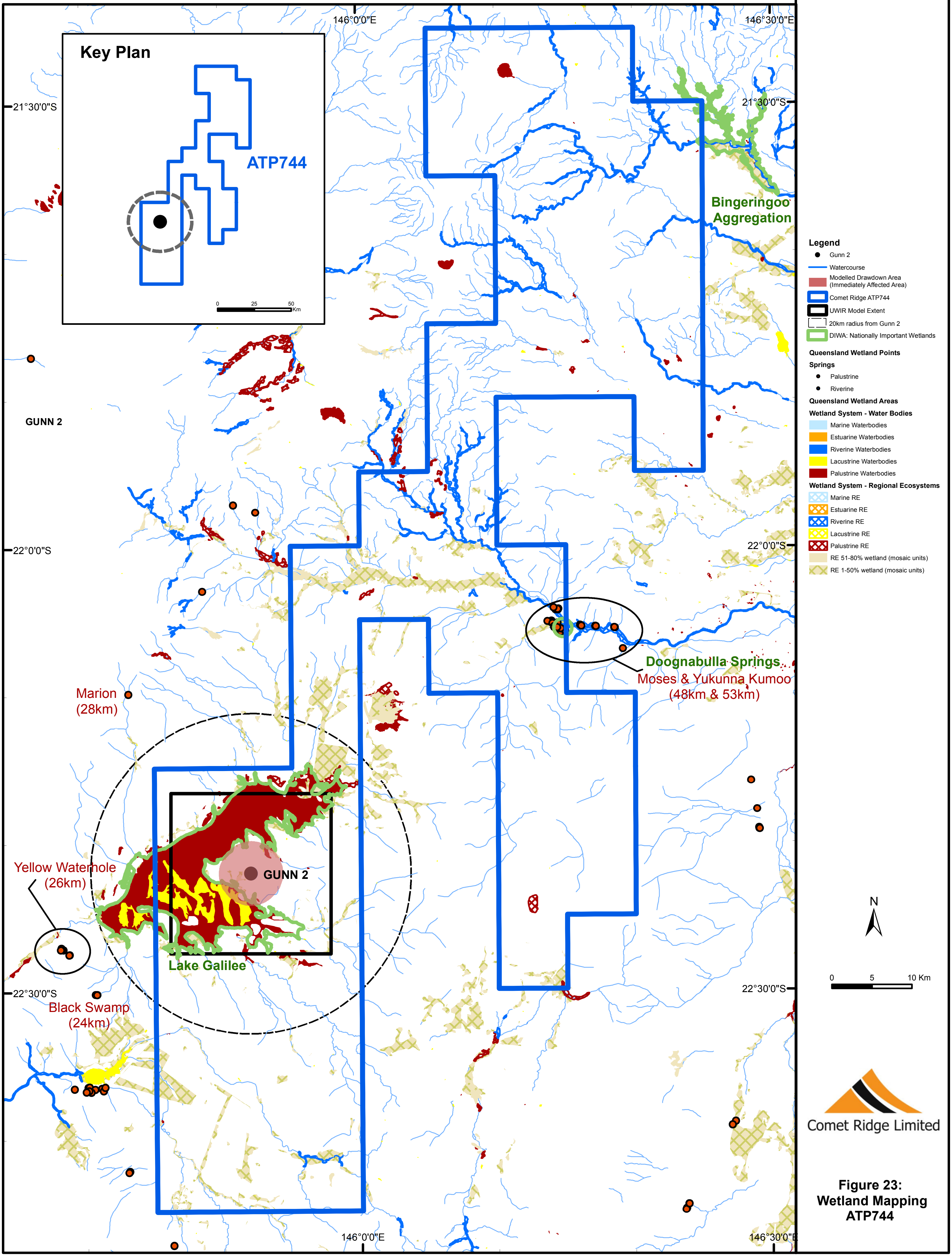


Figure 23: Wetland Mapping ATP744

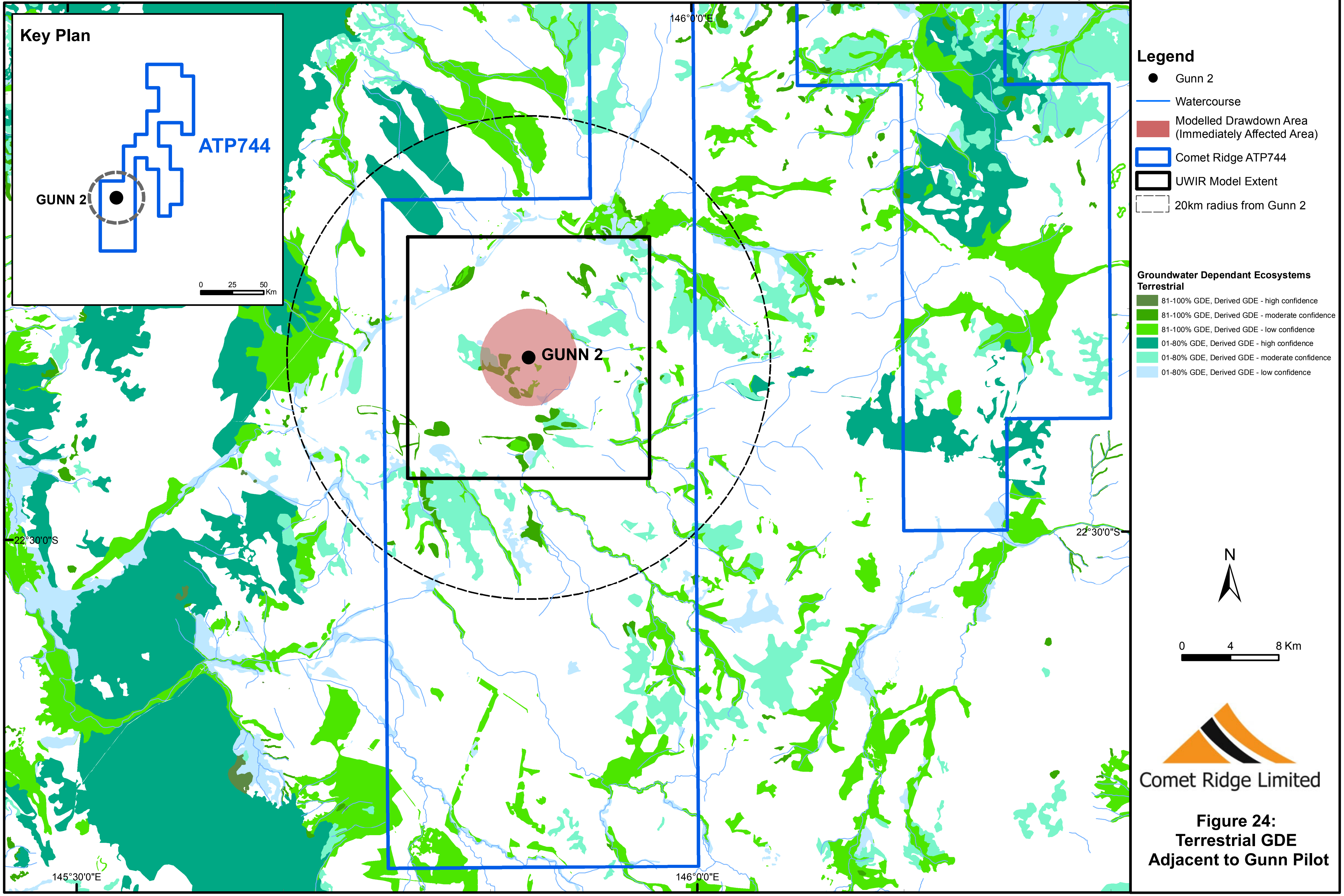


Figure 24: Terrestrial GDE Adjacent to Gunn Pilot

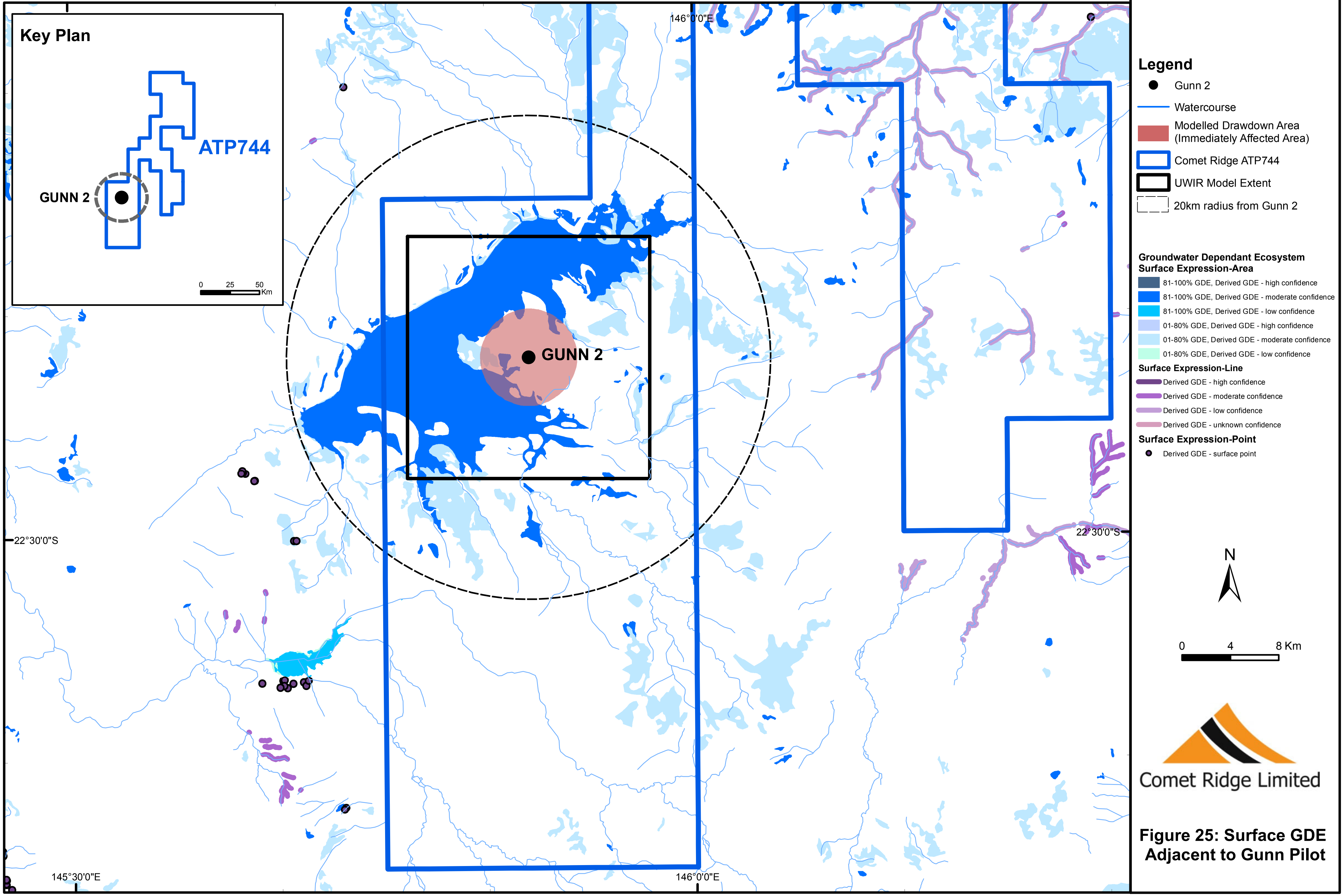


Figure 25: Surface GDE Adjacent to Gunn Pilot

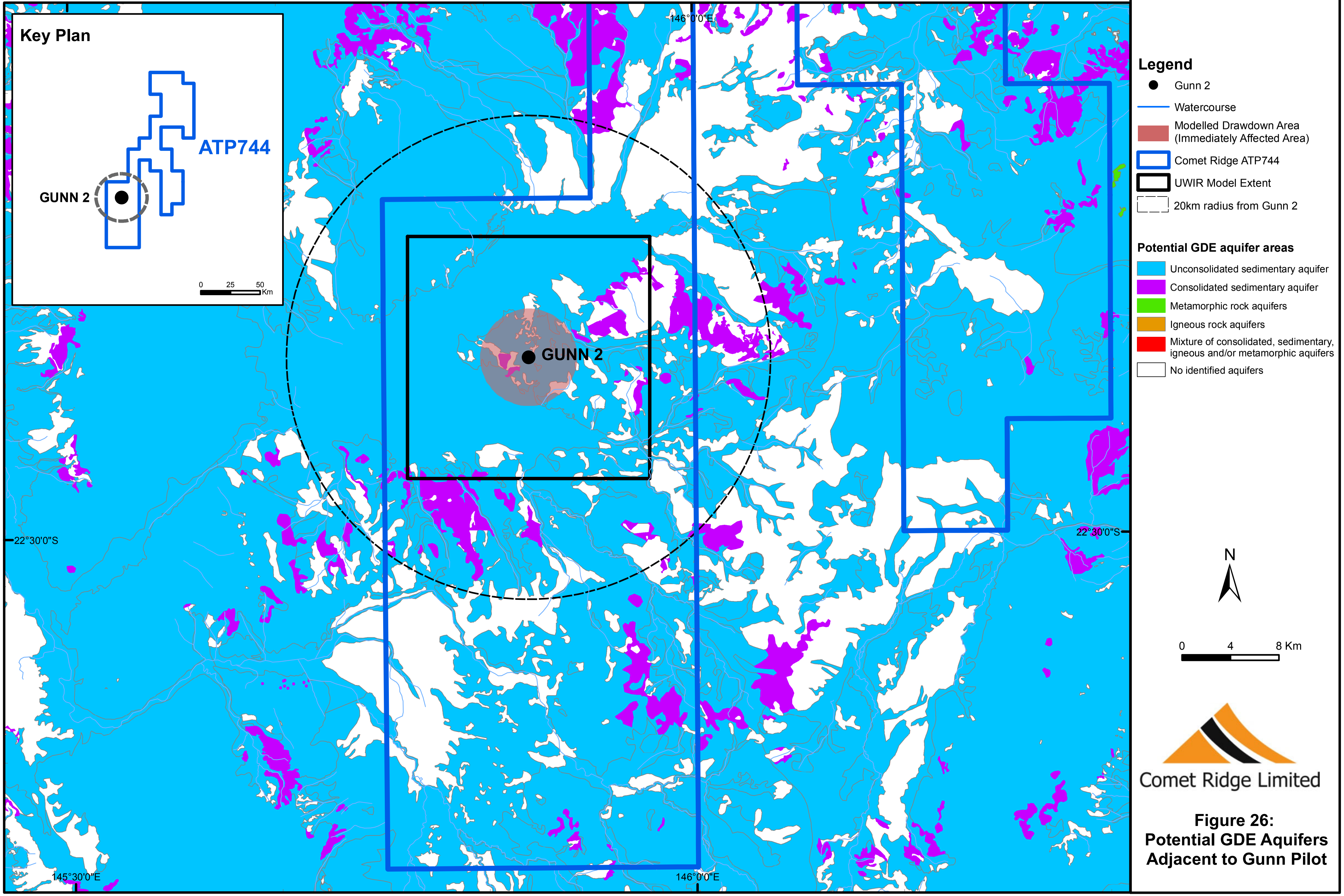


Figure 26: Potential GDE Aquifers Adjacent to Gunn Pilot

Part E: Groundwater Monitoring

The underground water monitoring strategy has been developed to address the findings of this UWIR, and to timely identify any changes in underground water levels and quality associated by the exercise of underground water rights within ATP744. The information obtained through the monitoring strategy will also be used to confirm and refine future iterations of the groundwater modelling.

The proposed groundwater monitoring strategy is compliant with section 376(f) of the Water Act, and will verify the model predicted magnitude of impact and its reduction with time. Should there be a large discrepancy between monitoring data and the predictions generated through the model, the model will be updated with new information and re-run to generate updated predictions.

Rationale

The modelling predicts that there will be an IAA within the C1 seam of the Betts Creek Beds, and there is no "long term affected area" predicted as the impact reduces rapidly after production testing ceases. No anticipated impacts are predicted by the current modelling in the nearby aquifers.

Registered bores nearby the project area are primarily accessing the Moolayember and the Clematis aquifers. These aquifers are separated from the targeted coal seams by the Rewan Group. In addition, the production wellbores are cemented and cased to best practice to avoid aquifer cross-contamination.

A spring management strategy is not considered to be required for this UWIR due to:

- No springs are located within 20km of the Gunn Pilot;
- No springs are located within the IAA;
- There is no known hydrological interconnection between the springs and the affected coal seams of the Betts Creek Beds.

Monitoring Strategy

Groundwater impact assessment criteria have been designed to identify any potential depressurisation within the coal measures and any adverse impacts that such depressurisation might induce on the adjacent aquifers including the alluvial aquifer systems. Impact assessment criteria for existing and proposed bores include piezometric pressure (measured as depth to water level) and water quality parameters (inclusive of field parameters and laboratory analytes) contained in the Section 3.6.4, Guideline Baseline Assessments, ESR/2016/1999, Version 3.02,DES.

If routine monitoring reveals either of the following scenarios an investigation into whether the changes can be attributed to the proposed production testing will be undertaken. If the change can be attributed to the production testing activities mitigation actions will be initiated.

Scenarios

- Water Level: Compare measured water level to previous monitoring rounds. If:
  - (a) water level is lower than previous lowest measurement by >5m or
  - (b) three subsequent monitoring events record a fall in water level >1m.
- Water Quality: Compare concentrations of analytes within **Table 11** to previous monitoring. If:
  - (a) value departs highest or lowest previous measurement by more than 25% or
  - (b) three subsequent monitoring events record an increase in one or more analytes concentrations.

Results will be assessed against the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)* and *Australian Drinking Water Guidelines (2011).*

Monitoring Locations

Existing bores extending into the Betts Creek Beds available for monitoring in close proximity to the maximum impact zone of the IAA include the Gunn #1 bore and the proposed additional Gunn Pilot. Additional monitoring locations proposed are:

- within the Moolayember Formation respectively registered bores RN: 118169, RN: 93822, RN: 93059 and RN: 163506 (refer **Figure 27** for location); and
- within the Clematis Group for registered bores RN: 163503 and RN: 163553 (refer **Figure 27** for location).

As there is no LTAA predicted, baseline sampling within or outside ATP744 is not recommended.

The water monitoring program is proposed to commence when the pilot has been commissioned and has commenced production testing, which is assumed to be October 2020 for the purposes of this report.

A list of bores and wells proposed to be monitored with parameters to be analysed and frequency of monitoring is shown in **Tables 10, 11 and 12**.

Table 10: Groundwater monitoring strategy

Registered Bore	Aquifer	Parameters	Frequency
Gunn #1	Clematis Group	Standing Water Level (SWL), Total Depth (TD), field parameters (pH, EC, T, DO, TDS and ReDox), Chemistry(1)	6 monthly
Gunn Pilot Wells	Betts Creek Beds	SWL, TD, field parameters, Chemistry(1)	6 monthly
RN:118169	Moolayember Formation(2)	SWL, TD, field parameters, Chemistry(1)	6 monthly for 12 months, then annually
RN: 93822	Moolayember Formation(2)	SWL, TD, field parameters, Chemistry(1)	6 monthly for 12 months, then annually
RN: 93059	Moolayember Formation(2)	SWL, TD, field parameters, Chemistry(1)	6 monthly for 12 months, then annually
RN:163506	Moolayember Formation	SWL, TD, field parameters, Chemistry(1)	6 monthly for 12 months, then annually

Registered Bore	Aquifer	Parameters	Frequency
RN: 163503	Clematis Group	SWL, TD, field parameters, Chemistry(1)	6 monthly for 12 months, then annually
RN: 163553	Clematis Group	SWL, TD, field parameters, Chemistry(1)	6 monthly for 12 months, then annually

Chemistry – proposed analytes are presented in **Table 11** below.
Interpreted aquifer by Comet Ridge Limited

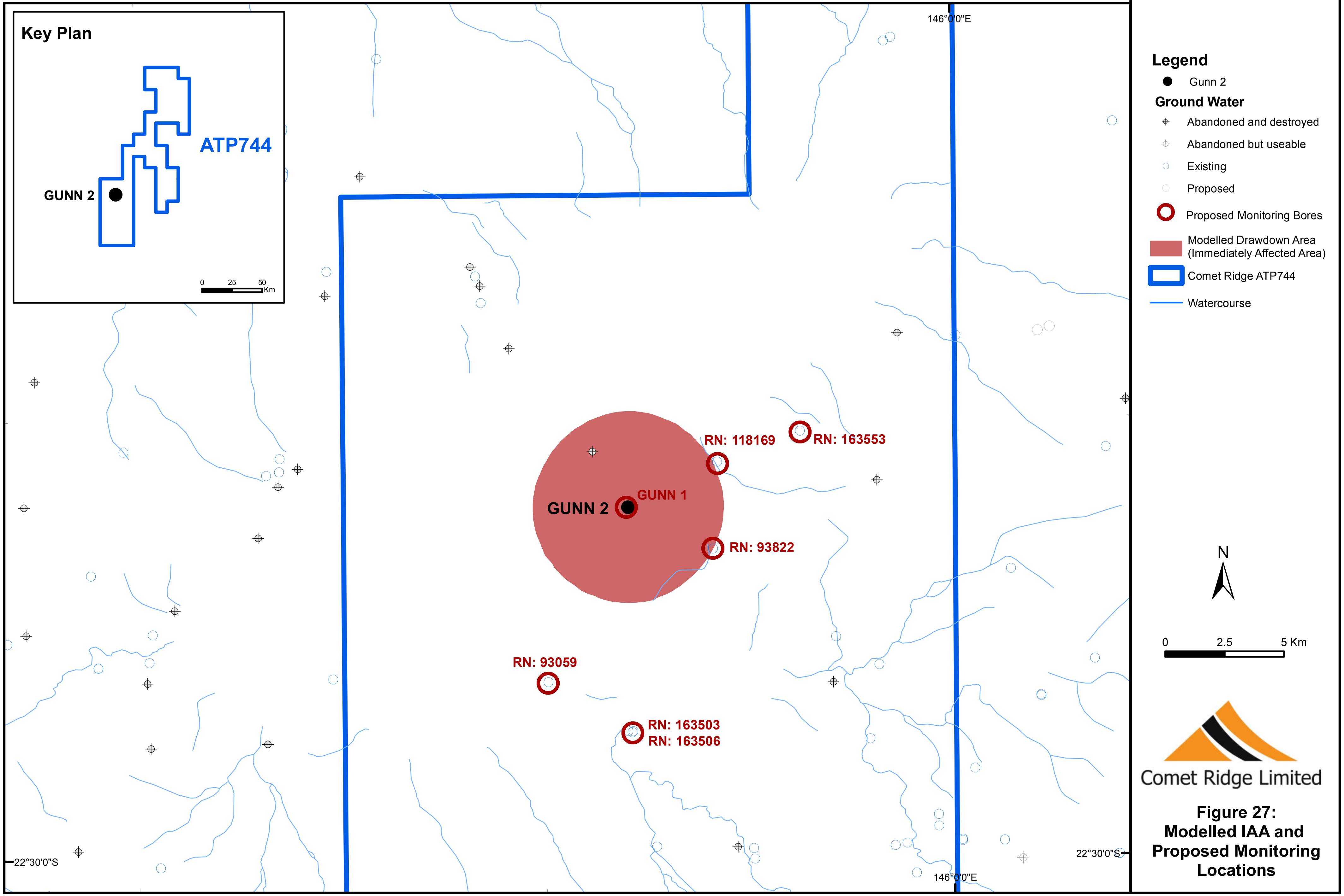
Table 11: Analytical plan-basic analytes

Category	Parameters
Ions	Calcium Chloride Fluoride Potassium Sodium Sulphate Magnesium
Metals (total and dissolved)	Aluminium Arsenic Barium Beryllium Boron Cadmium Chromium Cobalt Copper Iron Lead Manganese Mercury Molybdenum Nickel Selenium Uranium Vanadium Zinc
Alkalinity and hardness	Alkalinity – Total hardness as $CaC0_3$
Dissolved Gases	Carbon dioxide Methane Hydrogen sulphide

Additional parameters may also be analysed if Comet Ridge deems prudent based on the activities occurring in the area and preliminary results. A likely list of potential analytes that will be additionally considered is presented in **Table 12**.

Table 12: Analytical plan-extended analytes

Category	Parameters
Physical (Laboratory)	Benzene Toluene Ethyl-benzene Xylene (total) Formaldehyde Naphthalene Phenanthrene Benzo (a) pyrene Sodium hydroxide
Nutrients	Ammonia Nitrate as N Nitrite as N Nitrite + nitrate as N Notal nitrogen as N Total phosphorus



Comet Ridge Limited

Figure 27: Modelled IAA and Proposed Monitoring Locations

Sampling Methodology

Groundwater sampling will be undertaking according to the relevant methodology outlined in the Baseline Assessments Guideline 2017, (ESR/2016/1999), Version 3.02, DES, including:

- Samples will be collected, preserved and stored in accordance with the Environmental Protection (Water) Policy 2009 - Monitoring and Sampling Manual, Guidance on the sampling of groundwaters, Version May 2018, DES;
- EPA Guidelines: Regulatory Monitoring and Testing–Groundwater Sampling (Environment Protection Authority, 2007); and
- Groundwater Sampling and Analysis–A Field Guide (Sundaram, et al., 2009).

QA/QC

QA/QC control measures will be implemented during the sampling program. These measures will be consistent with :

- AS/NZ 9000 Quality management system series;
- quality assurance/quality control of AS/NZS 5667.11:1998; and
- Water quality - Sampling - Guidance on sampling of groundwaters (Joint Technical Committee EV/8, 2016).

This includes:

- Groundwater sampling will be conducted by a suitably qualified and experienced professional in accordance to the relevant guidelines;
- All the laboratory analysis will be conducted by National Association of Testing Authorities (NATA) approved for the analyses required; and
- All the equipment used to collect field parameters will be calibrated according to the manufacturer standard operating procedures.

An annual review of the monitoring data will be conducted once the pilot has been commissioned and has commenced production testing. The review will be conducted by a suitably qualified and experienced hydrogeologist and will include assessment of groundwater level and quality data, and the suitability of the monitoring network.

All groundwater-based complaints will be investigated, and a register kept of the nature of any complaints, the results of the assessment, and any actions taken. The register will be made available to the regulating authority upon request.

Review and Reporting

The accuracy of the predicted IAA will be reviewed on an annual basis once the pilot has been commissioned and has commenced production testing. This will be based on a comparison of the two six-monthly sampling round results and water production data with the groundwater model predictions and the assumptions that were used to prepare it. The results of this comparison will be provided to the DES within 20 business days after the comparison report has been completed. Further, the report to DES will highlight if there has been a material change in any of the parameters since the modelling and IAA map were generated. For the purposes of this statement, a discrepancy of more than 25% from predicted values will be treated as a material change.

A report relating to the implementation (including results) of the monitoring strategy required under section 378(1)(d) of the Water Act will be submitted annually to the Office of Groundwater Impact Assessment.

Further, records of all underground water extracted while exercising water rights will be collected on a daily basis. Water Production reports will be submitted to the DNRME as per the requirements under the P&G Act.

The results of any further Baseline Assessments required under Chapter 3 of the Water Act will be given to the Office of Groundwater Impact Assessment in the approved form.

Part F: Spring Impact

UWIRs are required to identify springs which could be potentially affected by underground water extraction activities. For these springs where predicted water levels within the source aquifer would decline more than 0.2 metres, a spring impact management strategy is required.

A desktop review of spring inventories has been completed, searching for springs within 20 km of proposed production testing. Springs and watercourses were identified using the following sources of information, and cross-checking against project maps.

- Queensland Government Information Service (Queensland Wetland Data – Springs)
- Wetland Info Website
- Great Artesian Basin Resource Operation Plan Spring Register

Based on this data one group of springs (Moses Complex) were identified within the boundary of ATP744, refer **Figure 21**. The Moses Complex springs are located >50km from the proposed pilot location. The closest spring is located approximately 24 km to the west of the area, refer **Figure 21**. Additional information and descriptions on springs have been compiled under the **Springs** sections of the report.

A spring monitoring or management strategy is not considered to be required for this UWIR due to:

- No springs are located within 20km of the Gunn Pilot;
- No springs are located within the IAA;
- There is no known hydrological interconnection between the springs and the affected coal seams of the Betts Creek Beds.

ALBANY STRUCTURE PROJECT

Project Information

Conventional Exploration Background

In the past, the work program for the exploration activities across ATP744 were primarily focussed on CSG and further appraisal of the Gunn Project Area. Since 2015, following the reinterpretation of the reservoir data over the Albany Structure, Comet Ridge changed the primary exploration and appraisal focus for ATP744 from CSG to conventional oil and gas.

Conventional resources are generally appraised and developed in a shorter timeframe than CSG, as no prior de-watering of coals is required.

The objective of the current conventional exploration across ATP744 is to determine the presence of hydrocarbons in the Lake Galilee Sandstone reservoir section in the southeast culmination of the Albany Structure, and to test the ability to obtain commercial gas flow rates through hydraulic stimulation. Conventional exploration across ATP744 and the greater Galilee Project Area has included seismic acquisition to identify new structures and better define identified leads and prospects, of which may progress to potential drillable targets.

Project History

Results from historical petroleum exploration wells drilled within the Comet Ridge Galilee Permit areas have confirmed the presence of an active petroleum system over the Koburra Trough in the eastern Galilee Basin (**Figure 28**).

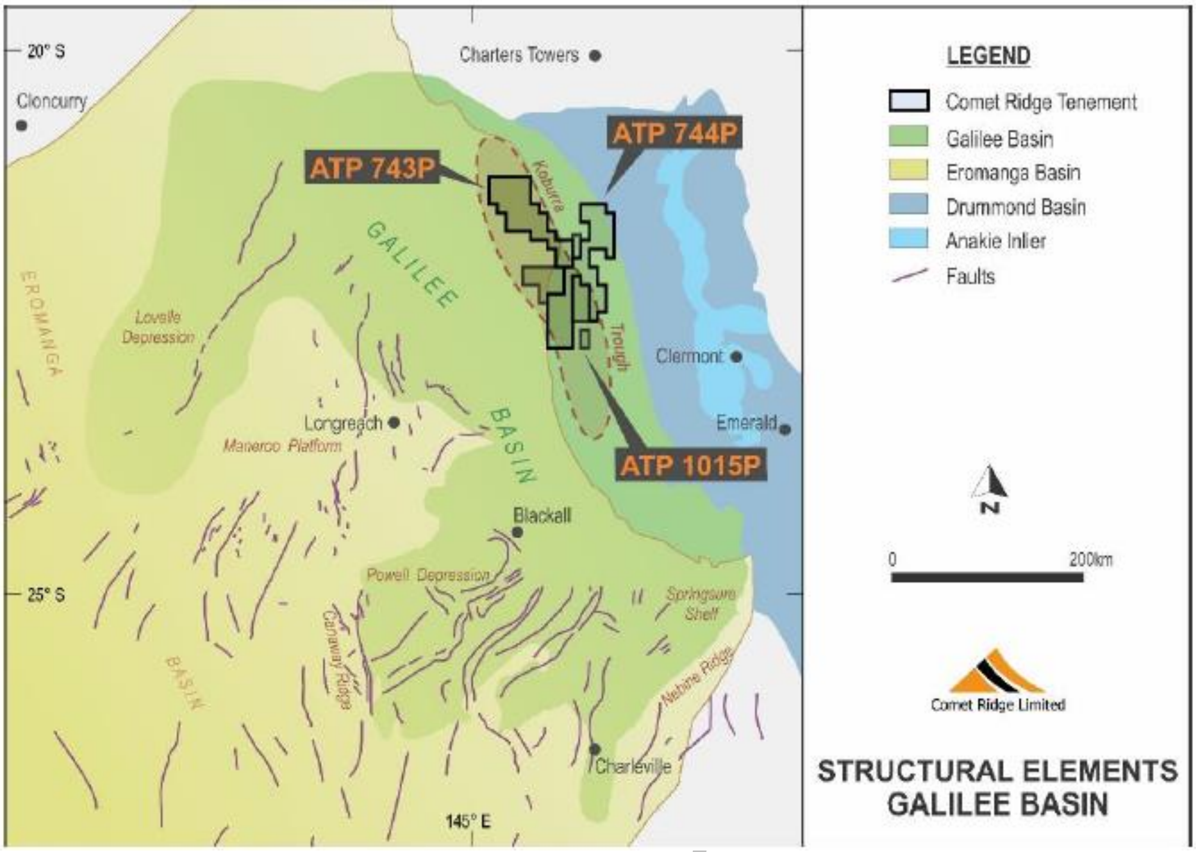


Figure 28. Comet Ridge Galilee Permits, showing regional structural elements

Three wells (Koburra 1, Lake Galilee 1, and Carmichael 1) flowed gas to surface, and one well (Lake Galilee 1) recovered oil from the Lake Galilee Sandstone at the base of the Galilee Basin (**Figure 29**). An in-house prospectivity review was undertaken to define the hydrocarbon system, identify prospective intervals for conventional/tight hydrocarbons, and design a future exploration and appraisal program of these prospects.

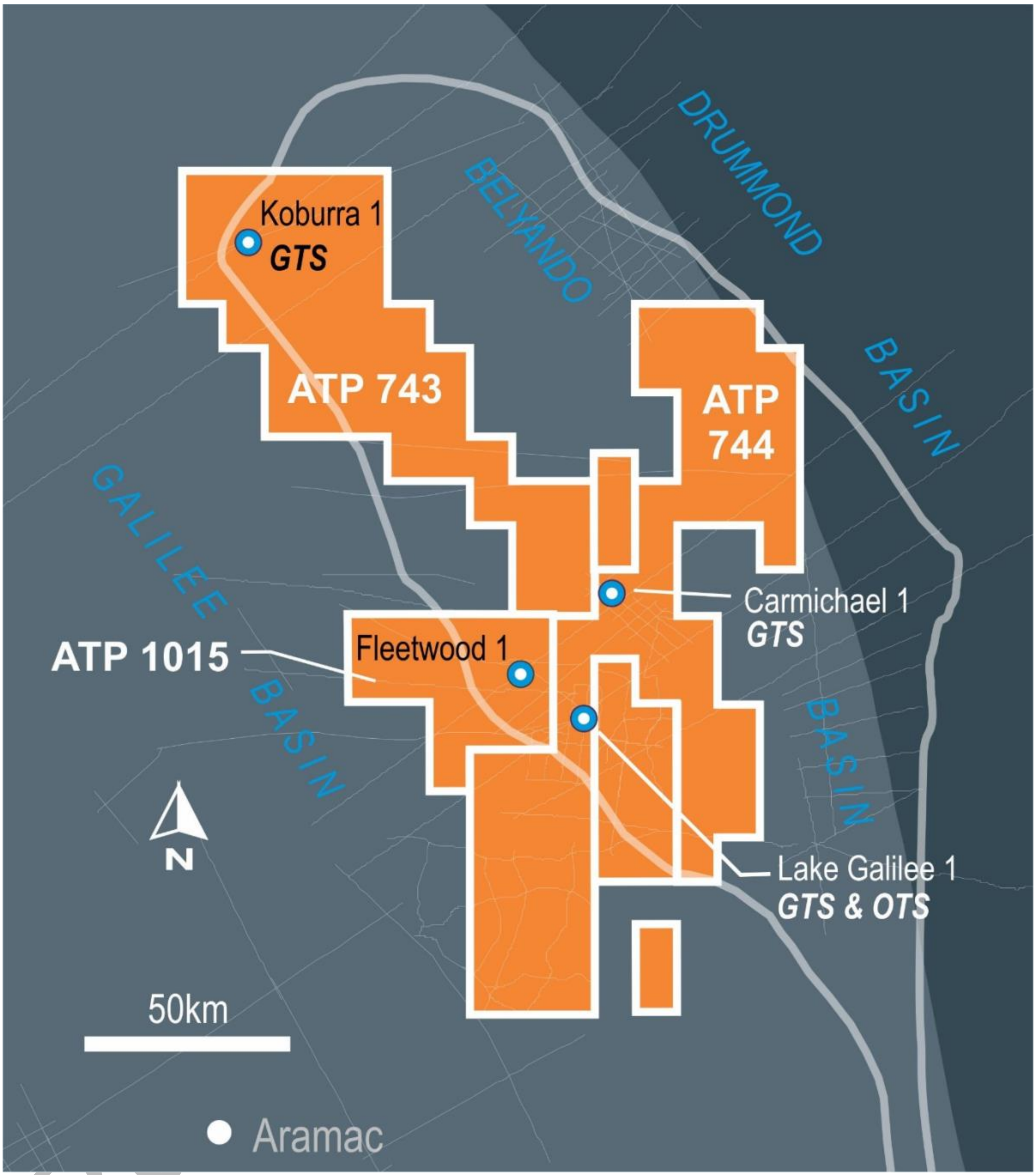


Figure 29. Historical wells drilled in Comet Ridge Galilee Permits

Prior to the acquisition of the 2019 Koburra 2D Seismic Survey, the Albany Structure in ATP 744 where Carmichael 1 was drilled was identified as the only valid structure with closure of the three previous structures drilled. This has been re-interpreted following reprocessing of existing and newly acquired seismic as a significantly larger structure than previously thought. The current extent of the interpreted Albany Structure is shown in Figure 30.

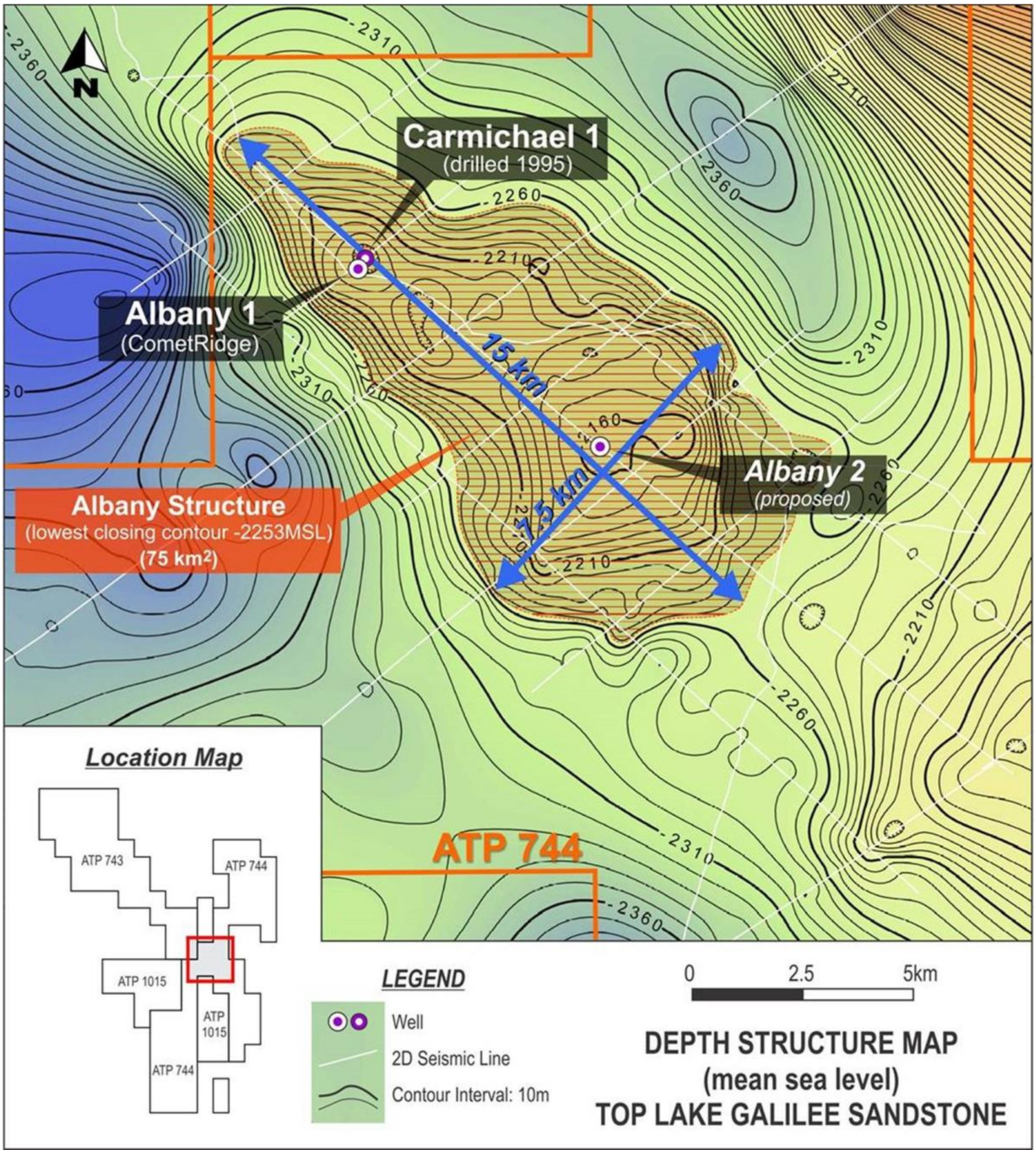


Figure 30. Revised mapped extent of Albany structure

Comet Ridge sought a farm-in partner to further appraise conventional resources across the Galilee permits. On 1 November 2017, Comet Ridge announced an agreement had been executed with Vintage Energy Limited to farm-out the sandstone reservoir sequence of ATP 744, 743 and 1015.

Stage 1 of the farm-in agreement consisted of the drilling and production testing of one conventional gas well (Albany 1) on the Albany Structure, close to where Carmichael 1 well flowed gas in 1995.

Pending success of Albany 1, further drilling of the Albany structure and/or seismic acquisition to better define the structure and define further drilling targets across the permit areas was to be considered as Stage 2 of the farm-out agreement.

Albany 1 was drilled by Comet Ridge in mid-2018 within the north-western closure on the Albany Structure (**Figure 30**). This was the first conventional well drilled in the eastern Galilee Basin in almost 25 years. The well was drilled as a twin to Carmichael 1 to re-evaluate the Lake Galilee Sandstone, the basal formation of the Galilee Basin. Carmichael 1 flowed gas to surface on tests at very low rates (rates to small to measure) over three intervals within the Lake Galilee Sandstone despite significant mud overbalance in the well. Albany 1 was drilled with nitrogen rather than drilling mud through the sandstone reservoir section, and recorded a stabilised gas flowrate of 230,000 scf/d across a 13m interval in the Lake Galilee Sandstone. This gas flow is the first measurable flow of natural gas from the Lake Galilee Sandstone in the Galilee Basin. Unfortunately, the drill string became stuck while drilling of the flowing reservoir interval and the well was suspended before reaching the planned total depth (TD). Although planned TD was unable to be reached, the recorded flow rate was encouraging and has established a motive for further exploration and appraisal of gas resources across the Koburra Trough.

In early 2019, 332km of 2D seismic was acquired across the Galilee Project area. 59.5km was acquired across ATP744 to identify new structures and better define the 23 identified leads and prospects. This is the first regional seismic acquisition program in the eastern Galilee Basin targeting deep conventional targets in almost 35 years. Interpretation of the seismic data has identified additional one-line roll over structures and confirmed a closed four-way structure is present in the area around Lake Galilee 1.

Primary Conventional Target

The Lake Galilee Sandstone is the primary target for conventional exploration and appraisal activities in ATP744. The Lake Galilee Sandstone is Late Carboniferous in age and comprises sandstone with minor interbeds of siltstone, claystone and shale, and rare coal seam, and is prospective for gas and/or oil/condensate. The Lake Galilee Sandstone is the basal unit of the Galilee Basin (**Figure 31**). The Galilee Basin unconformably overlies the Drummond Basin across the Koburra Trough.

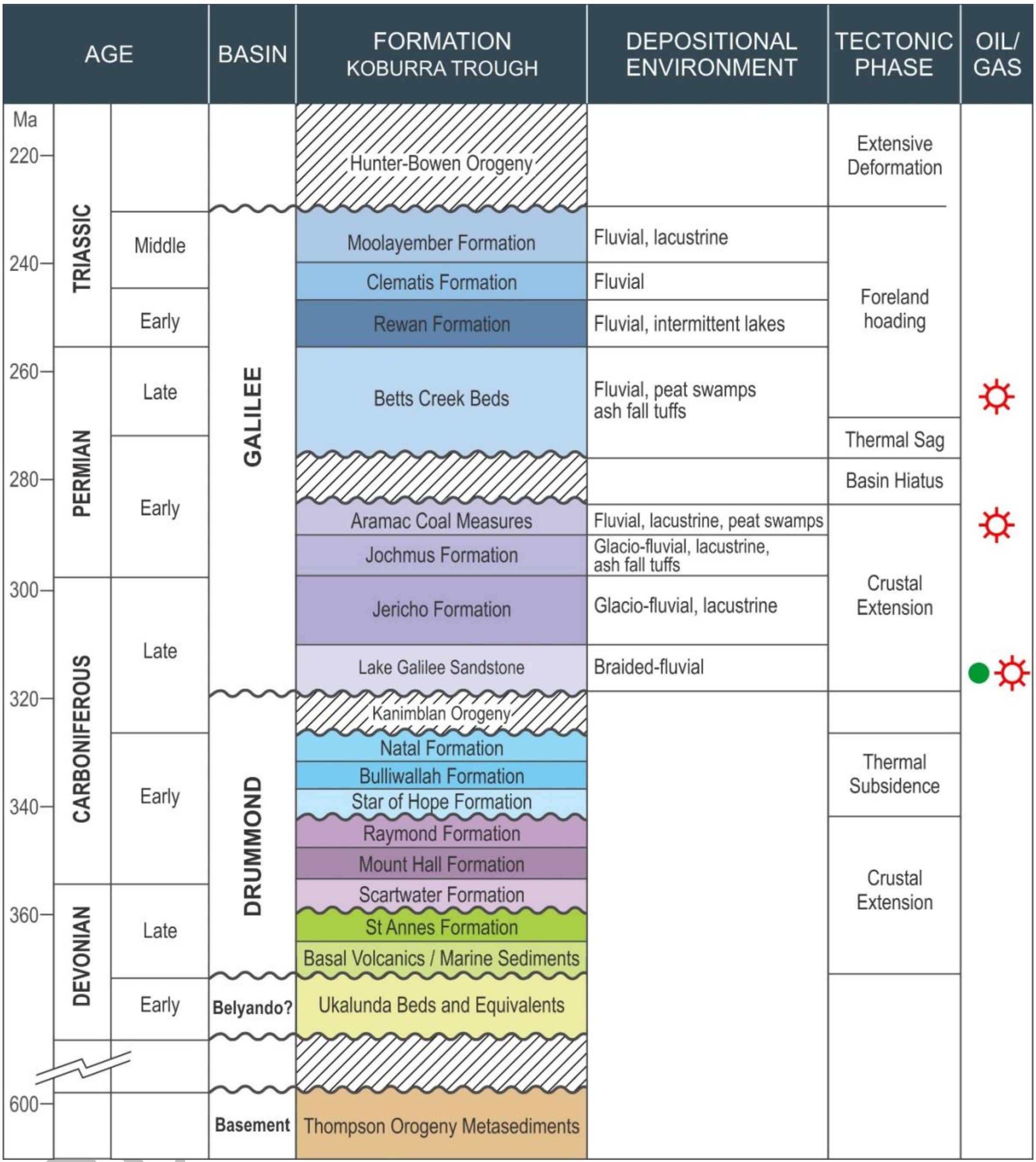


Figure 31. Regional Stratigraphy – Koburra Trough - Galilee Basin

Overview of Current Activities

In mid 2019 Comet Ridge drilled Albany-2 and later Albany-1 ST1 (sidetrack to the existing Albany-1 well).

The Albany-1 ST1 and Albany-2 wells fall within the category of unconventional reservoirs or tight gas, characterised by gas saturated low permeability sandstones. To potentially commercialise the gas resource, the wells will require hydraulic stimulation treatment. The treatment is designed to improve deliverability within the gas saturated sandstones by increasing the pore volume connected to the wellbore.

Drilling Operations

Albany 2 appraisal well was spudded on 30 July 2019 on the south-east culmination of the Albany Structure (**Figure 30**), approximately 7.5km SE of Albany 1 well. The well was subsequently drilled to the final depth of 2702mMD into the Natal Formation - top of the Drummond Basin (**Figure 32**). The primary objective of this well was to evaluate the gas-saturated sands of the Lake Galilee Sandstone.

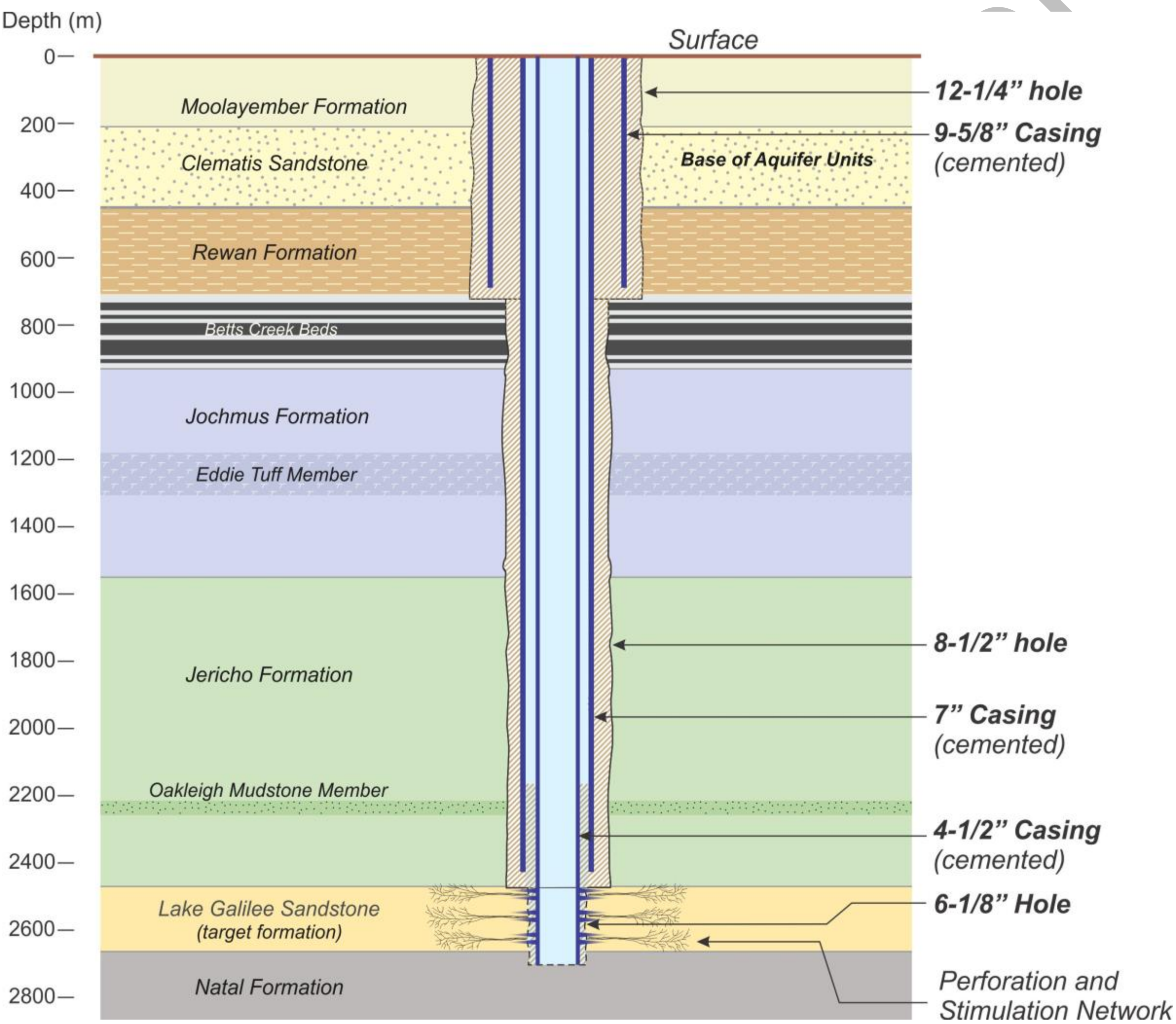


Figure 32. Albany 2 Well Design and Stimulation Schematic

Following Albany 2, Albany 1 appraisal well was re-entered and side-tracked from inside the 7" casing to the TD of 2822mMD in the Natal Formation (upper Drummond Basin). The primary objective of this well was to evaluate the gas-saturated sands of the Lake Galilee Sandstone. The well schematic is shown in **Figure 33**.

The reservoir interval is characterised by tight gas-saturated sands with average porosities ranging from 4-7% and very low permeability's in the range of 0.01-0.6mD.

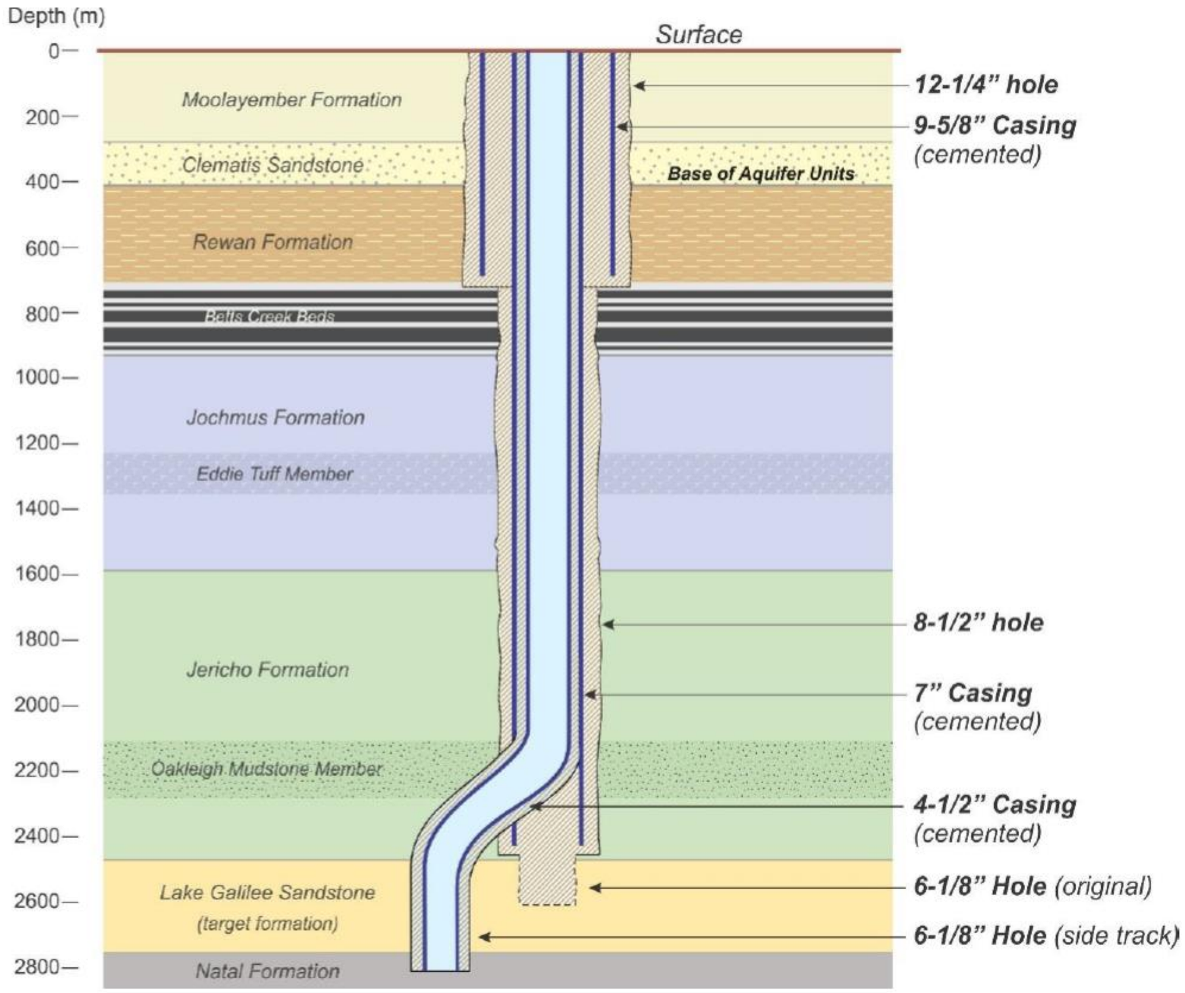


Figure 33. Albany 1 ST1 Well Design

Part A: Underground Water Extraction

Water Extraction to Date

Conventional gas production is different from CSG gas production. Conventional gas production is from porous sandstone formations which does not require the depressurisation of the target beds (with respect to groundwater, and the need to remove groundwater to release the gas) to produce at economic quantities. Some water may be produced as a by-product, however the volumes are relatively small.

The reservoir at the Albany Structure is interpreted to be predominantly dry gas with minor condensate. It is worth noting that no water was intersected while drilling the reservoir section of Carmichael 1 in the past and no formation water was intersected or produced during the air/nitrogen (underbalanced) drilling phase of the reservoir section of Albany 1.

Quantity of Water Estimated to be Produced Over the Next Three Years.

As previously mentioned , the reservoir at the Albany Structure is interpreted to be predominantly dry gas with minor condensate. It is anticipated that no water is likely to be produced during the planned well testing.

The Lake Galilee Sandstone formation within the study area is of very low permeability of less than 1 mD, which translates to less than 1 x 10-8 m/s hydraulic conductivity. Such low hydraulic conductivity values are typical for aquitards and confining units rather than aquifers.

To flow significant volumes of gas, the formation needed to be hydraulically stimulated to increase the pore volume connected to the wellbore. Albany 2 was stimulated at the end of 2019, Albany 1 ST1 has not been stimulated. At the time of writing of this report, both wells are suspended. There is no current timeframe to stimulate Albany 1. Typically, following the hydraulic stimulation, the well is flowed-back to recover the stimulation fluid, before it can be flow tested. At the time of writing this report, Comet Ridge had completed the flow-back from Albany 2.

At the time of writing the report there was no confirmed time frame as to when the Albany wells will be tested. It is anticipated, the testing will be carried out for the maximum period of 30 days.

Any additional production from these wells, post short term production testing will be dependent on the testing results. At this stage, no production is expected within the next three years, to which this current UWIR relates.

Based on the drilling experience of Albany and Carmichael 1 wells, Comet Ridge is not expecting to produce water during the testing activities. However, to assess the potential impact of the testing activities on the surrounding hydrogeological regime, a nominal water production rate of 100 bbl/d (16 m^3/d) is assumed to be extracted daily from each of the wells during the entire period of 30-day testing. Such rate would total 480 m^3 of water from each of the Albany wells during the proposed testing period.

Part B: Aquifer and Underground Water Flow and Levels

Geological and Hydrogeological Settings

The Galilee Basin sediments were mainly deposited in a fluvio-lacustrine environment (i.e. by rivers and lakes), resulting in channel sands, floodplain siltstones and coals, lacustrine shales, alluvial fan deposits and some glacial deposits. The two major unconformities in the Galilee Basin divide the infilling of the Basin into two depositional episodes (CSIRO, 2014):

- Late Carboniferous-Early Permian - during this period the climate varied from glacial in the Late Carboniferous and early 'Early Permian' to warm and humid in the late 'Early Permian'. This episode is characterised by the sediments of the Joe Joe Group, which consists of the Lake Galilee Sandstone at its base, the Jericho Formation, the Jochmus Formation and the Aramac Coal Measures in the Koburra Trough (Hawkins 1978).

- Late Permian-Middle Triassic – the climate varied during this period from warm and humid in the Late Permian to more temperate in the Triassic. This episode started during the Upper Permian when the Betts Creek Beds were deposited across the entire Basin (Allen & Fielding 2007b) and during the Triassic when there was deposition of the Rewan Group, the Clematis Group and the Moolayember Formation in the Koburra Trough.

The sequence is schematically presented in **Figure 34** below (CSIRO, 2014 after RPS, 2012). It should be noted that Moolayember and Clematis Sandstone are no longer formally part of GAB.

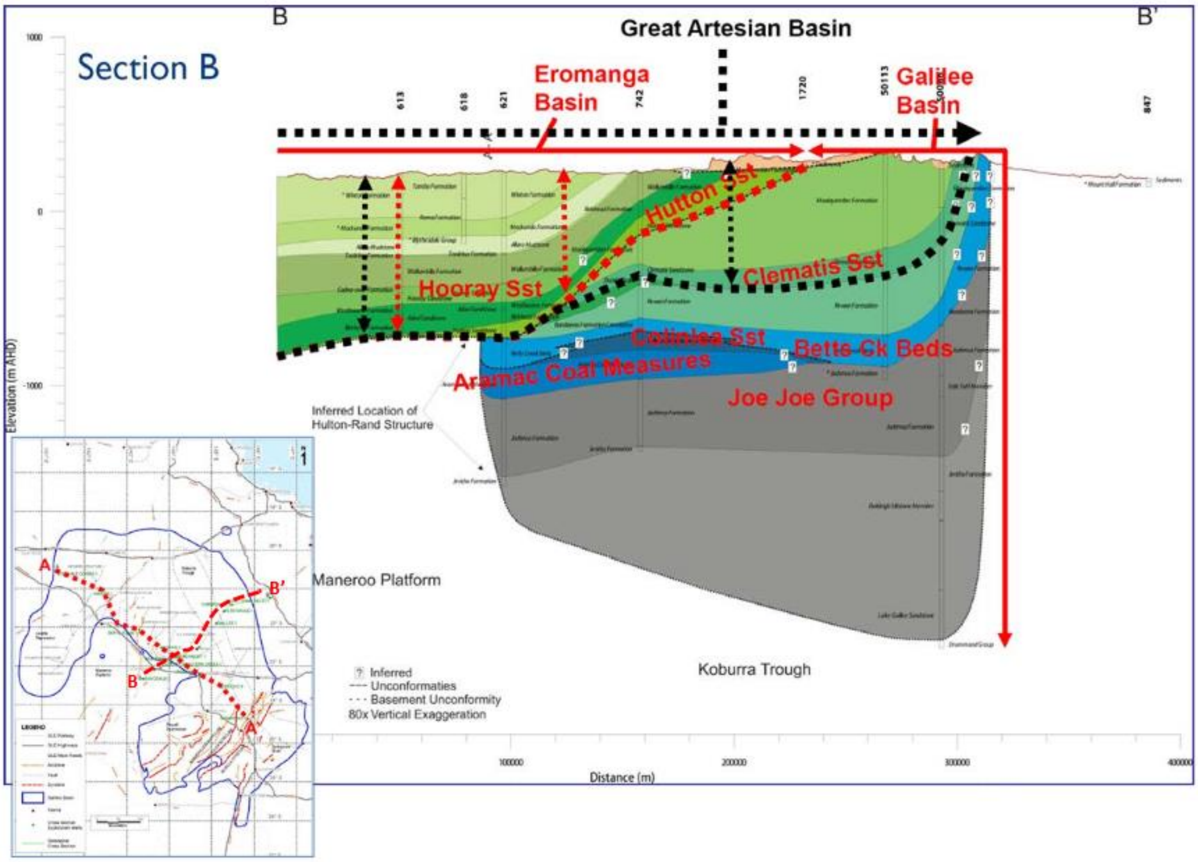


Figure 34. East to west stratigraphic cross section of the Galilee Basin (RPS 2012).

The Moolayember Formation, Clematis Group and Dundas Beds comprise the main aquifer systems in the tenure area. Aquifers within the Moolayember Formation and Clematis Group form the main groundwater source for agricultural and domestic use within the region. The Clematis Group is separated from the underlying Betts Creek Beds by the Rewan Formation, which is a regionally significant confining unit.

In the permit area, the Rewan Group is up to 300m thick and separates the GAB aquifers in the upper Galilee Basin from the underlying Permian and Late Carboniferous water-bearing units of the lower Galilee Basin.

The lower Galilee Basin section comprises Late Carboniferous to Early Permian units of the Jochmus Formation, Jericho Formation and Lake Galilee Sandstone, respectively. The Jochmus Formation unconformably underlies the Betts Creek Beds in the tenure area. The Jericho Formation is over 750m below the Jochmus Formation and no wells within the ATP other than oil and gas exploration wells penetrate this formation. The lower part of the Jericho Formation is interpreted to form a local aquitard above the reservoir interval of the targeted Lake Galilee Sandstone.

A high level hydrostratigraphy of the Galilee Basin is presented in **Figure 35** below (after Moya 2011). Based on the lithology of the units, it classifies them as aquifers, possible aquifers, or aquitards. The description of the units is presented below.

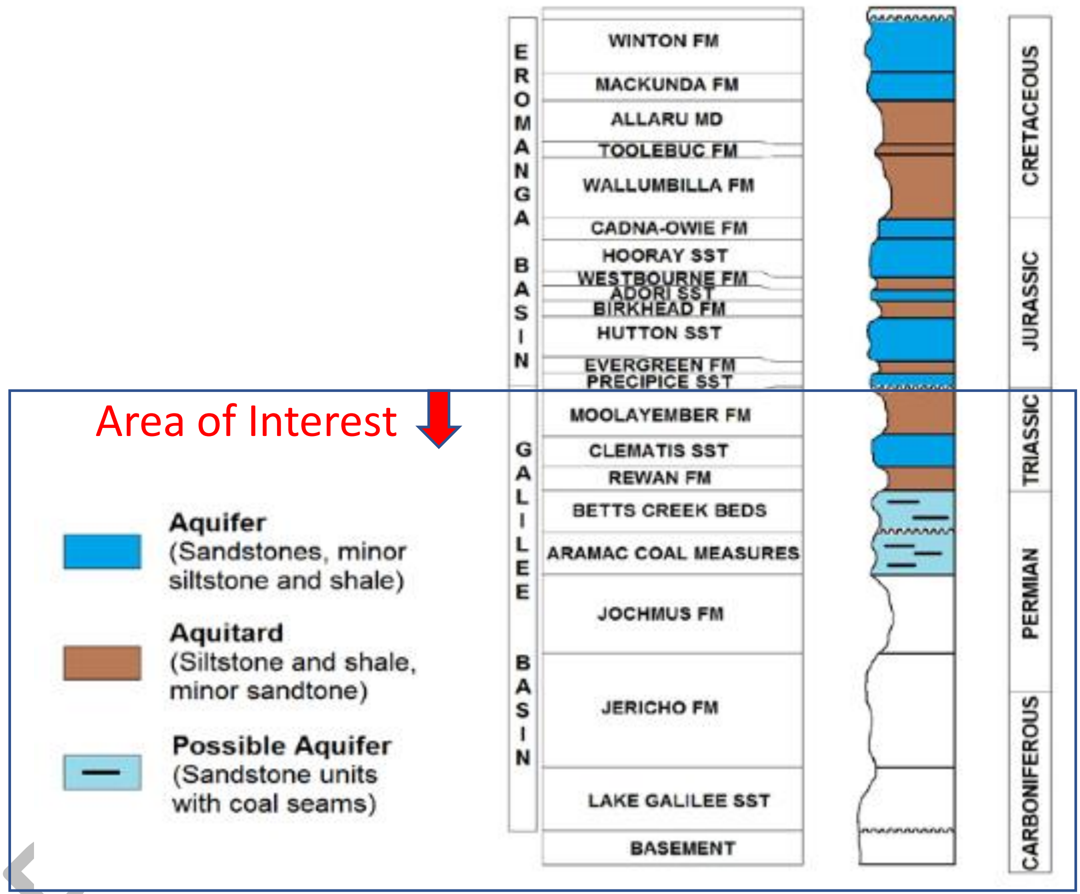


Figure 35. Simplified hydrostratigraphy in the Galilee and Eromanga Basins (after Mooya, 2011)

Quaternary Alluvial and Tertiary Sediment Aquifers

Quaternary alluvium and Tertiary sediments are widespread over the tenure area. According to RPS (RPS, 2012) shallow unconfined groundwater hosted in the Quaternary alluvium and Tertiary basalt and sediment aquifers are tapped by the largest number of bores in the Galilee Basin, partially because of its shallow depth. However, none of the registered groundwater bores within at least a 20 km range of the Albany wells is sourcing water from this formation based on DNRME database.

Moolayember Formation

The Middle Triassic age Moolayember Formation contains the uppermost sediments of the Galilee Basin sequence. The Moolayember Formation, which can be up to 315m thick, is a confining bed and consists of mudstone with minor siltstone and sandstone (Scott *et al. 1995*). Small, isolated outcrops of this formation occur through the overlying younger sediments found along the eastern margin of the Koburra Trough (RPS, 2012). The contact with the underlying Clematis Sandstone is gradational in the northern portion of the Galilee Basin (McKellar, 1977).

The Moolayember Formation is considered highly prospective as a sealing unit for potential carbon dioxide storage in the Galilee Basin (Marsh *et al*. 2008). Marsh *et al.* (2008) cited a range of permeabilities for the Moolayember Formation, from 0 to 503 mD, with an average of 81 mD (approximately 0.1 m/day), which is not indicative of an aquitard (i.e. hydraulic conductivity is too high); however the Marsh *et al.* (2008) dataset was very small (quoted after CSIRO, 2014).

The majority of the existing water wells in the proximity of the Albany wells within ATP744 source water from this unit according to DNRME database (2020).

Clematis Group

The underlying Clematis Sandstone is the most significant aquifer within the Galilee Basin. There are some users tapping this aquifer in the Galilee Basin, predominantly in the east, where the aquifer is shallower (CSIRO, 2014). However, the quality of groundwater is variable, and supplies are dominantly sub-artesian and low yielding (<1L/s). This unit has provided only stock and domestic supplies (Queensland Department of Natural Resources and Mines 2005).

The Early to Middle Triassic age Clematis Sandstone, which can be up to 130 m thick, consists of medium to coarse-grained quartzose to sublabile, micaceous sandstone, siltstone, mudstone and granule to pebble conglomerate. The Clematis Sandstone outcrops though the younger sediments in a similar pattern to the Moolayember Formation (RPS, 2012).

Rewan Group

The Rewan Formation is considered to be an aquitard – it is comprised of interbedded sandstone, mudstone and siltstone, however the sandstone is predominantly labile and has an abundance of clay and silt (Moya 2011).

This formation is locally more than 300m thick. Silicification and clay alteration has significantly reduced the porosity and permeability in this formation and no significant aquifers exist (Queensland Department of Natural Resources and Mines 2005). The Rewan was deposited in a fluvial-lacustrine environment and is considered a regionally significant confining unit. As a result, this formation is expected to form a hydraulic barrier between the overlying aquifers of GAB and underlying Permian and Late Carboniferous formations.

In the Koburra Trough, the Clematis Sandstone is underlain by the Dunda Beds, which are correlative with the upper Rewan Formation. The Dunda Beds are composed of lithic to quartzose sandstone, siltstone and mudstone. The Dunda Beds are recognized to be the upper facies of the Rewan Formation in the outcrop areas, which lie to the east of the Clematis Sandstone outcrops (RPS, 2012).

Betts Creek Beds

Betts Creek Beds, which are approximately 100m thick, are composed of conglomerate and sandstone at the base, with siltstone, mudstone, and coal seams present towards the top. The coal seams within the Betts Creek Beds represent the major target formation for the Gunn Pilot in the southern part of ATP 744. The Betts Creek Beds outcrop area is small and is confined to the northern extent of the Koburra Trough at the basin boundary (RPS, 2012).

The Permian coal measures (Betts Creek Beds and Aramac Coal Measures) represent aquifers of poor to moderate permeability based on the sandstone layers within these units (CSIRO, 2014).

Only two water bores have been identified to be sourced from sandstones within the Betts Creek Beds within ATP744 since the initial UWIR for Gunn Pilot was approved, therefore utilisation of this formation as an aquifer is considered minimal. Since the initial UWIR, eight mine-monitoring bores have been drilled within coal mining permits which partially overlap the central part of ATP744. These bores have been drilled to monitor water levels and water quality within the formation.

Jochmus Formation

Jochmus Formation – this formation is comprised of sandstone in the upper and lower parts, with a middle part composed of tuff with minor mudstones and siltstone. Marsh *et al.* (2008) considered that the sandstones within the Jochmus Formation appear to be more porous and permeable than the formations below, but suggests there may be a high proportion of clay present (related to volcanic activity during deposition) but likely less in the Lovelle Depression. Permeabilities for this unit cited in Marsh *et al.* (2008) of 0 to 1634 mD (approximately zero to 1.6 m/day) are not indicative of an aquifer from a typical water resource perspective, but indicate higher permeability than in underlying aquitards (CSIRO, 2014). The formation is approximately 650m thick in the Albany Project area.

Jericho Formation

Jericho Formation – this formation is predominantly comprised of siltstone and mudstone and is considered to act as an aquitard. This formation is over 800m thick in the project area, based on logs from the Albany wells.

Lake Galilee Sandstone

The Late Carboniferous age Lake Galilee Sandstone is the basal formation of the Galilee Basin sequence. Even though this formation has a sandstone lithology, quartz cementation has reduced the porosity and permeability to virtually zero, hence this unit can be considered an aquitard. Marsh *et al.* (2008) cites porosities of 2 to 10 per cent and permeability from 0 to 7 mD (average of 0.9 mD, which is approximately 0.001 m/day). The Lake Galilee Sandstone can be up to 260 m thick. There are no known outcrops of the Lake Galilee Sandstone (RPS, 2012).

Hydraulic Properties.

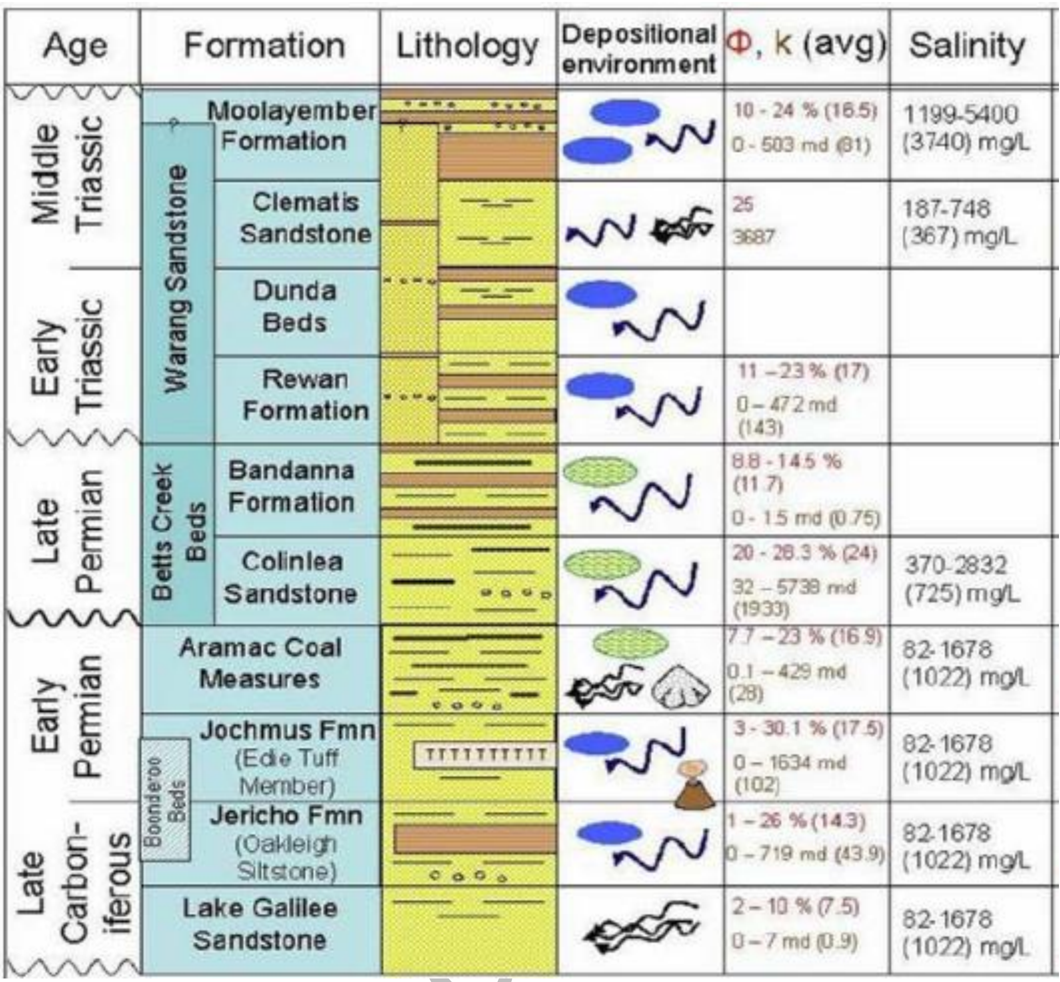


Figure 36. Summary of key properties of formations in the Galilee Basin (Marsh et al. 2008)

The high-level summary of the hydraulic parameters for the Galilee sequence is presented in **Figure 36** (after Marsh *et al.* 2008). The wide range of permeabilities measured within formations is likely to be related to various lithologies within that particular formation. It should also be noted that Marsh *et al. 2008* made no distinctions between horizontal and vertical permeabilities, which in the majority of depositional basins are expected to be significantly lower than horizontal permeabilities.

Worth noting are also the salinity measurements, suggesting the poorest quality groundwater is expected in the shallowest units of the area, while deepest parts of the basin show moderate quality with average measured salinity of just over 1000 mg/L.

Geological Structure

A series of NW-SE trending anticlines and synclines have been mapped on seismic surveys across the permit area and minimal faulting is observed on surface mapping (**Figure 4**). Faulting interpreted on seismic surveys is primarily associated with basement rocks of the Drummond Basin (**Figure 10**). Significant structural features have been mapped outside the permit area to the north-east (**Figure 4 & Figure 10**).

Some of the faults that have been identified across the tenure area and the Albany structure extend from basement (Drummond) through the Lake Galilee Sandstone and into the Jericho Formation (possibly Lower Jochmus Formation). However, no faults have been identified that connect the Lake Galilee Sandstone with the Betts Creek beds or the overlying Triassic or Cenozoic aquifers or the ground surface. The intervening geological units seem to show good lateral continuity across the area of interest and lack large-scale structural features that may form vertical conduits between the target zone and shallower aquifers.

Groundwater Bores

A review of the DNRME Groundwater Database was undertaken to identify registered existing groundwater bores within the permit area. There is a total of 110 registered groundwater bores within ATP 744. From the total number of 110 registered water bores, 23 have been abandoned and destroyed, and 87 registered/licensed bores are still existing. It is believed that groundwater is primarily being used as water supply either for livestock watering or farm supply. It seems that the groundwater is principally drawn from either Tertiary Sediments, Moolayember Formation or Clematis Group, although there is currently insufficient data available to assign an aquifer to more than a handful of groundwater bores (**Appendix 1**). Despite this, the Moolayember Formation and Clematis Group are considered to be the most relevant locally significant aquifers.

Groundwater bores within 10km radius of the Albany Wells are predominantly drawing/accessing water from shallow aquifers within the Moolayember Formation. There are seven (7) groundwater bores within a 10km radius of both Albany 1 and Albany 2 refer to **Table 13** below and **Figure 37**.

Table 13: Summary of groundwater bores nearby Albany Project

Bore ID	Registration number	Distance to Well	Well
Mosquito Bore	RN96545	<2 km	Albany 1
Cockatoo Bore	RN39801	<2 km	Albany 1
Kades Bore	unregistered	<5 km	Albany 2
Carmichael House Bore	unregistered	<5 km	Albany 2
Cow Pasture Bore	unregistered	<10 km	Albany 2
Nankeroo Bore	RN16895	<10 km	Albany 2
Caseys Bore	RN16896	<10 km	Albany 2

No groundwater bores are within a 2km radius of Albany 2. Two water bores are within a 2km radius of Albany 1, respectively RN96545 (Mosquito Bore) and RN39801 (Cockatoo Bore).

RN96545 (Mosquito Bore) is located approximately 204m from the surface location of Albany 1. Records from the Baseline Assessment Report 2019 indicate the bore was not in use prior to drilling Albany 1.

RN39801 (Cockatoo Bore) is located approximately 1.75km from Albany 1. This bore was not operational at the time of the baseline assessment due to a collapsed surface casing. The broken windmill stroke prevented access to the aquifer.

Two unregistered bores respectively Kades Bore and Carmichael House Bore are located within the 5km buffer zone of Albany 2. Records from the Baseline Assessment Report 2019 indicates Kades bore has never been used by the landholder since installation. Carmichael House Bore is currently operational and used by the landholder. The bore was sampled at the time of the baseline assessment in 2019.

Three bores are located within 10km of Alabany 2, respectively unregistered (Cow Pasture Bore), RN16895 (Nankeroo Bore) and RN16896 (Caseys Bore). Nankeroo Bore is non-operational, a new bore was drilled adjacent to Nankeroo Bore, in late 2019. Water quality data is available only for RN16896 (Caseys Bore).

Records for all the bores indicate water is being drawn from the Moolayember Formation, which is vertically separated from the target reservoir, the Lake Galilee Sandstone, by approximately 2200m.

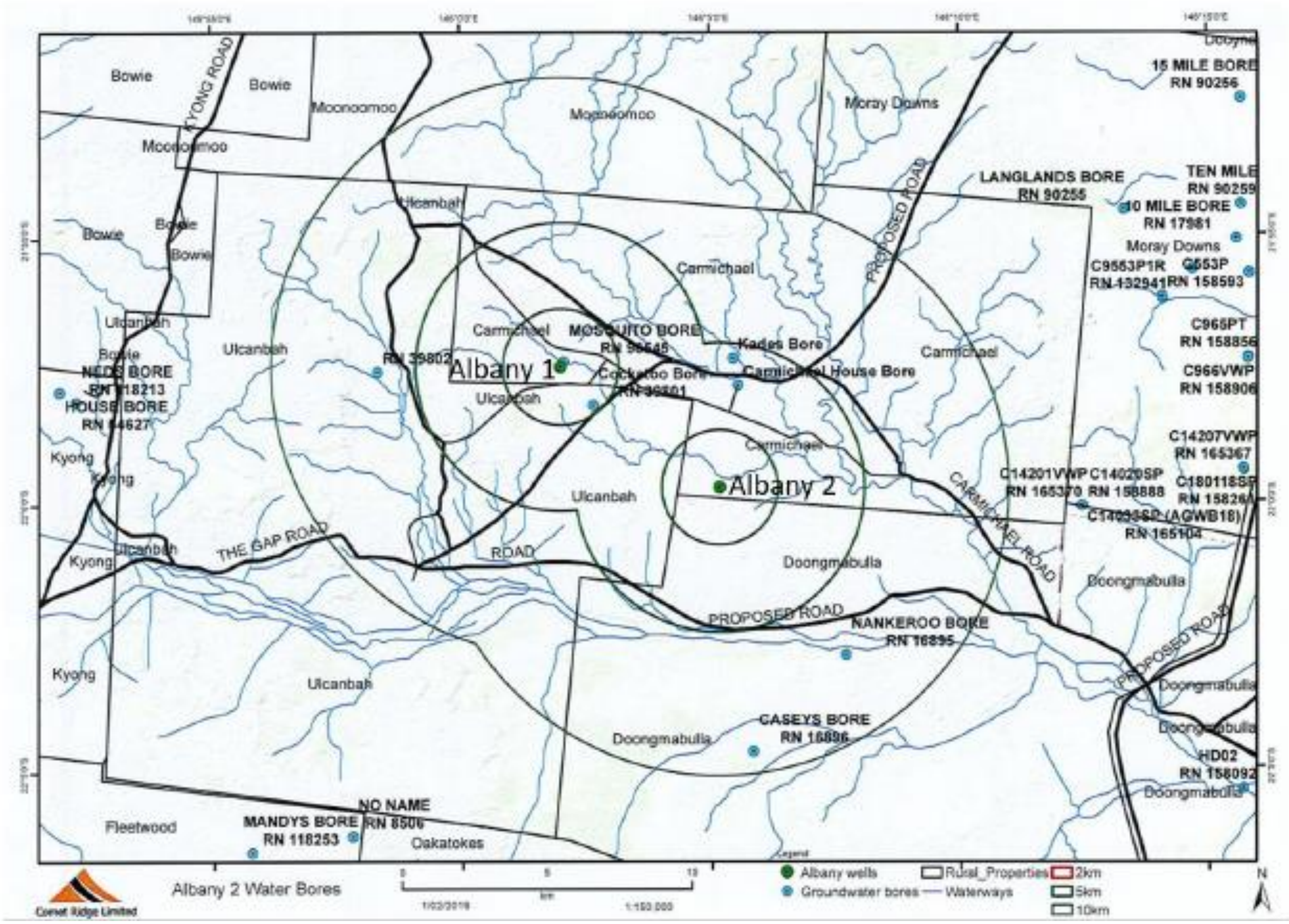


Figure 37. Groundwater Bores within 10km of Albany 2 and Albany 1 ST1. Inner circle represents 2km radius, middle circle represents 5km radius and outer circle represents 10km radius.

Groundwater Level

A limited number of groundwater level observations have been recorded within ATP744. The summary of the water level measurements collected from the water bores within 20km radius from the Albany wells is presented in **Table 13** below.

Table 13: Available groundwater level data in the vicinity of Albany Project

RN	Formation Name	Date	S.W.L (m) TOC
96545	Moolayember Formation	19/10/2019	-28.8
Unregistered (Kades Bore)	Moolayember Formation	19/10/2019	-28.3
Unregistered (Carmichael House Bore)	Moolayember Formation	19/10/2019	-26.5
16896	Moolayember Formation	19/10/2019	-29.2
16895	Moolayember Formation	14/07/1966	-32.9
39801	Moolayember Formation	26/05/1975	-35.4
158888	Moolayember Formation	30/7/14	-45.12
39802	Unknown	9/04/1951	-36.0
153582	Clematis Group	19/10/13	-59.5
54627	Clematis Group	15/8/06	-45
118253	Clematis Group	17/2/03	-48
165540	Clematis Group	14/3/18	2.04
165541	Clematis Group	20/3/18	-4.5
158592B	Betts Creek Beds	1/1/12	-48.33
158076	Betts Creek Beds	6/8/11	-37.35
132938	Betts Creek Beds	6/8/12	-39.6
158075	Betts Creek Beds	2/8/11	-36.09
158077	Betts Creek Beds	4/8/11	-39.03
158593B	Betts Creek Beds	30/8/12	-54.77
158592C	Rewan Group	1/1/12	-43.08
158593C	RewanGroup (?)	8/9/12	-44.08
158849	Colinlea Sandstone	22/11/13	-48
132941	Unknown	27/10/12	-41.3

As the existing information has only recorded an individual water level for the different bores, the analysis of change in water level and cumulative departure from average rainfall have not been undertaken. Ongoing monitoring of underground water level will be conducted in the future as required (refer to **Groundwater Monitoring** section below for the proposed monitoring details). As additional information becomes available, further data analysis will be undertaken and information revised.

There are no groundwater bores accessing aquifers deeper than the Colinlea Sandstone within 208km of either Albany 2 or Albany 1. There is one single groundwater bore accessing a deep aquifer from the Jochmus Formation (**Figure 38**). This groundwater bore is located 208km to the south-east of Albany 1 and Albany 2 where the Jochmus Formation shallows along the basin margin. No groundwater bores access the Jericho Formation (immediately above the Lake Galilee Sandstone target formation) or the Lake Galilee Sandstone.

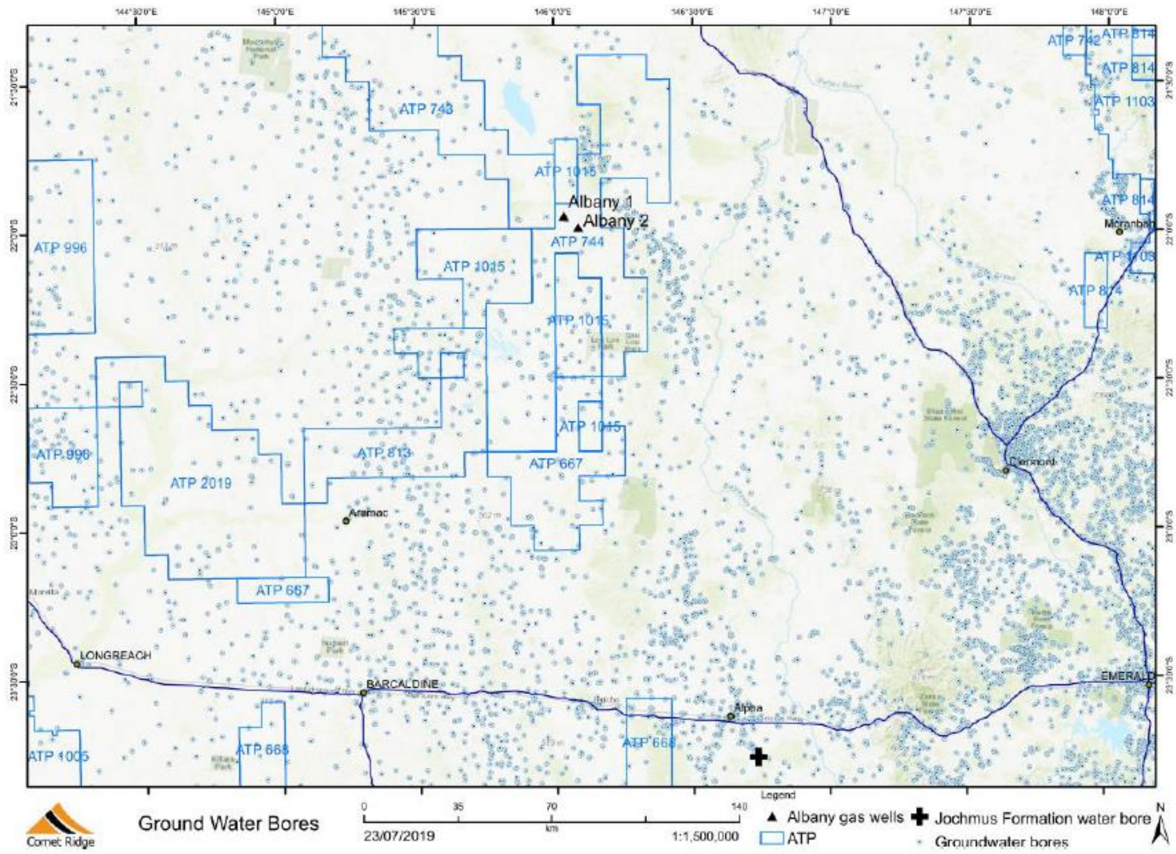


Figure 38. Albany wells and the closest groundwater bore accessing the Jochmus Formation.

Groundwater Quality

There is limited data on groundwater quality available within the ATP744. Available water quality data is presented in Appendix A.

In the vicinity of the Albany wells, the only water quality information available is from the Baseline Assessment Report conducted in October 2019. The report included bores RN 96545 (Mosquito Bore), Unregistered (Kades Bore), Unregistered (Carmichael House Bore) and RN16896 (Caseys Bore). The data is presented in **Table 14**.

Additional water quality data were sourced from the DNRME, Queensland groundwater database. Over the time there have been significant changes in how the data are collected from drilled bores. This has an implication on the quality of the historical data. Therefore, this set of data is of unknown quality as related to measurements dated back to the time of the bore installation.

Based on the available data:

- The groundwater quality of the Moolayember Formation is typically slightly brackish to saline (Bioregional Assessment Programme, Australian Government 2017). Recent measurements conducted as part of the baseline assessment in 2019, resulted in EC varying between 1527 to

3280 µS and TDS varying between 809mg/L and 1800mg/L. The results are consistent with previous studies. However, significant variability in water quality within the Moolayember Formation was observed in the data sourced from the groundwater database. The range of sampled TDS varied between 700 and 8600mg/L including few outliers in the range of 27,000mg/L. The reason of this variability is unknown, as the data in the government database are of unknown quality.

- Within the Clematis Group the water quality is generally reported as "potable". Within the QLD Government dataset available, samples seem to be collected from one bore (RN 11644) and have widely ranging TDS readings between 3,000 and 19,000 mg/L. The data are unlikely to be representative of this aquifer characteristic.
- Groundwater quality is highly variable with depth and location within the Betts Creek Beds. While the whole range of samples sourced from the groundwater database vary in TDS between 200 and 43,000 mg/L, it is likely that only the samples collected from Gunn 2 during its initial flow testing represent the actual formation water quality. RPS (RPS, 2012) suggest that bores screened within the coal seams yield slightly brackish to brackish groundwater, whilst bores screening the interburden yield fresh to slightly brackish groundwater.
- There are only two available analyses from the Lake Galilee 1 well from Lake Galilee Sandstone Formation. It is not clear whether those samples are representative of the formation water.
- Most of the samples from "undifferentiated aquifers" may be attempted to be associated with either Moolayember or Clematis. Their composition fits the general expectations of groundwater quality from those units, and well depths suggest they are collected from one or the other.

It is difficult to speculate whether water quality data confirms or disproves any possible connections between aquifers. If anything, it may suggest a possible hydraulic connection between the groundwater in the Moolayember Formation and the Clematis Group, although that conclusion is highly speculative, as the quality variation within Moolayember formation potentially exceeds the differences in water quality between those two units. Further geochemical data from definitive aquifer intervals would be required to potentially confirm the degree of hydraulic connection between these two formations.

Table 14: Available Water Quality data in the vicinity of Albany Project

RN	96545 (Mosquito bore)	Unregistered (Carmichael House Bore)	Unregistered (Kades Bore)	16896 (Caseys Bore)
Aquifer	Moolayember Formation	Moolayember Formation	Moolayember Formation	Moolayember Formation
Depth (m)	213	61.3	74.82	98.95
Conductivity (uS/cm)	1527	1864	1727	3280
pH	7.14	7.29	7.7	7.94
Hardness (mg/L Ca)	135	159	NA	144
Alkalinity (mg/L)	119	130	NA	146
TDS (mg/L)	809	971	NA	1800
Na (mg/L)	251	322	NA	669
K (mg/L)	16	19	NA	7
Ca (mg/L)	31	24	NA	29
Mg (mg/L)	14	24	NA	22
Fe (mg/L)	0.12	<0.05	NA	<0.05
Bi- carbonate (mg/L)	119	130	NA	146
Carbonate (mg/L)	<1	<1	NA	<1
Cl (mg/L)	429	548	NA	983
F (mg/L)	0.3	0.3	NA	0.3
Sulphate (mg/L)	28	38	NA	91

Springs

A review of the Queensland Springs Database was undertaken in January 2020. This report includes updated Version 5 of the Queensland Wetland Database. The current mapped locations of springs are shown in **Figure 39**.

Springs located in the eastern Galilee Basin comprise the Barcaldine Supergroup (DNRME, 2015).

A review of the database found one cluster of springs which are located within the extent of the permit area and are understood to be discharge springs from the Moses complex (DES, 2019). These springs form part of a larger isolated cluster of wetlands, known as the Doongmabulla Spring complex, and are associated with the Carmichael River and its tributaries within and adjacent to the permit area. This group of springs is associated with the Galilee Basin, however, due to limitations in available data their aquifer source is ambiguous (Queensland Herbarium, 2017). Geological mapping and intersections from Shoemaker #1 coal seam gas well located approximately 600m to the north of the spring complex suggests an association with either the Moolayember Formation or Clematis Group. Shoemaker #1 intersected the Moolayember Formation beneath a thin veneer (3.20m) of Quaternary surficial sediments. The Clematis Group underlies the Moolayember Formation and was intersected at 80.8m depth. The Moses springs comprise approximately 30 individual mound springs and contribute to riverine wetland which are associated with the springs. The Doongmabulla Springs complex is also recognised as a Nationally Important Wetland area (**Figure 40**).

The Moses spring complex is located approximately 17km from the Albany Project area and is considered to be sufficiently separated horizontally and vertically from the proposed production testing, and as such no impacts are expected.

The other closest spring group which is located outside of ATP 744 is the Groove complex located approximately 17km to the west of Albany 1. These springs are associated with the Hooray Sandstone aquifer system (RPS, 2012) and are west of the inferred Hutton - Rand unconformity and part of the Eromanga basin. These springs are not associated with the Lake Galilee Sandstone or any of the overlying aquifers.

The Eromanga Basin sequence is absent from the tenure and is not expected to be encountered during the proposed activities. There is currently no evidence of hydrogeological connection between the band of springs to the west of the permit area and the Galilee Sandstone formation.

It is considered that those springs are sufficiently separated from the Albany Project site, and that it is highly unlikely that production testing at the Albany Project may result in any decline in water levels of springs and as such no impacts are expected.

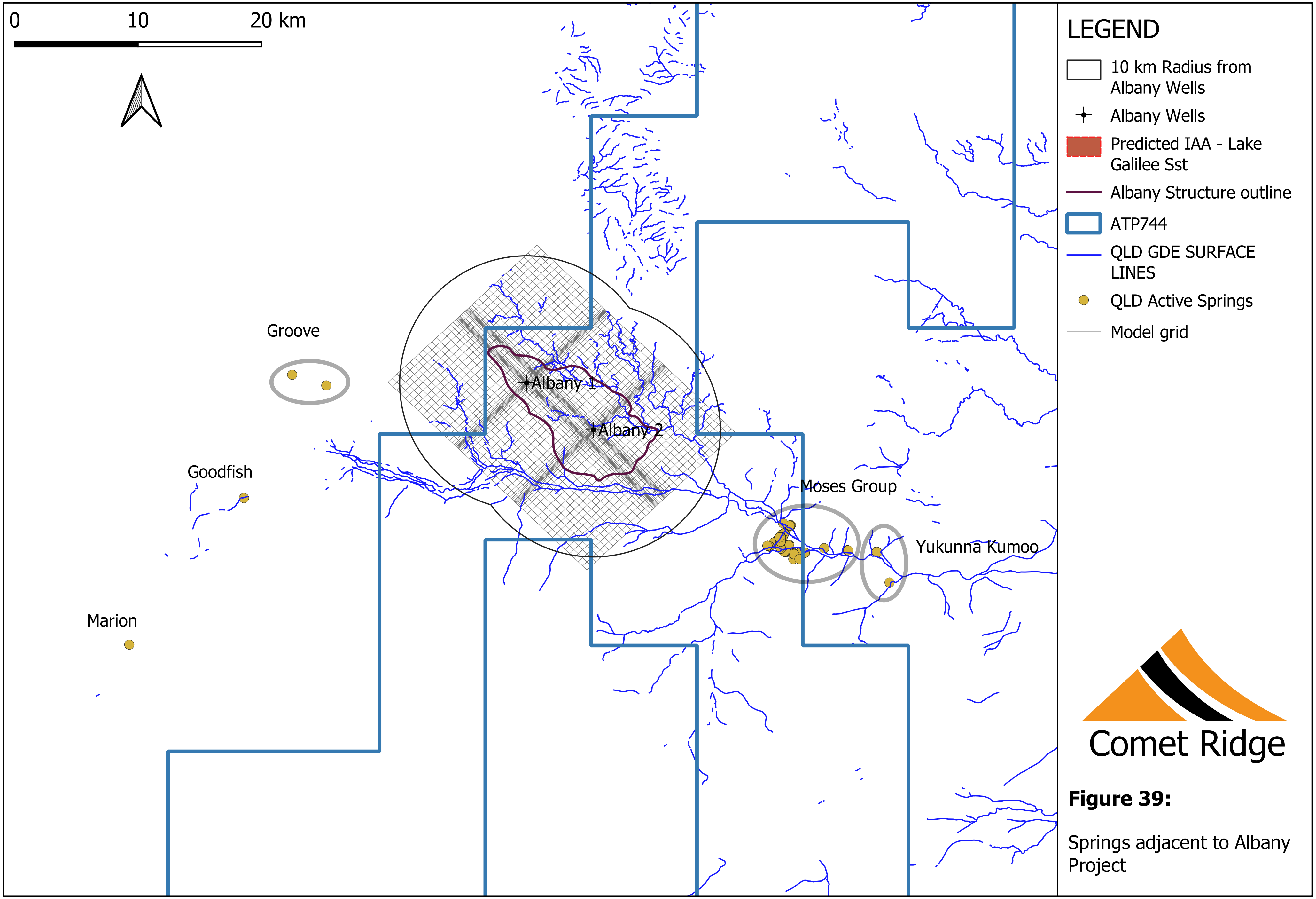


Figure 39:

Springs adjacent to Albany Project

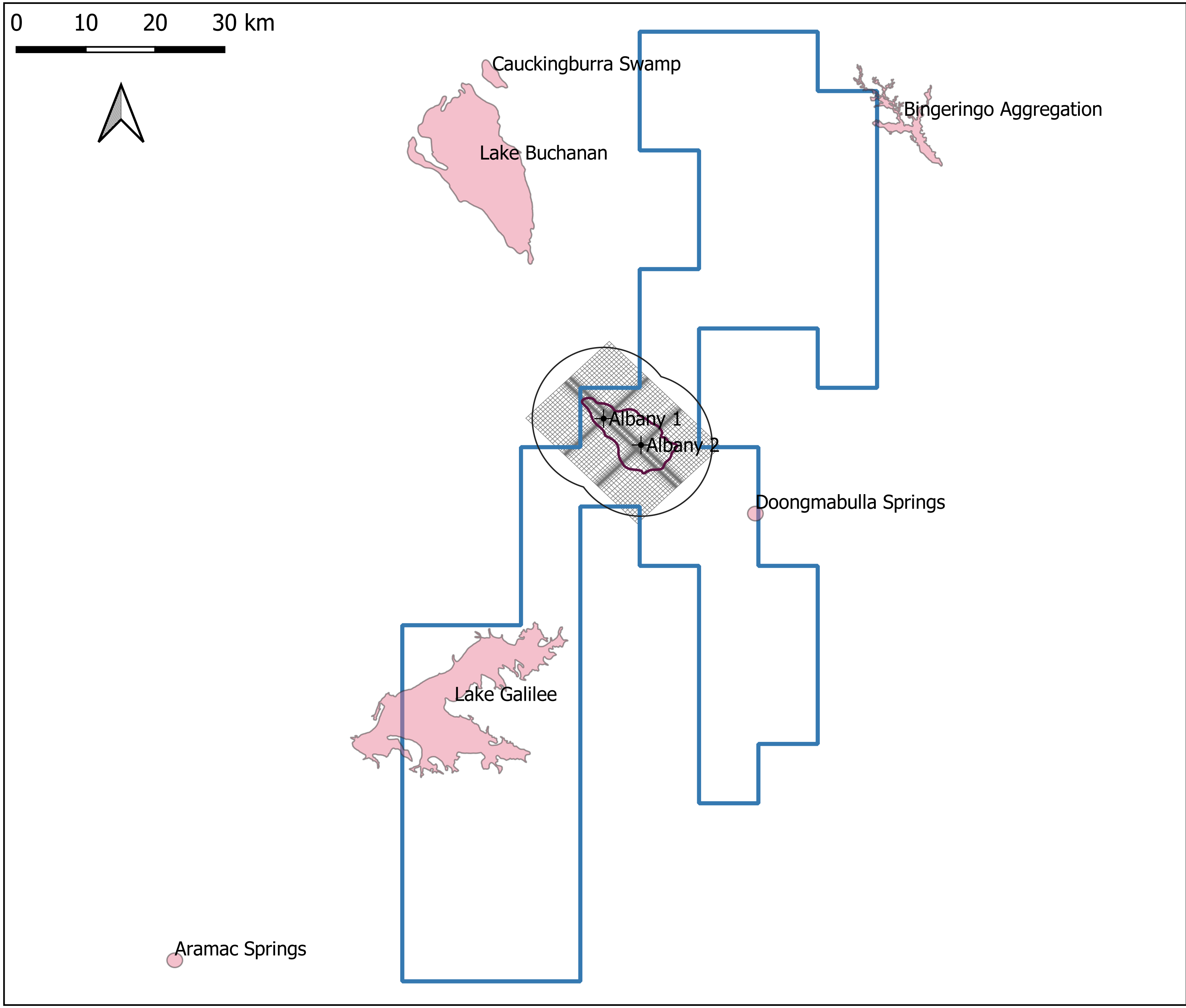


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Figure 40:

Nationally Important Wetland Areas

Part C: Predicted Water Level Declines for Affected Aquifers

Introduction

In order to understand and estimate the possible impacts of the groundwater extraction associated with planned production testing of the Albany wells, a numerical groundwater model has been constructed. In particular, the objective of the groundwater modelling was to estimate the water level decline in the Lake Galilee Sandstone and the potential for an impact on groundwater levels in the overlying formations including shallow aquifers.

Methodology

Model grid

A three-dimensional, nine-layer groundwater model was constructed in MODFLW under Groundwater Vistas user interface.

The model covers the area of approximately 390km^2 (17 x 21km), and it is centred on the Albany Structure. Model grid was constructed with variable grid size. The individual cell dimensions vary between 900m and 30m, with smaller grid cells around the Albany wells. The finite differences grid was rotated 45degrees to better align with the general, regional groundwater flow directions in the basin. Model grid and its location is presented in **Figure 41**.

Model vertical discreditation comprise nine (9) layers representing respective hydrogeological units, with the Lake Galilee Sandstone represented by three (3) numerical layers for greater accuracy of reproducing sand and shale sublayers.

Where stratigraphic surfaces were available, these were used to define top and bottom layer elevations. The summary of represented model layers and their average thicknesses is presented in **Table 15** below.

Table 15. Average thicknesses of model layers

Layer No	Formation	Average thickness (m)
1	Moolayember Fm	240
2	Clematis Group	128
3	Rewan	309
4	Betts Creek Beds incl Colinlea Sandstone	259
5	Jochmus Fm	690
6	Jericho Fm	820
7-9	Lake Galilee Sandstone	265

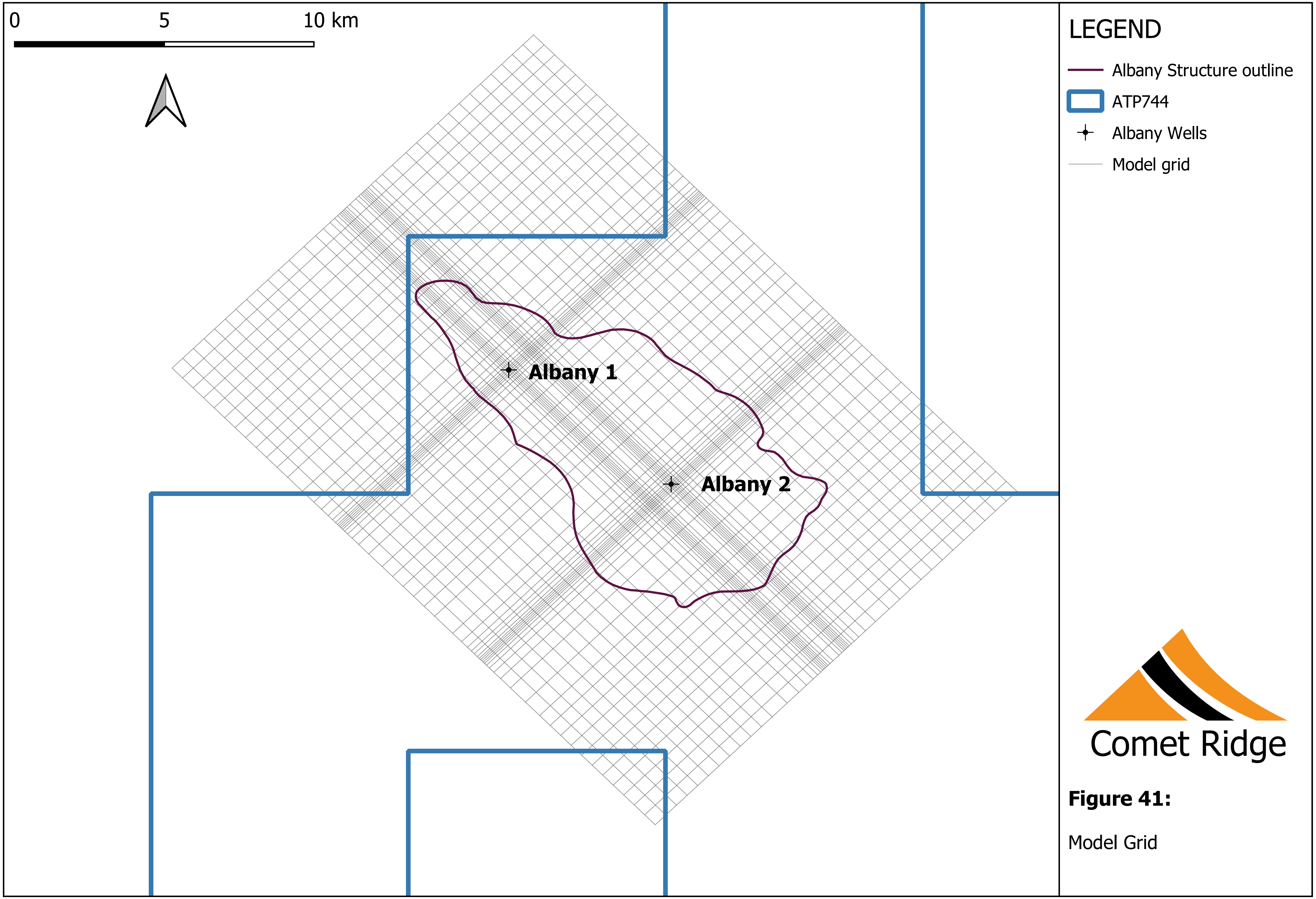

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Figure 41:

Model Grid

Boundary conditions

The literature on recharge processes in the Galilee Basin appears to be very limited. Marsh *et al.* (2008) states that groundwater recharge for the Triassic part of the Galilee sequence (the major aquifer sequence) occurs in the north-east with generally south westerly flow (CSIRO, 2014).

The recharge applied in the model was consistent with recommendations by the GAB resource study (GABCC 1998) to use a recharge rate of 1 – 2% of mean annual rainfall as a basin wide average. The mentioned study also suggested that the evaporation rates in GAB typically exceed rainfall rates.

Taking the above into account, recharge and evapotranspiration rates were fine-tuned during the model steady state calibration, resulting in:

- Recharge - 0.0003 mm/d (equivalent to approximately 1.5% of mean annual rainfall for the area);
- Evapotranspiration - 0.001 mm/d

To maintain the regional flow directions, the south-western edge of the model in layer 2 (Clematis Sandstone – main aquifer in the area) was designed as an outflow boundary, using MODFLOW's drain cells.

Model parameters

Hydraulic conductivity data applied in the model was based on literature review, regional data analysis and DST results from oil and gas wells drilled in the Galilee basin. In general, the availability of data decreases with depth, mostly because less wells are drilled to greater depths. There are no wells drilled deeper than Betts Creek Beds, apart from conventional oil and gas wells in the area.

The Moolayember, Clematis and Rewan formations data is mostly based on regional data derived from water bores, while deeper formations hydraulic conductivity is derived from available DSTs (Albany 2, Lake Galilee 1, Koburra 1, Jericho 1, Jericho 2, Gunn-1, Hergenrother-1 and DNRME database).

Permeability data collected from DSTs was re-calculated into hydraulic conductivity using a conversion of 1mD = 1.1 x 10-8 m/d. Specific storage was calculated based on the formula provided in literature (Kruseman, de Ridder, 1992) and assuming sandstone compressibility of 1E-9 1/Pa.

The hydraulic parameters adopted in the model are presented in **Table 16** below.

Table 16. Hydraulic parameters adopted in the model.

Formation	Layer no	Kh (m/d)	Kv (m/d)	Ss	sy
Moolayember Fm	1	0.251	0.084	1.00E-05	8.8
Clematis Group	2	3.110	0.294	1.00E-05	12.5
Rewan	3	0.136	0.003	1.00E-05	3.0
Betts Creek Beds	4	0.251	0.006	1.00E-05	3.0
Jochmus Fm	5	0.097	0.008	1.00E-05	5.0
Jericho Fm	6	0.067	0.003	1.00E-05	3.0
Lake Galilee Sandstone	7 - 9	0.006	0.003	1.00E-05	6.0

In the absence of available water level hydrographs from the wells within the model domain, only steady state calibration has been carried out. In general, the steady state calibration was carried out with the assistance of PEST, and focused on achieving results consistent with general flow directions in GAB.

There is a very limited amount of SWL data in the area, and available data varies significantly in quality and timing (some water level measurements are available from close-by wells in DNRME database date back to 1950). Therefore, the steady state calibration focused on the most recent data, collected during Baseline Assessment carried out in October 2019, complemented by the most recent measurements from the DNRME database.

The calibration was focused on adjusting recharge, evapotranspiration and the elevation of the drain boundary condition to match measured groundwater levels. No changes to the regional values of hydraulic conductivity or storage parameters have been carried out. It is believed that hydraulic conductivity values represent well documented regional values, and lack of transient data prevented meaningful storage parameter calibrations.

The resulting water table calibrated reasonably well (within a few meters) with the Moolayember water level measurements, and also aligned well with deeper formations pressure measurements recorded in some of the deeper wells. Steady state calibrated model heads were then used as the initial heads for the model predictions.

As mention earlier in Part A, Comet Ridge believes that no water is likely to be produced during testing activities. However, for the modelling purposes, water production of 16m^3/d (100 bbl/d) from both of the Albany wells was assumed, for the period of 30 days. This assumption is considered conservative, in that it is likely to overestimate water production and predicted impact. For the modelling purposes, the testing was assumed to start on 1 July 2020 and continue until 1 August 2020.

Result and discussion

According to the simulation results, only Lake Galilee Sandstone is expected to experience drawdown (**Figure 42**). Therefore, the IAA is only expected within the sands of the Lake Galilee Sandstone and no impact was predicted in any of the overlying formations.

Due to the low horizontal permeabilities and relatively high porosities for the Lake Galilee Sandstone, the predicted cone of depression is confined to the proximity of the tested wells. The maximum extent of 5m drawdown contour (IAA) is predicted to a distance of approximately 100m from the well. The maximum drawdown extent is predicted at the end of the proposed testing period. The recovery is quick, with predicted drawdown decreasing to nil within a year. No drawdown is predicted at the end of the 3-year period to which this UWIR relates to.

No drawdown has been predicted in the overlying formations, and therefore no impact on any of the water bores or other environmental receptors is expected.

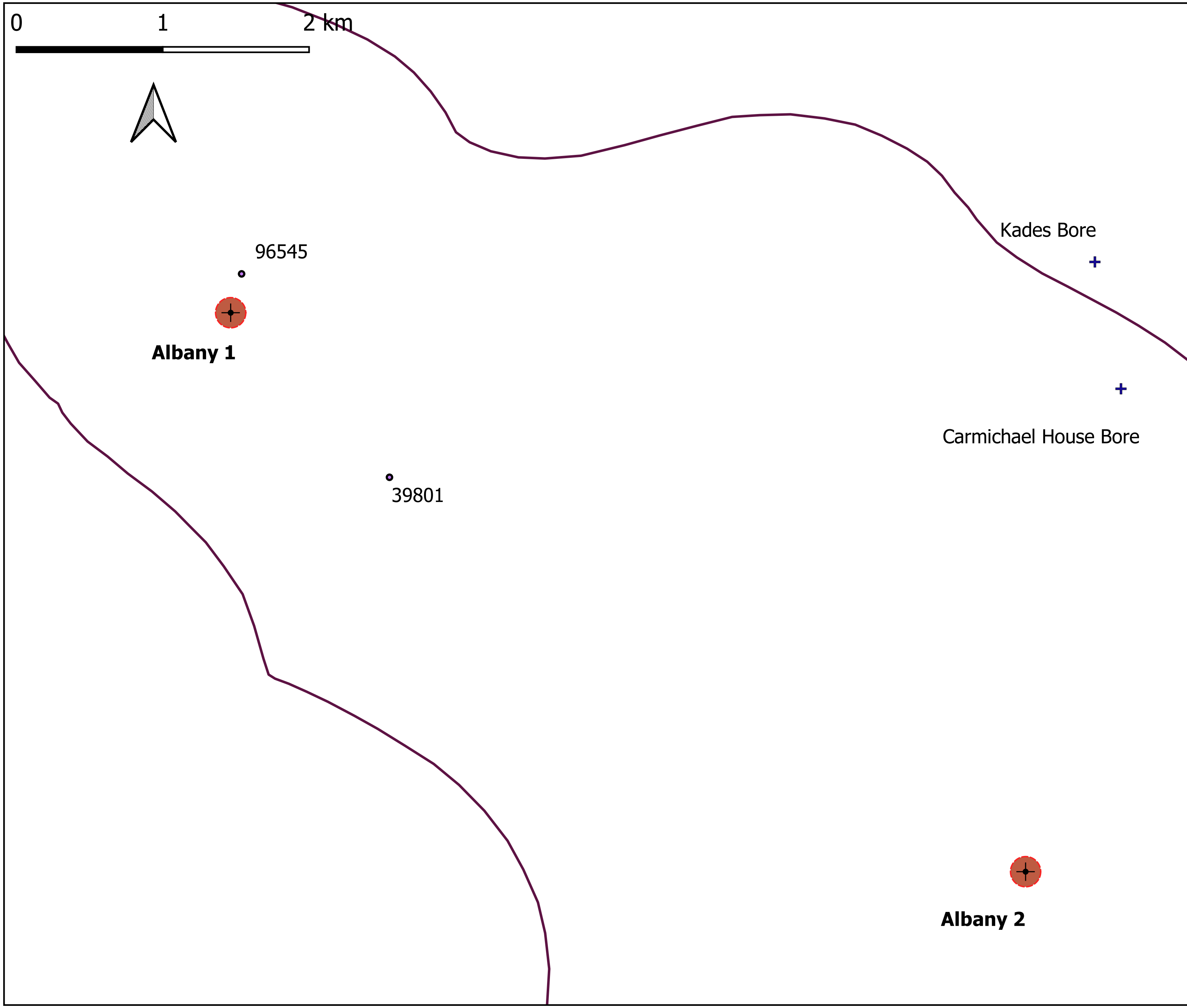
As discussed in Part A above, the most likely scenario is that no water will be produced from any of the wells during testing activities and potential production thereafter. In which case, there is no impact predicted in any of the formations including the Lake Galilee Sandstone itself.

In summary, the results of the modelling indicate the following:

- The IAA is only predicted within the Lake Galilee Sandstone;
- No impacts to any of the identified aquifers or springs is predicted;
- There are no registered groundwater water bores within the predicted IAA;
- The drawdown in the Lake Galilee Sandstone is likely to be only temporary, and recovery is expected to occur before the end of the 3-year assessment period; and
- No Long Term Affected Area (LTAA) is predicted.

Limitations

It should be noted that the numerical model has some inherent limitations impacting the accuracy of the predictions. The most obvious of which are the quality of available data the model is based on, the single-phase simulation, and the assumption of the magnitude of the water production rates during testing.



LEGEND

Registered water bores [DNRME and private]

- Existing
- Unregistered Water Bores
- Albany Wells
- Predicted IAA - Lake Galilee Sst
- Albany Structure outline
- ATP744

Comet Ridge

Figure 42:

Predicted IAA within Lake Galilee Sandstone

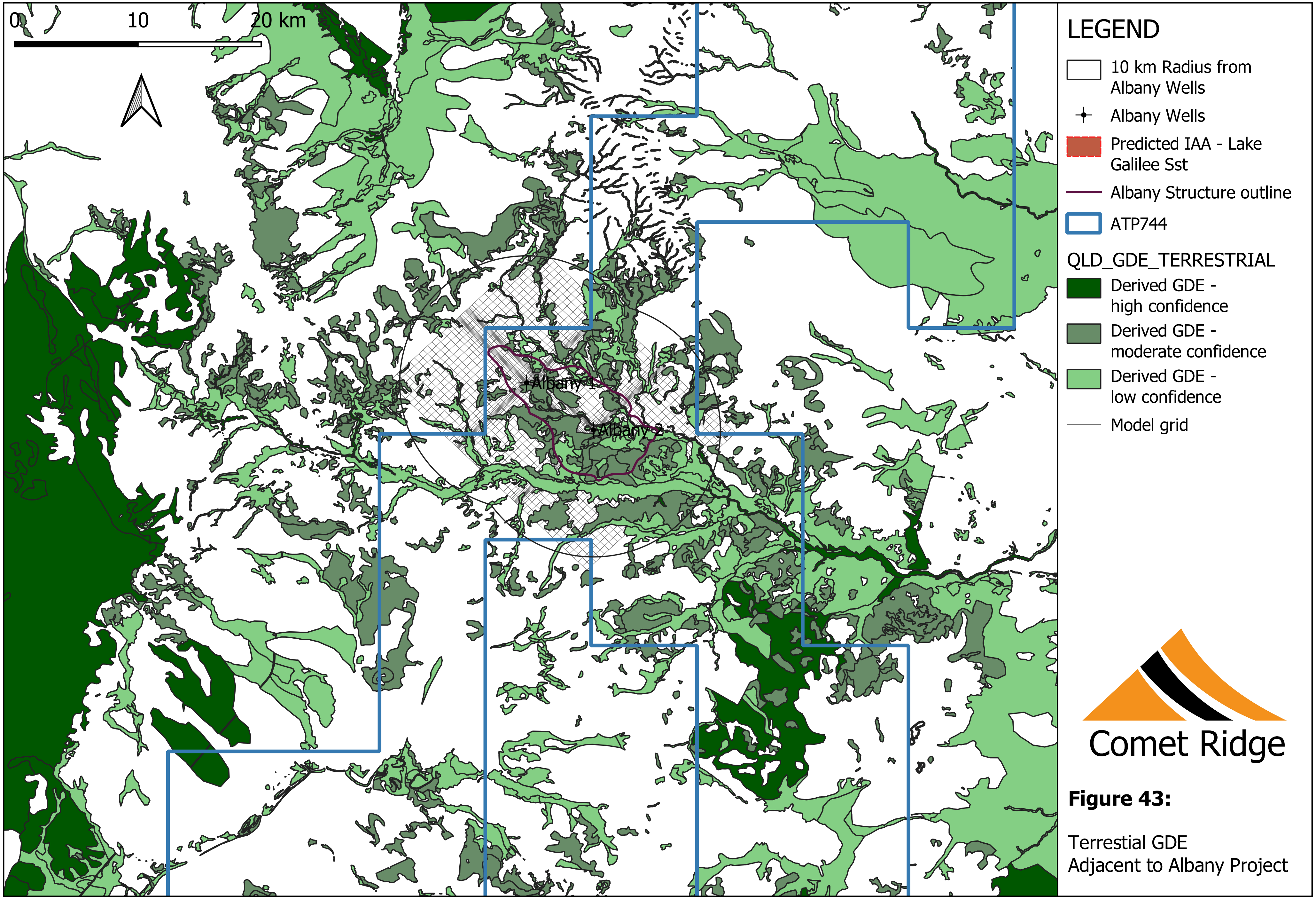


Figure 43:

Terrestial GDE Adjacent to Albany Project

Part D: Environmental Values

The environmental values of water to be enhanced or protected are outlined in Section 6 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019*.

For waters that are not included in Schedule 1 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019;* environmental values include:

(a) for high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued; or
(b) for slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators; or
(c) for moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree; or
(d) for highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in paragraphs (a) to (c); or
(e) for waters from which aquatic foods intended for human consumption are taken—the suitability of the water for producing the foods for human consumption; or
(f) for waters that may be used for aquaculture—the suitability of the water for aquacultural use; or
(g) for waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes; or
(h) for waters that may be used for recreation or aesthetic purposes—the suitability of the water for—
    (i)primary recreational use; or
    (ii)secondary recreational use; or
    (iii)visual recreational use; or
(i) for waters that may be used for drinking water—the suitability of the water for supply as drinking water having regard to the level of treatment of the water; or
(j) for waters that may be used for industrial purposes—the suitability of the water for industrial use; or
(k) the cultural and spiritual values of the water.

Identified Environmental Values

The following environmental values have been identified in ATP744:

- Farm water supply (i.e. use of groundwater from water bores);
- Stock watering (i.e. use of groundwater from water bores);
- Domestic use (i.e. use of groundwater from water bores);
- Aquatic ecosystem (i.e. Lake Galilee, Moses Springs and waterways);
- Visual appreciation (i.e. aesthetic qualities of Lake Galilee and Moses Springs);
- Cultural values (i.e. aesthetic qualities of Lake Galilee and Moses Springs)

All the above listed environmental values are primarily associated with either surface water features (lakes and waterways), springs, or Quaternary, Tertiary and Triassic aquifers accessed by registered groundwater bores.

Groundwater Dependant Ecosystems

Groundwater Dependant Ecosystems (GDE's) are ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes, and ecosystem services. Ecosystem dependency may vary temporally (over time) and spatially (depending on its location in the landscape). GDE's include aquifers, caves, lakes, palustrine, lacustrine and riverine wetlands including springs, rivers and vegetation that access groundwater through their roots.

Maps of the following GDE's are provided to show spatial relationship between the IAA, model extent, and the 10km radius from the proposed Albany Project with mapped GDE's including wetlands and springs.

- Springs and watercourses adjacent to the Albany Project (**Figure 39**)
- Queensland Wetland Areas – water bodies, regional ecosystems and mapped nationally important wetlands, including springs across ATP744 (**Figure 40**)
- Terrestrial Groundwater Dependant Ecosystems adjacent to the Albany Project (**Figure 43**)
- Surface Groundwater Dependant Ecosystems (area, line and point data) adjacent to the Albany Project (**Figure 44**)

No underground GDE's are mapped across the permit area or surrounding area.

Wetland Areas and Nationally Important Wetlands

Wetlands are areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres. To be a wetland the area must have one or more of the following attributes:

- At least periodically the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle;
- The substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers;
- The substratum is not soil and is saturated with water or covered by water at some time.

The closest wetland to the Albany Project site is the Doongmabulla Springs. It is recognised as a nationally important wetland, and it's located approximately 20km away from the Albany 2 well. Its seasonal water balance is constant with some evaporation and associated reduction in extent in summer. It flows permanently, usually to a depth of 5-20cm. The water quality is fresh.

The most significant surface feature in the ATP744 is Lake Galilee which is recognised as a nationally important wetland and comprises both lacustrine wetland system (e.g. lakes 15.8%) and palustrine wetland system (e.g. vegetated swamps – 84.2%). Lake Galilee habitat mainly comprises arid to semi-arid grass, sedge and herb swamp, saline lake and saline swamp and tree swamp. The wetland area is primarily sourced from shallow, unconfined, unconsolidated sedimentary aquifers which are closed alluvial systems with fluctuating and intermittent flow. Lake Galilee is located over 30km away from either of the Albany wells.

The second-biggest wetland in the area, Lake Buchanan, is located outside of ATP744, and just under 30km from Albany 1 well. The lake is a closed alluvial system with brackish, intermittent groundwater connectivity regime.

The other nationally important wetland area, Bingeringo Aggregation, is located within, and adjacent to, the permit boundaries. The Bingeringo Aggregation primarily comprises both riverine wetland system (e.g. river and creek channel - 92.6%) and palustrine wetland system (e.g. vegetated swamps - 7.4%). It is located approximately 60km north from the Albany Project area.

Terrestrial groundwater dependant ecosystems in the area are primarily associated with either Tertiary Ironstone jump-ups or alluvium and sandy plains and wetlands (**Figure 43**). Tertiary Ironstone jump-ups comprise unconfined intermittent aquifers sourced from local bedrock which primarily support specific melaleuca vegetation. Unconsolidated alluvial and sandy plain systems are primarily sourced from localised shallow alluvial aquifers which generally support specific vegetation ecosystems (such as Bloodwood or Melaleuca) on old loamy and sandy soils with fluctuating or intermittent flow.

Riverine wetlands have also been identified and are associated with waterways traversing the central and north-eastern portion of the permit area. Some areas of remnant regional ecosystem comprising 1-50% wetland by area have also been mapped across the permit.

Watercourses traversing the permit area are described as either channels on sandstone ranges with fluctuating and intermittent flow sourced from unconfined consolidated sedimentary aquifers or channels on alluvia and sandy plains below 300m in elevation with fresh, intermittent flow sourced from unconfined shallow alluvial aquifers (**Figure 44**).

Mapped springs are discussed further under the **Springs** section of this report.

Potential GDE Aquifers across the permit area comprise primarily either consolidated or fractured sedimentary aquifers (Tertiary Ironstone jump-ups) or unconsolidated sedimentary aquifers (i.e. sandy plains, Quaternary Alluvium) with intermittent groundwater flow. Water quality ranges between fresh and brackish.

Impacts Arising from Previous Exercise of Underground Water Rights

The water subject to the underground water rights in ATP744 petroleum activities for the Albany Project is within the Lake Galilee Sandstone. No activities resulting in extracting water from this formation have been located within the ATP744 and therefore no previous impact have occurred.

Impacts Arising from Future Exercise of Underground Water Rights

No impact from future exercise of underground water rights is expected. Based on the results of the groundwater modelling, general geology, and hydrogeological settings, no impact to identified environmental values is expected from the water production (if any) from testing of the Albany Project wells.

The Lake Galilee Sandstone reservoir is separated from overlying Triassic aquifers by at least 2000m, of which the majority are low permeability formations and regional aquitards. There is a very high degree of confidence that the chance of vertical connection between the gas-saturated Lake Galilee Sandstone targets and all potential aquifers is very low. This includes potential aquifers of the lower Galilee basin within the Jericho and Jochmus formations and the Betts Creek Beds, and the potential aquifers of the basal GAB in the Moolayember Formation, Clematis Group and Dundas Beds.

The results of the groundwater modelling for the Albany Project wells suggest that no drawdown is expected in any other formations above the Lake Galilee Sandstone. The Lake Galilee Sandstone is the only layer where drawdown was predicted. Where the drawdown was greater than the 5m threshold for a confined aquifer, an immediately affected area (IAA) was mapped and only applies to the Lake Galilee Sandstone. The results of the groundwater modelling for this UWIR support other available hydrogeological information in suggesting that there is very limited interaction between the Lake Galilee Sandstone and any other formation in the model area. For more information, refer to **Part C: Predicted Water Level Declines for Affected Aquifers.**

In addition, no faults have been mapped within the IAA or Albany Structure that have been interpreted to connect the Lake Galilee Sandstone to overlying Triassic or Cenozoic aquifers or the ground surface. The intervening geological units show good lateral continuity across the area of interest and lack large scale structural features that may form vertical conduits between the target zone and shallower aquifers.

The potential for leakage to aquifers due to loss of well integrity is also very low. Comet Ridge has reduced that risk to As Low As Reasonably Practical (ALARP) in the well design and during operations at each step in the process through monitoring. In particular:

- The well design and construction provide the mechanical integrity that reduces this risk to ALARP;
- Pressure testing confirms that production casing meets designed pressure specification;
- Cement bond logs confirm the integrity of cement that fills the casing-well bore space and prevents migration;
- Pressure safety trip out systems installed during the stimulation prevent pressure limits of the surface pipework and downhole casing equipment being exceeded;

- The installation of a production casing packer and brine filled annulus in the final downhole completion provides an additional monitored barrier between the production tubing (conduit of produced fluids) and all aquifers;
- The potential aquifers of the lower Galilee basin in both wells are protected behind both the 4-1/2" production casing and the 7" intermediate casing strings and their respective annular cement sheaths;
- The potential aquifers of the basal GAB are additionally protected by the 9-5/8" surface casing and cement.

Comet Ridge is confident that the confirmed integrity of the well construction; stimulation design, and the small scale of the planned stimulation treatments coupled with the described geological separation, is enough to minimise the risk of the treatment impacting aquifer units.

The Lake Galilee Sandstone is not used as a water source, and therefore the impact on water users is unlikely. However, the necessary monitoring strategies are documented under **Part E: Groundwater Monitoring** section of this document and any necessary baseline assessments on bores will be completed as required per ATP744 Baseline Assessment Plan. All active landowner bores within 10km of Albany Project wells have been nominated as monitoring bores in this report.

Table 17: Environmental values associated with the future exercise of underground water rights.

Future exercise of underground water rights	Environmental Values											
	Aquatic ecosystems	Irrigation	Farm supply	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary Recreation	Visual Appreciation	Drinking Water	Industrial Use	Cultural and Spiritual
Lake Galilee Sandstone within the IAA	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

If further development on the resource tenure continues, and Albany wells are put on production, there would be an expansion of the IAA, and there may be a LTAA in the future. However, the future development of the area is contingent upon results from future production testing.

A review of the impact of environmental values from the exercise of underground water rights will be undertaken as part of the annual review process for the UWIR.

Figure 44: Surface GDE adjacent to Albany Project

Part E: Groundwater Monitoring

The underground water monitoring strategy has been developed to address the findings of this UWIR, and to accurately quantify potential water level and water quality changes caused by the exercise of underground water rights within ATP744. The information obtained through the monitoring strategy will also be used to confirm and refine future iterations of the groundwater modelling.

The proposed groundwater monitoring will verify the model predicted magnitude of impact and its reduction with time. Should there be a large discrepancy between monitoring data and the predictions generated through the model, the model will be updated with new information and re-run to generate updated predictions.

Rationale

The modelling predicts that there will be a small and temporary IAA within the Lake Galilee Sandstone, and there is no LTAA predicted as the impact reduces rapidly within weeks after production testing ceases. No anticipated impacts are predicted by the current modelling in the nearby aquifers. However, the groundwater monitoring of these aquifers will continue, and the information will be routinely fed back into the model to verify and improve the predictions of the modelling in the future.

Registered bores nearby the project area are primarily accessing the Moolayember and the Clematis aquifers. These aquifers are separated from the targeted Lake Galilee Sandstone formation by the Rewan Group and Jericho Formation, both considered regional aquitards. In addition, there is a number of low permeability clay and silt layers within the lower portion of the Betts Creek Beds and the Jochmus Formation, which act as additional flow barriers for the vertical movement of water. In general, the vertical separation distance between the targeted gas reservoir and the aquifers from which local registered bores are sourcing water exceeds 2000m in most of the cases.The Albany wells are cemented and cased to the best practice to avoid aquifer cross-contamination.

A spring management strategy is not considered to be required for this UWIR for the following reasons:

- No springs are located within the IAA of the Albany Project;
- There is no known hydrological interconnection between the springs or aquifer feeding the springs, and the Lake Galilee Sandstone formation from which the Albany Project may extract small volumes of water during well testing program;
- Vertical distance between the gas reservoir and the springs exceeds 2500m. Significant portion of those 2500m is comprised of formations with very low hydraulic conductivities, which are considered regional aquitards and confining beds and restrict the vertical movement of groundwater between aquifers;
- No faults with a potential to hydraulically connect target reservoir and surface have been identified in the area.

The proposed groundwater monitoring will verify the model-predicted magnitude of impact and its reduction with time. Should there be a large discrepancy between monitoring data and the predictions generated through the model, the model will be updated with new information and re-run to generate updated predictions.

Monitoring Strategy

Groundwater impact assessment criteria have been designed to identify any potential depressurisation within the Lake Galilee Sandstone (if technically possible) and any adverse impacts that such depressurisation might induce on the overlying aquifers including alluvial aquifer systems. Impact assessment criteria for existing and proposed bores include piezometric pressure (measured as depth to water level) and water quality parameters (inclusive of field parameters and laboratory analytes) contained in the Section 3.6.4, Guideline Baseline Assessments, ESR/2016/1999, Version 3.02, DES.

If routine monitoring reveals either of the scenarios below, an investigation into whether the changes can be attributed to the proposed production testing will be undertaken. If the change can be attributed to the production testing activities, mitigation actions will be initiated.

Scenarios

- Water Level: Compare measured water level to previous monitoring rounds. If:
    - (a) water level is lower than previous lowest measurement by >5m or
    - (b) three subsequent monitoring events record a fall in water level >1m.
- Water Quality: Compare concentrations of analytes within **Table 11** to previous monitoring. If:
    - (a) value departs highest or lowest previous measurement by more than 25% or
    - (b) three subsequent monitoring events record an increase in one or more analytes concentrations.

Results will be assessed against the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)* and *Australian Drinking Water Guidelines (2011).*

It should be noted that water level triggers are applicable only to the dedicated monitoring bores (i.e. not used by landholders). In case the monitoring bore is also a landholder bore which may be actively used, the potential changes in water level and water quality must be assessed in accordance to the requirements outlined in the Guideline Bore Assessments (ESR/2016/2005), DES authorised under section 413 of the Water Act 2000.

The below strategy will facilitate monitoring of the water volumes extracted from the Lake Galilee Sandstone, and water levels and quality in overlying Triassic aquifers and regional impacts of the production testing.

The water monitoring program is proposed to commence when the Albany Project has been commissioned and has commenced production testing, which is assumed to be mid 2020 for the purposes of this report.

Monitoring Locations

There are no registered or existing groundwater bores within close proximity to the Albany wells which would be deeper than the Moolayember Formation. Therefore, the possibility to monitor pressure/water level changes during production testing may be possible only if the testing program utilises downhole pressure gauges installed in the tested wells.

In case, and only in case, when water is produced during testing, the additional monitoring is proposed in the closest available bores to the testing site including RN: 96545 (Mosquito Bore) and two unregistered bores – Kades bore and Carmichael House Bore.

As there is no LTAA predicted, baseline sampling within or outside ATP744 is not recommended.

A list of bores and wells proposed to be monitored with parameters to be analysed and frequency of monitoring is shown in **Tables 18, 19 and 20**.

Table 18: Groundwater monitoring strategy

Bore	Formation	Parameters	Frequency
Albany ST1	Lake Galilee Sandstone	Water volumes, formation pressure, pH, EC, Chemistry[1]	Formation pressure measurements are recommended ONLY if well equipped with downhole gauges. Water volumes and quality measurements to be collected during testing activities.
Albany 2	Lake Galilee Sandstone	Water volumes, formation pressure, pH, EC, Chemistry[1]	Formation pressure measurements are recommended ONLY if well equipped with downhole gauges. Water volumes and quality measurements to be collected during testing activities.
RN96545 (Mosquito bore)	Moolayember Formation[2]	Standing Water Level (SWL), Total Depth (TD), field parameters (pH, EC, T, DO, TDS and ReDox), Chemistry[1]	6 monthly for 12months, then annually
unregistered (Kades Bore)	Moolayember Formation[2]	SWL, TD, field parameters, Chemistry[1]	6 monthly for 12months, then annually
unregistered (Carmichael House Bore)	Moolayember Formation[2]	SWL, TD, field parameters, Chemistry[1]	6 monthly for 12months, then annually
RN39801 (Cockatoo Bore)	Moolayember Formation	SWL, TD, field parameters, Chemistry[1]	6 monthly for 12months, then annually

(1) Chemistry – proposed analytes are presented in **Table 11** below.
(2) Interpreted aquifer by Comet Ridge Limited

Table 19: Analytical plan

Category	Parameters
Ions	Calcium Chloride Fluoride Potassium Sodium Sulphate Magnesium
Metals (total and dissolved)	Aluminium Arsenic Barium Beryllium Boron Cadmium Chromium Cobalt Copper Iron Lead Manganese Mercury Molybdenum Nickel Selenium Uranium Vanadium Zinc
Alkalinity and hardness	Alkalinity – Total hardness as $CaC0_3$
Dissolved Gases	Carbon dioxide Methane Hydrogen sulphide

Additional parameters may also be analysed if required by Comet Ridge and based on the activities occurring in the area and the preliminary results from the base set of analytes. A likely list of potential analytes that will be considered is presented in **Table 20**.

Table 20: Analytical plan-extended analytes

Category	Parameters
Physical (Laboratory)	Benzene Toluene Ethyl-benzene Xylene (total) Formaldehyde Naphthalene Phenanthrene Benzo (a) pyrene Sodium hydroxide

Category	Parameters
Nutrients	Ammonia Nitrate as N Nitrite as N Nitrite + nitrate as N Notal nitrogen as N Total phosphorus

Sampling Methodology

Groundwater sampling will be undertaking according to the relevant methodology outlined in the Baseline Assessments Guideline 2017, (ESR/2016/1999), Version 3.02, DES, including:

- Samples will be collected, preserved and stored in accordance with the Environmental Protection (Water) Policy 2009 - Monitoring and Sampling Manual, Guidance on the sampling of groundwaters, Version May 2018, DES;
- EPA Guidelines: Regulatory Monitoring and Testing—Groundwater Sampling (Environment Protection Authority, 2007); and
- Groundwater Sampling and Analysis—A Field Guide (Sundaram, et al., 2009).

QA/QC

QA/QC control measures will be implemented during the sampling program. These measures will be consistent with :

- AS/NZ 9000 Quality management system series;
- quality assurance/quality control of AS/NZS 5667.11:1998; and
- Water quality - Sampling - Guidance on sampling of groundwaters (Joint Technical Committee EV/8, 2016).

This includes:

- Groundwater sampling will be conducted by a suitably qualified and experienced professional in accordance to the relevant guidelines;
- All the laboratory analysis will be conducted by National Association of Testing Authorities (NATA) approved for the analyses required; and
- All the equipment used to collect field parameters will be calibrated according to the manufacturer standard operating procedures.

An annual review of the monitoring data will be conducted when production testing has commenced on either of the Albany Project wells.The review will be conducted by a suitably qualified and experienced hydrogeologist and will include assessment of groundwater level and quality data, and the suitability of the monitoring network.

All groundwater-based complaints will be investigated, and a register kept of the nature of any complaints, the results of the assessment, and any actions taken. The register will be made available to the regulating authority upon request.

Review and Reporting

The accuracy of the predicted IAA will be reviewed on an annual basis once production testing has commenced on either of the Albany Project wells. This will be based on a comparison of the two six-monthly sampling round results and water production data with the groundwater model predictions and the assumptions that were used to prepare it. The results of this comparison will be provided to the DES within 20 business days after the comparison report has been completed. Furthermore, the report to DES will highlight if there has been a material change in any of the parameters since the modelling and IAA map were generated. For the purposes of this statement, a discrepancy of more than 25% from predicted values will be treated as a material change.

A report relating to the implementation (including results) of the monitoring strategy required under section 378(1)(d) of the Water Act will be submitted annually to the Office of Groundwater Impact Assessment (OGIA).

In addition, records of all underground water extracted while exercising water rights will be collected on a daily basis. Water Production reports will be submitted to the Department of Natural Resources and Mines as per the requirements under the P&G Act.

The results of any further Baseline Assessments required under Chapter 3 of the Water Act will be given to the OGIA in the approved form.

Part F: Spring Impact

UWIR is required to identify springs which could be potentially affected by underground water extraction activities. For these springs where predicted water levels within the source aquifer would decline more than 0.2 metres, a spring impact management strategy is required.

A desktop review of spring inventories has been completed, searching for springs within 20km of proposed production testing. Springs and watercourses were identified using the following sources of information, and cross-checking against project maps.

- Queensland Government Information Service (Queensland Wetland Data – Springs);
- Wetland Info Website;
- Great Artesian Basin Resource Operation Plan Spring Register.

Based on this data, one group of springs (Moses Complex) was identified within the boundary of ATP744, and another group (Groove Complex) was identified within the search distance but outside of ATP 744 (**Figure 39**).

The Moses Complex springs are located approximately 20km from the Albany Project site. The closest spring is located approximately 17km to the south-east of the Albany 2 well. The Groove Complex springs are located approximately 17km from the Albany Project site with the closest spring in this group located approximately 16km to the west of the Albany 1 well. Additional information and descriptions of springs have been compiled under the **Springs** sections of the report.

A spring monitoring or management strategy is not considered to be required for this UWIR due to:

- No springs are located within the IAA of the Albany Project site;
- There is no known hydrological interconnection between the springs or aquifer feeding the springs and the Lake Galilee Sandstone from which the Albany Project may extract small volumes of water during well testing program;
- Vertical distance between the gas reservoir and the springs exceeds 2500m. Significant portion of those 2500m is comprised of formations with very low hydraulic conductivities, which are considered regional aquitards and confining beds and restrict the vertical movement of groundwater between aquifers;
- No faults with a potential to hydraulically connect target reservoir and surface have been identified in the area.

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Appendix 1 –ATP744 Water Quality Observations

Bore registration number	Permit	Identified aquifer	Depth of Sample (m)	Conductivity (uS/cm)	pH	Hardness (mg/L Ca)	Alkalinity (mg/L)	SAR	Total Dissolved Solids (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Iron (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulphate (mg/L)
2439	744	undifferentiated aquifer		6410	7.5	732	60	19.2	3834.44	1195		190	62.5		73		2234	1.05	116
5940	744	undifferentiated aquifer	203	0	7.5	3783	160	19.5	11091.5	2755.6		572	572		0	95.8	6046	0.5	1049.6
6559	744	undifferentiated aquifer		6500	7.8	719	171	19.5	3837.37	1201		110	108		208		2075	1.1	240
11644	744	Clematis Group	25	0		3268	356	45.7	19195.3	6010.3		570.6	447.6		0	213.1	9613.9	0.3	2339.5
11644	744	Clematis Group	127	0		2657	110	30.2	12013.7	3572.1		533.4	321.8		0	65.8	6751	0.3	769.3
11644	744	Clematis Group	188	0		2515	108	31.1	ND	3587.9		624.9	231.7		0	64.4	6512.2	0.3	986.7
11644	744	Clematis Group	289	0		844	81	14.8	ND	985.3		198.8	84.4		0	48.6	1833.3	0.1	307.5
11644	744	Clematis Group	289	0		639	76	18.9	3542.3	1096.8		201.6	32.9		0	45.8	1877.6	0.2	287.4
11644	744	Clematis Group	289	0	7.5	206	72	9	ND	296		48	21	12	88		512	0.25	55
11644	744	Clematis Group		4800	7.8	720	70	13.5	2918.02	830		180	65.6		85.3		1590	0.48	210
16896	744	Moolayember Formation	118	8600	6.4	1265	100	18.6	5216.49	1518		256	152		122		2970	0.5	260
16897	744	Moolayember Formation	230	1400	8	116	65	15.7	776.34	388		10	22		79		275	0.5	42
772	744	Moolayember Formation	114		7.4	5200	180		19000	5000		765	800		220		10450	1.8	1110
772	744	Moolayember Formation	158		7.6	440	115		27000	817		148	17		140		1480	0.5	14
772*	744	Lake Galilee Sandstone	2738	NA	7.3	130	285		3500	955	NA	50	NA		348	NA	1305		76
30929	744	undifferentiated aquifer		3120	7.6	162	70	18.4	1519.76	540	9	12	32.2		85		880	0.27	4.5
47637	744	undifferentiated aquifer	36	5600		1010	90	12.8	ND	932		116	175		110		2098		0
47640	744	undifferentiated aquifer		750		110	55	5.2	ND	124		6	23		67		231		
67626	744	undifferentiated aquifer		470	7.2	38	30	4.7	246.88	67	11	2.7	7.6	0.03	36.5	0	115	0.1	13.5
50066*	744	Betts Creek Beds	918	NA	8	NA			NA	NA	NA	22.4	NA		NA	NA	1100		NA
50066*	744	Lake Galilee Sandstone	2597	NA	8	64			NA	NA	NA	NA	NA		NA	NA	3000		NA
62965*	744	Betts Creek Beds		35700	7.3	840	1950	20	22603	1320	13700	275	36.4	33.0	1950	<10	19000	24.0	28.0
62965*	744	Betts Creek Beds		17500	7.3	610	726	14	11080	796	4610	204	25.6	24.0	726	<10	7300	16	7.2
62965*	744	Betts Creek Beds		11000	7.5	380	528	14	6965	622	2130	125	15.3	17.0	528	<10	3500	3.5	9.8
62965*	744	Betts Creek Beds		8570	7.6	67	478	29	5426	549	1710	9.0	10.9	9.3	478	<10	2400	<0.5	8.9
63063*	744	Betts Creek Beds		12000	9.3	80	1090	23	7598	470	38000	16	9.5	34	920	170	3600	<5	210
63063*	744	Betts Creek Beds		38000	10.0	60	3110	71	24060	2167	20000	60	47	38	2300	810	13000	<5	540
63856*	744	Betts Creek Beds		38000	8.2	720	700	18	24060	1100	17000	240	29	22	700	<20	15000	2	160
63856*	744	Betts Creek Beds		38000	8.2	700	710	18	24060	1100	18000	230	28	22	710	<20	15000	2	160
63856*	744	Betts Creek Beds		69000	8.5	1200	1300	22	43687	1800	32000	400	61	52	1300	<20	15000	<5	1
63856*	744	Betts Creek Beds		69000	8.4	1200	1400	21	43687	1700	31000	390	61	59	1400	<20	27000	<5	300
63856*	744	Betts Creek Beds		9400	8.3	93	750	21	5952	460	2400	29	5.1	5.2	750	<20	2300	2	110
63856*	744	Betts Creek Beds		9100	8.2	95	760	20	5762	450	2400	30	4.9	4.7	760	<20	2300	2	110
63856*	744	Betts Creek Beds		86000	8.3	1300	1700	89	54451	1400	50000	420	68	170	1700	<20	35000	<0.5	410
63856*	744	Betts Creek Beds		330	7.6	77	140	7	209	26	44	21	6	<1	140	20	38	<0.5	<0.5
63857*	744	Betts Creek Beds		31000	7.4	110	880	11	19628	270	2100	36	5.5	24	880	20	12000	<5	8.1
63857*	744	Betts Creek Beds		51000	7.4	1500	980	150	32291	2400	34000	470	77	39	980	20	15000	2	14
63857*	744	Betts Creek Beds		51000	7.4	620	1100	18	32291	1000	12000	200	32	40	1100	20	18000	<5	15

Bore registration number	Permit	Identified aquifer	Depth of Sample (m)	Conductivity (uS/cm)	pH	Hardness (mg/L Ca)	Alkalinity (mg/L)	SAR	Total Dissolved Solids (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Iron (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Sulphate (mg/L)
63857*	744	Betts Creek Beds		14000	7.3	480	860	22	8864	1100	4100	160	22	20	860	20	3700	2	18
63857*	744	Betts Creek Beds		14000	7.5	500	950	21	8864	1100	4100	170	22	17	950	20	4900	<5	15
63857*	744	Betts Creek Beds		17000	7.5	680	760	21	10764	1200	4300	230	25	18	760	20	4800	<0.5	78
63857*	744	Betts Creek Beds		17000	7.5	640	1500	21	10764	1200	4600	2 10	26	1.8	1500	20	6200	1	56
63857*	744	Betts Creek Beds							35456	1500	30000	280	58		1700	20	20000		17
Within 20Km Gunn #2 (Outside ATP744)																			
16197	Outside 744	undifferentiated aquifer	514	500	7.1	12	176		252.97	73.3		4.8	0		214.5		64	0.4	5
35917	Outside 744	undifferentiated aquifer		5150	7.6	800	150	22.2	4607.68	1442		256	39		183		2780	0.7	0
35917	Outside 744	undifferentiated aquifer		10000	7.2	1361	72	19.9	5767.97	1687		500	27		88		3510	0.7	0
35917	Outside 744	undifferentiated aquifer		10000	7.1	1298	8	20.3	5697.62	1682		470	30		10		3510	0.7	0
69531*	Outside 744	Betts Creek Beds		30600	6.79	450	921		19900	1740	6560	144	22	11.6	921	<1	7970	6.7	1260
BAP within 20 Km Gunn #2																			
16197	Outside 744	undifferentiated aquifer	514	462	7.76	<1	164		300	96	6	<1	<1	0.50	164	<1	42	0.2	<1
93059	744	Moolayember Formation	246	40250	6.8		122		27100	8300	116	1540	1040	3. 27	122	<1	14810	0.7	1230
93822	744	Clematis Group[1] / Moolayember Formation[2]	271	12600	7.53	1470	61		8632	2080	30	424	100	0.82	61	<1	4540	0.7	2
118169	744	Moolayember Formation	204	7456	7.29		111		3840	1500	50.5	206	30.7	0. 359	111	<1	1912	0.53	78.5
93768	Outside 744	undifferentiated aquifer	127	5300	7.81	573	155		3440	902	16	114	70	0.1	155	<1	1480	0.5	119
Gunn #2 Sample 1	744	Betts Creek Beds		1780	8.26	15	846	54.4	1080	484	28	6	<1	0.16	733	113	126	11	<1
Gunn #2 Sample 2	744	Betts Creek Beds		1770	8.24	15	821	52	1050	463	20	6	<1	1.74	802	19	110	11.9	<1
Gunn #2 Sample 3	744	Betts Creek Beds		1730	8.26	15	818	52.4	1030	466	14	6	<1	1.76	810	8	97	11.7	<1
Gunn #2 Sample 4	744	Betts Creek Beds		1700	8.38	12	697	50.7	915	412	9	5	<1	2.5	672	24	99	11.1	<1
Within 20 Km Albany Wells																			
Mosquito bore	744	Moolayember Formation	213	1527	7.14	135	119		809	251	16	31	14	0.12	119		429	0.3	28
Carmichael House Bore	744	Moolayember Formation		1864	7.29	159	130		971	322	19	24	24		130		548	0.3	38
Kades Bore	744	Moolayember Formation		1727	7.70														
16896 (Caseys Bore)	744	Moolayember Formation	98.95	3280	7.94	144	146		1800	669	7	29	22	<0.05	146	<1	983	0.3	91

***DST Samples**

Appendix 2 – ATP744 Water Level Observations

Registration Number	Formation Name	Date	Groundwater Level (m bGL)	S.W.L (m)(1)
11644	Clematis Group	20/11/1950	-29.26	
69442	Clematis Group	18/07/1986	-24	
103565	Dunda Beds	20/06/2002	-36	
6350	Moolayember Formation	1/10/1910	-7.6	
16895	Moolayember Formation	14/07/1966	-32.9	
16896	Moolayember Formation	5/07/1966	-27.43	
16897	Moolayember Formation	26/06/1966	-32	
69288	Moolayember Formation	28/01/1986	-16.2	
69628	Moolayember Formation	11/01/1990	-36.58	
5940	Unknown	1/01/1924	-66.7	
7046	Unknown	10/01/1983	-48.76	
7047	Unknown	10/01/1983	-33.52	
39801	Unknown	26/05/1975	-35.4	
47637	Unknown	4/10/1977	-4.9	
47638	Unknown	5/10/1977	-10.2	
47639	Unknown	9/11/1977	-0.3	
69451	Unknown	18/09/1987	-16.5	
69934	Unknown	29/02/1992	-12.1	
22367	Unknown	1/11/1965		-25.91
96545	Unknown	21/03/1995		30
118253	Moolayember Formation	17/02/2003		-48
118371	Clematis Group	8/06/2004		-7
118169	Moolayember	25/05/2013		-46.95
93059	Moolayember	26/05/2013		-9.8
93822	Clematis Group [1] / Moolayember[2]	10/10/2012		-60.71
44487	Clematis Group	17/10/1973		-18.3
67626	Clematis Group	24/07/1987		-12
93819	Clematis Group	05/07/2001		-8
93822	Clematis Group	08/08/2001		-16
93827	Unknown	18/08/2001		-33
103875	Betts Creek Beds	28/08/2008		-51
103876	Betts Creek Beds	28/08/2008		-50
103878	Tertiary - undefined	29/12/2005		-19
118164	Unknown	25/08/2003		-54
132701	Moolayember Formation	21/09/2009		-38
132703	Clematis Group	23/02/2009		-69.5
146685	Clematis Group	13/08/2013		-12.6

Registration Number	Formation Name	Date	Groundwater Level (m bGL)	S.W.L (m)(1)
146795	Clematis Group	02/10/2013		-30.4
158152	Betts Creek Beds	05/06/2013		-59.35
158887	Unknown	02/08/2014		-35
158888	Moolayember Formation	30/07/2014		-45.12
163079	Unknown	12/12/2013		-18
163503	Clematis Group	05/10/2015		-7.9
163506	Moolayember Formation	09/07/2015		-6.8
163553	Clematis Group	15/08/2015		-18
165061	Betts Creek Beds	03/07/2013		-71.26
165062	Betts Creek Beds	03/07/2013		-71.09
165064	Betts Creek Beds	15/12/2013		-33.29
165065	Betts Creek Beds	21/01/2013		-33.99
165066	Rewan Group	03/07/2013		-62.19
165125	Unknown	18/07/2015		-36
165126	Unknown	27/06/2015		-18
165169	Unknown	24/10/2015		-25
96545	Moolayember Formation	19/10/2019		-28.8
Unregistered (Kades Bore)	Moolayember Formation(	19/10/2019		-28.3
Unregistered (Carmichael House Bore)	Moolayember Formation(	19/10/2019		-26.5
39802	Unknown	9/04/1951		-36.0
153582	Clematis Group	19/10/13		-59.5
54627	Clematis Group	15/8/06		-45
165540	Clematis Group	14/3/18		2.04
165541	Clematis Group	20/3/18		-4.5
158592B	Betts Creek Beds	1/1/12		-48.33
158076	Betts Creek Beds	6/8/11		-37.35
132938	Betts Creek Beds	6/8/12		-39.6
158075	Betts Creek Beds	2/8/11		-36.09
158077	Betts Creek Beds	4/8/11		-39.03
158593B	Betts Creek Beds	30/8/12		-54.77
158592C	Rewan Group	1/1/12		-43.08
158593C	RewanGroup (?)	8/9/12		-44.08
158849	Colinlea Sandstone	22/11/13		-48
132941	Unknown	27/10/12		-41.3

(1) DNRME Groundwater Database aquifer

(2) Interpreted aquifer by Comet Ridge Limited