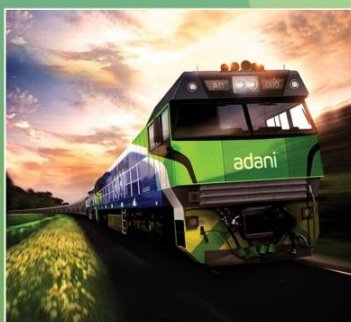




Adani Mining Pty Ltd

NORTH GALILEE BASIN RAIL PROJECT

Environmental Impact Statement

Appendix H3 Construction water supply strategy

November 2013



NORTH GALILEE BASIN RAIL CONSTRUCTION WATER SUPPLY STRATEGY: VOLUME 1



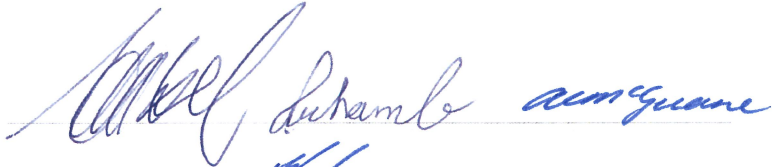
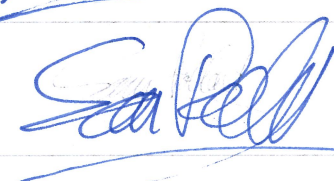
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ADANI

NGBR

North Galilee Basin Rail Construction Water Supply Strategy Volume 1

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Report No	0006-AA005967-AAR-02	
Date	02/08/2013	

This report has been prepared for Adani in accordance with the terms and conditions of appointment for NGBR dated 29 April, 2013. Hyder Consulting Pty Ltd (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

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Appendix A Cost Estimation Tables

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Appendix C Expected Daily Flows in Major Waterways

Appendix D Surface Water Source Options

Appendix E Water Source Hydrant Infrastructure Footprints

1 INTRODUCTION

Adani Mining Pty Ltd ('Adani') commissioned Hyder Consulting Pty Ltd ('Hyder') to detail the options and recommendations for the supply of water for construction of the 306.9km North Galilee Basin Rail (NGBR) Project. The NGBR rail line runs from the intersection of Gregory Development Road, located east of the proposed Carmichael Coal Mine, to the Port of Abbot Point, Queensland. As shown in Figure 1.1 the section of the rail line from the mine site to chainage 67.5km (Gregory Development Road) connects with the proposed Separable Portion 1 (SP1) rail line. Water supply options for this rail line were previously studied by Hyder as part of the Carmichael Coal Mine and Rail Project EIS.

This report has been prepared to describe the methodologies for the extraction and supply of water from available sources for the construction of the NGBR Project.

1.1 SCOPE OF WORKS

1.1.1 HYDROGEOLOGY

The hydrogeological study included the following works:

- Conduct a search of the Department of Natural Resources and Mines (DNRM) Groundwater Database to identify, review and map existing groundwater bores within 20km of the rail corridor from the search;
- Review the borehole logs from the available geotechnical investigations to identify potential groundwater sources to supplement the desktop activities;
- Identify geological units and prospective aquifers along the rail line;
- Provide a summary of potential groundwater yields from groundwater bearing formations intersected by bores identified within a 20km buffer zone along the rail alignment;
- Undertake a qualitative assessment of aquifers to identify key hydrogeological parameters including: saturated thickness, recharge boundaries, water table gradients, flow directions, bore yield, aquifer potential and water quality;
- Identify existing water infrastructure which may be utilised as a potential water source;
- Undertake a borehole optimisation exercise to rationalise spacing and locations of potential boreholes, configuration of sources in conjunction with the use of transfer pipelines and/or tankers, with the aim of minimising expenditure; and



LEGEND

- NGBR Line
- Carmichael Project (Rail)
- Carmichael Project (Mine)
- Burdekin River Basin
- Major Highways
- Railway
- Watercourses

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Map scale: 1:2,500,000 at A3
DATA SOURCES:
DERM

Source: Esri, DigitalGlobe, GeoEye,
i-cubed, USDA, USGS, AEX,
Getmapping, Aerogrid, IGN, IGP,
swisstopo, and the GIS User
Community

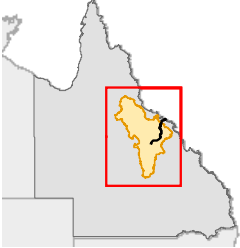


Figure 1.1: Burdekin Basin Catchment

1.1.2 SURFACE WATER

The surface water desktop study explored the following water sources: river extraction, overland flow harvesting, storage supply options (mine voids, in-stream and off-stream) and third party providers such as local councils, SunWater and nearby coal seam gas (CSG) fields.

For the river extraction source investigation, the reliability of flow was determined for the following waterways:

- Elliot River
- Bogie River
- Sandy Creek
- Strathmore Creek
- Pelican Creek
- Bowen River
- Suttor River

Surface water supply options were explored using existing infrastructure, as well as proposed new storages on private properties. Using available mapping data, aerial photography and site reconnaissance, existing in-stream, off-stream and mine void storage options were analysed. These were considered with reference to the proposed rail line location and water supply points (hydrants) provided by Adani. Each option was analysed with consideration for demand requirements at each hydrant, initial and on-going costs, reliability of supply, water quality and environmental factors.

Investigations for third party providers included initial discussions with the Whitsundays Regional Council and SunWater to understand location of water access points and unit costs. Review of CSG sources was desktop and based on identified fields in the area currently producing water.

Minimum water quality requirements for the surface water study were those cited in AS1379 for concrete batching and the ANZECC et. Al., (2000), guidelines for camp drinking water.

1.1.3 SITE RECONNAISSANCE

A site reconnaissance was undertaken on the 2nd of July, 2013 to confirm existing surface water supply options and to identify any additional potential sources. This was a one-day flyover of the proposed rail line by helicopter. The site visit provided photographs and geographical information about the hydrant locations and existing surface water sources close to the rail corridor.

1.1.4 ENVIRONMENTAL IMPACT

A high level study of the likely environmental and social (primarily landholder) impacts was carried out. Sources of these impacts included vegetation clearing, ground surface disturbance, a reduction in groundwater levels and response to pumping effects on vegetation and aquatic habitats. Consideration for likely time for water sources to recharge following discontinuation of pumping & recommended mitigation measures was included.

1.1.5 INFRASTRUCTURE, TIMING AND COSTS

The assessment of required infrastructure, timing and costs was carried out and included the following components:

- Specification of infrastructure requirements for overall water supply options (pumping, storage, transport, piping, fuel, treatment); and
- Development of a high level cost plan, timing and approval requirements around each water supply options. This included recommendations to Adani on which option(s) to adopt.

1.2 PREVIOUS WORK

The basis of this report follows on from findings from a prior study conducted by Hyder of the Carmichael Project (Rail) located in the same basin (Hyder, 2013a). The findings of the current report are based on similar methodologies to those of the SP1 and SP2 water supply strategy in *Railway Construction and Water Supply Study* (Hyder, 2013a). A key issue for this report is that limited information was available for the NGBR Project. This included limited geological and hydrogeological information, as well as the lack of an environmental impact statement (EIS) for this site. As an alternative, findings (and their basis) from the Carmichael Coal Mine and Rail EIS were incorporated into the NGBR Project as well as those from similar existing coal mining EIS in the area (Kevin's Corner and Alpha) which are available in the public domain. As a result, the NGBR Project water supply study is considered a high level assessment only.

Other aspects of the study such as infrastructure costs and regulatory requirements are similar to previous Adani studies completed by Hyder, in particular the Carmichael Coal Mine and Rail study and the Carmichael Coal Mine Bankable Feasibility Study Report (Hyder, 2013b). Hence findings and baseline information from prior reports were adopted during analyses in the NGBR construction water supply study.

1.3 RELEVANT LEGISLATION

The NGBR Project will need to comply with a number state legislative acts and regulations. Key to the success of the project, will be adherence to relevant water, planning and construction regulations and acts which are discussed below.

Water Act 2000

The *Water Act 2000* (Water Act) provides for the sustainable management and allocation of water to meet Queensland's future water requirements including the protection of natural ecosystems and security of supply to water users through the development of Water Resource Plans (WRP), and other activities.

Under the Water Act, each water management area has a separate WRP and associated Resource Operations Plan (ROP). A WRP is written for each catchment to provide a framework to regulate water extractions and to maintain a sustainable resource. The rail line construction and associated water use will need to comply with the Burdekin Basin WRP and ROP.

Native Title Act 1993

The *Native Title Act 1993 (Cth)* is an Act between the Government of Australia and indigenous peoples that regulates claims to land and proposals for land use.

Whilst not directly applicable under the Water Act, the regulatory process for water permits and licences requires investigation of potential native title impacts (construction impacts) and agreements.

Sustainable Planning Act 2009

Any proposed developments in Queensland need to go through an application process in accordance with the *Sustainable Planning Act 2009* (SPA). The Integrated Development Assessment System (IDAS) is part of the SPA and is the system for integrating State and local government assessment and approval processes for development.

Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) was written to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development). All proposed infrastructure for water supply will need to satisfy the requirements under the EP Act.

State Development and Public Works Organisation Act 1971

The *State Development and Public Works Organisation Act 1971* grants the Co-ordinator General the power to declare a project to be a 'significant project'. The NGBR Project has been declared a Project of State Significance.

Groundwater legislation

The Queensland Government manages the access to groundwater under the *Water Act 2000*, its subordinate regulation (*Water Regulation 2002*, Water Resource Plans and Wild River Declarations) and also the *Sustainable Planning Act 2009* (SPA). This is accomplished through the key elements as follows:

- Requirement to obtain an authorisation to take water under the *Water Act 2000* for certain purposes where groundwater is managed, either in groundwater management areas (GMA) or "Declared Subartesian Areas" or where a Water Resources Plan or Wild River Declaration regulates the taking of groundwater for those purposes;
- Requirement to obtain a development permit under the *Sustainable Planning Act 2009* to construct water bores where a regulation or Water Resource Plan specifies that a development permit is required;

The proposed route lies entirely within the areas covered by the Burdekin Basin Water Resource Plan (WRP). The proposed rail line east of chainage 18km also falls within the Bowen groundwater management area and the section of line west of chainage 271 km also lies within the Highlands declared subartesian area. Access to groundwater within these groundwater management areas is controlled, however, the Burdekin Basin WRP does not regulate access to groundwater within the remaining area crossed by the rail line. Further detail around the processes to extract water can be found in section 4.1.

2 STUDY APPROACH AND METHODOLOGY

The objective of this report is to suggest viable water supply options for the NGBR alignment. To do this, an assessment of available water supply options along the rail alignment is needed. A methodology for this assessment was developed and carried out, and is given below:

- 1 Definition of demand volumes and supply points
- 2 Desktop studies
 - a Hydrogeology
 - b Surface water
 - c Environmental
 - d Regulatory requirements
- 3 Site reconnaissance and verification of desktop studies
- 4 Water supply options identification and concept design
- 5 Cost analysis for options assessment and preferred design costing
- 6 Option prioritisation/ preferred option

The approach to the above methodology for water supply assessment is summarised below.

2.1 DEMAND VOLUMES AND SUPPLY POINTS

The required water demands (quality and quantity) were provided by Adani, which included a breakdown of spatial requirements (average demand for earthworks over 10km interval spacing, exact location of construction camps and concrete batching plants) of each demand type.

The basis for the 10km intervals for earthwork demands came from previous projects (SP1/SP2 where 7kms was used) and ongoing discussions around practicality of supply with construction contractors.

These demands were assessed and developed into discrete water supply points (hydrants) along the alignment. Water quality for each supply point was defined dependent on the demand type (earthworks - raw, camps - potable or concrete - AS1379).

Once identified, the hydrant positions were then provided to Adani for review before a final agreement was made on the assumed water demands and hydrant locations.

2.2 DESKTOP STUDIES

These studies provided baseline information which was used in the development of the available water supply options. The studies also allowed for the initial selection of the preferred water supply option at each hydrant location.

2.2.1 HYDROGEOLOGY

Hyder sourced information on groundwater boreholes relevant to this project by purchasing the Department of National Resource Management (DNRM) Queensland groundwater database (GWDB). This GWDB dataset was extracted on the 8th May 2013. Numerous other sources of information have been researched for the groundwater areas as described in Section 4 of this report. The spacing of the boreholes was discussed and agreed together with the estimated water demands and the required water quality for different water uses.

The locations of the proposed boreholes/fields are to be at the agreed point of supply but will move within the rail construction easement if no water is available locally.

There is very little data on salinity levels of the groundwater and a maximum useable salinity level will depend on the tolerance of the local soil and associated vegetation. The groundwater salinity and acceptable water quality levels for supply will need to be determined once exploration bores have been drilled, tested and other investigations (geotechnical and soil) have been completed along the NGBR Rail-line.

The likely depth, methodologies, techniques, casing and aquifer testing requirements are described in Section 4 of this report and Edition 3 of the Minimum Construction Requirements for Water Bores in Australia (NUDLC, 2012).

2.2.2 SURFACE WATER

The NGBR rail line is located inside the Burdekin Basin. A number of water supply options using surface water sources have been considered. These include the following:

- Existing and proposed in-stream storages;
- Existing and proposed off-stream storages;
- Mine voids at rehabilitated or closed mines
- CSG associated water,
- Minor overland flow capture structures; and
- Proposed river harvesting via diversion or pump.

Each of the above were investigated to understand potential supply yields and reliabilities. These investigations are summarised below and detailed in Section 4 of this report.

Storages

The search for existing storages has been limited to within 2km of the proposed rail alignment due to the increased cost and potential environmental constraints (footprint of disturbance) for longer pipelines and larger pumping head requirements. These options are discussed in Sections 5, 7 and 10 of the report. Due to their size, and potential to supply a number of hydrants, mine voids within a 20km radius were identified. All existing storages were identified during the desktop study then verified during the site flyover.

Construction of new storages has been considered as an option at appropriate locations. These are intended to collect overland flow in the wet season as well as providing buffer storage for boreholes when yields are expected to be lower than the demand at each location.

Regional Flow Analysis

A regional flow analysis was completed on all of the major river and creek crossings that crossed the alignment. This was to ascertain the potential for a temporary river extraction/diversion from the rivers and creeks to nearby hydrants. The flow analysis provided some detail around potential yields and reliabilities over different time of the year.

CSG Associated water

Nearby CSG tenements were identified and staging of each was assessed to understand if any water would be available in line with Adani's NGBR Project construction timeline. This is discussed further in section 5.

2.2.3 ENVIRONMENTAL IMPACT ASSESSMENT - DESKTOP

A high level environmental assessment was undertaken in accordance with the supply points outlined in Section 10 of this report and considers potential impacts for water supply options required for construction of the rail line. This section of the report outlines general impacts associated with the following supply source options:

- groundwater from bores
- surface water from overland flow and rain collection
- river extraction
- proposed new storage dams
- existing storage dams
- off stream and in stream storage dams
- import of potable water
- Mine voids and CSG water was not included, as no viable options were found. This is discussed further in section 5 of the report.

Environmental Desktop Review

A desktop review was undertaken to provide an understanding of the environmental constraints across the site, specific to the proposed supply locations. This entailed investigating publicly available environmental data, and available environmental information from concurrent EIS development along the proposed rail corridor. This information was used to map and identify key environmental constraints at potential water supply locations. The following database searches and information have been used:

- Regional Ecosystem Maps / Regrowth Vegetation Maps (Department of Environment and Heritage Protection);
This database generates maps of the regional ecosystems within a specified area, each of which has a Vegetation Management Status as gazetted under the Vegetation Management Act 1999 (VM Act) and a Biodiversity Status as recognised by DEHP.
- EPBC Act Protected Matters Search and Report (Department of Sustainability, Environment, Water, Population and Communities);
This search and resulting report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act within a selected area.
- Wildlife Online (Department of Environment and Heritage Protection);
This search enables generation of species lists based on data contained within the WildNet for geographic areas of Queensland including national parks, State forests and local government areas.
- Atlas of Living Australia;
The Atlas of Living Australia (Atlas) contains information on all the known species in Australia aggregated from a wide range of data providers: museums, herbaria, community groups, government departments, individuals and universities.
- Australian Wetlands Database search including Ramsar sites (Department of Sustainability, Environment, Water, Population and Communities);

This database provides online access to information on Australia's Ramsar wetlands and sites listed in the Directory of Important Wetlands of Australia, our internationally and nationally important wetlands respectively.

- Map of Referable Wetlands search (Department of Environment and Heritage Protection);
The map of referable wetlands identifies the location of wetland protection areas (WPA) in Great Barrier Reef catchments.
- Good Quality Agricultural Land, Strategic Cropping Land (Department of Natural Resources and Mines);
Good Quality Agricultural Land is recognised as a finite resource requiring conservation and management to maintain the future productivity and efficiency of Queensland's rural industries.
Strategic Cropping Land (SCL) is recognised as Queensland's best cropping land and is protected under state legislation. Regulation of SCL is aimed at striking a balance between the agriculture, mining and urban development sectors to maintain the long-term viability of food and fibre industries, and support economic growth for regional communities in Queensland.
- Previous publicly available environmental studies undertaken along the proposed rail corridor; and
- Concurrent environmental studies being undertaken for the NGBR project EIS.

Hyder's environmental team has worked in close contact with Hyder's design team to locate hydrants, water supply points and associated infrastructure, to meet the project's practical and economic criteria with minimum environmental impact based upon the desktop assessment.

Key environmental constraints were mapped and identified prior to the site visit to identify any key considerations within the proposed hydrant footprint and to assist site selection for required infrastructure, in order to avoid significant environmental impacts where possible. The environmental constraints informed the design method and location of water supply options, through the following:

- design and placement of infrastructure; and
- minimise vegetation/habitat clearing extent and degree of disturbance during construction.

Once preliminary locations were identified a more focused assessment of key potential impacts was undertaken via a site flyover of each proposed hydrant footprint to investigate the likely footprint of disturbance (note that ground surveys were undertaken for this assessment). Further consideration was given to limitations of each proposed hydrant footprint in terms of environmental values via the site flyover. Limitations of placement of infrastructure and construction methodologies to avoid impact on these values were identified in terms of environmental considerations at each location. This assessment was a high level, qualitative and rapid assessment only, specific to nature conservation (flora and fauna)- predominantly vegetation (assessment of flora and fauna values was limited due to the scope of assessment and included assessment of available data/mapping and identification of any species observed during the flyover), surface and groundwater resource values.

The extent of the hydrant footprints was based on the required infrastructure at each hydrant location, described in Section 10, and the generic footprints of this infrastructure given in drawings 0011-AA005967-AU-D-01 and 0012-AA005967-AU-D-01 in Appendix E.

2.2.4 REGULATORY REQUIREMENTS

The regulatory requirements to source water from the recommended water supplies were investigated to understand the potential for delays and/or restrictions to water access. No consultation was undertaken with the regulator due to assumptions from the previous Water Supply Strategy Report for Carmichael Project (Rail) being applied.

The option of purchasing potable water from local council sources and transporting it to the supply locations was also considered as a potential water supply option and any regulatory issues for this option were reviewed.

The required approvals for the recommended water supplies are discussed in Section 6 of this report.

2.3 SITE RECONNAISSANCE

A site reconnaissance was completed using a helicopter to follow the full 306.9km of alignment. From the helicopter, existing water infrastructure, geological and topographical features as well as vegetation factors were surveyed and verified along the route.

Photographs and site notes were taken to verify imagery used during the desktop study and to assist in confirming the acceptability of each of the identified supply options. These are included in Appendix E.

2.4 WATER SUPPLY OPTIONS ASSESSMENT AND CONCEPT DESIGN

Based on the water demand requirements for each hydrant, and information taken from the desktop studies and site visit, options for water sources were identified for each of the supply points. The water supply options for each of the supply points included:

- **Boreholes** – Borefields will be developed through the adoption of existing bores and the construction of new boreholes. Where possible, the borefield option will be utilised as it is typically the most reliable and cost effective water source. Capital costs are generally low, however for instances when bores need a depth of 200m or more to achieve sufficient yields, the cost vs supply/yield ratio makes the option un-viable. In addition, if yields are low, buffer storages (to boost reliability and yield) may be required increasing costs further. The study also showed that in some areas, poor water quality has been encountered with high salinity levels.
- **Overland flow harvesting** – existing dams of this nature are generally small, hence delivering a low yield, and are only full for 3-4 months of the year. The are experiences high evaporation rates which adds to the low reliability of these shallow structures constructed for pastoral purposes. Costly modifications would be required to ensure sufficient reliability to meet the required water demands. This is discussed further in section 5 of the report.
- **In-stream and off-stream storages** – both existing (including mine voids) and proposed storages were considered for this option. Where possible, existing storages are recommended for water supply, however were often too small, too far away (mine voids), poorly maintained or had insufficient catchment to provide reliable inflows.
- **River extraction** – was considered as an option where the rail line crossed a waterway that had both high flood levels and a reasonable amount (more than 200l/s) of flow for the majority of the year.
- **Urban water supply infrastructure** – in areas around townships potable water supply from local councils or from SunWater was investigated.
- **CSG associated water** – was considered although no tenements have progressed far enough to be producing water at a location that was considered spatially acceptable,

A standardised design for each option was developed and is discussed in detail in Section 7 and drawings provided in Appendix B.

2.5 COST ANALYSIS AND DESIGN COSTING

At each of the hydrant locations, a number of water supply options were developed, with the capital costs estimated for each. The resulting cost was then used as one of the key constraints when selecting the preferred option. Water supply options and their costs for each site is explained in Section 10 of the report.

The costs were developed based on unit rates from recent similar projects (last 2 years), such as the Carmichael Project (Rail) Construction Water Supply and the Carmichael Project (Mine) Water Supply BFS completed by Hyder. To ensure the pricing of construction is realistic, enquiries were made with various suppliers and contractors to reference costs. Further details and supporting information for the cost analysis are provided in Section 7.2 of this report.

These estimates allow for a 40% contingency and are based on standard drawings included in Appendix B which detail typical arrangements associated with each of the water supply options.

Once the preferred option was selected, a high-level cost plan for each hydrant was developed. This includes comment on the risk of having a reliable water yield and discussion on recoverable costs. Further details are included in Section 10.

2.6 PREFERRED OPTIONS

A preferred option for each hydrant was selected as a result of the analyses performed with the aforementioned methodology.

Section 10 of this report provides the preferred water supply option for each hydrant and all of its details including proposed design, cost, key constraints, environmental footprint, impacts and mitigation, reliability and yield.

3 WATER DEMANDS AND SUPPLY POINTS

Adani provided a water demand for all aspects of the NGBR projects construction needs. Due to the variance in water demands over the rail line (cut and fill requirements, camp population numbers, wet and dry antecedent conditions) a conservative average was given (over 10km intervals for earthworks, for max camp populations) and was used for this study.

The provided demands were then assessed (and broken down into different quality and quantity requirements) and developed into 34 discrete water supply points (hydrants) along the alignment. Water quality for each supply point was defined dependent on the demand type (earthworks - raw, camps - potable or concrete - AS1379). Further details are provided in section 3.2 of this report.

3.1 WATER DEMANDS

The required water demands identified by Adani were categorised based on the requirements for each demand type, which included:

- Earthworks, at 10 km intervals;
- Camps, maintenance yards and laydown areas; and
- Batching plants.

Batching plants will be located adjacent to the camps and laydown areas, reducing the need for multiple supply points and sources over a small area. In addition, in calculating the maximum instantaneous demand, it was assumed that water consumption was averaged over the rail line due to variance in concept and earthwork quantities.

The project water demand is described in the sections below.

3.1.1 EARTHWORKS

Earthwork activities which require water include:

- Excavation;
- Dust suppression; and
- Compaction

The rate of water consumption varies during the hours of the day and time of year. It also varies based on the type of activities in each working shift, rate of progress, hours of the working shift, weather conditions, time of year, type of material, use (cut or fill) and required compaction ratio. This results in a high variance of water demands throughout the mine life. To allow for a clear assessment of demands, the maximum instantaneous and average daily water demands for the expected working duration was used. The spatial distribution of the demands was provided by Adani to Hyder at 10km intervals. This information is tabulated in Table 3.1.

The total water demand was estimated by multiplying the daily water demand by the expected working duration (called placement time). Based on the uses, and source water quality, treatment of the raw water used in earthworks activities is not required.

The chainages denoted in Table 3.1 are related to the interval where water demand for earthworks is required. These points do not reflect the final hydrant locations given in Section 3.2 of the report, which are based on available water sources

Table 3.1: Water Supply Requirements for Earthworks along the NGBR alignment

Chainage	Water Demand	Placement Time	Daily Water Demand	Instantaneous Demand	Quality
(m)	Total (kL)	Days	(L)	(L/s)	
-5	108479	108.9	995929	41.5	Raw Water
5	42264	42.4	996334	41.5	Raw Water
15	152287	171.0	890816	37.1	Raw Water
25	77975	86.4	902890	37.6	Raw Water
35	75439	96.0	785461	32.7	Raw Water
45	486812	520.7	934903	39.0	Raw Water
55	170204	319.4	532865	22.2	Raw Water
63	183420	297.1	617462	25.7	Raw Water
75	369001	489.0	754552	31.4	Raw Water
85	262908	298.0	882268	36.8	Raw Water
95	71753	118.2	606994	25.3	Raw Water
105	123695	162.7	760331	31.7	Raw Water
115	113043	160.5	704133	29.3	Raw Water
125	118196	212.3	556612	23.2	Raw Water
135	89424	143.2	624377	26.0	Raw Water
145	66735	82.9	804934	33.5	Raw Water
155	442329	679.1	651392	27.1	Raw Water
165	217707	359.8	605072	25.2	Raw Water
175	102497	173.4	591126	24.6	Raw Water
185	236742	317.6	745442	31.1	Raw Water
195	98799	170.2	580419	24.2	Raw Water
205	144600	287.7	502688	20.9	Raw Water
215	88210	134.8	654363	27.3	Raw Water
225	57459	58.6	980012	40.8	Raw Water
235	57346	107.4	533809	22.2	Raw Water
245	76169	130.4	583981	24.3	Raw Water
255	31523	39.0	808939	33.7	Raw Water
262	23464	23.5	1000000	41.7	Raw Water
275	46448	49.1	946619	39.4	Raw Water
285	41959	56.5	743037	31.0	Raw Water
295	83322	89.8	927512	38.6	Raw Water

Chainage	Water Demand	Placement Time	Daily Water Demand	Instantaneous Demand	Quality
(m)	Total (kL)	Days	(L)	(L/s)	
305	31275	45.7	683875	28.5	Raw Water

3.1.2 CAMPS AND BATCHING PLANTS

The water demands at the camps were identified by Adani and categorised into:

- Water demand for camps and yards (200l/Equivalent Persons (EP)/Day)
- Water demand for batching plants

200l/EP/day is then broken down further into 120l/p/day of potable water and 80l/p/day of non-potable water.

Potable water - Camp

The example below outlines the method by which the potable water demands in Table 3.4 were calculated. The example is provided for the calculation of the water demand at the camp located at chainage 63km.:

Assumptions:

- Potable water per person per day: 120 L/day
- Number of staff: 400
- Average daily demand: 48000 L/day
- Treatment Quality: Drinking standard (potable)

Calculation:

- Maximum daily demand: $1.5 \times 48000 = 72000$ L/day
- Maximum treatment rate: $72000 / 24 / 3600 = 0.83$ L/s
- Instantaneous water demand: $0.83 \times 5 = 4.15$ L/s

Non-potable water demands - camp and yard

The example below outlines method by which the non-potable water demands in Table 3.5 were calculated. The example is provided for the calculation of the water demand at the camp located at chainage 63km:

Assumptions:

- Non-potable water per person per day: 80 L/day
- Number of staff: 400
- Average daily demand: 32000 L/day
- Treatment Quality: AS1379 standard/Raw

Calculation:

- Maximum daily demand: $1.5 \times 32000 = 48000$ L/day
- Maximum treatment rate: $48000 / 24 / 3600 = 0.56$ L/s
- Instantaneous water demand: $0.56 \times 5 = 2.80$ L/s

Batching plants

The example below outlines method by which the concrete mix water demands in Table 3.6 were calculated. The example is provided for the calculation of the water demand at the batching plant located at chainage 63km:

Assumptions:

- Average daily demand: 52000 L/day
- Treatment Quality: AS1379 standard

Calculations:

- Maximum daily demand: $1.5 \times 52000 = 78000$ L/day
- Maximum treatment rate: $78000 / 24 / 3600 = 0.9$ L/s
- Instantaneous water demand: $7800 / 10 / 3600 = 2.17$ L/s

Based on the above calculation methods, tables 3.2 and 3.3 provide the calculated water demand. .

Table 3.2: Water Demand for Batching Plants

Location	Chainage of Supply Point (km)	Water Demand per 10hr Day (L)	Instantaneous Flow Demand (inc. 1.5 peaking factor) (L/s)	Quality
Batching plant 1	15	52000	2.17	AS 1379
Batching plant 2	63	52000	2.17	AS 1379
Batching plant 3	130	52000	2.17	AS 1379
Batching plant 4	170	52000	2.17	AS 1379
Batching plant 5	262	52000	2.17	AS 1379

Table 3.3: Peak Water Demand for Camps and Yards

Location (Equivalent Population)	Chainage of Supply Point (km)	Peak Water Demand per 10hr day (L)	Peak Instantaneous Flow (inc. 1.5 peaking factor) (L/s)	Quality
Construction Camp 1 (300)	15	60000	2.50	AS 1379/Potable Water
Construction Camp 2 (400)	63	80000	3.33	AS 1379/Potable Water
Construction Camp 3 (300)	130	60000	2.50	AS 1379/Potable Water
Construction Camp 4 (400)	170	80000	3.33	AS 1379/Potable Water

Location (Equivalent Population)	Chainage of Supply Point (km)	Peak Water Demand per 10hr day (L)	Peak Instantaneous Flow (inc. 1.5 peaking factor) (L/s)	Quality
Construction Camp 5 (300)	262	60000	2.50	AS 1379/Potable Water
Construction Depot	302	1692000	17.63	AS 1379/Potable Water

The batching plant water should be treated to the quality defined in AS1379. Water used for drinking and sanitary purposes (potable) in the camps and yards must be treated to drinking water quality standards. Water for non-potable purposes at the camp may be treated to AS1379 or less dependent on its use.

To economise the water treatment costs, it has been proposed to provide a separate treatment plant and distribution network for the batching plant and potable water (raw water for earthworks will come straight from the source). The volumes specified in Table 3.3 were separated based on the expected potable and non-potable water requirements and presented in Tables 3.4 and 3.5.

Table 3.4: Potable water supply requirements at camp sites

Supply Point Chainage (km)	Total Water Volume (kL)	Expected Camp Duration (Days)	Average daily Demand (L)	Peak Treatment Rate (L/s)	Quality
15	28800	730	36000	0.62	Drinking
63	28800	600	48000	0.83	Drinking
130	21600	600	36000	0.62	Drinking
170	38400	730	48000	0.83	Drinking
262	14400	400	36000	0.62	Drinking
302					Drinking

Table 3.5: Water supply requirements for other camp activities except those in Table 2.2

Supply Point Chainage (km)	Total Water Volume (kL)	Expected Camp Duration (Days)	Average daily Demand (L)	Peak Treatment Rate (L/s)	Quality
15	19200	730	24000	0.42	AS1379
63	19200	600	32000	0.55	AS1379
130	14400	600	24000	0.42	AS1379
170	25600	730	32000	0.55	AS1379
262	9600	400	24000	0.42	AS1379
302			1692000?		AS1379

Table 3.6 specifies the total concrete mix quality (non-potable) water demand for the camp and batching plant. These quantities were calculated as the sum of the demands specified in Tables 3.2 and 3.5.

Table 3.6: Water demand for batching plants

Supply Point Chainage (km)	Total Water Volume (kL)	Expected Camp Duration (Days)	Average daily Demand (L)	Peak Treatment Rate (L/s)	Quality
15	41600	730	52000	0.9	AS1379
63	31200	600	52000	0.9	AS1379
130	31200	600	52000	0.9	AS1379
170	41600	730	52000	0.9	AS1379
262	20800	400	52000	0.9	AS1379
302					AS1379

The expected camping duration in Tables 3.4, 3.5 and 3.6 are estimated based on the identified earthworks duration along the project route (refer to Table 3.1) with a small increase to allow for the consequential nature of the work at different segments, site setups and various other works that may require water.

Discussion of assumptions

Due to cost implications (shown in the cost analysis section 7.2) of sourcing and treating water for peak demands, average demands were used, with on-site storage used when more than average demands were required. During days of peak demand, the treatment system will be working on 24hr a day basis and the treated water will be stored in separate storage tanks for drinking and non-drinking purposes. The stored water will feed the demand points based on the instantaneous requirements.

3.2 SUPPLY POINTS

Based on the above water demands, specific supply points (hydrants) along the alignment were developed. The hydrants, made up of one, two or all three of the given demand types (camp, concrete batching or earthworks), were defined loosely around 10km intervals. This 10km spacing was based on the earthwork requirements, which make up the majority of water demands. As discussed earlier, the volume required was based on an average across the 10kms. It should be noted that variance in the actual demands will occur across the 10kms, with water requirements such as cut and fill, dust suppression, dictating exact water amounts.

Additional water is needed for the camps and concrete batching plants. As this quantity is minor compared to the earthwork quantities, the hydrant quantities were adjusted where appropriate to allow for these additional demands within the 10km interval.

Based on the above, an estimate of the hydrant locations was developed, with 34 hydrants along the 306.9km alignment developed. The exact location of each water supply point should be based on the final water source selected (storage/river extraction/bores) and may vary within the 10km interval if ground or surface water yields (storages or water ways) are lower than expected.

The hydrants are based on the provided chainage (chainage 0 at the Aurizon Dump station, chainage 306.9km at the connection with SP1) and located within the 10km interval nearest to the supply source (storage, borefield or river extraction).

The water quality required (often more than one quality) at each node was also identified. The positions were then provided to Adani for review before a final agreement was made on the assumed value for water demands and hydrant locations. Table 3.7 below provides the spatial

location of the required hydrants and the table below summarises the water demands and hydrant point details.

Table 3.7: Total daily demand at each hydrant

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)
HYD-N001	Raw Water	-5	996
HYD-N002	Raw Water	5	996
HYD-N003	Raw and Treated Water	15	1003
HYD-N004	Raw Water	25	903
HYD-N005	Raw Water	35	785
HYD-N006	Raw Water	45	935
HYD-N007	Raw Water	55	533
HYD-N008	Treated Water	63	132
HYD-N008	Raw Water	65	617
HYD-N009	Raw Water	75	755
HYD-N010	Raw Water	85	882
HYD-N011	Raw Water	95	607
HYD-N012	Raw Water	105	760
HYD-N013	Raw Water	115	704
HYD-N014	Raw Water	125	557
HYD-N015	Treated Water	130	112
HYD-N016	Raw Water	135	624
HYD-N017	Raw Water	145	805
HYD-N018	Raw Water	155	651
HYD-N019	Raw Water	165	605
HYD-N019	Treated Water	170	132
HYD-N020	Raw Water	175	591
HYD-N021	Raw Water	185	745
HYD-N022	Raw Water	195	580
HYD-N023	Raw Water	205	503
HYD-N024	Raw Water	215	654
HYD-N025	Raw Water	225	980
HYD-N026	Raw Water	235	534
HYD-N027	Raw Water	245	584
HYD-N028	Raw Water	255	809
HYD-N029	Treated Water	262	112
HYD-N029	Raw Water	265	1000
HYD-N030	Raw Water	275	947
HYD-N031	Raw Water	285	743
HYD-N032	Raw Water	295	928
HYD-N033	Raw and Treated Water	302	1692
HYD-N034	Raw Water	305	684

4 HYDROGEOLOGICAL STUDY

The hydrogeological assessment was conducted based on a desktop study of publicly available information related to a 20km buffer zone along the NGBR alignment. A 20km buffer zone was chosen to ensure coverage of all existing bores occurred. Bores outside this buffer with good data (yields, quality) and considered to be in the same aquifer were also included. This enabled a better chance of understanding water yield potential along the alignment.

4.1 GROUNDWATER MANAGEMENT AREAS

As described in section 1.3, of the report, groundwater is managed within two areas occurring at either end of the proposed alignment. The proposed rail line east of chainage 18km also falls within the Bowen groundwater management area and the section of line west of chainage 271 km lies within the Highlands declared subartesian area. Access to groundwater within these groundwater management areas is controlled, however, the Burdekin Basin WRP does not regulate access to groundwater within the remaining area crossed by the rail line.

Highlands and Bowen

The sections of proposed rail line within the Highlands declared subartesian area and the Bowen groundwater management area are subject to restrictions on access to groundwater. This includes a requirement for all wells to be licensed under an allocation by the DNRM for uses other than stock and domestic supply. The Bowen groundwater management area has further restrictions with seasonal water assignments and water sharing rules. Figure 4.1 illustrates the proposed route for the NGBR alignment in relation to these areas.

Undeclared

The rail alignment outside of these management areas are within an 'undeclared' or 'unmanaged' groundwater area. Where groundwater is not managed there is no formal requirement to obtain either an authorisation to take water or a development permit to construct works to take water. However, advice from the DNRM in Mackay (*Pers comm June 2013- Ian Gordon, Regional Manager - Water Services, Central Region*) suggests that DNRM would be open to a discussion regarding the exploration and taking of groundwater in the unmanaged areas for a limited time, pending availability of groundwater and mitigation of impacts on current groundwater users. Adani should undertake these discussions with DNRM prior to the extraction of groundwater.

While there is no formal regulatory process the approach would be to assess the availability of groundwater with the consent of local landowners. Once the presence of a resource is established the DNRM should be approached as per a protocol for the authorised taking of water without a water entitlement under the Water Regulation 2002 (WAP/2011/4668 – Version 2). This protocol allows for the taking of water for temporary purposes such as the construction of utilities.

All groundwater bores, both within and outside of a managed area, must still be constructed and completed in accordance to Minimum Construction Requirements for Water Bores in Australia 2nd ed. (Land and Water Biodiversity Committee, 2003). This requirement applies to all constructed water bores.

A summary of the relevant features of these Subartesian Areas are provided in Table 4.1.

Table 4.1: Relevant Features of Groundwater Areas

Declared Area	Affected Area of Proposed Alignment		Subordinate Legislation Defining the Groundwater Area	Water Licence Not Required For
	Chainage from (km)	Chainage to (km)		
Bowen Groundwater Management Area	0	18	Water Regulation 2002	Stock or Domestic Use
Highlands Subartesian Area	271	306.9	Water Regulation 2002	Stock or Domestic Use



	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Construction Water Supply	
		DRAWN LHG	TITLE GROUNDWATER MANAGEMENT AREAS	
		DATE 10/07/2013		
	SCALE 1:1,500,000	A4	PROJECT No NGBR	FIGURE No 4.1

4.2 REGIONAL BORE ASSESSMENT

The DNRM maintain a database of all registered groundwater bores in Queensland known as the groundwater database (GWDB). An extract of the database was obtained on the 8th May 2013 identifying over 2000 registered bores within the 20km buffer zone (20km each side of the alignment) along the proposed NGBR alignment. In locations where bores were scarce, registered bores adjacent to the buffer zone were included in the search.

When dealing with data contained within the GWDB it should be noted that there has been very little verification of this data as it has been accumulated from various reports, departmental (government) drilling programs and commercial driller's logs over more than a hundred years.

While the DNRM and the preceding custodians of the GWDB have attempted to update and verify the contained data over time this task has yet to be completed. Two important areas where vagaries in the data will be relevant to this project are in bore location and water quality and these are discussed below:

GWDB bore location in increasing order of accuracy:

- Bores located from historic property maps and descriptive locations
- Bores located using the centroid of the cadastral boundaries of land parcels
- Bores located by digitising from field topographic and cadastral maps
- Bores located by field (hand held) GPS with accuracy 15-200m depending on the satellite constellation at the time of positioning (more recent = more accurate)
- Bores located by survey or differential GPS (particularly mining and government monitoring bores)

Water quality is generally entered into the GWDB based on either notes in a drillers log or by actual field testing, some data may also be available from laboratory analysis, however there is no consistency to water quality entry in the DCDB and data. The most commonly recorded data is related to salinity/conductivity which may be entered as numerical data or word descriptions. Once again there is no validation of the numerical data nor are the descriptive terms related to specific data ranges as they may simply have been a "taste" observation of the driller at the time of bore construction.

Within this report the location and water quality data, along with all other data, are provided as given in the GWDB however for a comparative guide to groundwater conductivity the following ranges may be used as a guide only (Salinity Management Handbook 2011):

- Potable and Domestic (fit for human consumption) < 1600 $\mu\text{S}/\text{cm}$
- Saline >2500 $\mu\text{S}/\text{cm}$
- Stock use
 - Pigs and poultry < 3300 $\mu\text{S}/\text{cm}$
 - Cattle and horses < 6700 $\mu\text{S}/\text{cm}$
 - Sheep < 10000 $\mu\text{S}/\text{cm}$

4.3 ALIGNMENT SUBDIVISION.

The alignment was divided into sections according to the five regional zones described in the Desktop Geotechnical Assessment for the NGBR Alignment (Cardno UNG, February 2013). This was done in order to group and identify bores within the 20km buffer zone within each section. The regional zones, characterised by different topographical and geological features, and approximate chainage sections are as follows:

- Abbot Point Coastal Plains – chainage 0 to 46km;
- Clarke Range – chainage 46 to 107km;
- Bowen River Valley – chainage 107 to 153km;
- Leichhardt Range – chainage 153 to 228km; and
- Suttor River Flood Plains – chainage 228 to 309km.

The distribution of the regional zones along the are NGBR alignment shown in Figure 4.2 and a description of each of these zones is given below.

4.3.1 ABBOT POINT COASTAL PLAIN BORES

At the Abbot Point Coastal Plain regional zone, 1,760 bores were identified within 20km of the NGBR rail alignment. A total of 1,073 bores had associated aquifer data. These are listed in Table 4.2. The information was taken from the DNRM GWDB file which was provide to Hyder as a data file on the 8/5/2013.

The following formation descriptions from the GWDB were combined and described as Alluvium:

- ALLUV
- ALLUV COMM
- ALLUV MOLO
- ALLUV SPLI
- ALLUVALDON
- ALLUCREEK
- ALLUVIUM
- ALLUVIUMDR
- ALLUVLEVRI
- ALLUVMEURI
- COMMON ALLUVIUMALUV



(Source: Digital Atlas Pty Ltd)

- | | | | |
|---|----------------------------|---|--------------------------|
|  | Abbot Point Coastal Plains |  | Leichhardt Range |
|  | Clark Range |  | Suttor River Flood Plain |
|  | Bowen River Valley | | |

(after Cardno 2013)

	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Construction Water Supply	
		DRAWN LHG	TITLE Geomorphological Zones	
		DATE 10/07/2013		
	SCALE Not to Scale	A4	PROJECT No NGBR	FIGURE No 4.2

Table 4.2: Bores Located within the Abbot Point Coastal Plain (20km Buffer)

No. Of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Formation Description
303	0	50			Alluvium
1	42	44			BLACKWATER GROUP
1	2	10.5	Good	10	BOWEN BEDS
35	4	36			BOWEN GRANITES
3	6	24			BULGONUNNA
1	14	14			CAPE RIVER ALLUVIUM
2	6	21			DON & EURI ALLUVIUM
437	0	34	very good- potable	1.2-45	DON RIVER ALLUVIUM
2	7.6	26			DON RIVER GRANITES
1	11	18			EARTH LIME
1	0	2			ELLIOT RIVER ALLUVIUM
1	7.8	24			ELLIOT RIVER GRANITE
97	0	74.3	Good/Potable	0.1-10	EURI CREEK ALLUVIUM
7	2.4	24.5			EURI CREEK GRANITES
41	1	45	1270-3300 pH8.8	0.14-37.88	GRANITE
1	10.7	19.8			GUTHALUNGRA GRANITES
1	6	?		2	HECATE GRANITE
1	15	20			MOLONGLE CK GRANITES
4	6.7	18.3			MOUNT BUCKLEY ALLUVIUM
1	111	118			NATAL FORMATION
2	2	22			PERMGRANIT
1	0	2			RIVER SAND
1	13	18		25.25	SEDIMENTARY - UNDIFF.
1	4.2	19.8			SLATE ROCK
3	4.9	15.9			SPLITTERS CK GRANITE
2	4.5	7.2	1500-1700 pH8.4-8.8	4	SPLITTERS CREEK ALLUVIUM
13	3	18	potable - 1500	3-3.8	TOWN COMMON ALLUVIUM
1	9	15			UNNAMED (Fractured)
54	0	25			UPPER CARBONEFEROUS
13	0	33			URANNAH IGNEOUS COMPLEX

No. Of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Formation Description
41	0	31.4	potable to salty		UNKNOWN/UNRECORDED
1073	0	118	very good to saline	0.1-45	

*Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.

The aquifer yield range, for those limited number of bores with recorded data, along this section of alignment was between 0.1 L/s and 45 L/s. Bores intersecting the Don River Alluvium appear to have potentially high yields. There were 437 bores drilled into this formation, however only 25 bores had aquifer yield information. Out of these bores, 15 had yields of 10 L/s or more, five had yields between 5 L/s and 10 L/s, while the remaining five were below 5 L/s. Bore RN153200 was the highest yielding bore along this section of alignment (45 L/s between 8m and 13.3m deep) intersecting the Don River Alluvium however no groundwater quality was recorded at this bore. The second highest yielding bore is RN140765 (40L/s at depth between 6.5m and 15m) also intersects this formation.

All bores intersecting the Don River Alluvium which had water quality data available were listed as very good, good or potable, with the exception of RN140839, where conductivity was recorded as 2,200 µS/cm and pH of 8.5, which has not been specifically reported in Table 4.2 as it is not considered to be representative of this unit. Deepest base of aquifer was recorded as 34m below ground level (mBGL). This aquifer is a good potential source of groundwater which could satisfy the water requirements within this section of the alignment.

Out of 97 bores intersecting the Euri Creek Alluvium, only six had associated aquifer data. Three bores recorded yields of more than 5 L/s; RN96593 yielded 7 L/s, RN96608 yielded 10 L/s and RN140682 yielded 6 L/s. These yields were recorded between 4.2m and 21.6m deep. Available quality records indicate 'good/potable' groundwater. This formation could be another potentially good groundwater source.

Two bores intersected Splitters Creek Alluvium; RN140843, yielding 4 L/s between 4.5m – 6.3m deep with recorded conductivity of 1,500 µS/cm and pH 8.4, and RN140852 yielding 4 L/s between 4.8m – 7.2m deep with recorded conductivity of 1,700 µS/cm and pH 8.8.

Out of 13 bores intersecting Town Common Alluvium, three had yield data (RN140963, RN140964 and RN140965). Recorded yield was between 3 L/s and 4 L/s at depth of between 9.5m and 15.2m. Groundwater quality recorded as potable with the exception of RN140963.

Bores intersecting 'granites' (unnamed) are one of the highest yielding, up to 37.88 L/s (RN76436), however yields have been recorded as low as 0.14 L/s (RN140281). RN76435 yielded 25.26 L/s, while RN140318 yielded 12 L/s. Yields occurred at relatively shallow depths from 3.2m to 45m. Groundwater conductivity was recorded between 1,270 µS/cm to 3,660 µS/cm. This aquifer could be a potential source of groundwater but may be a 'hit or miss' in terms of yield, and water quality is relatively low.

Other bores included:

- One sedimentary (undifferentiated) bore RN60391, that yielded 25.25 L/s between 13m-18m deep. No quality information was recorded.
- Hecate Granite (fractured) bore RN141428, that yielded 2L/s. Top of aquifer was recorded as 6m, however no quality information was recorded.

- Bowen Beds bore RN96573 that yielded 10 L/s of 'good' quality water between 6m and 10.5m.

Bores drilled into other formations along this section of alignment have no yield or quality information.

4.3.2 CLARKE RANGE

Within the Clarke Range regional zone, 200 bores were identified within 20km of the NGBR rail alignment. A total of 116 bores had associated aquifer data. These are listed in Table 4.3.

The following formation descriptions from the GWDB were combined and described as Alluvium:

- Allulbogie
- alluv
- alluv bogi
- ALLUVALDON
- ALLUVBOOIE
- ALLUVIUM
- CREEKALLUV

Table 4.3: Bores Located within the Clarke Range Regional Zone (20km Buffer)

No. of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Form_Desc
17	0	21			ALLUVIUM
6	0	30.5			BOWEN GRANITES
5	8	27			BULGONUNNA VOLCANIC GROUP
1	5	12			DON RIVER ALLUVIUM
2	6.1	19.2			ELLIOT RIVER GRANITE
3	0	2.5			EURI CREEK ALLUVIUM
1	9	12			FORMATION UNKNOWN
17	1	53	potable	1.25-5.74	GRANITE
1	15	22			HECATE GRANITE
7	5	150		0.5-10	LIZZIE CREEK VOLCANIC GROUP
6	6.1	25.9			NAVADA GRANITE
1	40	60			SUTOR FORMATION
3	30	150		15-25	TERTIARY - UNDEFINED
2	17	21			THUNDERBOLT GRANITE
10	3	27			UPPER CARB

No. of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Form_Desc
34	0	144	potable - 1482	0.01-72?	UNKNOWN/UNRECORDED
116	0	150	potable - 1482	0.01-72?	

*Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.

Yields along this section of alignment ranged between 0.01L/s and 25 L/s. The highest yield was recorded as 72 L/s in bore RN140762 (between 31m – 32m deep) intersecting an unknown aquifer identified as being fractured. However, at a shallower depth (24m to 26m also within fractured material) yields in the same bore were recorded as 0.29 L/s, and 0.14 L/s between 18m to 24m deep in unconsolidated material. The water quality was recorded to be potable at the shallower depth. Aside from this bore, relatively high yields were recorded in three bores (RN153167, RN153168 and RN153169) that intersected the Tertiary (undefined) Formation, yielding between 15 L/s to 25 L/s. No water quality data was available for these bores.

A total of 17 bores intersected 'Granite'; only two had yield data. Bore RN114063 yielded 1.25 L/s of potable water between 16m and 18m deep, and 5.74 L/s of unknown quality of water between 19m and 22m deep. Bore RN140904 yielded 2.4 L/s between 12m and 18.5m deep. No water quality was recorded for this bore.

Seven bores intersected the Lizzie Creek Volcanic Group, six with yield data. Bore RN153145 had the highest yield (10 L/s) at about 45m in depth, but only 0.5 L/s at about 23m in depth. This bore intersected fractured material. Bore RN153144, intersected consolidated material and yielded up to 7.7 L/s at 70m in depth, with deeper water bearing zones yielding 1.7 L/s and 2.3 L/s at 130m and 150m depth, respectively. At a depth of 42m, this bore yielded only 1 L/s. Bore RN153147 yielded 5 L/s at a depth of 91m in unconsolidated material and 2 L/s at a depth of 66m. All other bores intersecting the Lizzie Creek Volcanic Group yielded 2 L/s or less. No water quality was recorded for these bores.

All other yield data was recorded in bores of an unknown/unrecorded formation. These yields ranged between 0.01 L/s and 3.8 L/s, with one bore (RN125703) yielding potable water at 19.2 L/s between 9m and 23m deep. Water quality was recorded as potable to brackish (1,482µS/cm).

Bores intersecting other formations along this section of the alignment had no recorded yield or water quality information.

4.3.3 BOWEN RIVER VALLEY

A total of 131 bores were identified along the Bowen River Valley regional zone within 20km of the NGBR alignment. These bores are listed in Table 4.4. As many as 39 bores had aquifer information, however yields and/or quality were only available in bores intersecting 'unknown/unrecorded' formation. These bores yielded between 0.02 L/s to 6 L/s between 8m and 37m deep and water quality was recorded as potable.

Table 4.4: Bores Located within the Bowen River Valley Regional Zone (20km Buffer)

No. of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Form_Desc
8	6	19			ALLUVIUM
6	5	21			BASALT
2	18.3	27			BOWEN RIVER GRANITES

No. of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Form_Desc
3	3	17			BULGONUNNA
1	31	35			FORMATION UNKNOWN
3	6	10			GRANITE
3	11	70			LIZZIE CREEK VOLCANIC GROUP
1	8	9			THUNDERBOLT GRANITE
12	8	37	potable	0.02 - 6	UNKNOWN/UNRECORDED
39	3	70			

*Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.

4.3.4 LEICHHARDT RANGE

A total of 68 bores identified within 20km of the NGBR rail alignment within the Leichhardt Range regional zone. Of these, 31 bores had associated aquifer data. The bores are shown in Table 4.5.

The highest yields were recorded in bores intersecting 'unknown/unrecorded' formation (RN125974 and RN125977, each yielding 12 L/s). All other bores within this formation yielded less than 7 L/s, while electrical conductivity ranged between 1,200 µS/cm and 1,500 µS/cm where water quality was recorded.

Only three bores intersected the Rangal Coal Measure; RN63239 yielded 5 L/s between 20m to 29m deep, RN63240 yielded 9 L/s between 26m to 29m deep, and RN63241 yielded 10 L/s between 39m to 44m deep. No water quality data was available.

Table 4.5: Bores Located within the Bowen River Valley Regional Zone (20km Buffer)

No. of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Form_Desc
3	19	74			ALLUV
2	33	62		1-4.4	BASALT
5	19	81		0.88-3.5	BLACKWATER GROUP
1	18.9	19.8			NAVADA GRANITES
3	20	44		5.0-10	RANGAL COAL MEASURES
1	42	56		2.5	TERTIARY - UNDEFINED
1	5	6		-	UPPER CARB
15	24	120	1200-1500	0.1-12	UNKNOWN/UNRECORDED
31	5	120	1200-1500	0.1-12	

*Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.

Bores intersecting other formations, had recorded yields below 5 L/s and had no associated water quality data available. These bores are as follows:

- Two bores intersecting Basalt (weathered zone) yielding less than 4.5 L/s.

- Five bores intersecting the Blackwater Group Formation, yielding less than 3.5 L/s.
- One bore intersecting Tertiary (Undefined) Formation, yielding 2.5 L/s.

No yield information was available for bores intersecting Alluvium, Nevada Granites or the Upper Carboniferous Formation.

4.3.5 SUTTOR RIVER FLOOD PLAIN

Within the Suttor River Flood Plain regional zone, 56 registered bores identified within 20km of NGBR alignment and are shown in Table 4.6. Aquifer data was available for 35 of these bores.

Table 4.6: Bores Located within the Suttor River Flood Plain Regional Zone (20km Buffer)

No. of Bores	Top Of Aquifer	Base of Aquifer	Quality * µS/cm	Yield L/s	Form_Desc
4	3	11			ALLUVIUM
1	18	60			BULGONUNNA VOLCANIC GROUP
1	18	19		0.45	GRANITE
4	5.8	13.6			MISTAKE CREEK ALLUVIUM
4	54.9	142	1900	1.14	MOUNT HALL FORMATION
5	61	145	160-872	0.1-10	SILVER HILLS VOLCANICS
2	22	83	2000-2200	0.75	STAR OF HOPE FORMATION
6	8.5	91	potable to brackish	0.01-5	SUTTOR FORMATION
4	33	88.6	1126-13500		TERTIARY - UNDEFINED
4	0	152	potable to brackish	0.29-5	UNKNOWN/UNRECORDED
35		152	Potable - brine	0.01 -10	

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

Yield range along this section of alignment was between 0.01 L/s and 10 L/s. The highest yielding bore is RN132786 (10 L/s at 155m deep) intersecting Silver Hill Volcanics. Groundwater quality was recorded as 872 µS/cm. Following this, the next high yielding bores are RN125851 (yielding 5 L/s at depth between 42m-91m) in the Suttor Formation, and RN125849 (yielding 5 L/s at depth ranging between 86m-98m) in an 'unknown/unrecorded' formation. All other bores yielded less than 4 L/s.

Bores intersecting the Silver Hills Volcanics had the highest yields but the range of yields varied greatly (between 0.1 L/s to 10 L/s). Available quality data from three bores indicated that conductivity ranged between 160 µS/cm to 872 µS/cm. The aquifer depth ranged between 8.5m to 91m deep.

Bores intersecting the Suttor Formation yielded between 0.01 L/s and 5 L/s. Available data from five bores indicated that groundwater quality ranged from potable to saline (up to 6,210 µS/cm). The aquifer depth ranged between 8.5m to 91m deep. Based on limited data available, it appears that groundwater quality improves with depth in this formation within this regional zone. Other formations intersected are as follows:

- Granite; one bore RN140783 yielded 0.45 L/s at depth between 18-19m,
- Mount Hall Formation; six bores identified but only one with aquifer data, yielded 1.14 L/s, 1,900 µS/cm at depth between 54.9m to 142m,
- Star of Hope Formation; two bores of varying depth were identified. RN132195, yielded 0.75 L/s at depth between 75m - 83m with conductivity recorded as 2,000 µS/cm; RN12030156 had no yield data but conductivity was recorded to be 2,200 µS/cm at depth between 22m - 33m.
- Tertiary (Undefined) Formation; four bores were identified but no yield data was available, however water quality from two bores were recorded as 13,500 µS/cm (RN12030175) and 1,126 µS/cm (RN12030177).

No information was available for bores intersecting Alluvium, Bulgonunna Volcanic Group or the Mistake Creek Alluvium.

4.4 REVIEW OF GEOLOGY ALONG THE NGBR ALIGNMENT

4.4.1 KEY GEOLOGICAL STRUCTURES

There are four key geological structures that are present along the NGBR alignment. These are listed below from the youngest to oldest:

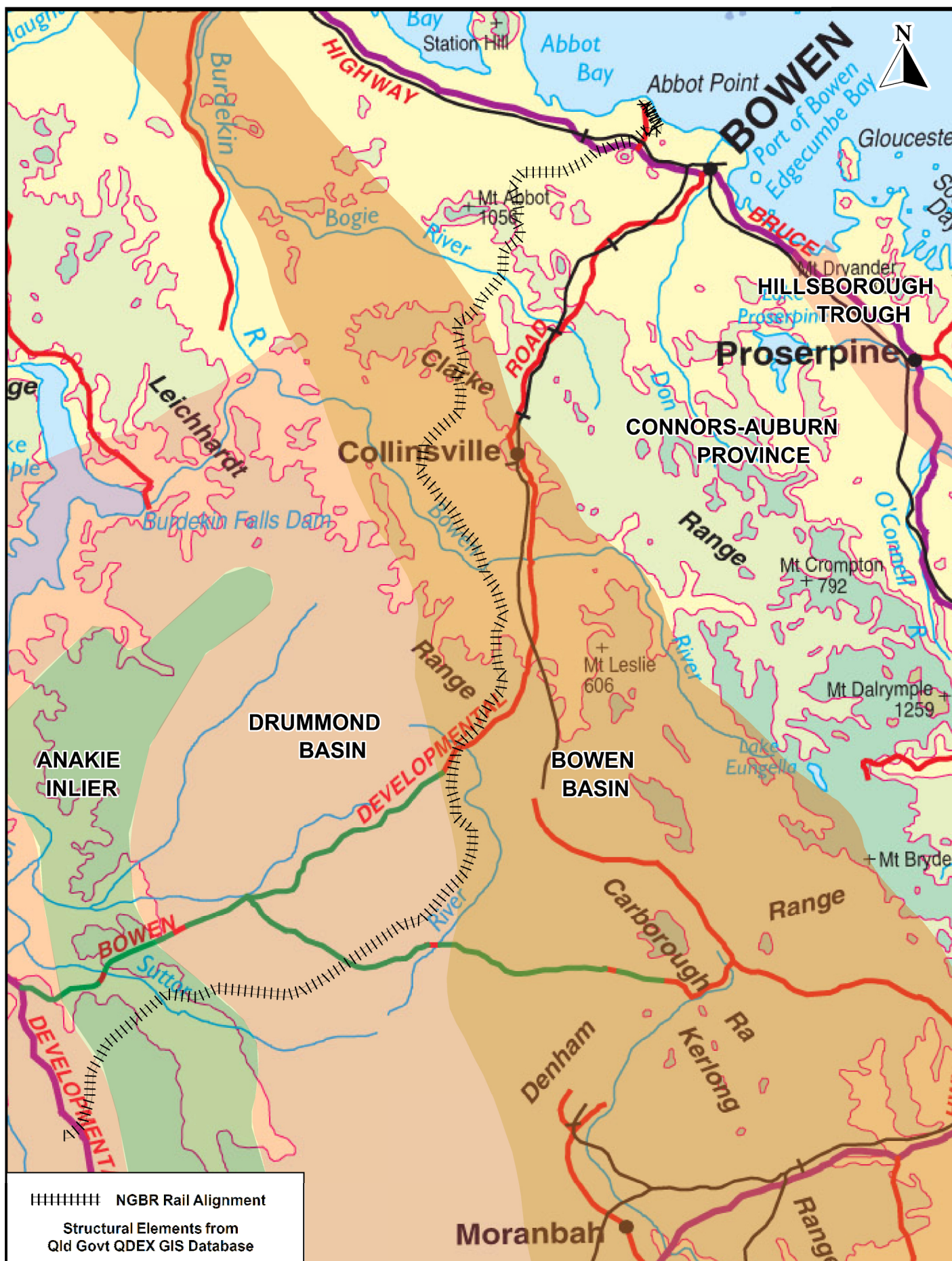
- The Bowen Basin
- The Connors – Auburn Province
- The Drummond Basin
- The Anakie Inlier

Figure 4.3 shows the location of the proposed alignment together with these key structural units, which are described in more detail in the following sections. Table 4.7 provides a summary of the structural units along the proposed route.

Table 4.7 Key Geological Structural Units along the Proposed Alignment

Chainage from (km)	Chainage to (km)	Geological Structural Unit	Age of structural unit	Broad overview of geology
0	77.7	Connors Auburn Province	Early Carboniferous to Permian	Mafic to felsic volcanics & plutonic igneous rocks
77.7	212.2	Bowen Basin	Mesozoic (Permian to Triassic)	Fine to coarse grained consolidated sedimentary rocks (sandstone, siltstone, shale, coal)
212.2	268.7	Drummond Basin	Early Devonian to Early Carboniferous	Fine grained consolidated sedimentary rocks (siltstone & mudstone) & volcanics (andesite & rhyolite)
268.7	296.6	Anakie Inlier	Neoproterozoic-early Palaeozoic	Metamorphic rocks, generally siltstone, fine sandstone, phyllite, & schist, commonly cleaved & multiply deformed

Chainage from (km)	Chainage to (km)	Geological Structural Unit	Age of structural unit	Broad overview of geology
296.6	306.9	Drummond Basin	Early Devonian to Early Carboniferous	Fine grained consolidated sedimentary rocks (siltstone & mudstone) & volcanics (andesite & rhyolite)

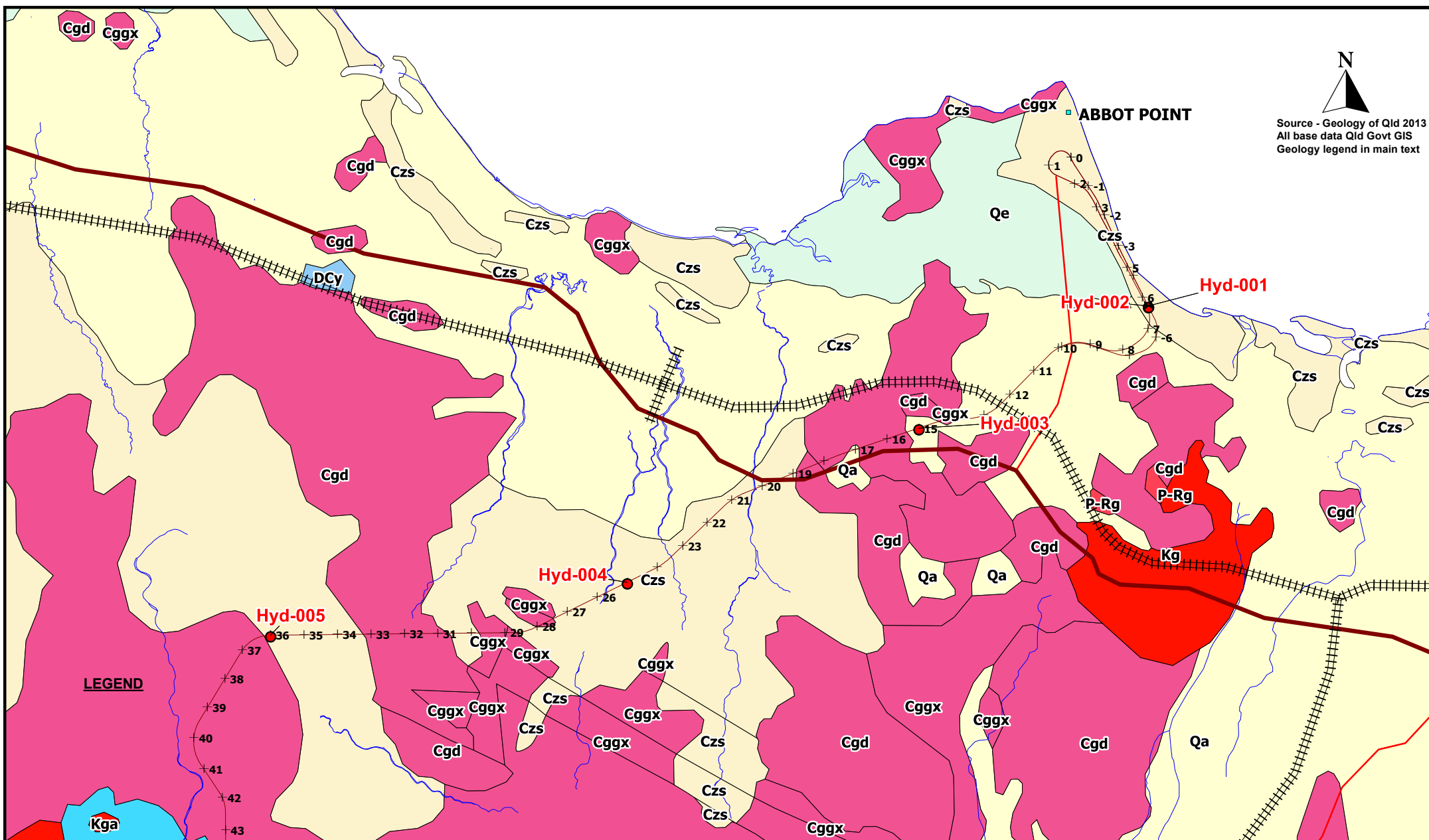


	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Water Supply Strategy	
		DRAWN LHG	TITLE KEY GEOLOGICAL STRUCTURAL UNITS	
		DATE 10/07/2013	PROJECT No NGBR	
	SCALE 1:1,000,000	A4	FIGURE No 4.3	

These main units are, in places, overlain by younger Tertiary age sediments and basaltic volcanics and Quaternary age alluvium, residual and coastal sediments (at the northern end of the alignment). Figures 4.4 through 4.8 show the proposed alignment over regional surface geological mapping along with the location of DNRM registered water bores. The following table (4.8) provides a geological key to figures 4.4 to 4.8.

Table 4.8 Geological Key to Figures 4.4-4.8

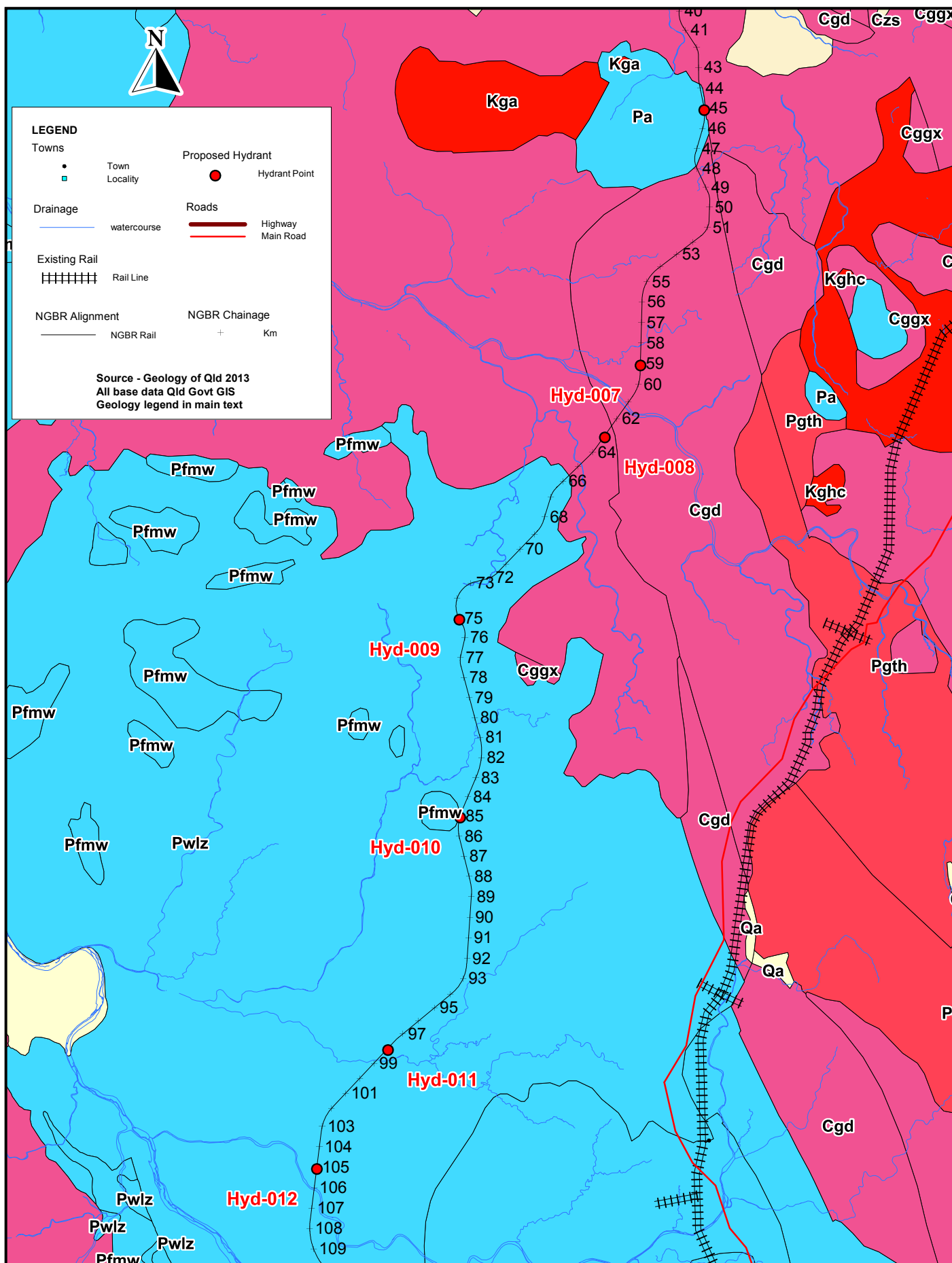
AGE	MAP SYMBOL	UNIT NAME
Quaternary	Qa	alluvium
	Qrc	colluvium
Paleozoic	Cza	alluvium
	Czs	sand plain
	Czc	sedimentary rocks
	Czb	mafic volcanic rocks
	Czcsu , Czl	Suttor Formation, Ferruginous duricrust
Cretaceous	Kg	undifferentiated felsic intrusives
	Kga	Mount Abbot Igneous Complex
	Kghc	Hecate Granite
Triassic	Rsr	Rewan Group
	Rsl	Clematis Group
Permian	Pok	Blackwater Group
	Psb	Back Creek Group
	Pwlz	Lizzie Creek Volcanics
	Pa	undifferentiated volcanoclastics
	Pfmw	Mount Wickham Rhyolite
	Pgth	Thunderbolt Granite
Late Carboniferous - Early Permian	Cfb, Cf	Bulgonunna Volcanic Group, felsic volcanics and high level intrusives
	Cwst, Cdgh	Star of Hope Formation, mafic intrusives
	Csmh, Csmr	Mount Hall Formation, Mount Rankin Formation
Carboniferous	Cgcx	felsic intrusives
	Cggx	felsic to intermediate intrusives
	Cgd ,Cgi, Cglg, Cgnn	Diorite, intrusive rhyolite, Bluegrass Creek Granite, Manaman Granodiorite
Devonian	Dcy, Dfiv, Dwbi	metamorphic rocks, Silver Hills Volcanics, Bimurra Volcanics
Early Cambrian	Nya	Anakie Metamorphic Group



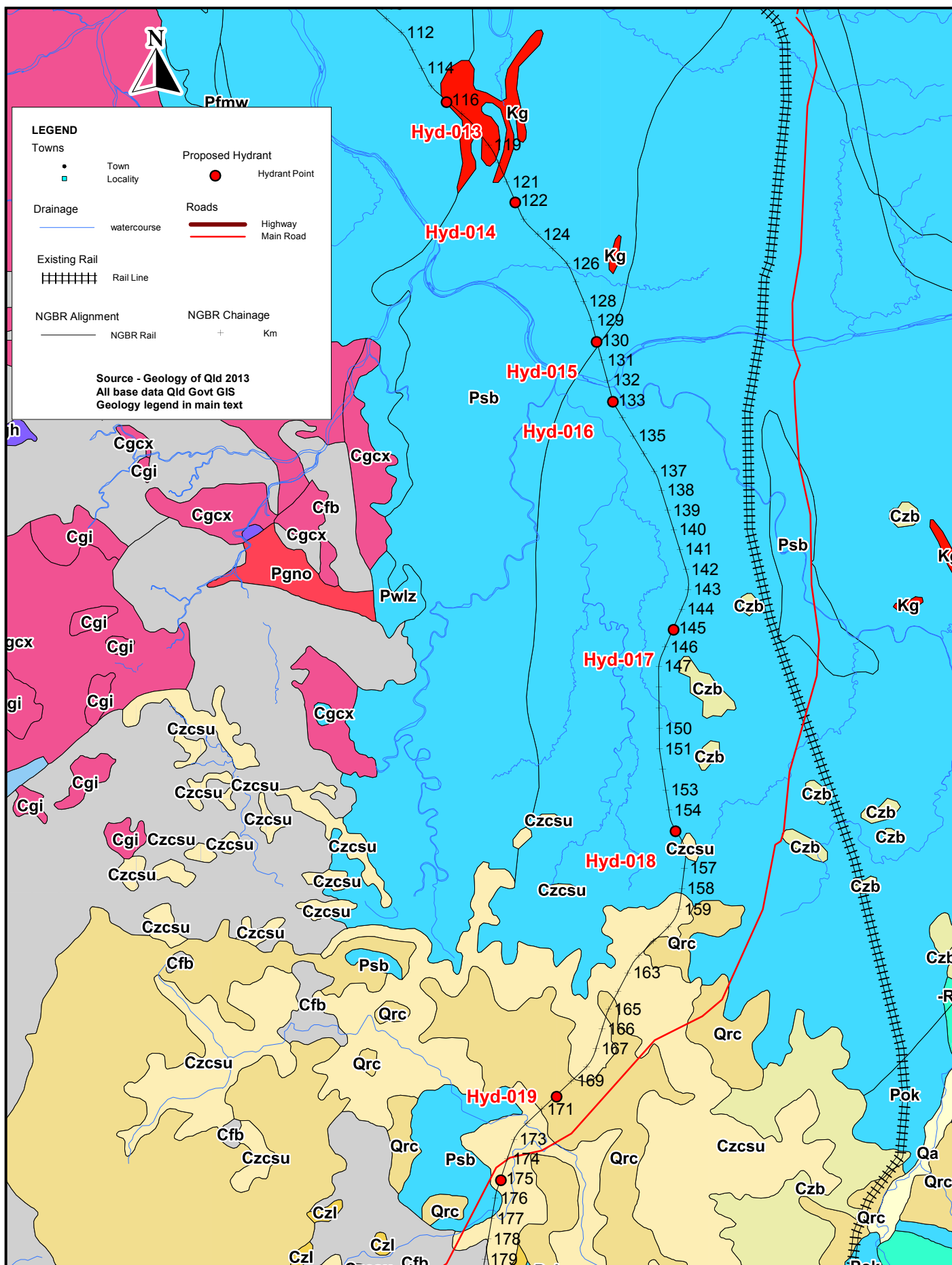
LEGEND		
Towns		Drainage
• Town		— Watercourse
□ Locality		
Roads		Existing Rail
— Main Road		Rail Line
— Highway		
— Road		Proposed Hydrants
NGBR Alignment		• Hydrant Point
NGBR Rail		
+	Km	



CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Construction Water Supply	
	DRAWN LHG	TITLE ALIGNMENT GEOLOGY 0km - 40km	
	DATE 10/07/2013		
SCALE 1:150,000	A4	PROJECT No NGBR	FIGURE No 4.4



	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Construction Water Supply	
		DRAWN LHG	TITLE ALIGNMENT GEOLOGY 40km - 110km	
		DATE 10/07/2013		
	SCALE 1:250,000	A4	PROJECT No NGBR	FIGURE No 4.5



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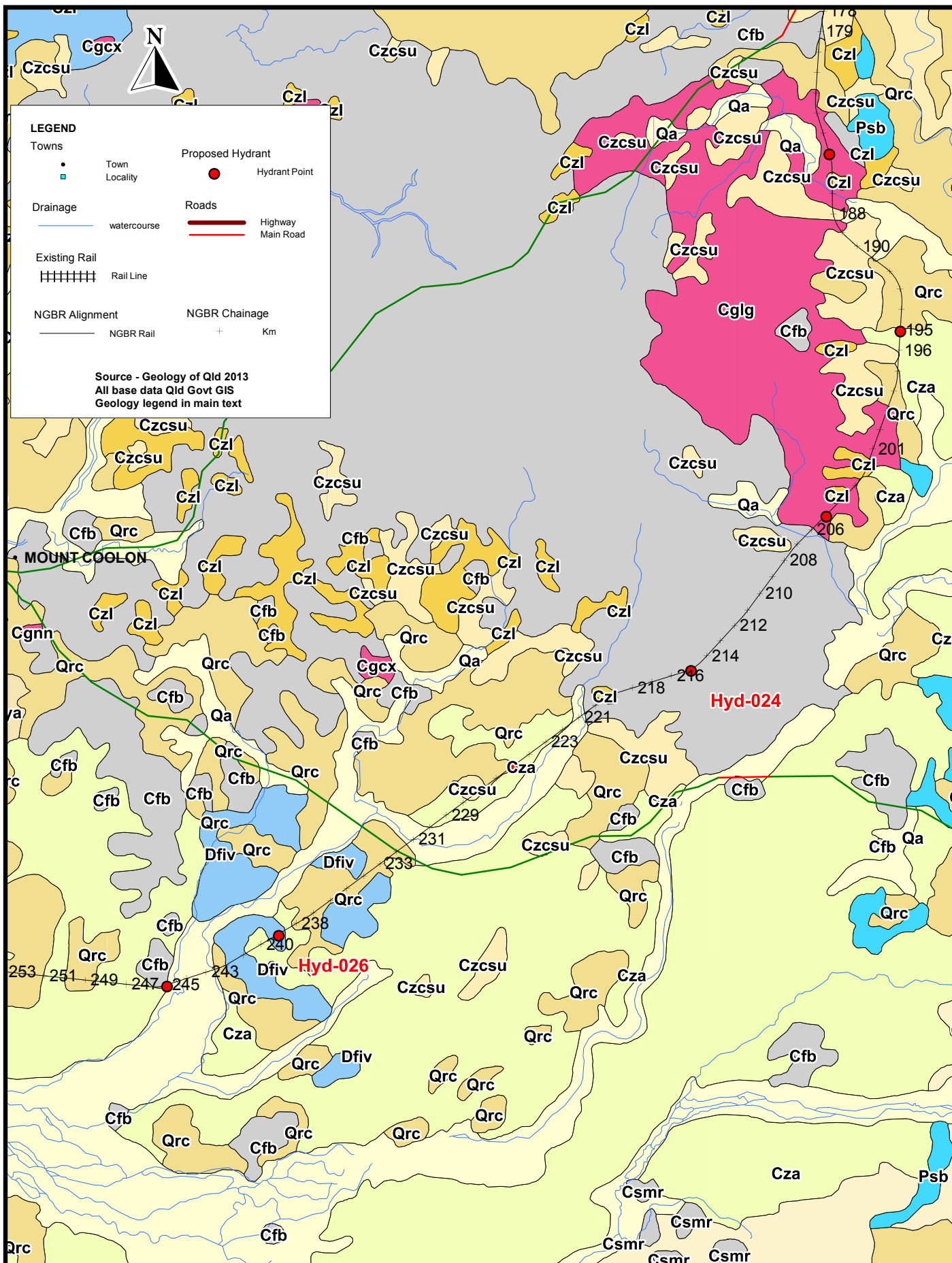
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PROJECT
NGBR Construction Water Supply

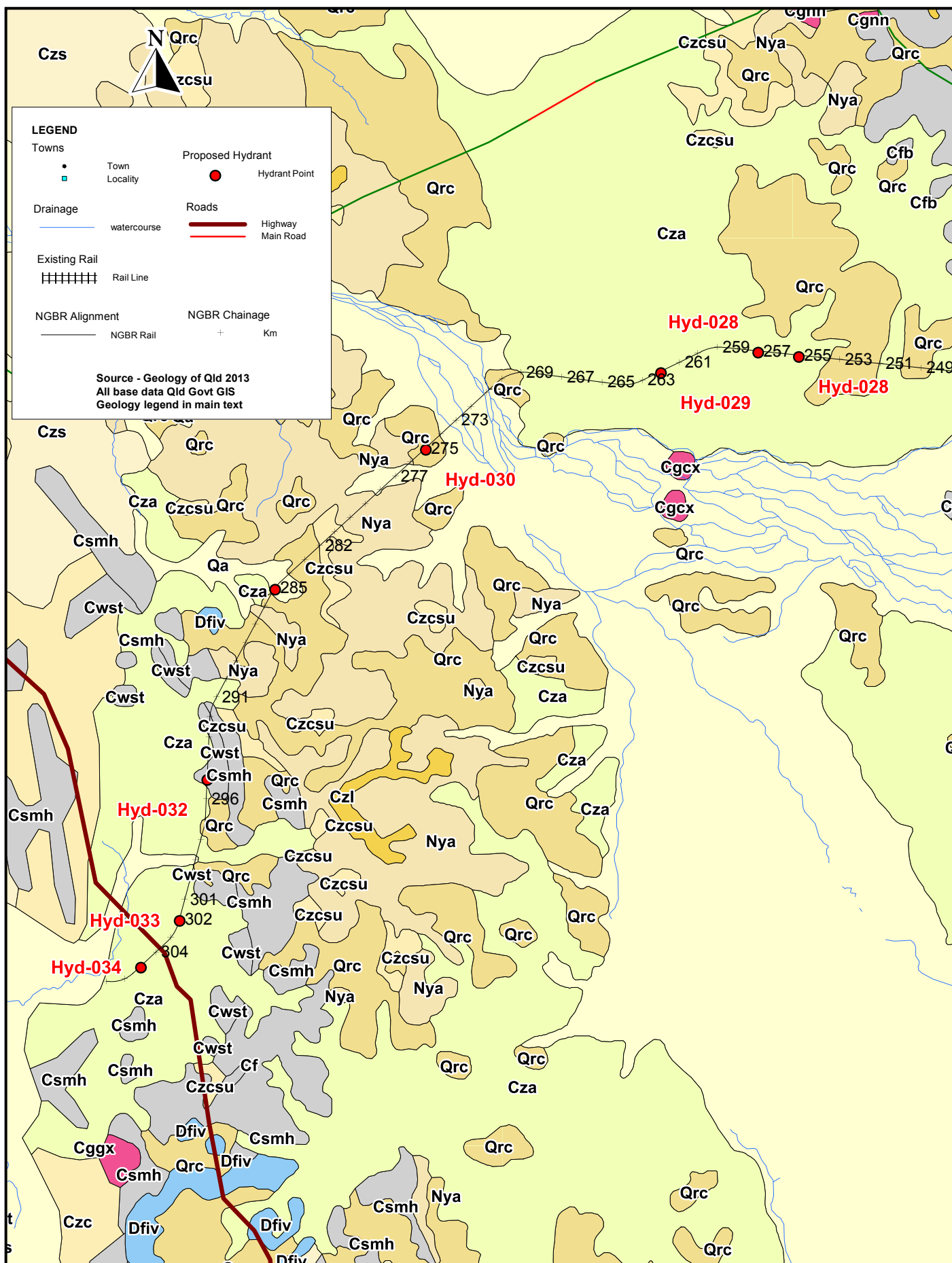
TITLE
ALIGNMENT GEOLOGY
110km - 180km

PROJECT No
NGBR

FIGURE No
4.6



	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Construction Water Supply	
		DRAWN LHG	TITLE ALIGNMENT GEOLOGY 180km - 250km	
		DATE 10/07/2013		
	SCALE 1:250,000	A4	PROJECT No NGBR	FIGURE No 4.7



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DRAWN
LHG
DATE
10/07/2013

SCALE
1:250,000

A4

PROJECT
NGBR Construction Water Supply

TITLE
ALIGNMENT GEOLOGY
250km - 306km

PROJECT No
NGBR

FIGURE No
4.8

4.4.2 BOWEN BASIN

The Bowen Basin hosts Permian age deltaic and shallow-marine sediments, including coal, and basic and intermediate volcanics; overlain by Triassic age continental sediments. The basin also hosts basal volcanics and Permian and Cretaceous age ultrabasic and acid intrusives; overlain in part by Tertiary age basalt. The Bowen Basin rocks have not been subject to regional metamorphism. The basin hosts open to tight folding and moderate faulting (Hutton et al., 1998).

Within the Bowen Basin the main geological units of interest include the Lizzie Creek Volcanics, and Blackwater Group (namely the Rangal Coal Measures).

The Lizzie Creek Volcanics generally consist of Permian age basaltic to andesitic lava and volcanoclastic rocks (including breccia and arenite), rhyolitic to dacitic lava and volcanoclastic rocks (including ignimbrite); local siltstone, shale and polymictic conglomerate. Paine et al (1972) have indicated that on the Bowen 1:250,000 scale geological sheet that the Lower Permian age Lizzie Creek Volcanics have a maximum thickness of approximately 6,000 m. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the Lower Permian age Lizzie Creek Volcanics have a maximum thickness of approximately 3,000 m.

Paine et al (1972) have indicated that on the Bowen 1:250,000 scale geological sheet that the Blackwater Group has a maximum thickness of between approximately 2,030 and 2,380 m. Overall the Blackwater Group generally consists of late Permian age feldspathic and lithic sandstone, silty sandstone, calcareous sandstone, ash-stone and cherty mudstone, carbonaceous mudstone and coal; commonly abundant plant fossils and fossil wood. Paine et al (1972) have indicated that on the Bowen 1:250,000 scale geological sheet that the Blackwater Group has a maximum thickness of approximately 1,900 m.

The Rangal Coal Measures lie stratigraphically above the Fort Cooper. The Rangal Coal Measures generally consist of late Permian age Calcareous sandstone, calcareous shale, mudstone, coal, concretionary limestone. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the Rangal Coal Measures have a maximum thickness of approximately 200 m. Porosity in most of these rocks is would be dominated by secondary porosity due to jointing, weathering and coal cleat jointing. Some primary porosity could occur in the sandstone units, however in the Bowen Basin sequences the sandstones tend to generally be poorly permeable compared to the coals.

Further to the east of the proposed rail route, in the area near the core of the Bowen Syncline lie the following younger Bowen Basin units:

- Rewan Group
- Clematis Group; and
- Moolayember Formation.

The Rewan Group is a Triassic age unit that largely consists of Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanilithic pebble conglomerate (at its base). Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the Rewan Group has a maximum thickness of approximately 1,200 m.

The Clematis Group are Triassic age rocks that largely consist of medium to coarse-grained quartzose to sublithic, micaceous sandstone, siltstone, mudstone and granule to pebble conglomerate. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the Clematis Group has a maximum thickness of approximately 500 m.

The Moolayember Formation is a Triassic age unit which forms part of the upper section of the Bowen Basin. The Moolayember Formation generally consists of micaceous lithic sandstone and micaceous siltstone. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the Moolayember Formation has a maximum thickness of approximately 100 m.

Tertiary age formations

A series of Tertiary age formations overlies parts of the older rock units along the proposed alignment. The key Tertiary age sedimentary formation in the area of interest is the Suttor Formation which is specifically recognised on the Bowen, Mount Coolon and Clermont 1:250,000 scale sheets but not specifically differentiated further south west on the Galilee or Jerricho 1:250,000 sheet areas.

Hutton et al. have noted that in some areas of the Mount Coolon 1:250,000 scale sheet area palaeodrainage lines are obvious as a result of preferential induration of old valley floors, which now stand up in inverted relief. Hutton et al. suggested that these are particularly well developed about the margins of the Bulgonunna high, where they show a radial drainage pattern, and on the Gunjulla 1:100,000 scale sheet where they show a drainage system running off the basement Anakie high.

On the Mount Coolon 1:250,000 scale sheet, Hutton et al. (1998) has indicated that the overall palaeodrainage pattern appears to have been similar to the present with an antecedent to the Suttor River draining south in the Byerwen area, and then west and finally north-west into a postulated Tertiary age lake in the Rosetta Creek area.

Hutton et al. (1998) noted a break near Eaglefield between the outcrops of the Byerwen area and those of the main Suttor River area, where any connection must have been via a fairly narrow valley cut into the basement rocks. It is not certain whether or not this narrow valley contains coarse grained sediment fill. Hutton et al. have suggested an alternative palaeodrainage scheme whereby the upper Suttor River in the Byerwen 1:100,000 scale area may have originally drained south to Moranbah, and was diverted to the west by the basalt flows.

The Suttor Formation generally consists of Quartz sandstone, clayey sandstone, mudstone and conglomerate; fluvial and lacustrine sediments; and minor interbedded basalt. Paine et al (1972) have indicated that on the Bowen 1:250,000 scale geological sheet that the Suttor Formation has a thickness range of 60 to 120 m. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale sheet that the tertiary age sediments range in thickness from < 20 m to > 100 m.

4.4.3 CONNORS – AUBURN PROVINCE

Donchak et. Al (2013) described the Connors-Auburn Province as the volcanic arc of the northern New England Orogen separating the backarc Bowen Basin from the forearc Yarrol Province. The Auburn Subprovince in the south and the Connors Subprovince in the north are preserved as broad basement highs or arches.

The main part of the Bowen Basin flanks the province to the west. A narrow strip of the Bowen Basin flanks the province in the east and separates it from the Yarrol Province. The subprovinces probably formed as a continuous belt, but are now separated by the Gogango Thrust Zone, which continues south along the eastern side of the Auburn Subprovince, separating it from the Yarrol Province. The Gogango Thrust Zone is a belt of monotonous, strongly cleaved sandstone and mudstone of the Permian Back Creek Group with belts of deformed intermediate to felsic volcanic rocks up to 10km long. (Extract from: Donchak, P.J.T.,

et al., 2013. New England Orogen. In Jell, P. A., (eds) *Geology of Queensland*, Geological Survey of Queensland.)

The main geological units of the Connors-Auburn Province that are of interest include the granites and alluvium units.

4.4.4 DRUMMOND BASIN

The Drummond Basin largely consists of Late Devonian to Early Carboniferous age continental sedimentary and volcanic rocks with sporadic marine beds towards its base. The basal Late Devonian age shallow-marine sediments are overlain unconformably by Early Carboniferous age fluvial and lacustrine sediments and acid volcanics. The acid volcanics are thickest in the eastern part of the basin. The Drummond Basin rocks have been subjected to significant folding but have not been metamorphosed.

The main geological units intersected by identified bores (with yield data) within the Drummond Basin along the proposed alignment include but are not restricted to the Silver Hills Volcanics and Star of Hope Formation.

The Silver Hills Volcanics generally consists of rhyolite, dacite, rhyolitic ignimbrite, volcaniclastic sediments, sinter, minor sandstone and siltstone. Senior (1973) has indicated that on the Jericho 1:250,000 scale geological sheet that the Upper Devonian to Lower Carboniferous age Silver Hills Volcanics has a maximum thickness of approximately 1,000 m. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the late Devonian to early Lower Carboniferous age Bimura Volcanics have a maximum thickness of approximately 1,000 m.

The Star of Hope Formation generally consists of lithic conglomerate, feldspatholithic sandstone, rhyolitic to dacitic ignimbrite and flows, tuffaceous siltstone and rare sinter. Senior (1973) has indicated that on the Jericho 1:250,000 scale geological sheet that the Lower Carboniferous age Star of Hope Formation has a maximum thickness of approximately 300 m. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the Star of Hope Formation has a maximum thickness > 30m.

Other formations of the Drummond Basin include, but are not restricted to the following:

- Raymond Sandstone
- Bulliwah Formation
- Natal Formation
- Ducabrook Formation

The Raymond Sandstone generally consists of fine to medium-grained, quartzose sandstone, locally feldspathic, clayey sandstone and olive-green mudstone interbeds. Senior (1973) has indicated that on the Jericho 1:250,000 scale geological sheet that the Lower Carboniferous age Raymond Formation has a maximum thickness of approximately 300 m.

The Bulliwah Formation generally consists of fine to medium grained feldspathic quartz sandstone; minor olive mudstone, pebbly feldspathic quartz sandstone and algal limestone. The entry for this formation on the Geoscience Australia stratigraphic database indicates a maximum thickness of 1,800 m for this formation.

The Natal Formation generally consists of alternating fine grained feldspathic quartz sandstone and olive siltstone. The entry for this formation on the Geoscience Australia stratigraphic database indicates a maximum thickness of 1,200 m for this formation.

The Ducabrook Formation generally consists of feldspatholithic sandstone, mudstone, siltstone (commonly tuffaceous), minor algal and oolitic limestone. Senior (1973) has indicated that on the Jericho 1:250,000 scale geological sheet that the Lower Carboniferous age Ducabrook Formation has a maximum thickness of approximately 750 m.

Overlying the Drummond Basin are the rocks of the Bulgonunna Province. The Bulgonunna Province unconformably overlies the Anakie Metamorphic Group and Late Devonian to Early Carboniferous age sediments and volcanics to the west, and underlies the Bowen Basin in the east. These rocks are dominated by the Bulgonunna Volcanics which include, amongst other constituent formations the Locharwood Rhyolite which consists of moderately crystal rich to crystal rich rhyolitic ignimbrite with a well-developed eutaxitic texture. The entry for the Bulgonunna Volcanics on the Geoscience Australia stratigraphic database indicates a maximum thickness of 1,000 m for this group. The entry for the Locharwood Rhyolite on the Geoscience Australia stratigraphic database indicates a maximum thickness of 80 m for this formation. This thickness is also indicated by Hutton et al. (1998) for the formation on the Mount Coolon 1:250,000 sheet area.

Porosity in most of these rocks is dominated by secondary porosity due to jointing and weathering, although there may be some minor primary porosity present in the coarser grained sandstone units.

4.4.5 ANAKIE INLIER

The Anakie Inlier is a north-south trending block of multiply deformed Neoproterozoic to early Palaeozoic age rocks that divides the late Palaeozoic age Drummond Basin into two sections; an eastern and western section. The Anakie Inlier comprises an older multiply deformed sequence, the Anakie Metamorphic Group, which is unconformably overlain by the Ukalunda beds (Early Devonian sediments), and intruded by the Retreat Granite. It is presumed to be the only exposure of basement rocks that underlie the Drummond, Adavale, Cooper, Galilee and Eromanga Basins.

The Anakie Metamorphic Group consists of a commonly cleaved and multiply deformed sequence of siltstone, fine sandstone, phyllite, slate and schist. These rocks usually do not host significant primary porosity.

The only geological unit intersected by identified bores (with yield data) within the Anakie Inlier is the Mount Hall Formation. This formation generally consists of quartzose to feldspathic sublabile sandstone, quartz-pebble conglomerate, mudstone and red and green siltstone. Olgers (1969) has indicated that on the Clermont 1:250,000 scale geological sheet that the Lower Carboniferous age, Mount Hall Formation has a maximum thickness of approximately 610 m. Hutton et al. (1998) have indicated that on the Mount Coolon 1:250,000 scale geological sheet that the late Devonian to early Lower Carboniferous age Mount Hall Formation has a maximum thickness of approximately 1,000 m.

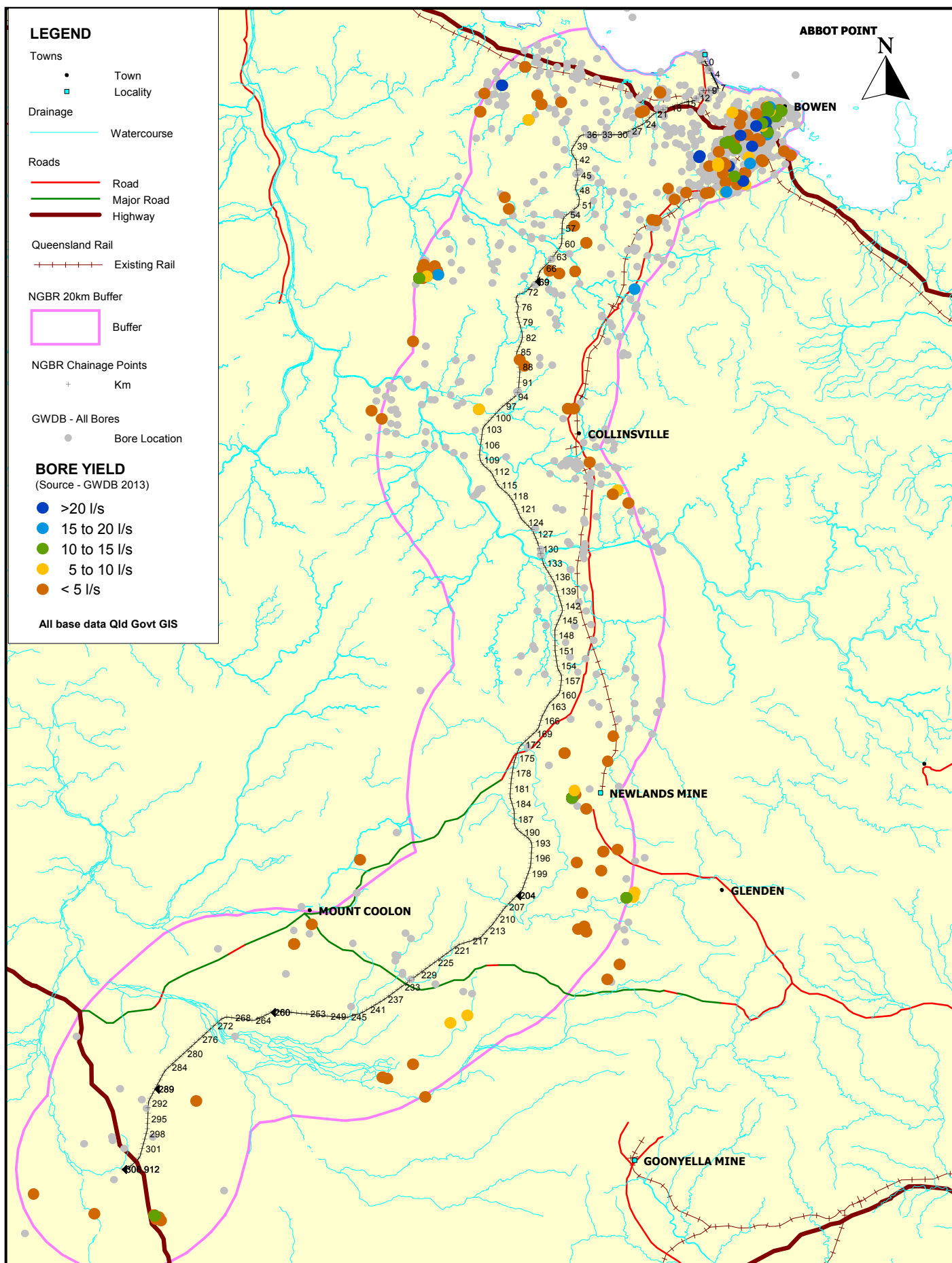
4.5 GROUNDWATER YIELD

Based on the registered bore information obtained in Section 4.3, available groundwater yield data was grouped as follows:

- less than 5 L/s;
- between 5 and 9.99 L/s;
- between 10 and 14.99 L/s;
- between 15 L/s and 19.99 L/s; and
- more than 20 L/s.

The locations of these bores are shown in Figure 4.9 and the buffer zone is shown as a reference for bores located adjacent to the buffer margin.

Formations with yield data were grouped according to the sedimentary basin within which the bores are located as shown in Table 4.9.



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PROJECT
NGBR Water Supply Strategy

TITLE
Bore Yields - GWDB

PROJECT No
NGBR

FIGURE No
4.9

Table 4.9: Formations Related to Major Structural Elements

Connors-Auburn Province	Bowen Basin	Drummond Basin	Anakie Inlier
Don River Alluvium	Basalt	Granite	Mount Hall Formation
Euri Creek Alluvium	Blackwater Group	Silver Hills Volcanics	
Granite	Lizzie Creek Volcanic Group	Star of Hope Formation	
Hecate Granite	Rangal Coal Measures	Suttor Formation	
Splitters Creek Alluvium	Tertiary Unit		
Town Common Alluvium			
Bowen Beds			
Sedimentary Unit			

The following section of this report provides a review of the route hydrogeology by key hydrogeological units.

4.5.1 CONNORS-AUBURN PROVINCE HYDROGEOLOGY

Don River Alluvium

Table 4.10 provides a summary of key DNRM recorded data for bores interpreted to intersect Don River Alluvium within the Connors-Auburn Province.

Table 4.10: Statistics for key DNRM data for bores intersecting the Don River Alluvium

Statistics	Value	Units
Number of bores with DNRM yield records	27	Bores
Lowest recorded yield value	0	L/s
Highest recorded yield value	45	L/s
Mean of recorded yield values	12.74	L/s
Median of recorded yield values	10	L/s
Lowest recorded depth value	2	m BGL
Highest recorded depth value	27	m BGL
Mean of recorded depth value	11.21	m BGL
Median of recorded depth values	10.7	m BGL
Number of bores with water quality description	17	
Water quality description	Very good, good, potable*	
Number of bores with electrical conductivity value	1	bore
Recorded electrical conductivity value	2,200	µS/cm
Least recorded depth to standing groundwater levels	2.00	m BGL
Deepest recorded depth to standing groundwater levels	15.00	m BGL
Mean of recorded depth to standing groundwater levels	5.61	m BGL
Median of recorded depth to standing groundwater levels	5.18	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.10 indicates that the existing bores intersecting the Don River Alluvium are likely to provide supplies in the order of 10 to 13 L/s from individual bores, although high yields between 30 and 45 L/s were recorded in four bores. However, the recorded drilling depths indicate only relatively shallow drilling averaging in the order of 10m with a maximum depth of 27m.

Most groundwater quality data recorded were subjective with only one bore where electrical conductivity was measured.

This formation represents a relatively low-risk target that would require relatively shallow drilling to secure relatively moderate yields.

Bowen Beds

Only one bore intersected the Bowen Beds Formation in the Connors-Auburn Province. This bore recorded a yield of 10 L/s, between depths of 6m to 10.5m. Water quality was recorded as 'good' with standing water levels at 3.5m BGL.

Euri Creek Alluvium

Table 4.11 provides a summary of key DNRM recorded data for bores interpreted to intersect Euri Creek Alluvium within the Connors-Auburn Province.

Table 4.11: Statistics for key DNRM data for bores intersecting the Euri Creek Alluvium

Statistics	Value	Units
Number of bores with DNRM yield records	6	Bores
Lowest recorded yield value	0.1	L/s
Highest recorded yield value	10	L/s
Mean of recorded yield values	4.72	L/s
Median of recorded yield values	5.2	L/s
Lowest recorded depth value	4	m BGL
Highest recorded depth value	21.6	m BGL
Mean of recorded depth value	10.18	m BGL
Median of recorded depth values	8.15	m BGL
Number of bores with water quality description	1	
Water quality description	Potable*	
Number of bores with electrical conductivity value	0	bore
Recorded electrical conductivity value	-	-
Least recorded depth to standing groundwater levels	4	m BGL
Deepest recorded depth to standing groundwater levels	11.77	m BGL
Mean of recorded depth to standing groundwater levels	7.70	m BGL
Median of recorded depth to standing groundwater levels	7.5	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.11 indicates that the existing bores intersecting the Euri Creek Alluvium are likely to provide supplies in the order of 4 to 6 L/s from individual bores, although a higher yield of 10 L/s was recorded in one bores. Recorded drilling depths indicate only relatively shallow drilling averaging in the order of 10 m with a maximum depth of 21.6 m.

The limited available groundwater quality data indicates 'potable' groundwater.

Depending on the supply requirement, a single bore drilled in to this formation may not meet the required supply amount. Multiple low capacity bores to supply a single water point may be required.

Granites

Table 4.12 provides a summary of key DNRM recorded data for bores interpreted to intersect Granites within the Connors-Auburn Province.

Table 4.12: Statistics for key DNRM data for bores intersecting Granites

Statistics	Value	Units
Number of bores with DNRM yield records	12	Bores
Lowest recorded yield value	0.14	L/s
Highest recorded yield value	37.88	L/s
Mean of recorded yield values	7.26	L/s
Median of recorded yield values	2.4	L/s
Lowest recorded depth value	3.2	m BGL
Highest recorded depth value	45	m BGL
Mean of recorded depth value	17.9	m BGL
Median of recorded depth values	18	m BGL
Number of bores with water quality description	1	
Water quality description	Potable*	
Number of bores with electrical conductivity value	5	bore
Lowest recorded electrical conductivity value	1,270	µS/cm
Highest recorded electrical conductivity value	3,660	µS/cm
Mean of recorded electrical conductivity value	2,562	µS/cm
Median of recorded electrical conductivity value	3,300	µS/cm
Least recorded depth to standing groundwater levels	5.9	m BGL
Deepest recorded depth to standing groundwater levels	15.3	m BGL
Mean of recorded depth to standing groundwater levels	9.98	m BGL
Median of recorded depth to standing groundwater levels	10	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.12 indicates that the existing bores intersecting Granites are likely to provide supplies in the order of 2 to 7.5 L/s from individual bores, although a higher yield of 37.9 L/s was recorded in one bore. Recorded drilling depths indicate only relatively shallow drilling averaging in the order of 18 m with a maximum depth of 45 m.

Limited groundwater quality data recorded indicated an average electrical conductivity of 2,562 µS/cm. Groundwater quality for one bore has been described as potable.

This formation represents a relatively low-risk target that would require relatively shallow drilling to provide relatively moderate yields.

Hecate Granite

Only one bore intersected the Hecate Granite in the Connors-Auburn Province. This bore recorded a yield of 2 L/s, at 6m (no base of aquifer value recorded). Water quality was not stated, but standing water levels were at 2.4m BGL.

Undifferentiated Sedimentary Unit

Only one bore intersecting the 'Sedimentary Unit' in the Connors-Auburn Province. This bore recorded a yield of 25.25 L/s, between depths of 13m to 18m. No groundwater quality was recorded but standing water levels were at 12.3m BGL.

Splitlers Creek Alluvium

Two bore intersected the Splitlers Creek Alluvium in the Connors-Auburn Province. Each bore recorded a yield of 4 L/s, between depths of approximately 4m to 7m. Electrical conductivity was recorded as 1,500 $\mu\text{S/cm}$ and 1,700 $\mu\text{S/cm}$ with standing water levels at around 3.5m BGL.

Town Common Alluvium

Three bores intersected the Town Common Alluvium. Recorded yield was between 3 L/s and 4 L/s at depths between 9.5m and 15.2m. Groundwater quality recorded as potable with exception of RN140963, where electrical conductivity was recorded as 1,500 $\mu\text{S/cm}$.

4.5.2 BOWEN BASIN HYDROGEOLOGY

Basalt

Two bores intersected Basalt within the Bowen Basin. Recorded data is as follows:

- RN85415; yield 4.4 L/s, depth between 33m and 45m, SWL 15m BGL. No groundwater quality recorded
- RN85442; yield 1 L/s, depth between 48m and 62m, SWL 40m BGL. No groundwater quality recorded.

Blackwater Group

Two bores intersected Blackwater Group within the Bowen Basin. Recorded data is as follows:

- RN85441; yield 0.88 L/s, depth between 80m and 81m, SWL 54m BGL. No groundwater quality recorded.
- RN85443; yield 3.5 L/s, depth between 55m and 61.5m, SWL 30m BGL. No groundwater quality recorded.

Lizzie Creek Volcanics

Table 4.13 provides a summary of key DNRM recorded data for bores interpreted to intersect the Lizzie Creek Volcanics.

Table 4.13: Statistics for key DNRM data for bores intersecting the Lizzie Creek Volcanics

Statistics	Value	Units
Number of bores with DNRM yield records	6	Bores

Statistics	Value	Units
Lowest recorded yield value	0.5	L/s
Highest recorded yield value	10	L/s
Mean of recorded yield values	2.98	L/s
Median of recorded yield values	1.85	L/s
Lowest recorded depth value	9	m BGL
Highest recorded depth value	150	m BGL
Mean of recorded depth value	67.4	m BGL
Median of recorded depth values	58.5	m BGL
Number of bores with water quality description	0	
Water quality description	_*	
Number of bores with electrical conductivity value	0	bore
Recorded electrical conductivity value	-	-
Least recorded depth to standing groundwater levels	0	m BGL
Deepest recorded depth to standing groundwater levels	13.38	m BGL
Mean of recorded depth to standing groundwater levels	9.18	m BGL
Median of recorded depth to standing groundwater levels	9.42	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.13 indicates that the existing bores intersecting the Lizzie Creek Volcanic Group are likely to provide supplies in the order of 1.5 to 3 L/s from individual bores, although a higher yield of 10 L/s was recorded in one bores. Recorded drilling depths indicate intermediate to deep drilling averaging in the order of 67m with a maximum depth of 150m.

No groundwater quality data was available for this formation.

Depending on the supply requirement, a single bore drilled in to this formation may not meet the required supply amount. Multiple low capacity bores to supply a single X L/s water point may be required, however this formation is considered high risk due to the relative depth of drilling required for relatively low yield. In addition, high yields as indicated in the DNRM data may not be able to be sustained by long-periods of pumping due to the nature of this fractured rock aquifer.

Rangal Coal Measures

Only three bores intersecting the Rangal Coal Measure had yield data:

- RN63239 yielded 5 L/s between 20m to 29m deep,
- RN63240 yielded 9 L/s between 26m to 29m deep, and
- RN63241 yielded 10 L/s between 39m to 44m deep.

No water quality data was available. SWL was only available for RN63240, recorded at 19.6m BGL.

This formation represents moderate risk as average drilling depth approx. 30m BGL, but water quality is not known.

Tertiary Age Sediments

Table 4.14 provides a summary of key DNRM recorded data for bores interpreted to intersect the Tertiary Age Sediments.

Table 4.14: Statistics for key DNRM data for bores intersecting the Tertiary Age Sediments

Statistics	Value	Units
Number of bores with DNRM yield records	4	Bores
Lowest recorded yield value	2.5	L/s
Highest recorded yield value	25	L/s
Mean of recorded yield values	15.63	L/s
Median of recorded yield values	17.5	L/s
Lowest recorded depth value	30	m BGL
Highest recorded depth value	150	m BGL
Mean of recorded depth value	73.5	m BGL
Median of recorded depth values	55.5	m BGL
Number of bores with water quality description	0	
Water quality description	-*	
Number of bores with electrical conductivity value	0	bore
Recorded electrical conductivity value	-	-
Least recorded depth to standing groundwater levels	5.23	m BGL
Deepest recorded depth to standing groundwater levels	40.2	m BGL
Mean of recorded depth to standing groundwater levels	16.79	m BGL
Median of recorded depth to standing groundwater levels	10.87	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.14 indicates that the existing bores intersecting the Tertiary Age Sediment are likely to provide supplies in the order of 15 to 18 L/s from individual bores. Recorded drilling depths indicate relatively deep drilling averaging in the order of 15 m with a maximum depth of 150 m.

No groundwater quality data was available.

This formation represents moderately high risk as higher yields are generally deeper (~100m). Additionally, no groundwater quality data available. Frequently, Tertiary age aquifers have quite channelized sand beds and possible boundary impacts which reduce effective longer-term pumping rates may not necessarily be obvious from short-term airlift testing (Alpha Coal Proj, 2010).

4.5.3 DRUMMOND BASIN HYDROGEOLOGY

With respect to the Drummond Basin aquifers, AGE (2006) has noted that in the Belyando – Suttor subcatchment, the Belyando and lower Suttor Rivers and Logan and Diamond Creeks traverse fine-grained sedimentary rocks (siltstone and mudstone) and volcanics (andesite and rhyolite) of the Drummond Basin and that weathering of volcanics has produced predominantly clay. AGE noted that weathering of the sedimentary rocks produced quartz sand and extensive

silt and clay-sized particles and that the clay and silt particles occupy pore spaces in the quartz sand, resulting in aquifers of relatively low permeability which act as aquitards.

Drummond Basin East

Granite

Only one bore intersected Granite in the Drummond Basin. This bore recorded a yield of 0.45 L/s, at depth between 8m and 9m. Water quality was not recorded, but standing water levels were at 9m BGL.

Suttor Formation

Table 4.15 provides a summary of key DNRM recorded data for bores interpreted to intersect the Suttor Formation.

Table 4.15: Statistics for key DNRM data for bores intersecting the Suttor Formation

Statistics	Value	Units
Number of bores with DNRM yield records	5	Bores
Lowest recorded yield value	0.01	L/s
Highest recorded yield value	5	L/s
Mean of recorded yield values	1.34	L/s
Median of recorded yield values	0.63	L/s
Lowest recorded depth value	8.5	m BGL
Highest recorded depth value	91	m BGL
Mean of recorded depth value	45.28	m BGL
Median of recorded depth values	44.9	m BGL
Number of bores with water quality description	2	
Water quality description	Potable to Brackish*	
Number of bores with electrical conductivity value	2	bore
Lowest recorded electrical conductivity value	2,500	µS/cm
Highest recorded electrical conductivity value	6,210	µS/cm
Mean of recorded electrical conductivity value	4,355	µS/cm
Least recorded depth to standing groundwater levels	40.61	m BGL
Deepest recorded depth to standing groundwater levels	59	m BGL
Mean of recorded depth to standing groundwater levels	46.2	m BGL
Median of recorded depth to standing groundwater levels	42.6	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.15 indicates that the bores intersecting the Suttor Formation are likely to provide supplies in the order of 0.5 to 1.5 L/s from individual bores. However, the recorded drilling depths indicate relatively deep drilling averaging in the order of 45 m with a maximum depth of 91 m.

Subjective groundwater quality data indicated that the groundwater within this formation is potable to brackish, with measured electrical conductivity recorded between 2,500 µS/cm and 6,210 µS/cm.

This formation represents a relatively high-risk target due to the depth of drilling required compared to the potential yield and quality of groundwater.

Drummond Basin West

Silver Hills Volcanics

Table 4.16 provides a summary of key DNRM recorded data for bores interpreted to intersect the Silver Hill Volcanics.

Table 4.16: Statistics for key DNRM data for bores intersecting the Silver Hills Volcanics

Statistics	Value	Units
Number of bores with DNRM yield records	5	Bores
Lowest recorded yield value	0.1	L/s
Highest recorded yield value	10	L/s
Mean of recorded yield values	2.42	L/s
Median of recorded yield values	0.38	L/s
Lowest recorded depth value	61	m BGL
Highest recorded depth value	155	m BGL
Mean of recorded depth value	106.63	m BGL
Median of recorded depth values	106.25	m BGL
Number of bores with water quality description	0	
Water quality description	_*	
Number of bores with electrical conductivity value	3	bore
Lowest recorded electrical conductivity value	6534	µS/cm
Highest recorded electrical conductivity value	16070	µS/cm
Mean of recorded electrical conductivity value	10441	µS/cm
Median of recorded electrical conductivity value	8720	µS/cm
Least recorded depth to standing groundwater levels	61	m BGL
Deepest recorded depth to standing groundwater levels	88	m BGL
Mean of recorded depth to standing groundwater levels	70.83	m BGL
Median of recorded depth to standing groundwater levels	70	m BGL

***Note – Quality units and descriptions are shown as entered in the GWDB and do not reflect accepted standards.**

The data sample presented in Table 4.16 indicates that the existing bores intersecting the Silver Hills Volcanics are likely to provide supplies in the order of 0.3 to 2.5 L/s from individual bores. However, the recorded drilling depths indicate relatively deep drilling averaging in the order of 106 m with a maximum depth of 155 m.

Limited groundwater quality data indicated that the groundwater within this formation is very poor, with electrical conductivity measured between 6,534 µS/cm and 16,070 µS/cm.

This formation represents a relatively high-risk target due to the depth of drilling required compared to the potential yield and quality of groundwater.

Star of Hope Formation

Only one bore intersected the Star of Hope Formation in the Drummond Basin. This bore recorded a yield of 0.75 L/s, at depth between 75m and 83m. Measured electrical conductivity was 2,000 µS/cm, while standing water levels were measured at 53m BGL.

4.5.4 ANAKIE INLIER HYDROGEOLOGY

Only one bore with yield data was identified in the Anakie Inlier. This bore intersected the Mount Hall Formation generally associated with the Drummond Basin. This bore recorded a yield of 1.14 L/s, between depths of 69m to 102m. Electrical conductivity was recorded as 1,900 µS/cm, with standing water levels at 54m BGL.

Further investigation is required to find suitable water supply along this chainage section.

4.6 POTENTIAL GROUNDWATER SOURCES: CHAINAGE SECTION BASIS

Table 4.17 provides summary documentation of proposed water points for groundwater sources along the proposed alignment.

Table 4.17: Potential Groundwater Sources on a Chainage Basis

Chainage (km)		Target Unit Name	Map Symbol	Expected Borehole Depth (max)	Expected Yield	Expected Yield	Expected Quality*
From	To			M BGL	L/s	ML/day	
Connor-Auburn Province							
0	78	Alluvium (Splitters Creek Alv)	Qa	70 (7)	3.2	0.28	Brackish (<2,000µS/cm)
		Sand Plain	Czs	30			
		Granite	Cgd Cggs	45 (45)	6	0.52	Brackish (<2,000µS/cm)
		Hecate Granite	Kghc	6	1.6	0.14	Not known
Bowen Basin (North)							
78	166.5	Lizzie Creek Volcanics	Pwlz	150	2.4	0.21	Not known
Bowen Basin (South)							
166.5	212.2	Blackwater Group	Pok	81	1.6	0.14	Not known
		Rangal Coal Measure	??	44	6.4	0.55	Not known
		Tertiary Sediments		150	14.4	1.24	Not known
Drummond Basin East							

Chainage (km)		Target Unit Name	Map Symbol	Expected Borehole Depth (max)	Expected Yield	Expected Yield	Expected Quality*
212.2	268.7	Granite	Pgth	9	0.36	0.03	Not known
		Suttor Formation	Czcsu	91	1.2	0.10	Saline (2,000 – 6,000µS/cm)
Anakie Province							
268.7	279.4	Mount Hall Formation	Csmh	102	1	0.08	Brackish (<2,000µS/cm
279.4	296.6	Highlands Declared Groundwater Area					
Drummond Basin West							
296.6	306.9	Highlands Declared Groundwater Area					

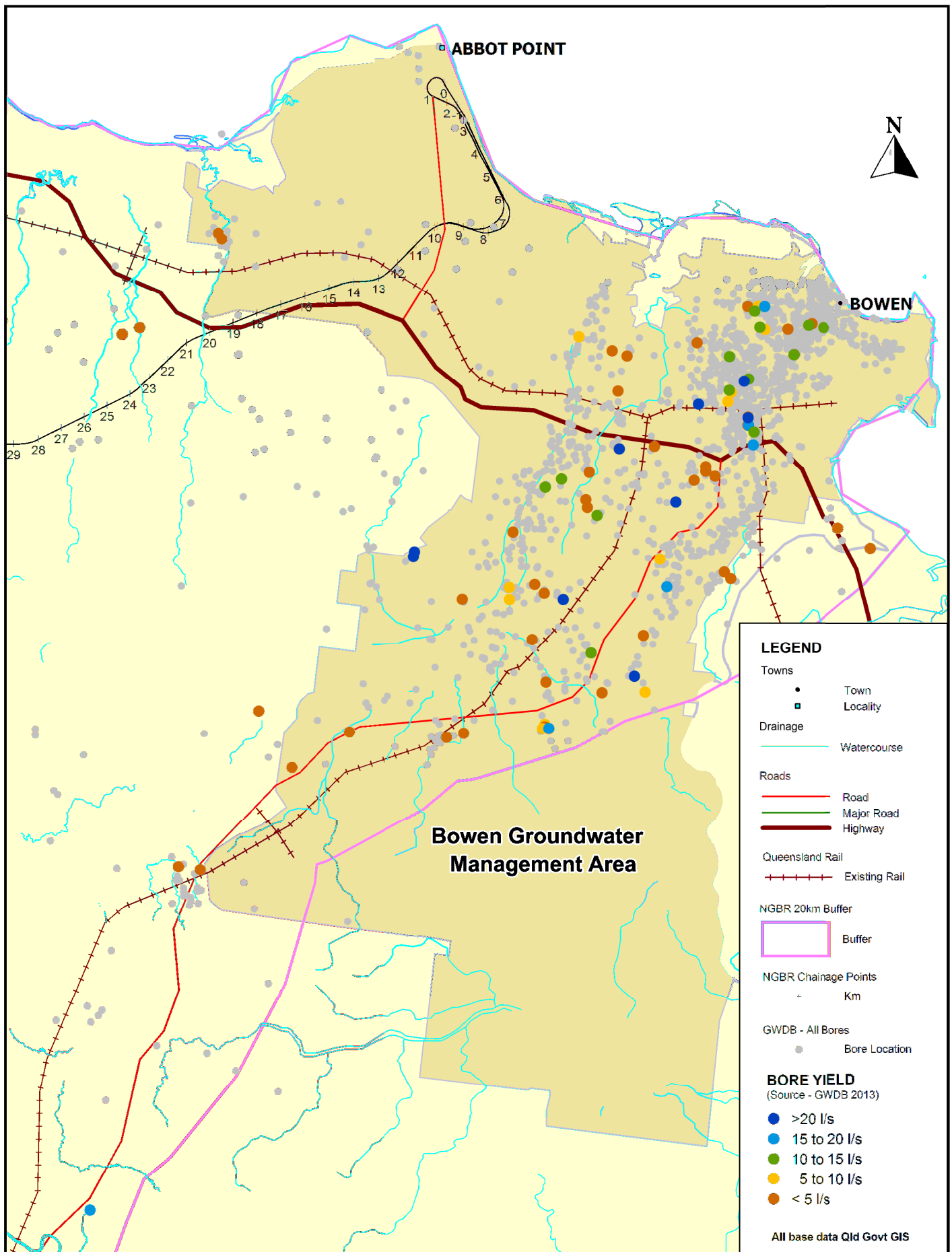
4.6.1 CONNORS AUBURN PROVINCE

The northern part of this section of the alignment (Ch0 to Ch27.5) is located within the Bowen Groundwater Area (Figure 4.10) and therefore groundwater bores may not be installed unless used for irrigation or stock watering purposes. Majority of bores within the Connor-Auburn Province with yield data, particularly those with higher yields, are within the Bowen Groundwater Declared Area. Available data from these bores indicate that the alluvium and granitic units will provide a limited supply of groundwater.

Two registered bores (RN76436 and RN76435) that intersected granite with recorded yield of more than 20L/s each are within the Bowen Groundwater Area approximately 11km SSE of northern part of the alignment (Ch26). However, these bores lie approximately 200m south of the undeclared groundwater area where new bores may be installed to target this formation.

Two registered bores that intersected the Splitters Creek Alluvium with recorded yield of 4L/s each are within the Bowen Groundwater Management Area approximately 3.5km north of the alignment (Ch 29). This formation may be a good groundwater supply and may be targeted within the undeclared groundwater area to the west of these bores.

An alternative target may include the Undifferentiated volcanics (Pa). Two bores, located west of Ch55 intersected decomposed granite unit, at shallow depths (less than 20m). The unit is approx. 5-10m thick, however, no yield data is available and therefore further (intrusive) investigations may be necessary.



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		DRAWN CMH	TITLE Bores of the Bowen Groundwater Management Area	
		DATE 30/07/2013		
	SCALE 1:200,000	A4	PROJECT No NGBR	FIGURE No 4.10

4.6.2 BOWEN BASIN

The Bowen Basin section of the alignment can be split into two parts, the northern area (Ch78.6 to Ch166.4) and the southern area (Ch166.4 to 212.2).

Bores with available yield data in the northern part of the Bowen Basin are located more than approx. 15km west northwest of Ch83.4. These bores intersect the Lizzie Creek Volcanics and Tertiary (Undefined) sediments.

There is limited bore yield data in the southern area. Available yield data indicate possible high yields in the Rangal Coal Measures (part of the Permian Blackwater Group) of up to 15 L/s, however these bores are just under 20km from the alignment (approx. Ch 206.5) and the quality of water is unknown. In a groundwater study undertaken by Peabody Pty Ltd for their Millennium Expansion Project approximately 20km east of Moranbah, monitoring data indicated that groundwater in the Rangal Coal Measures aquifer on-site is typically neutral to slightly alkaline with a median pH of 7.70, while EC ranged between 2,074-14,310 µS/cm (where fresher groundwater is found in bores closer to recharge areas).

A study of aquifers around the Clermont area in the Bowen Basin undertaken by Ishaq (1985) confirms that the best prospects for yields of good quality water are from a gravely horizon found at the base of the Tertiary sediments. This horizon was also observed by Hanna (1985) around Gordonstone, Central Bowen Basin where sand and gravel beds occurred in the palaeo-valleys of the early Tertiary land surface (Bowen Basin) with high porosity and permeability and significantly high water flows. However, it should be noted that the lateral continuity of this horizon is poorly understood. The salinity of the water is considered lower than that of the basalt aquifers (Hanna, 1985).

Tertiary basalts of the Bowen Basin were also identified as fractured rock aquifers. Ishaq (1985) discovered that Tertiary basalts now form groundwater preferential flow pathways where it had in-filled formally active drainage systems. Where fractured and faulted, these units may provide preferential areas for groundwater recharge and increased groundwater transmissivity, however the distinction of fracture zones within these units is not easily inferred. These basalts were described as providing the best prospects for moderate to high yields of good quality water compared to other aquifers in the (Clermont) region and that other fractured rocks in the region were highly variable with yield ranging from low to moderate and water quality from very good to poor (Ishaq, 1985).

Alternatively, groundwater investigations in certain parts of the Bowen Basin show that the unconsolidated Cainozoic sediments contain limited, but good quality water. Recharge in this area for the unconsolidated aquifers is mainly from rainfall, with some contribution from stream flow and overlying alluvial aquifers (Ishaq, 1985, Lech et. al, 2006).

4.6.3 DRUMMOND BASIN EAST

The main target formation in the Drummond Basin East is the Suttor Formation. The alignment intersects this formation between Ch 234.8 and 235.9.

Other potential formations to target include the Suttor River Alluvium, that trends almost parallel to the south of the alignment, colluviums and the Silver Hills Formation (Dfiv). The alignment intersects the Silver Hill Formation between Ch 246.9 to 247.8 and Ch 249 to 250.2.

4.6.4 ANAKIE PROVINCE

The majority of the alignment in this section is located within the Highlands Declared Subartesian Area (Figure 4.11), and therefore bores can only be used for irrigation and stock

watering purposes. For all other purposes, bores may only be installed within the undeclared area (from Ch268,700 to 279,400). As such, target formations are limited and water supply from Ch279,400 onwards will have to be sourced from other means.

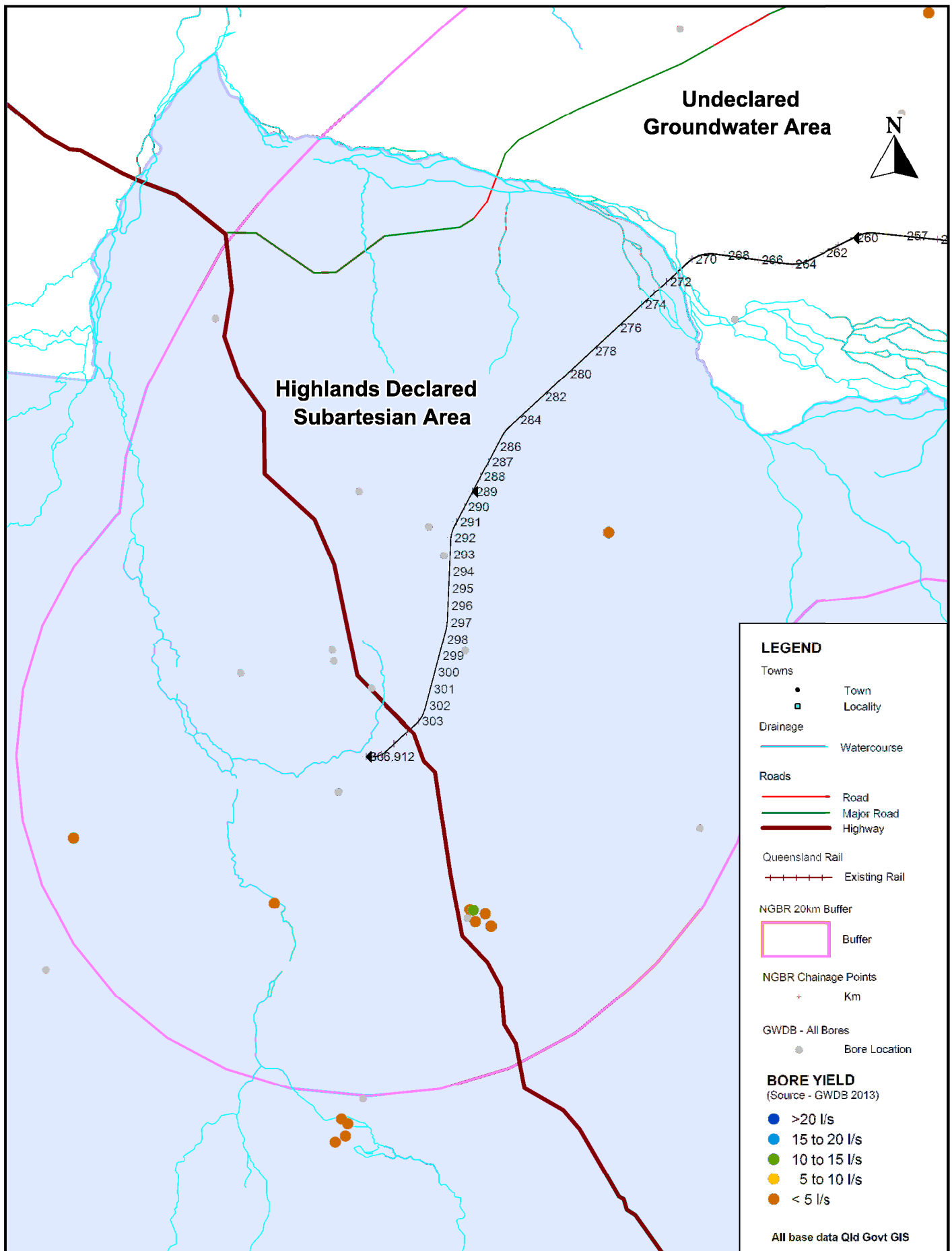
The only yield data available from this section of the alignment is from a bore identified to intersect the Mount Hall Formation, located within the Highlands Groundwater Area. Low yield was recorded (<2 L/s) with brackish groundwater quality. Strata logs indicate a sandstone layer between 102m to 108m (underlying the Mount Hall Formation). This could potentially provide higher yields, however further (intrusive) investigations will be necessary for confirmation of the presence of deeper water bearing sand units.

Other potential formations to target in this area include the colluvium, alluvium (Suttor River palaeochannel) and the Suttor Formation.

4.6.5 DRUMMOND BASIN WEST

This section of the alignment is located entirely within the Highlands Groundwater area and as such, no bores may be installed along this section of alignment (except for irrigation and stock water purposes). Therefore, water supply for this section of the alignment will have to be sourced elsewhere.

Bores containing yield data are located south of the alignment. Main formations to target include the Silver Hills Volcanics and Star of hope Formation. Bores intersecting the Mistake Creek Alluvium had no yield data however strata logs indicate sand and gravel layers exists from approximately 6m to 8m deep and are up to 3m (approx.) thick. These could potentially be water bearing, however further (intrusive) investigation is necessary.



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		DRAWN CMH	TITLE Bores of the Highlands Declared Subartesian Area	
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4.7 PROPOSED GROUNDWATER SOURCES BASED ON HYDRANT LOCATIONS

Based on the assessment undertaken above an evaluation of the potential for a groundwater supply option at each of the hydrant points is presented in Table 4.18. It should be noted that this assessment is based on very little data and that an aerial reconnaissance site visit failed to locate a number of bores listed in the literature as occurring along the alignment. Similarly a few bores, not previously listed, were located however there is no information regarding the construction and yield of these bores.

It is possible that bores unable to be located were provided with general coordinates when entered into the GWDB which is generally given as the centre of the parcel of land on which the bore was drilled while other bores may have collapsed and been abandoned with the sites no longer visible. Bores constructed for the purpose of providing water for utilities projects such as roads, power and pipelines are generally decommissioned following the period of use unless an agreement has been reached with the local landholder to take over the bore.

In determining the potential yield for prospective aquifers at each hydrant point it will be necessary to undertake exploratory drilling and conduct pumping tests on prospective bores. This testing will provide vital information for the design of each proposed borefield. Similarly, the aquifer testing program will provide a basis on which to determine the duty cycle of bores in particular areas such as allowing for slower recharge from fractured rock aquifers.

Table 4.18 Potential Groundwater Supply Options along the rail line

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
1	0	Earthwork	41.50	995.93	Raw Water	Coastal Alluvium	Unconsolidated alluvium	4.00	90	4	20 - 50	No yield information in this area however alluvium is prospective
2	5	Earthwork	41.50	996.33	Raw Water	Coastal Alluvium	Unconsolidated alluvium	4.00	90	4	20 - 50	No yield information in this area however alluvium is prospective

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
3	-5	Earthwork	37.10	1002.82	Raw Water	Coastal Alluvium	Unconsolidated alluvium	4.00	90	4	20 - 50	No yield information in this area however alluvium is prospective
3	-5	Potable Water	0.60		Drinking Water							
3	-5	Camps and Yards Except Drinking Water	1.90		AS 1379							
3	-5	Batching Plant	2.17		AS 1379							
4	15	Earthwork	37.60	902.89	Raw Water	Coastal Alluvium	Unconsolidated alluvium	4.00	90	3	20 - 50	No yield information in this area however alluvium is prospective
5	25	Earthwork	32.70	785.46	Raw Water	Intrusives with Alluvium	Fractured rock with alluvium along drainage lines	3.50	80	4	20 - 100	Yields of 1.5 L/s in Fractured rock and alluvial aquifers within 2km

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
6	35	Earthwork	39.00	934.90	Raw Water	Intrusives with Alluvium	Fractured rock with minor alluvium along drainage lines	2.00	80	7	30 - 150	No yield information in this area with highly variable targets
7	45	Earthwork	22.20	532.86	Raw Water	Volcanics and intrusives	Fractured rock with minor alluvium along drainage lines	1.00	60	11	30 - 250	No yield information in this area with highly variable targets
8	53	Earthwork	25.70	749.46	Raw Water	Volcanics and intrusives	Fractured rock	1.00	60	15	50 - 250	No yield information in this area with highly variable targets
8	53	Potable Water	0.80		Drinking Water							
8	53	Camps and Yards Except Drinking Water	2.53		AS 1379							
8	53	Batching Plant	2.17		AS 1379							

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
9	65	Earthwork	31.40	754.55	Raw Water	Volcanics and intrusives	Fractured rock with minor alluvium along drainage lines	1.00	60	15	30 - 250	No yield information in this area with highly variable targets
10	75	Earthwork	36.80	882.27	Raw Water	Volcanics and intrusives	Fractured rock	1.00	60	18	50 - 250	No yield information in this area with highly variable targets
11	85	Earthwork	25.30	606.99	Raw Water	Volcanics and minor Alluvium	Fractured or vesicular Volcanics and minor alluvial aquifers	2.50	70	5	30 - 100	No yield information for sediments and yields in volcanics up to 4.0 L/s at 3km from alignment
12	95	Earthwork	31.70	760.33	Raw Water	Permian Sediments, basalts and minor Alluvium	Indurated and unindurated Sediments, fractured or vesicular Volcanics	6.50	80	2	30 - 100	No yield information for sediments and yields in volcanics up to 6.0 L/s at 3km from alignment, also opportunity for mine void water

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
13	105	Earthwork	29.30	704.13	Raw Water	Permian Sediments, basalts and minor Alluvium	Indurated and unindurated Sediments, fractured or vesicular Volcanics	2.00	80	6	30 - 100	No yield information in this area however prospective due to mix of targets
14	115	Earthwork	23.20	556.61	Raw Water	Permian Sediments, Volcanics and minor Alluvium	Indurated and unindurated Sediments, Fractured Volcanics	1.50	80	6	30 - 100	No yield information in this area however prospective due to mix of targets
15	120	Earthwork		112.00	Various	Permian Sediments	Indurated sediments	1.00	70	2	50 - 150	No yield information in this area however prospective due to occurrence of Permian sandstone
15	120	Potable Water	0.60		Drinking Water							
15	120	Camps and Yards Except Drinking Water	1.90		AS 1379							

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
15	120	Batching Plant	2.17		AS 1379							
16	125	Earthwork	26.00	624.38	Raw Water	Permian Sediments	Indurated sediments, possible alluvial targets along drainage	2.00	70	6	50 - 150	No yield information in this area however prospective due to occurrence of Permian sandstone
17	135	Earthwork	33.50	804.93	Raw Water	Permian Sediments	Indurated sediments, possible alluvial targets along drainage	1.50	70	9	50 - 150	No yield information in this area however prospective due to occurrence of Permian sandstone
18	145	Earthwork	27.10	651.39	Raw Water	Permian Sediments	Indurated sediments	2.00	70	6	50 - 150	No yield information in this area however prospective due to occurrence of Permian sandstone
19	155	Earthwork	25.20	605.07	Raw Water	Permian Sediments	Indurated sediments	2.50	70	5	50 - 100	No yield information in this area however prospective due to occurrence of Permian sandstone

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
20	160	Earthwork		132.00	Various	Sediments with adjacent alluvium	Indurated and unindurated Sediments	2.00	80	1	50 - 100	No yield information in this area however prospective due to occurrence of alluvium over sandstone
20	160	Potable Water	0.80		Drinking Water							
20	160	Camps and Yards Except Drinking Water	2.53		AS 1379							
20	160	Batching Plant	2.17		AS 1379							
21	165	Earthwork	24.60	591.13	Raw Water	Sediments with adjacent alluvium	Indurated and unindurated Sediments	2.50	80	4	50 - 100	No yield information in this area however prospective due to occurrence of alluvium over sandstone
22	175	Earthwork	31.10	745.44	Raw Water	Sediments with adjacent alluvium	Indurated and unindurated Sediments	3.00	80	4	50 - 100	No yield information for sediments and yields in Alluvium up to 4.0 L/s at 10km from alignment

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
23	185	Earthwork	24.20	580.42	Raw Water	Sediments with adjacent alluvium	Indurated and unindurated Sediments	5.00	80	2	50 - 150	No yield information for sediments and yields in Alluvium up to 12.0 L/s at 12km from alignment
24	195	Earthwork	20.90	502.69	Raw Water	Sediments with adjacent alluvium	Indurated and unindurated Sediments	1.50	80	5	50 - 150	No yield information for sediments and yields in Alluvium up to 1.0 L/s at 10km from alignment
25	205	Earthwork	27.30	654.36	Raw Water	Volcanics with adjacent Alluvium within 4km	Fractured Rock and Alluvial	2.00	60	7	50 - 150	Yields in Alluvium up to 3.5 L/s at 10km from alignment
26	215	Earthwork	40.80	980.01	Raw Water	Volcanics	Fractured Rock	1.50	60	13	50 - 250	No yield information in this area and difficult to predict due to elevation and unknown potential of fractured rock storage
27	225	Earthwork	22.20	533.81	Raw Water	Alluvium over Sediments and Metamorphics	Indurated and unindurated Sediments, Fractured Metamorphics	1.50	70	6	50 - 150m	No yield information in this area however prospective due to occurrence of alluvium over sandstone

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
28	235	Earthwork	24.30	583.98	Raw Water	Alluvium over Sediments and Metamorphics	Indurated and unindurated Sediments, Fractured Metamorphics	2.00	70	5	50 - 150m	No yield information in this area however prospective due to occurrence of alluvium over sandstone
29	245	Earthwork	33.70	808.94	Raw Water	Alluvium	Alluvial with Sediment substrate	2.00	80	6	30 - 150m	No yield information in this area however prospective due to occurrence of alluvium along major drainage line
30	252	Earthwork	41.70	1112.00	Raw Water	Alluvium	Alluvial with Sediment substrate	2.00	80	9	30 - 150m	No yield information in this area however prospective due to occurrence of alluvium along major drainage line
30	252	Potable Water	0.60		Drinking Water							
30	252	Camps and Yards Except Drinking Water	1.90		AS 1379							

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
30	252	Batching Plant	2.17		AS 1379							
31	265	Earthwork	39.40	946.62	Raw Water	Alluvium - Drainage line	Alluvial with Sediment substrate	2.00	80	7	30 - 150m	No yield information in this area however prospective due to occurrence of alluvium along major drainage line
32	275	Earthwork	31.00	743.04	Raw Water	Alluvium - Drainage line	Alluvial with Sediment substrate	1.50	80	8	30 - 150m	No yield information in this area however prospective due to occurrence of alluvium along major drainage line
33	285	Earthwork	38.60	927.51	Raw Water	Alluvium over Sediments and Metamorphics	Indurated and unindurated Sediments, Fractured Metamorphics	1.50	70	11	30 - 230m	No yield information in this area however prospective due to occurrence of alluvium over sandstone
34	295	Earthwork	28.50	683.87	Raw Water	Alluvium over Sediments	Indurated and unindurated Sediments	1.00	70	12	30 - 230m	No yield information in this area however prospective due to occurrence of alluvium over sandstone

No.	Supply Point Chainage (km)	Demand Type	Instantaneous Demand (L/s)	Daily Volume (KL)	Water Quality	Geology	Aquifer Type	Assumed Pumping Rate (L/s per bore)	Assumed Cycle Time (% duty/day)	No. of Bores	Expected bore depth	Yield and Aquifer potential
35	305											

4.8 AQUIFER PROPERTIES

The desktop assessment for this project has highlighted the lack of publicly available data related to groundwater resources along much of the alignment. In order to assess potential drawdown and recharge characteristics the available data within the projects GWDB extract was searched to find bores which had sufficient information to make a qualitative assessment of aquifer properties. The only limitation on this search was that the bores were not located within the Bowen Groundwater Management Area as, even though groundwater is readily accessible, access to groundwater within this area is highly regulated.

The search criteria included the following:

- Groundwater level;
- Stratigraphy;
- Casing details, and
- Yield data.

Following the search six bores were identified and their properties are presented in Table 4.19 and locations shown in Figure 4.12.

Table 4.19 BORE properties found in the GWDB

Bore Number (RN)	63407	85415	85441	85442	85443	90096
EASTING (MGA94)	593148	595582	589056	587485	588640	549413
NORTHING (MGA94)	7621109	7623993	7630385	7630927	7631494	7602424
ZONE (MGA94)	55	55	55	55	55	55
AQUIFER TOP (mBGL)	42	33	81.5	48	55	47.8
AQUIFER BOTTOM (mBGL)	56	45	83	62	61.5	69
AQUIFER THICKNESS (m)	14	12	1.5	14	6.5	21.2
AQUIFER STRATIGRAPHY	VERY FINE SAND (LIGHT BROWN)	BASALT	COAL	HARD BASALT	COAL	SAND AND YELLOW CLAY
FORMATION DESCRIPTION	TERTIARY - UNDEFINED	BASALT	BLACKWATER GROUP	BASALT	BLACKWATER GROUP	SUTTOR FORMATION
AQUIFER TYPE	Confined	Confined	Confined	Confined	Confined	Confined
AQUIFER CONDITION	Unconsolidated	Weathered Zone	Weathered Zone	Weathered Zone	Cavernous	Unconsolidated
YIELD (L/s)	2.50	4.40	0.88	1.00	3.50	0.31
WATER LEVEL (mBGL)	40.2	15.0	54.0	40.0	30.0	41.0
AVAILABLE DRAWDOWN (m)	1.8	18.0	27.5	8.0	25.0	6.8
CASING Diameter (mm)	162	162	162	162	162	162
SCREEN TOP (mBGL)	53.3	32.0	78.0	48.0	56.0	19.0
SCREEN BOTTOM (mBGL)	56.4	35.0	85.0	54.0	62.0	63.2

4.8.1 DRAWDOWN

Using the information shown in Table 4.19 above and by making some basic assumptions about the aquifer properties from the stratigraphy, it is possible to derive an indication of the drawdown characteristics of these bores.

The assumptions on which this assessment has been made include:

- The aquifer is confined
- The aquifer has an infinite areal extent
- The aquifer is homogeneous, isotropic and of uniform thickness
- Discharge (yield) is constant
- The bore is screened over the entire thickness of the aquifer
- Pumping interference and seasonal variation is 2m
- Well loss is 2 m

Aquifer properties are derived from literature (Driscoll 1986 and Freeze and Cherry 1979) and the equations used in an Excel spread sheet for determining numerical coefficients and solutions are derived from Kruseman and de Ridder 1994 and Freeze and Cherry (1979). The standard pumping period for the assessment of groundwater resources in Queensland (Hazel 1975) has been used. This period is 100,000 minutes (approximately = 70 days) for general water supply bores and 1,000,000 (approximately 695 days) for town water bores.

Table 4.19 Drawdown assessment for selected bores

Bore Number (RN)	63407	85415	85441	85442	85443	90096
GWDB YIELD (L/s)	2.5	4.4	0.9	1.0	3.5	0.3
AVAILABLE DRAWDOWN (m)	13.1	17.0	24.5	8.0	26.0	6.8
HYDRAULIC CONDUCTIVITY (m/d)	2.0	2.0	2.0	2.0	2.0	2.0
TRANSMISSIVITY (m ² /d)	28.0	27.0	3.0	28.0	13.0	42.4
STORAGE COEFFICIENT	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
PUMPING PERIOD (days)	70	70	70	70	70	70
SUSTAINABLE PUMPING RATE (L/s)	1.5	1.8	0.4	0.8	1.6	0.2
SUSTAINABLE DRAWDOWN (m)	13	16.9	24.2	7.9	25.8	3

This assessment shows that for a pumping period of 70 days and with drawdown limited to above the top of the aquifer (to ensure no environmental harm to the aquifer) the actual pumping rates achieved are between 40% and 80% lower than the yields quoted in the GWDB.

There is some consistency in this data as the coals are typically 40% lower while the two sandy aquifers are 60-65% lower. Typically the two basalt aquifers are highly variable and show a sustainable pumping rate reduction of 40% and 80%.

This disparity in pumping rates is understandable given that the yields recorded in the GWDB are generally based on the drillers determinations using "air-lift" pumping and flow through a "V-notch" weir at best and their "guesstimate" at worst. As much of the proposed rail line is outside known groundwater areas there are no records of detailed groundwater assessment and aquifer testing through pumping tests, slug tests etc.

4.8.2 RECHARGE

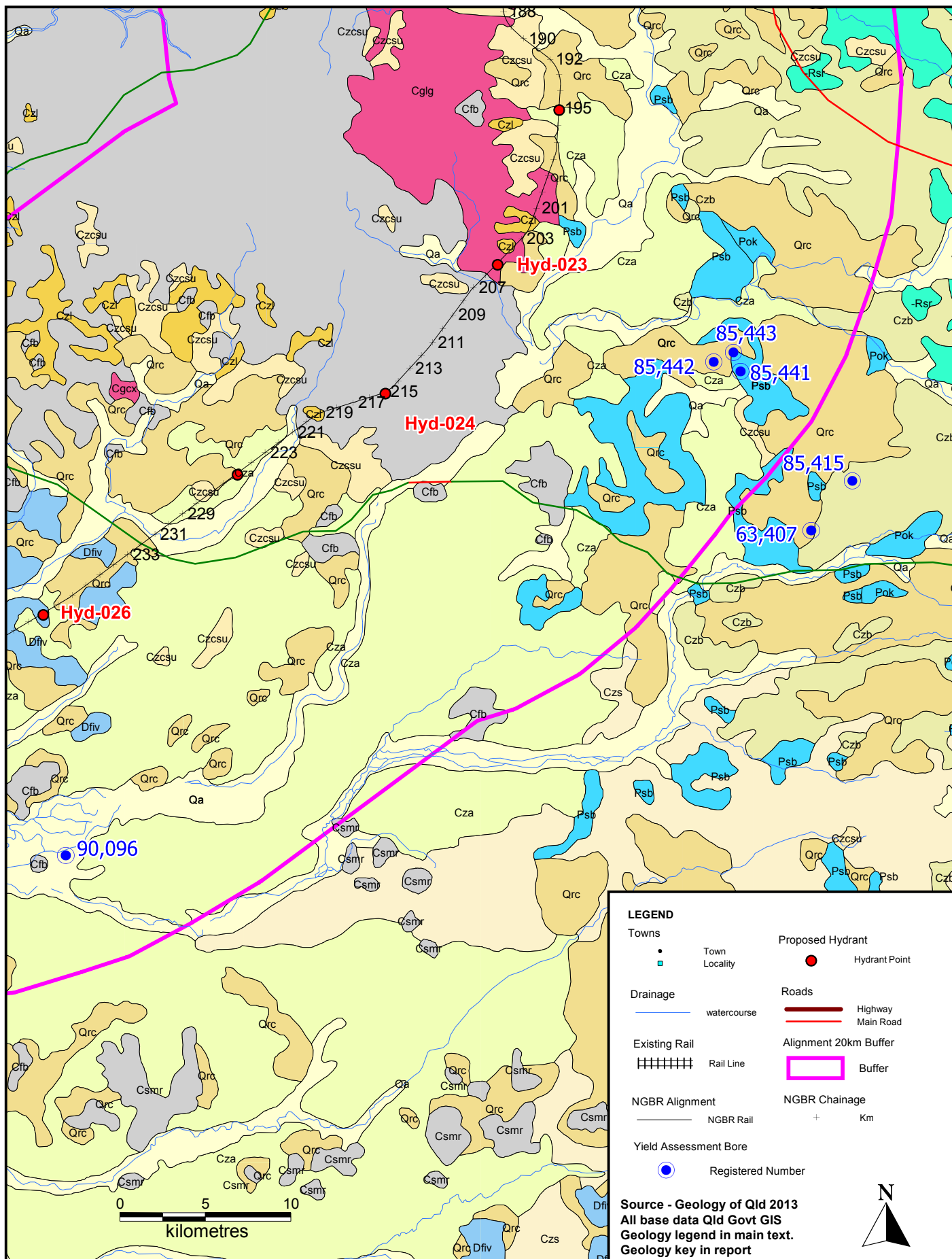
Due to the lack of information related to the local aquifer systems and aquifer testing it is not appropriate, nor possible, to determine recharge properties for the various formations along the proposed rail line.

It is expected that the three broad aquifer types will behave in a manner generally similar to equivalent aquifers further to the south within the Bowen Basin. The table below (Table 4.20) gives an indication of the expected recharge response however detailed field studies will be required to gain any surety.

The determination of reliable recharge rates will result from a targeted aquifer testing program,

Table 4.20 Qualitative assessment of recharge

Aquifer Type	Lithology	Recharge Mechanism	Recharge Rate	Recharge Period
Alluvium and Colluvium	Sediment – loose to semi-consolidated	Rainfall and stream loss	Rapid	2 - 3 years
Basalt (and other hard rock aquifers)	Vesicular to fractured	Rainfall and stream loss	Moderate	3 - 5 years
Coal	Consolidated sediment and secondary structural porosity	Minor stream loss	Slow to very slow	10 - 50 years



CLIENT
Hyder Consulting for Adani Mining



DRAWN
CMH
DATE
31/07/2013

SCALE
1:300,000

A4

PROJECT
NGBR Construction Water Supply

TITLE
BORES USED FOR
DRAWDOWN ANALYSIS

PROJECT No
NGBR

FIGURE No
4.12

5 SURFACE WATER STUDY

A number of sources of surface water are available to supply water for the construction of the rail line. They include:

- **River extraction** – occurs via pumped extraction or channelled diversion from a larger watercourse with either reliable base flow or during period of high flows;
- **Overland flow harvesting** – occurs through excavated tanks or farm dams that collect water from a localised catchment, either natural or supported by long collection drains;
- **In-stream and off-stream storage extractions** - occur via natural or man-made storages within ephemeral creek beds or as off-stream storage with extraction from the stream during flow conditions;
- **Mine voids** – Extraction of water from rehabilitated mine sites, where large voids exist that have filled with water; and
- **Existing Pipelines/Town water supplies** – SunWater operate a number of pipelines nearby and the Whitsunday Regional Council have a number of town water supplies, which may provide supply.
- **Associated water** from CSG fields.

Based on the site flyover that took place on the 2nd July 2013 and a desktop study of existing information, a review of each of the above options (site location, reliability and available volume) was completed to understand the potential to supply water for the construction project.

5.1 RIVER EXTRACTION

The majority of the rail line lies within the un-supplemented area of the Burdekin Basin, which means that no large water storage areas are available to provide additional reliability to river extractions. Many of the creeks and rivers located in the vicinity of the rail line that could be considered for extraction are ephemeral and only run with a sustainable amount of flow in the wet months. In the initial assessments, nine major waterways with catchments larger than 100km² were identified to provide a potential water source of reasonable yield and reliability for the rail line construction works. The daily flow of these waterways and its monthly variation has been assessed through a regional flow analysis. The assessment methodology and outcome is discussed in this section of the report.

5.1.1 CATCHMENT DESCRIPTION

The NGBR rail line alignment lies in the central-eastern segment of the Burdekin Basin with a small section near the coast located within the Don River Basin. This basin was not reviewed as the water supply requirements within the basin will not be provided via river extraction but via existing storages, council standpipes (potable) and the large existing 540ML storage at Adani's Abbot Point terminal.

Along the alignment, a total of nine major waterway crossings were identified and selected to be analysed. A major waterway was defined by a catchment area of at least 100km². Figure 5.1 shows the rail corridor, the major waterways crossing the rail alignment and the corresponding sub-catchments for these crossings that were used for the analysis. Table 5.1 specifies the approximate coordinates of the intersections of the waterways with the rail line.



Figure 5.1: Waterway-rail line crossings and catchment boundaries

Table 5.1: Coordinates of the intersection of the major waterways with the rail line

Crossing	Latitude	Longitude	Catchment Area (km ²)
Elliot River	-20.026087°	147.859492°	146
Bogie River	-20.219585°	147.793364°	445
Sandy Creek	-20.244632°	147.782421°	153
Strathmore Creek	-20.517589°	147.690515°	150
Pelican Creek	-20.574389°	147.661772°	566
Bowen River	-20.772345°	147.777484°	5829
Suttor River 3	-21.098022°	147.737988°	268
Suttor River 2	-21.378984°	147.712247°	99
Suttor River 1	-21.588451°	147.159609°	10758*

*Value based on DNRM data for a nearby gauging station

In addition to the above waterways, Mistake Creek also crosses the section of rail line common to NGBR and SP2. Flow reliability for this crossing can be found in the Hyder Report “*Railway Construction Water Supply Study, F2001-AA005171-AAR-03, Feb 2013*”.

5.1.2 FLOW ASSESSMENT

Input Data

Daily flow of the above major waterways was assessed using a regional flow analysis. In order to carry out the regional flow analysis, historical flow data based on gauging stations located throughout the Burdekin Basin was collated from DNRM. A statistical relationship between catchment area and flow was sought. In order to obtain a strong relationship, flow data from as many gauging stations located close to the rail line as possible was used. For the analysis to provide viable and applicable results, relatively homogeneous sub-catchment properties were required (compared with those of the waterway-rail line crossings). Many DNRM gauging stations were identified, however not all of them were appropriate for use in the analysis as they did not meet this criteria.

Included Gauging Stations

The following DNRM gauging stations were used in the analysis.

Table 5.2: Hydrometric Stations used in regional flow analysis

Gauging Station Reference	Catchment Area (km ²)	Mean Flow (ML/day)
120310A	10758	2270
120304A	1915	359
120205A	7104	2219
120209A	4308	964
120219A	8280	1484
120210A	1162	520
120213A	325	213
120212A	431	121
120299A	4199	1199
120206A	545	205
120220A	528	53

DNRM allocates a quality indicator to each data entry for all of its historical flow data. It was assumed that each data point that had been classified as ‘flow depth < gauge threshold’ indicated a zero flow. This assumption led to the development of conservative mean flow values for both monthly and annual flow averages.

Figure 5.2 below shows the locations of the DNRM gauging stations that were used for historical flow data extraction relative to the NGBR rail corridor.



Figure 5.2: Location of the existing applicable hydrometric gauging stations

Excluded Gauging Stations

Table 5.3 shows the gauging stations that are located close to the rail corridor but were excluded from the analysis for reasons outlined in the table.

Table 5.3: Available stations excluded from flow analysis

Gauging Station Reference	Reason for Exclusion
120211A	Mountainous catchment. Equal-area slope of catchment steeper than those of rail crossings, therefore different groundwater and surface water flow conditions.
120216A	Mountainous catchment. Equal-area slope of catchment steeper than those of rail crossings, therefore different groundwater and surface water flow conditions.
120207A	Mountainous catchment. Equal-area slope of catchment steeper than those of rail crossings, therefore different groundwater and surface water flow conditions.
120301A	Catchment area = 35,471 km ² , which is an order of magnitude larger than the largest sub-catchment to be analysed, hence non-homogeneous catchment properties.
120303A	Catchment area = 50,291 km ² , which is an order of magnitude larger than the largest sub-catchment to be analysed, hence non-homogeneous catchment properties.
120309A	Extents of sub-catchment boundary lie up to 400km from rail corridor, therefore not indicative of rail crossing catchments.

Statistical Analysis

To develop a relationship between the catchment area and mean flows, they were plotted against each other. Using a regression analysis, a linear relationship was established, with the results shown in Figure 5.3 below. The variability in the relationship was deemed within the bounds acceptability for this assessment, with an R-squared value of 0.90. In addition, flows pertaining to particular percentage reliabilities were calculated using the Gringorton Method, with an α value of 0.4. This produced similarly linear relationships between flow and catchment areas. Figure 5.3 also illustrates this, with curves for 25%, 50% (i.e. median flow value), 75% and 90% reliability each plotted.

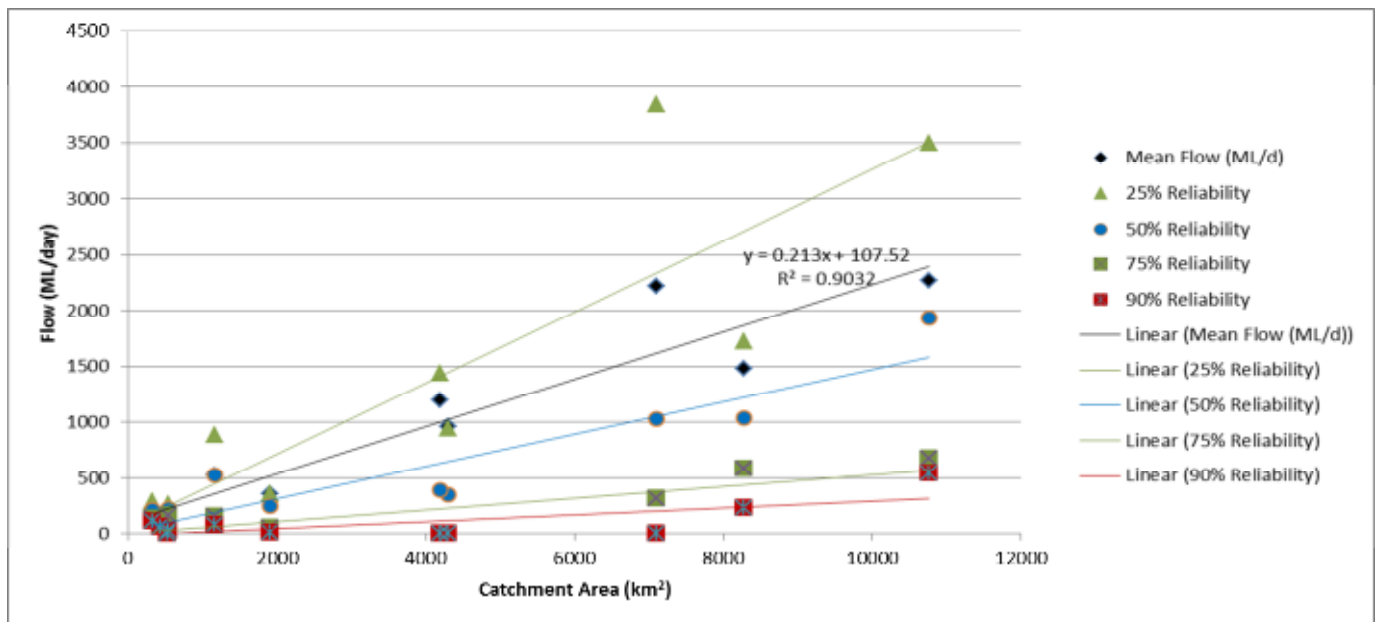


Figure 5.3: DERM gauging stations: Flow against catchment area

Monthly Flow Analysis

In order to determine which periods of the year will yield reliable flows, the monthly flow data for each of the aforementioned gauging stations was aggregated to give indicative wet and dry seasons for the catchments surrounding the rail corridor. The results are shown in Figure 5.4 below.

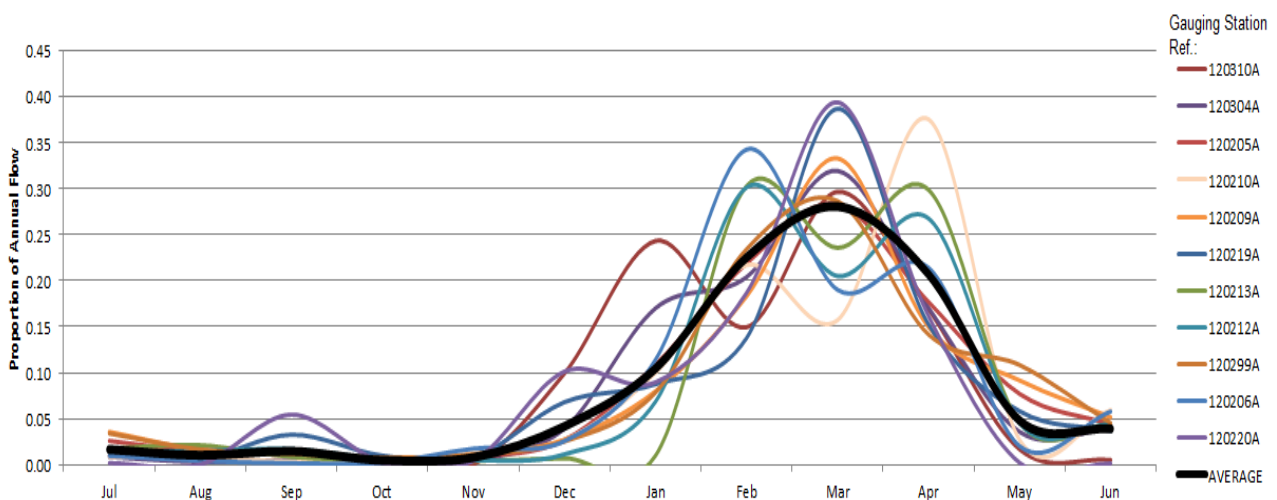


Figure 5.4: Proportion of Annual Flow for Water Year July-June

An estimate of seasonal flows at the various waterway-rail line crossings (including associated reliabilities) was then obtained by relating the area of the catchment of the crossing to the various analyses above. This was completed with the exception of the Suttor River 1 crossing. This crossing has a large catchment and is located approximately 14km upstream from existing DNRM gauging station 120310A. Given that there are no major inlet waterways between the gauging station and the rail line, the historical flow data at this gauging station was deemed acceptable without areal adjustment for determining flows at the rail line crossing.

5.1.3 RESULTS

The criteria to determine a reliable flow period was deemed to be the seasonal flows that exceed a consistent flow rate of 200 L/s (i.e. 17.3 ML/day) with a greater than 90% probability. The highest water demand extraction is less than 50 L/s so a minimum of 200 L/s was assumed adequate to meet all environmental and regulatory requirements. The following table shows the reliable flow period for each of the waterway crossings along the NGBR based on these criteria.

Table 5.4: Duration of the year with base flow of more than 200 L/s with 90% reliability

Crossing	Reliable Flow Period	Duration per Year
Elliot River	February - April	3 Months
Bogie River	January - April	4 Months
Sandy Creek	February - April	3 Months
Strathmore Creek	February - April	3 Months
Pelican Creek	January - April	4 Months
Bowen River	November – September	11 Months
Suttor River 3	January - April	4 Months
Suttor River 2	March only	1 Month
Suttor River 1	January - December	Year Round

Table 5.4 is based on 90% reliability, however seasonal mean and expected (median, 50th percentile) flows are much higher. Expected seasonal flows based on mean values and a range of reliabilities for each crossing are illustrated in Figures 5.5 to 5.13 below. Detailed tabular results are listed in Appendix C.

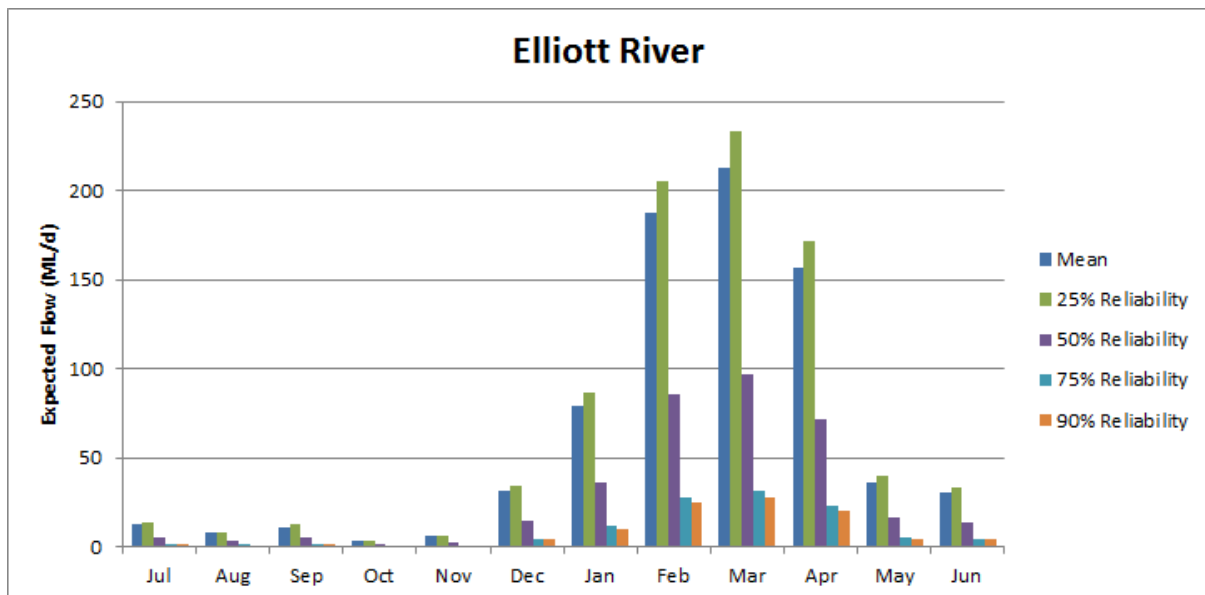


Figure 5.5: Expected flows at Elliot River crossing

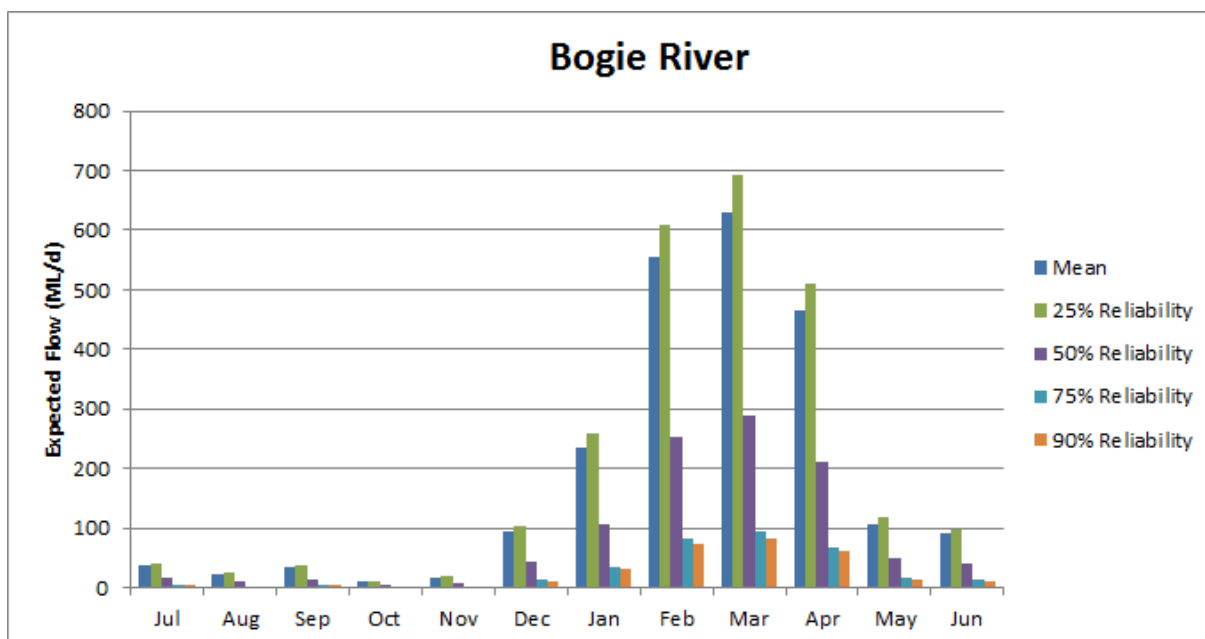


Figure 5.6: Expected flows at Bogie River crossing

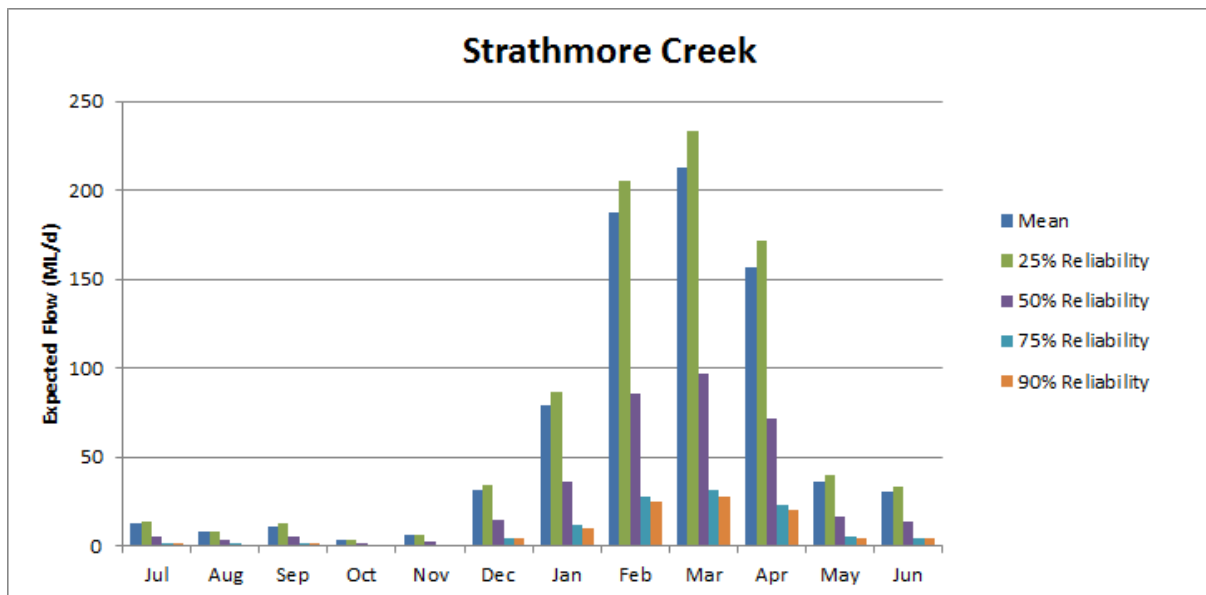


Figure 5.7: Expected flows at Strathmore Creek crossing

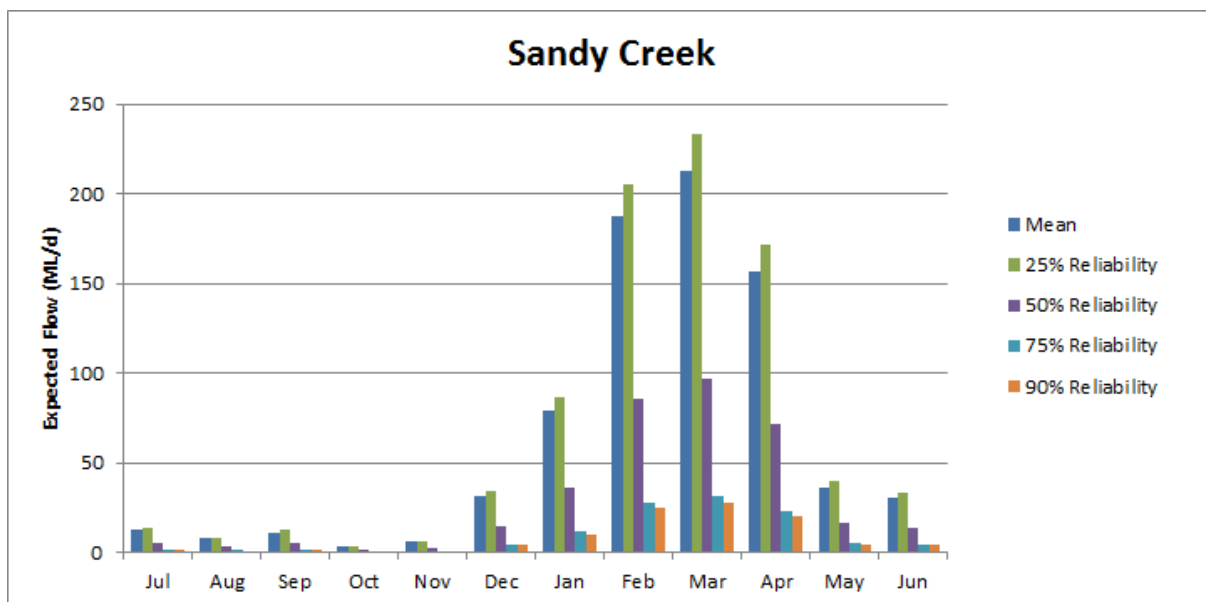


Figure 5.8: Expected flows at Sandy Creek crossing

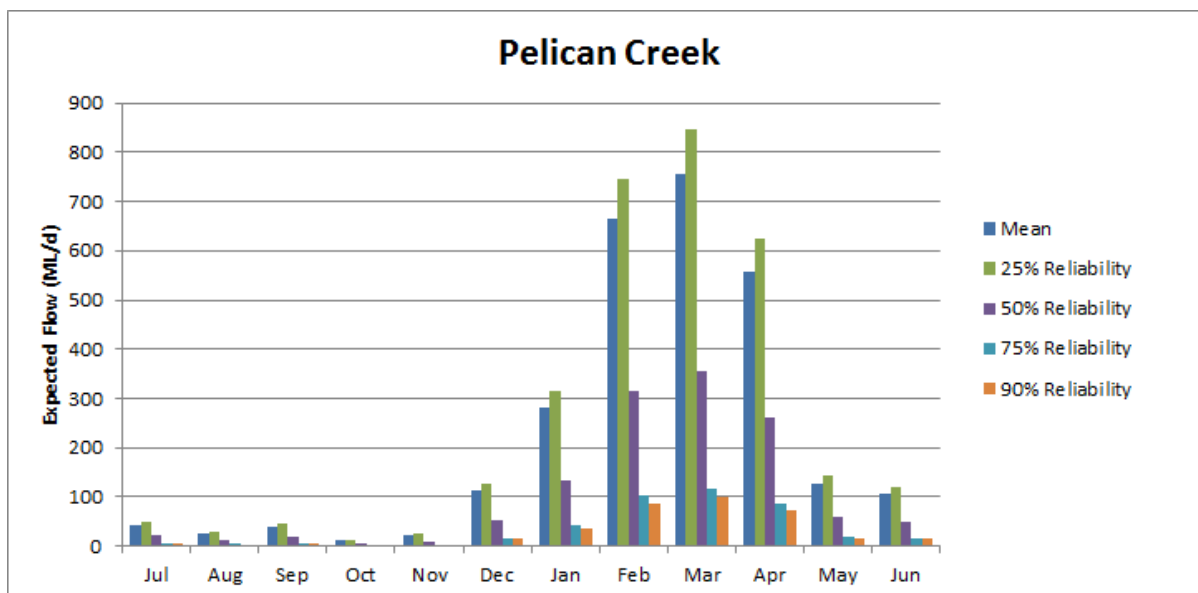


Figure 5.9: Expected flows at Pelican Creek crossing

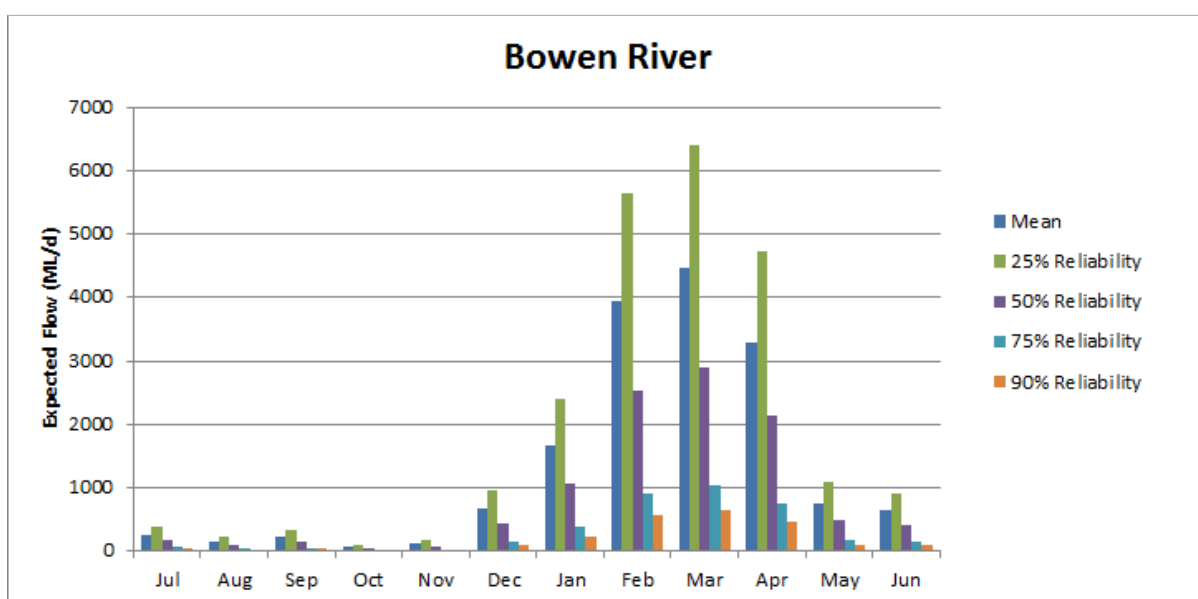


Figure 5.10: Expected flows at Bowen River crossing

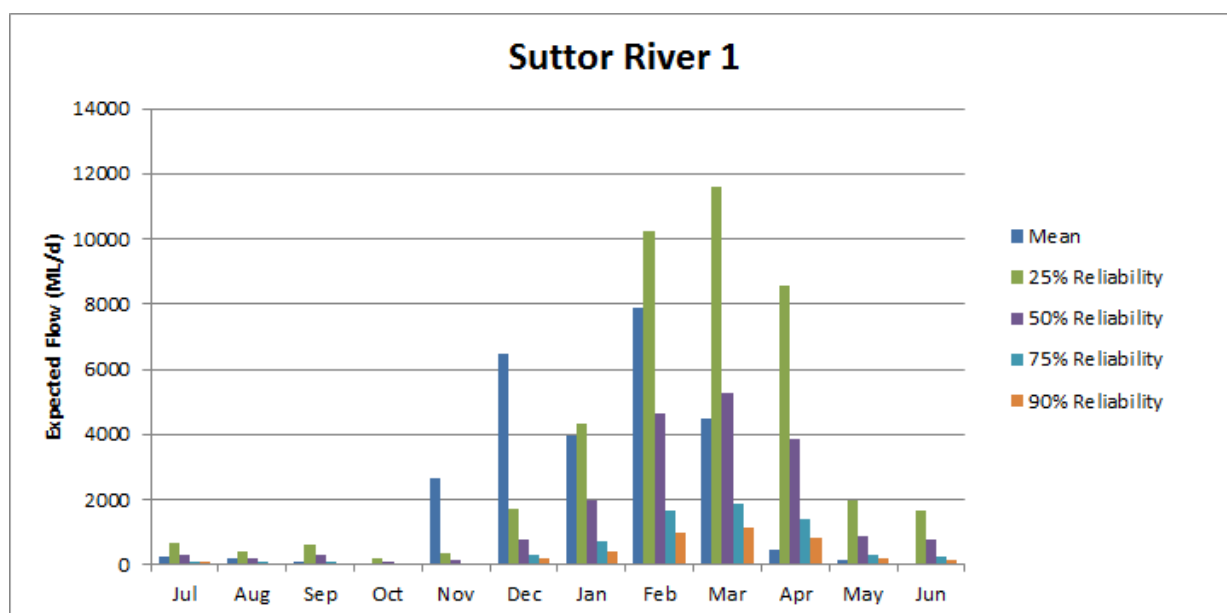


Figure 5.11: Expected flows at Suttor River 1 crossing

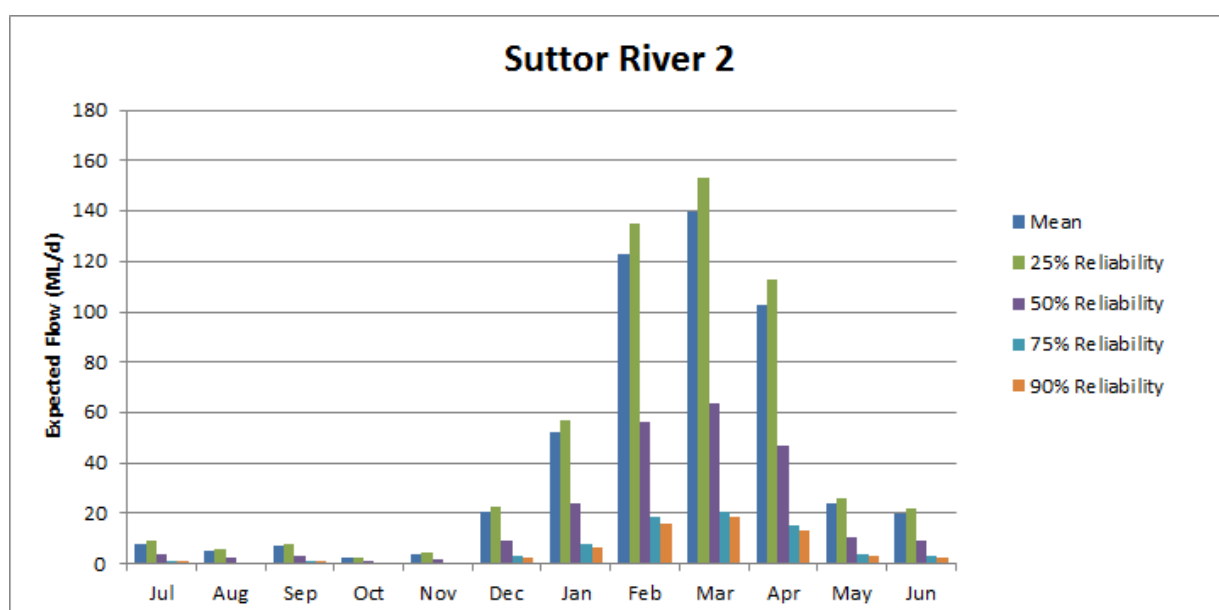


Figure 5.12: Expected flows at Suttor River 2 crossing

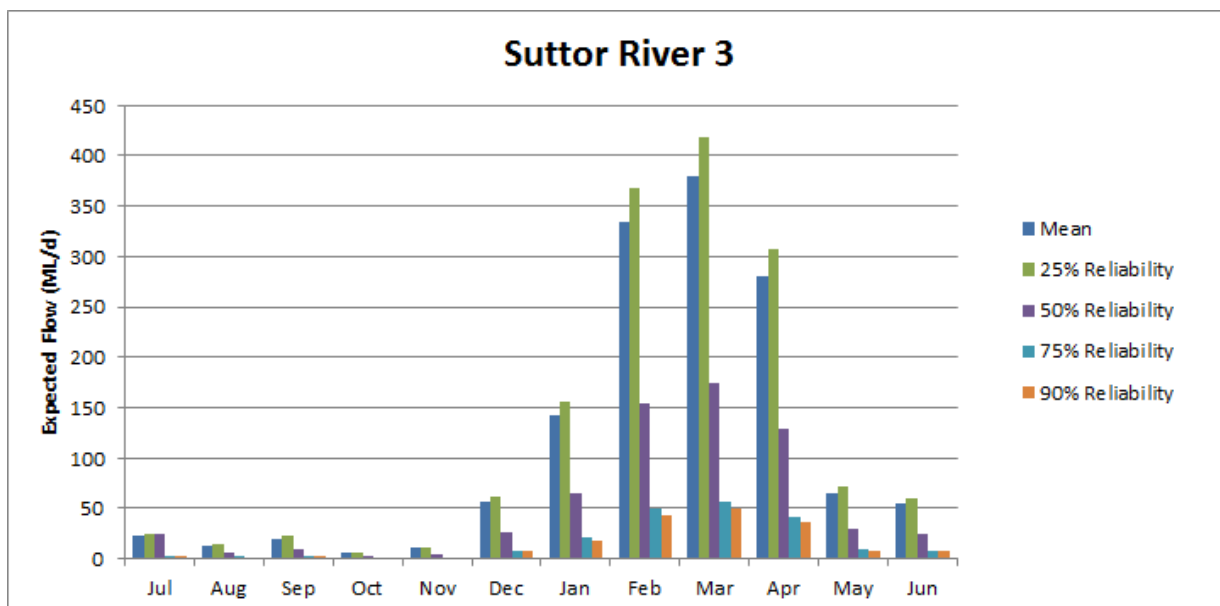


Figure 5.13: Expected flows at Suttor River 3 crossing

5.1.4 DISCUSSION ON RIVER HARVESTING

Using the above waterways as seasonal water sources is anticipated to provide a viable supply, with relatively large flows occurring at each crossing during the months of December to May. It is important to note, however, that flows in the region do diminish significantly outside of this time period. If a long term, year-round water supply is required at the sites listed above, the use of an alternative primary water source in conjunction with a waterway crossing will provide a more reliable water supply.

5.2 OVERLAND FLOW HARVESTING

Overland flow harvesting is undertaken via a type of surface water storage which is created by excavating storage ponds on the natural flow paths or ephemeral drainage lines which are not classified as waterways. These dams are left open at ground level at the flow fronting site to capture run-off generated from rainfall events to store for future use.

Construction of new overland flow harvesting dams for this project was not recommended as a primary option. This was due to the following:

- **Security of supply** – Collection and storage of water is reliant on rainfall events and are likely to be empty within a couple of months after the wet season due to evaporation and stock watering.
- **Volume** – These storages are generally quite shallow which means their storage capacity is limited, and their surface area to depth ratio is poor resulting in high evaporation losses. Additional earthworks would be required to rectify this.
- **Cost** – Pipework from and/or haul roads to these storages are likely to be prohibitively expensive for the amount of water and security of the supply offered, depending on the hydrant location.

In general, overland flow harvesting has a very low reliability and yield, although it is applicable for stock and domestic use. However, construction requirements for new overland flow storages are significant enough to make these options less viable, when compared to other options such as river harvesting and borefields.

Aside from the construction of new overland flow harvesting ponds, the possibility of using the existing farm dams located close to water supply hydrants was investigated. As there are numerous small farm dams along the route that collect overland flow, these were identified and assessed. Table 5.5 includes these storages.

As a supply source, based on the review of the storages, and the above issues, such water storages have been deemed inappropriate as a primary option. There are, however, seen as acceptable secondary or alternative options at many hydrants.

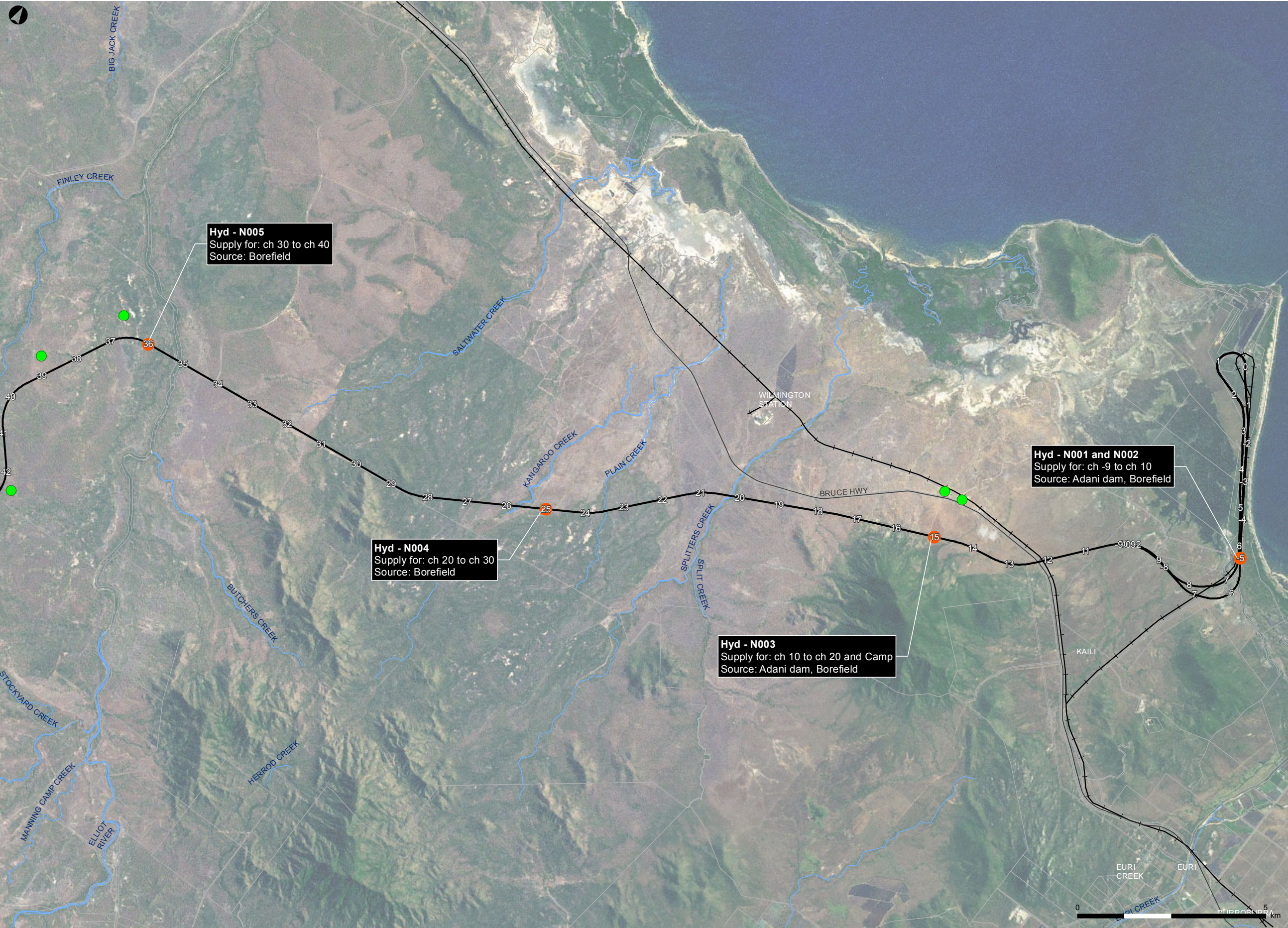
5.3 IN-STREAM AND OFF-STREAM STORAGES

An in-stream storage is a pond created by the construction of a dam within a defined waterway corridor. The storage volume can be increased by excavation of the water ponding area.

An off-stream storage pond may be constructed outside of the waterway with a diversion channel built into the storage pond or extracted via a pump and pipeline. The method of extraction is often dependent on the topographical condition, flows down the waterway, costs and the specific requirements of the water extraction permit.

Where supply of the water demands through boreholes is possible, construction of new in-stream and off-stream storages is generally not considered for the primary supply of water due to cost of construction. However, using existing storages (of sufficient size) or proposed storages when boreholes are not viable along the rail line has been considered.

A number of in-stream and off-stream storages with reliable capacity along the rail line route were identified are shown in Figure 5.14 below. Further details on the surface water supply options are provided in table shown in Appendix 'E' of the report.



- LEGEND
- Storage Ponds
 - Proposed Ponds
 - Proposed Hydrant Location
 - NGBR Option 06 Revision 02
 - Major Highways
 - Existing Rail
 - Property Boundaries
 - Watercourses

DATA SOURCES
QLD Govt (QGIS)
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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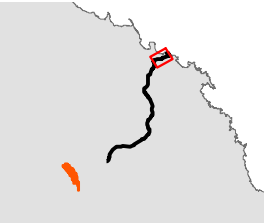
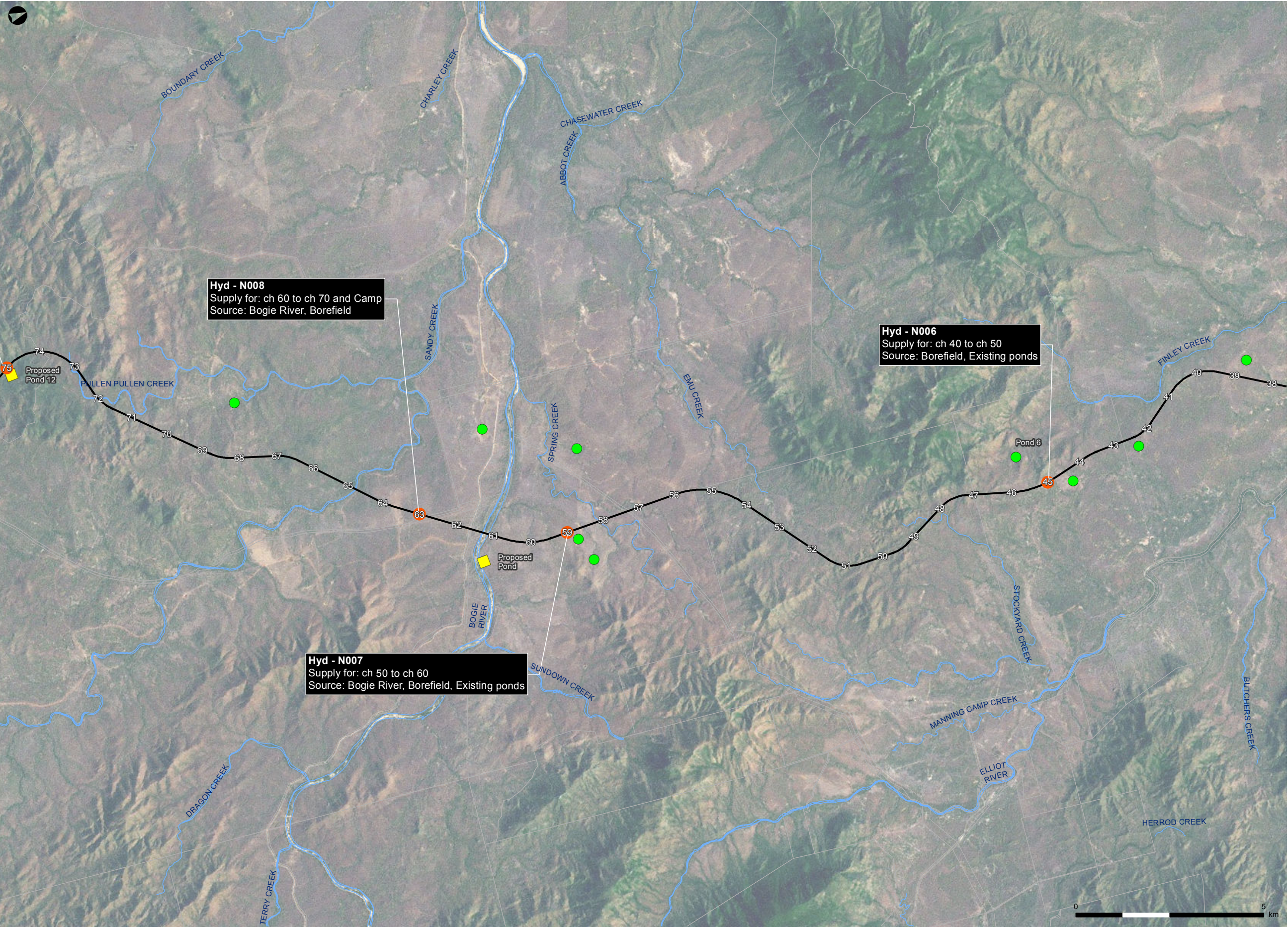


Figure 5.14: Location Of Existing Surface Water Storages



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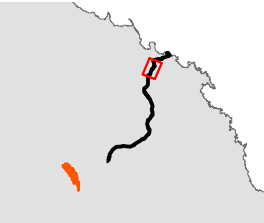


Figure 5.14: Location Of Existing Surface Water Storages

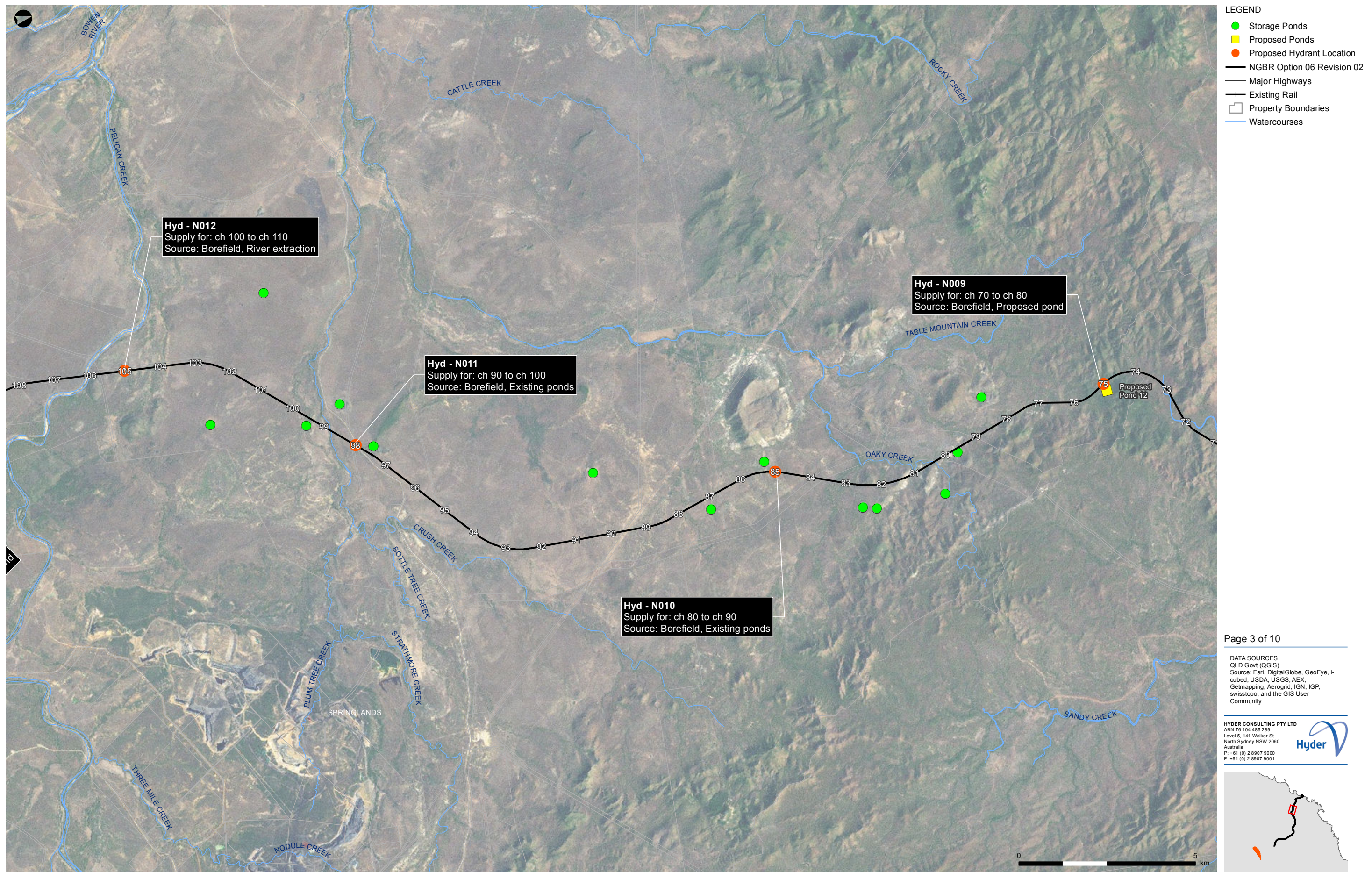
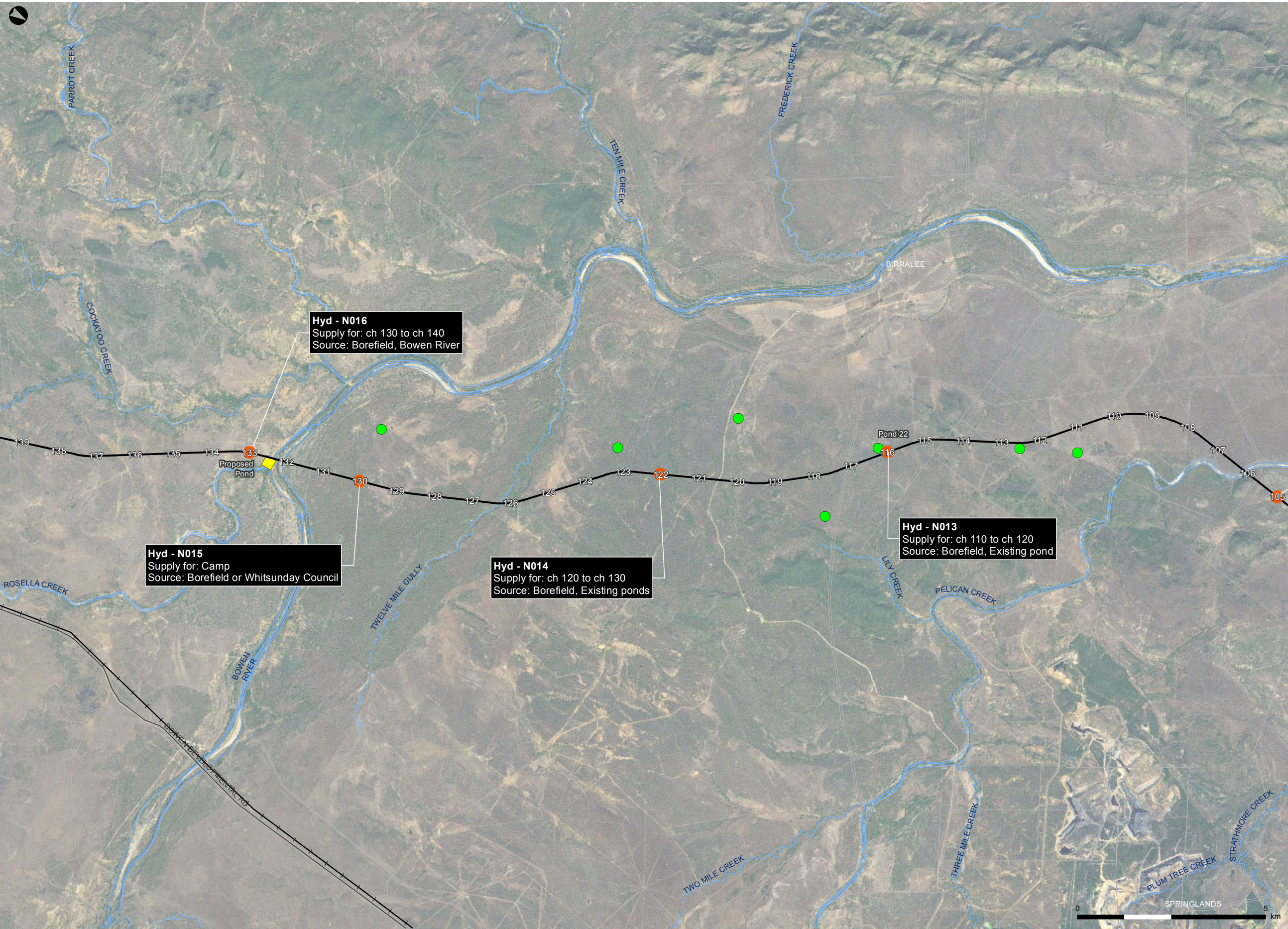


Figure 5.14: Location Of Existing Surface Water Storages



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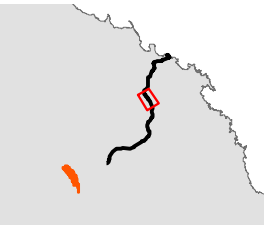
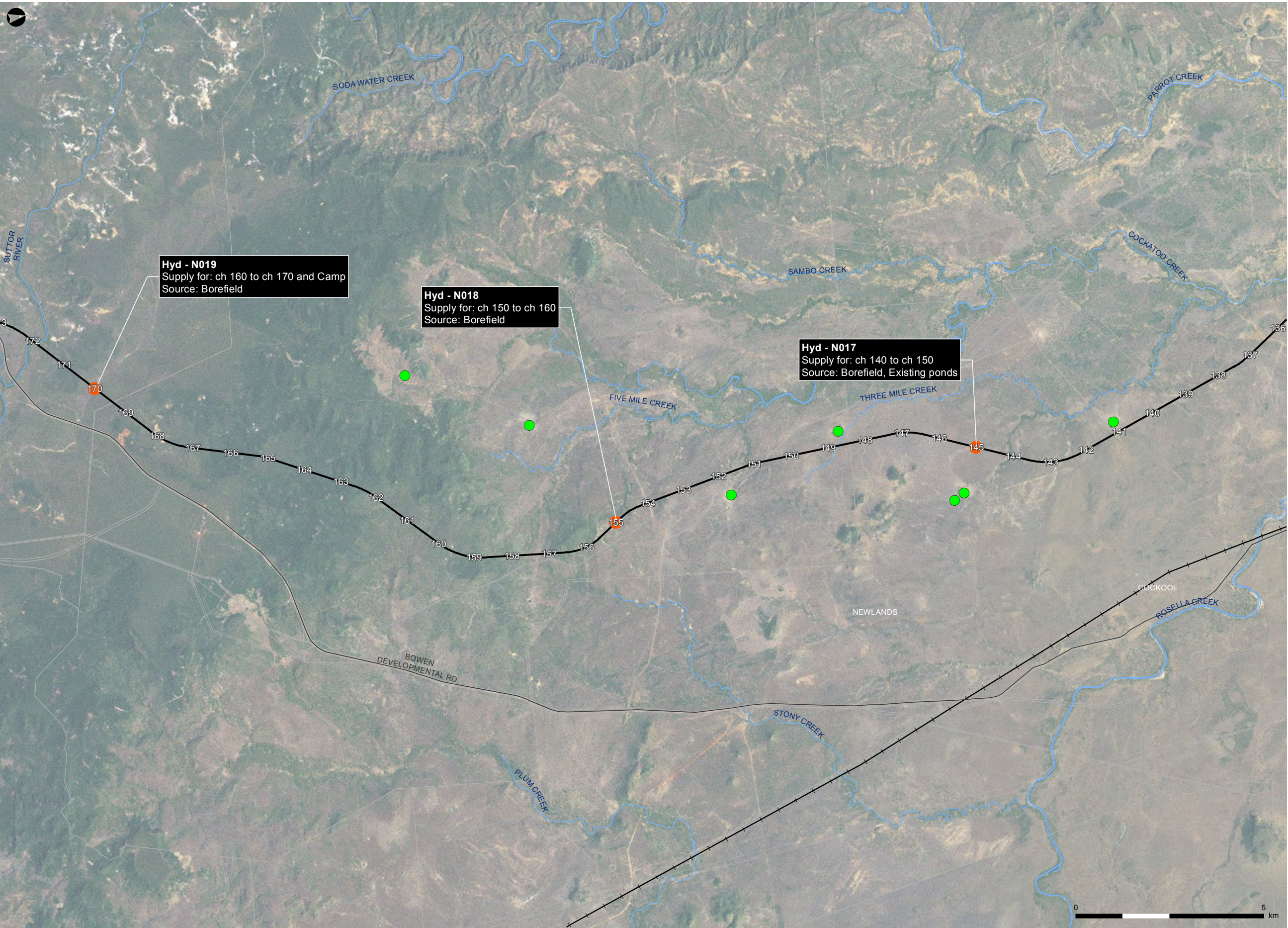


Figure 5.14: Location Of Existing Surface Water Storages



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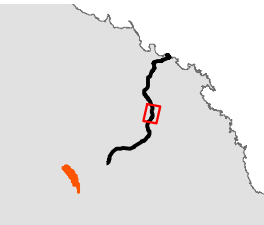
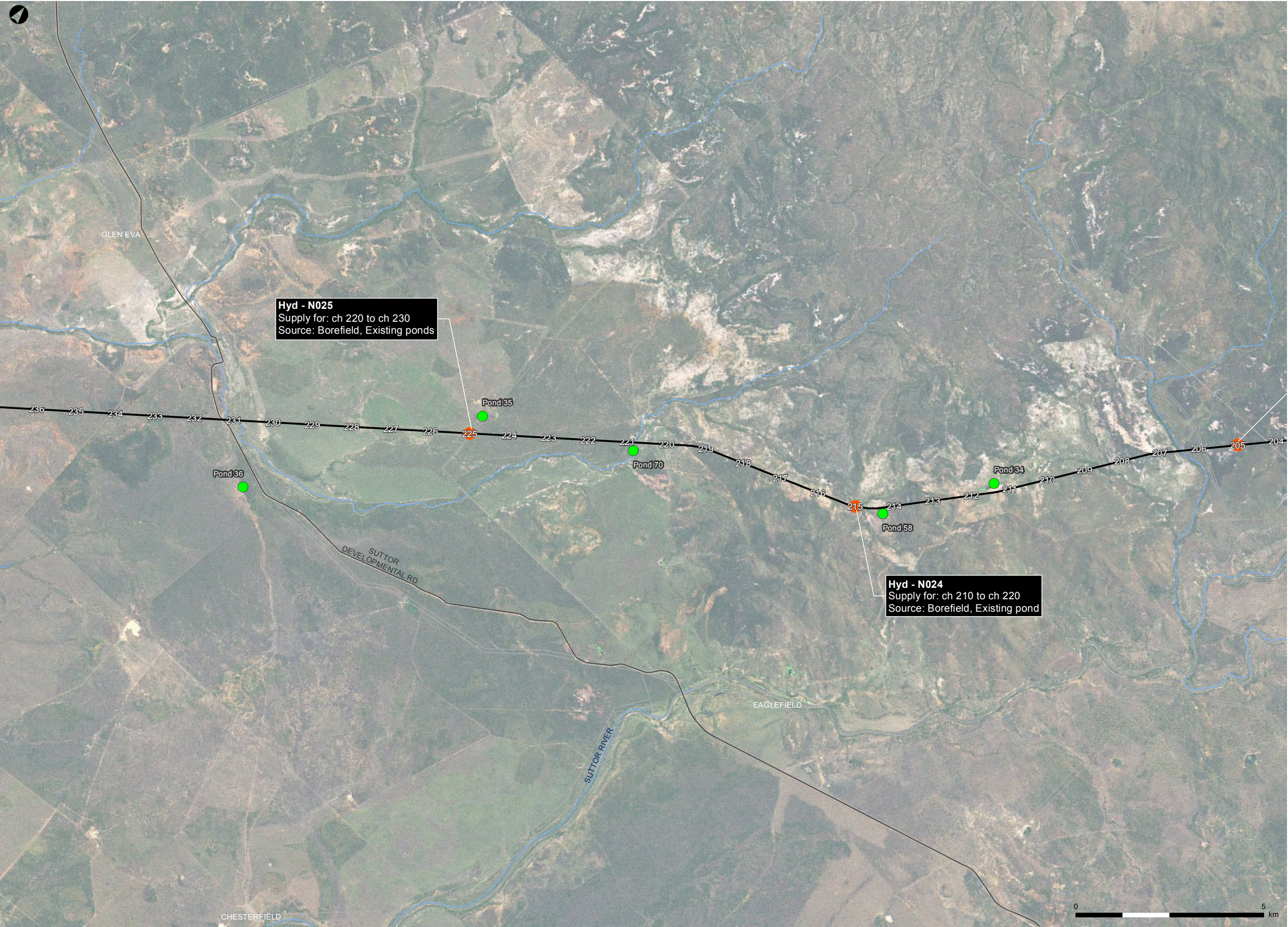


Figure 5.14: Location Of Existing Surface Water Storages



Figure 5.14: Location Of Existing Surface Water Storages



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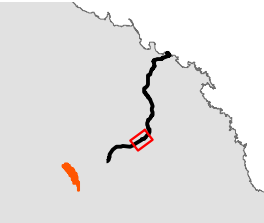
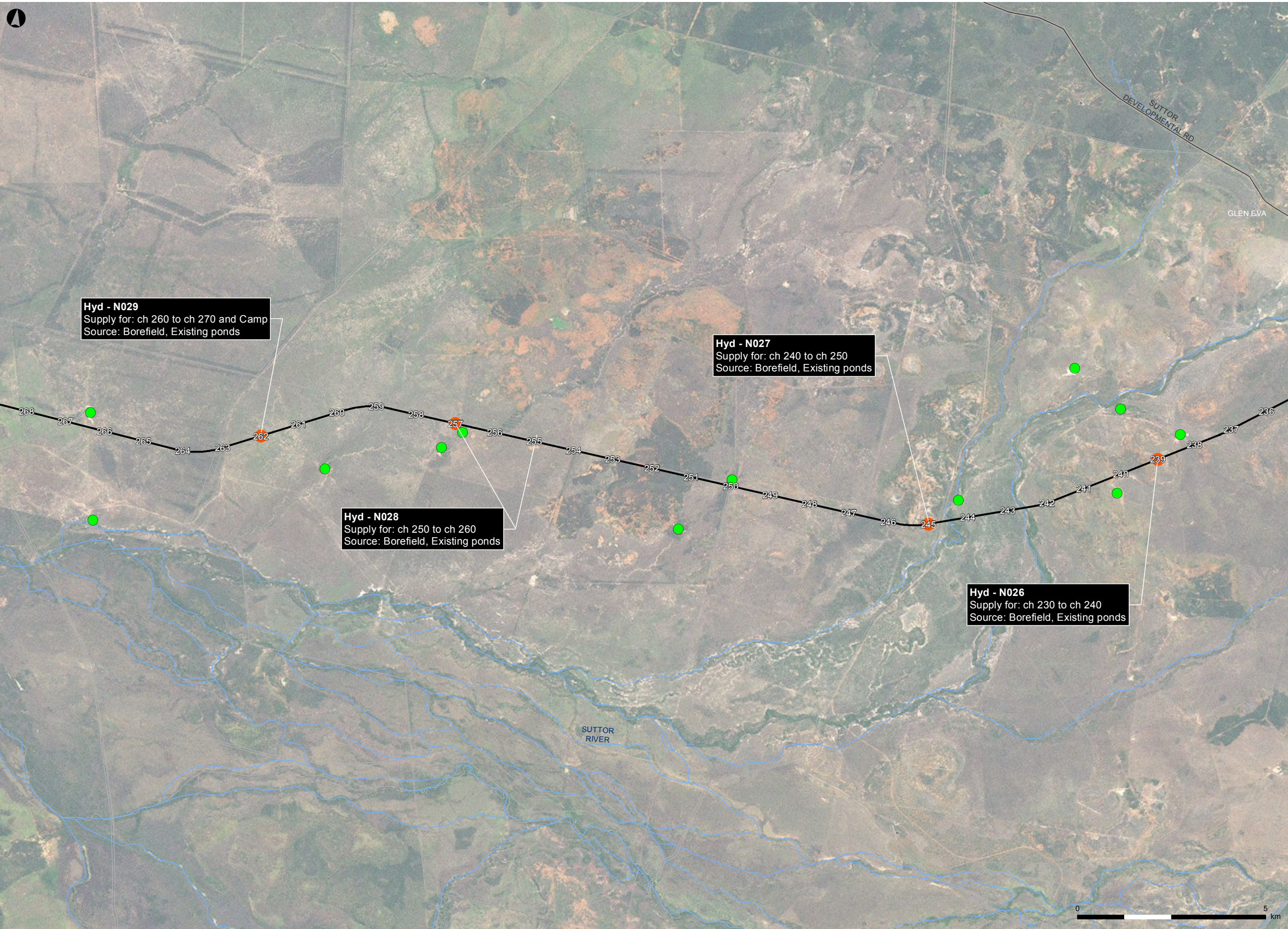


Figure 5.14: Location Of Existing Surface Water Storages



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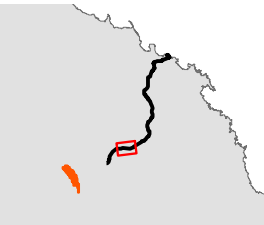


Figure 5.14: Location Of Existing Surface Water Storages

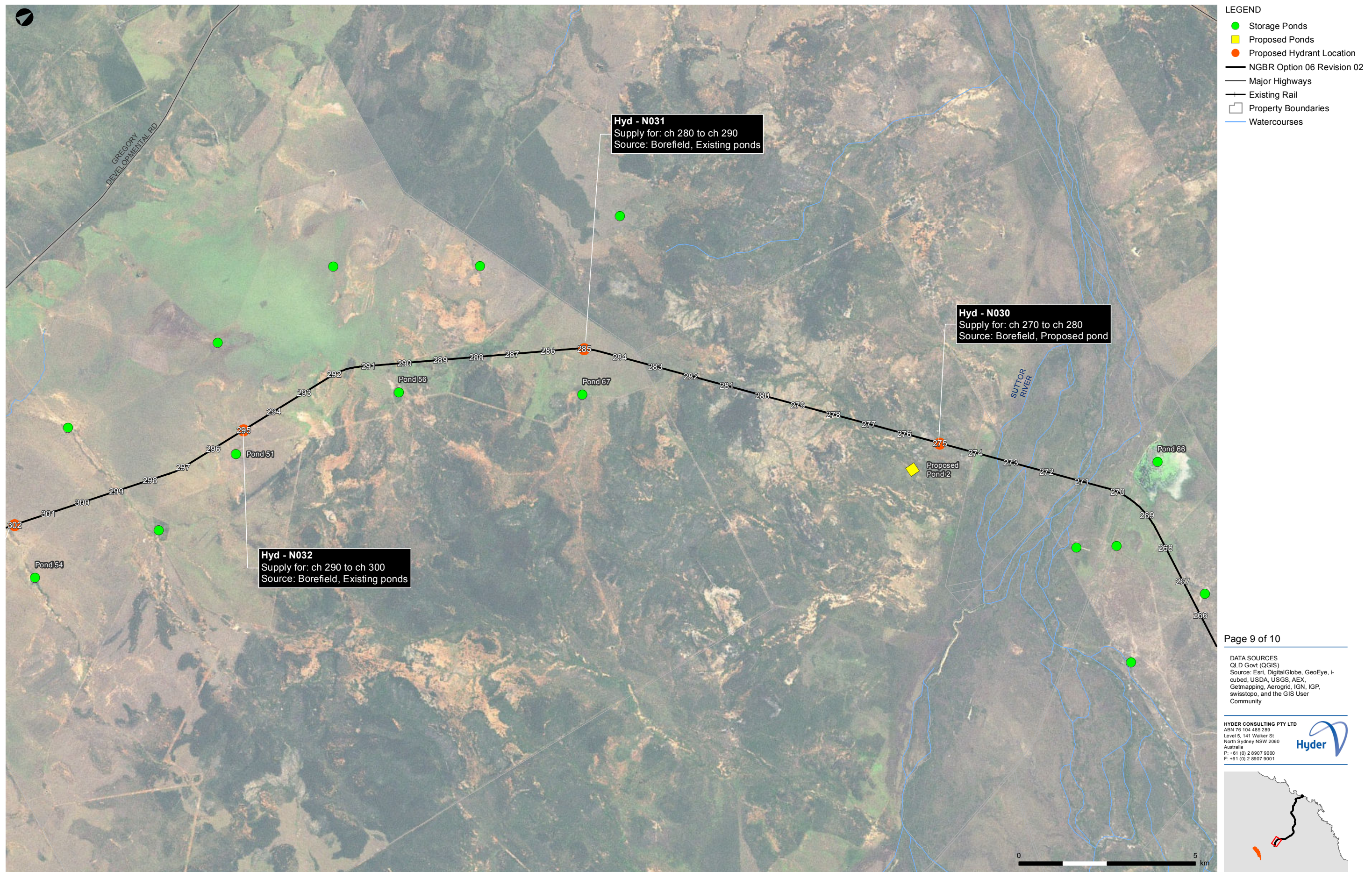


Figure 5.14: Location Of Existing Surface Water Storages



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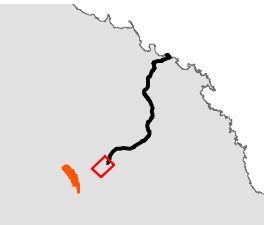


Figure 5.14: Location Of Existing Surface Water Storages

5.4 POTENTIAL WATER FROM ALTERNATE SOURCES

The regional bore search has revealed that there is a significant gap in the central segment of the proposed alignment, approximately from Chainage 80 – 190km, where yield data is not available. There are also areas along the alignment, especially along the crossing of the Great Dividing Range around chainage 40-10km, where surface water surfaces are also limited. As such, some initial considerations have been given to other potential sources of water which are discussed in the following sections.

5.4.1 SUNWATER-OPERATED PIPELINES

In the central part of the proposed rail alignment there are a series of major water pipelines operated by SunWater. These pipelines are:

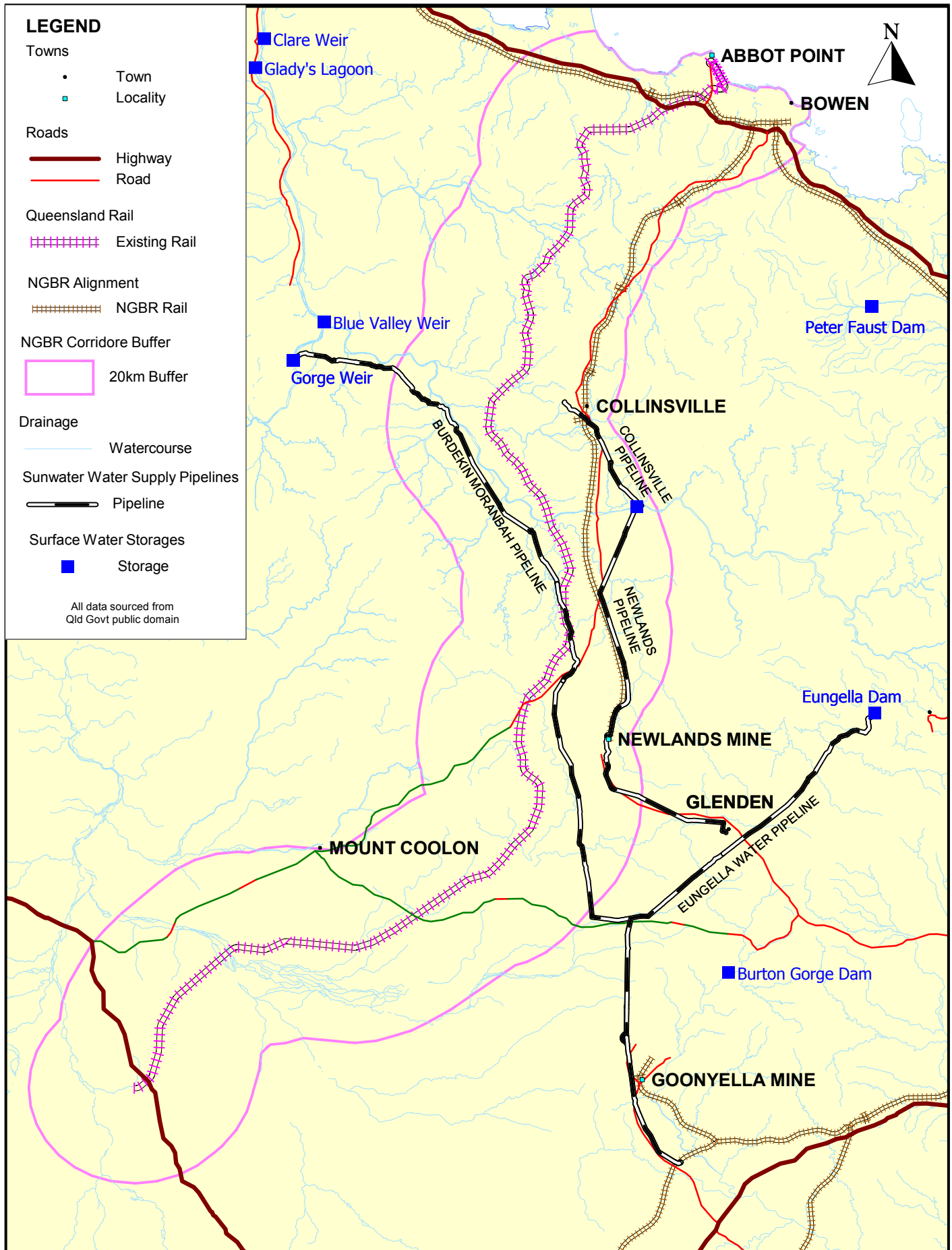
- The Burdekin – Moranbah pipeline which extends from Gorge Weir on the Burdekin River to Moranbah via the Eungella Water Pipeline to Moranbah; and
- The Newlands Pipeline which extends from Bowen River Weir to Collinsville and Collinsville Mine in the north and to Newlands Mine and Glenden in the south.
- The proposed new Gorge Weir to Byerwen Pipeline, a trunk water supply pipeline, extending from the Gorge Weir on the Burdekin River to the south predominantly adjacent to the existing Burdekin to Moranbah Pipeline.

Figure 5.15 indicates the locations of these pipelines in relation to the proposed route.

The northern part of the 218km-long Burdekin to Moranbah pipeline is within 10km of the alignment from approximate chainage 95km to 195km. The pipeline crosses the alignment between chainage 145km and 150km. The Newlands pipeline is approximately 8.5km from chainage 150km at its closest point, and within 17.5km of the alignment between chainage 155km and 190km. Both Pipelines are potentially reachable if connecting off takes are constructed and temporary connecting pipelines are laid. However, although operated by SunWater, the Newlands Pipeline is owned by Xstrata.

It should be noted that although it is likely that some water will be available from these pipelines via off takes, SunWater has significant existing customer supply commitments to meet from these pipelines and accordingly multiple large-capacity off-takes may not necessarily be achievable.

SunWater is proposing a new pipeline as a trunk water supply running approximately 110km (750mm in diameter) from the Gorge Weir on the Burdekin River, extending southwards, predominantly adjacent to the Burdekin to Moranbah Pipeline. The pipelines construction is scheduled for early 2013, with expected first water flow expected to be from late 2014. However, it is understood that the supply of water, at this stage, will only be available for industrial purposes for currently identified customers, or for landholders along the pipe alignment.



	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Water Supply Strategy	
		DRAWN CMH	TITLE Alignment of Sunwater Pipelines	
		DATE 10/07/2013		
	SCALE 1:1,000,000	A4	PROJECT No NGBR	FIGURE No 5.15

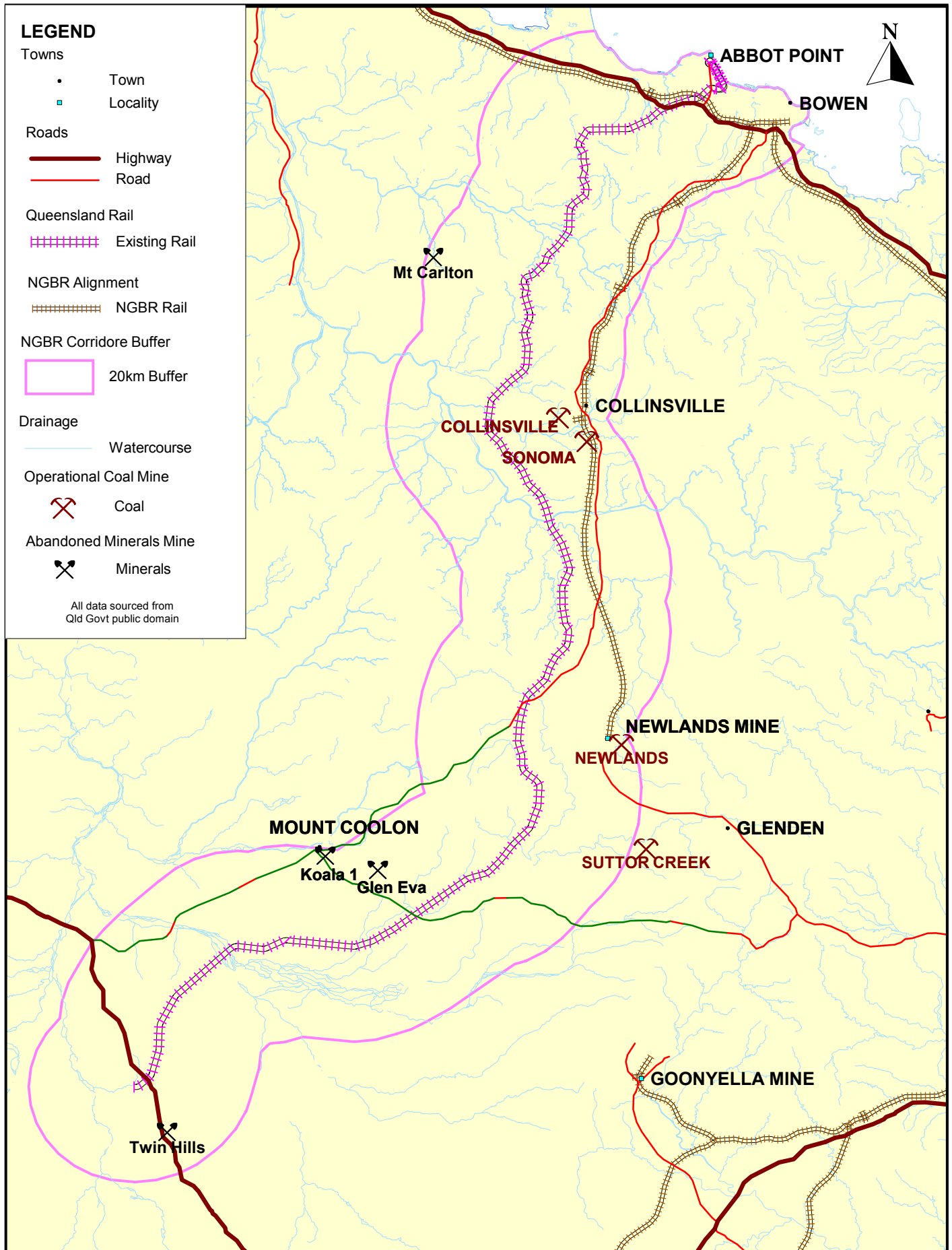
5.4.2 MINE VOIDS

There is a potential to acquire water along the NGBR corridor from abandoned and operational mining operations and mine voids. A search of mine sites within 20km of the alignment has been undertaken, and a total of 111 were identified of which less than 10 appear to offer an opportunity for obtaining water. These operational and abandoned sites are shown in Figure 5.16.

After an initial review it was found that it would be unlikely that water would be made available from operating mines due to production and environmental constraints. Abandoned sites offer some potential however the potential sites are located some distance from the alignment as shown in Table 5.6.

Table 5.6: Potential water sources from mining leases

Site	Status	Chainage	Distance from Alignment	Source	Pit Area (est ha ²)	Est Depth (est m)	Est Vol (ML)
Twin Hills	Abandoned	300	11km SE	Bores	N/A	N/A	N/A
Koala 1	Care & Maintenance	245	18km N	Pit	1.5	6	0.09
Glen Eva	Care & Maintenance	225	12km NW	Pit	1.5	4	0.06
Mt Carlton	Abandoned	70	18km NW	Bores	N/A	N/A	N/A



	CLIENT Hyder Consulting for Adani Mining		PROJECT NGBR Water Supply Strategy	
		DRAWN CMH	TITLE Operational Coal Mines & Abandoned Mineral Mines	
		DATE 30/07/2013		
	SCALE 1:1,000,000	A4	PROJECT No NGBR	FIGURE No 5.16

During the fly-over, only Twin Hills was identified as being within a viable pumping distance, but was found to be empty at the time. Based on the timing and recent rainfall, this indicates twin hills not being suitable due to limited yields and reliability issues.

For completeness, Each of the mineral lease areas are shown in Figures 5.17 – 5.20 below.

If mine voids where to be considered further during the project, Further investigation will need to be conducted including an assessment of water quantity, quality, treatment requirements, access and statutory authority to take water from the mine site.



Figure 5.17: Koala 1 Mining Lease Area



Figure 5.18: Twin Hills Mining Lease Area



Figure 5.19: Mt Carlton Mining Lease Area



Figure 5.20: Glen Eva Mining Lease Area

5.4.3 COAL SEAM GAS BY-PRODUCT WATER

Coal seam gas (CSG) projects involve drilling bores down into coal seams and then dewatering them by pumping to allow methane to desorb from the coal. The gas is then reticulated for use and the produced water reticulated way for management / disposal. As is well known, when CSG fields come into operation there can be appreciable water produced. The quality of this water is variable but often brackish to saline.

There are no operational CSG fields within the 20km corridor of the NGBR however there are numerous exploration wells drilled by Arrow Energy Pty Ltd and CH4 Pty Ltd.

These projects are considered to be in an early appraisal stage and it is not envisaged that they will be in operation and producing appreciable water within the next two years.

At this point in time, although there are some coal seam gas wells in the general vicinity of the proposed rail line route, there appears to be no prospect of harnessing water from them for production purposes.

6 REGULATORY REQUIREMENTS

Water in Queensland is regulated by the Department of Energy and Water Supply (DEWS), the Department of Natural Resources and Mines (DNRM) and the State Assessment and Referral Agency (SARA).

6.1 REQUIRED PERMITS FOR EXTRACTION AND SUPPLY

DEWS, DNRM and SARA are the governing bodies that will assess any applications made for water for construction and operations use.

The following activities will require various permits and entitlements:

Table 6.1: Trigger Activities requiring Regulatory Approval

Trigger Activity	Water Permit to Explore	Consent of the Chief Executive for New Operational Works	Development Permit to Construct	Water Permit to use
New Bores (in a managed area)	✓	✓	✓	✓
New Bores (in an unmanaged area)	✗ Must liaise with landholder and make arrangements with DNRM	✗ Must liaise with landholder and make arrangements with DNRM	✗ Must liaise with landholder and make arrangements with DNRM	✗ Must liaise with landholder and make arrangements with DNRM
Existing Off-Stream Storages	✗	✗	✗	✗ Must use water within property boundary of landholder or a new permit is required
Existing In-Stream Storages	✗	✓ If any new infrastructure is required or if the dam is expanded, otherwise not needed.	✓ If any new infrastructure is required or if the dam is expanded, otherwise not needed.	✓
New off-stream storages (meet self-assessable overland flow storage requirements)	✗	✗	✗ No development permits are required to construct the dams however the attached operational works will require a development permit.	✗

Trigger Activity	Water Permit to Explore	Consent of the Chief Executive for New Operational Works	Development Permit to Construct	Water Permit to use
New in-stream storages	✗	✓	✓	✓

The project specific approvals for the water supply options are detailed in Section 6.2. A generic discussion on the different entitlements is included in this section.

6.1.1 WATER PERMIT

A water permit is a temporary, non-renewable permit to access water and is issued by DNRM under *Chapter 2 Part 6 of the Water Act 2000*. Applications are assessed by DNRM and must meet all requirements stated in the Water Act.

Each water permit will be specific to a particular use such as extracting water for commercial and domestic uses, as well as for pump testing of bores to determine supply rates. A water permit is not required to extract a small amount of water to test for water quality. Applications for separate water permits to extract groundwater (for a single purpose) and surface water need to be made.

Water permits are issued for 'short-term' projects or for those which have a foreseeable conclusion date within a reasonable time period. The rail line construction is proposed to be completed within two years, and as such a water permit will be suitable for the construction period. This is in contrast to an activity that requires water over a longer period and would require a water licence.

The approval of a water permit does not give Adani access to the land or permission to construct any infrastructure. Landholder agreements will need to be negotiated to undertake both of these activities.

It should be noted that a water permit cannot be extended or renewed. Therefore when estimating the dates of water requirement, an allowance should be made for any delays in construction. If the permit runs out prior to the completion of the project, a new water permit will need to be acquired.

Water permits generally have an approval processing time of 2-3 months following submission of the application. DNRM will assess the application based on the amount of water required, the sustainability of the resource and any other relevant information.

6.1.2 DEVELOPMENT PERMIT

A development permit is required to construct all works that take water including pump stations, pipes and bores. A development permit is issued through and assessed under SPA Chapter 6 Part 1 and must be consistent with a current water entitlement. This means that Adani must first have a water permit to take water, prior to applying for a development to construct the works to take water.

To prove that the application is consistent with a current water entitlement, the applicant must be granted '*consent of the Chief Executive for new operational works that extract from and/or interfere with the flow of water*'. This application is made to DNRM and assessed by the Chief Executive.

Once the consent of the Chief Executive has been granted, Adani can apply for the development permit. The development permit is submitted through the IDAS.

6.1.3 LANDHOLDER NEGOTIATIONS

Whilst the landholder negotiations are not part of the regulatory, legislative permitting or entitlements process, they will be required.

A water permit can be issued to extract water from a property not owned by the applicant; however this does not give the permit holder permission to enter the property. Landholder negotiations and/or acquisition of appropriate tenure will need to be undertaken prior to accessing any property or using any existing infrastructure.

A development permit requires the landholder's permission to make an application for the required infrastructure to support the water permit. Landholders consent is a part of the application for the development permit.

6.2 REGULATORY PROCESS

6.2.1 NEW SELF-ASSESSABLE DAMS

The bore water storage dams are also intended to collect overland flow. An overland flow storage dam may be a self-assessable development under the SPA Chapter 6 Part 1, providing it is compliant with the "Code for self-assessable development for taking overland flow water using limited capacity works". In Burdekin Basin WRP the self-assessable storage volume limit is 250ML. As these dams are collecting overland flow they are mostly below ground and do not have above ground height restrictions. It is important to note that regardless of whether the dams have above ground height restrictions, if they are less than 250 ML in volume they are classed as self-assessable.

If the storage volumes exceed these limits or have additional infrastructure, a water permit will be required to store and use the water under the Water Act Chapter 2 Part 6 and a development permit will be required to construct the infrastructure under Chapter 6 Part 1 SPA. In addition, a failure impact assessment (FIA) is required under the Water Supply Safety and Reliability Act 2008, for an assessable dam. It is recommended that storage volumes are kept within the WRP limits to mitigate the requirement for permits.

Currently for the purposes of construction water supply for the NGBR, there is no proposal to build a storage that is outside of the above limits.

Once the dams have been constructed, the landowner must submit a notice of completed works to DNRM within 60 days of completion.

6.2.2 NEW BORES IN A DECLARED GROUNDWATER AREA

The proposed bores are in a groundwater management area if they are between the following chainages:

- The Bowen Groundwater Management Area, from chainage 0-27.5 km, and
- The Highlands Declared Subartesian Area, from chainage 279.4 km to 306.9 km.

The take of water within a groundwater management area is regulated under the Water Act and requires a water authorisation. The construction of the works (bore) will also require a development permit and is further discussed below.

As a limited number of existing viable bores exist in some areas across the NGBR Project, a new supply source will need to be developed for the required supply. This will require two water permits, issued under Chapter 2 Part 6 of the Water Act. The first water permit will be for exploratory and testing purposes and the second water permit will be for using the bore for construction or industrial purposes. These water permit applications will be made to DNRM.

Each aquifer is defined by the rock formation, or aquifer, in which the water is held. In the interest of minimising the number of permits that are required, DNRM will issue one permit for all bores in a single aquifer. DNRM have previously advised that all permit applications should be lodged simultaneously to reduce processing times.

The water permit applications for the extraction of water from new bores need to include the following:

- Purpose for which the water is to be used;
- Date of activity (water extraction) commencement and completion;
- Source (subartesian or artesian);
- Target formation (aquifer) or target depth;
- Location (lot on plan);
- Maximum rate at which water will be extracted;
- Volume required (ML/day); and
- Total volume required (ML over life of permit).

A map of the proposed bore locations will need to be attached to the permit applications. This map also needs to show the location of local registered bores and other water facilities (storages, pump stations etc.), as well as the locations of watercourses, lakes and springs.

The construction of a new bore is considered an assessable development and as such it requires a development permit under the SPA, which must be issued under an entitlement to take water under the Water Act. A water permit for the exploration of a water supply and construction of a new bore must first be obtained before an application for a development permit can be submitted.

As stated above, it will be possible to list multiple works under a single development permit provided that all listed works extract water from the same aquifer. The development permits should align with the water permits where possible. The applications for development permits should be submitted in a single document for the entire length of the rail line to reduce processing time.

The application for a development permit to construct a new bore must include the following:

- Owners consent for the application. Liaison with all landowners will be required and third party agreements will need to be made;
- The bore depth or target aquifer;
- Location of the works; and
- Details of the works including pump sizes.

The development permit applications are assessed under SPA Chapter 6 Part 1 and can be lodged electronically using the IDAS forms 1 and 12 through “MyDAS” online.

The drillers’ licensing arrangements under the Water Act ensure all water bore drillers are properly skilled and that their work meets minimum standards.

Under the *Environmental Protection Act 1994*, each person has a duty to take reasonable and practicable measures to prevent or minimise the environmental harm resulting from their actions. This general environmental duty applies to all drilling activities. The department administering the above legislation may also impose specific requirements on drilling activities through development permit conditions, environmental authorities or environmental protection orders.

If bore water is stored in above ground ring type tanks there is no restriction on the size of the tanks. In case the bore water is held in open storage ponds, a licence would be required for the volume of the ponds as these storages are usually designed to capture overland flows.

Process Flowchart – New Bores in a Declared Groundwater Area

The timeframes shown below are approximate and are for planning processes only. All processes must be followed and the two processes below are not alternative options. They can, however, be completed at the same time.

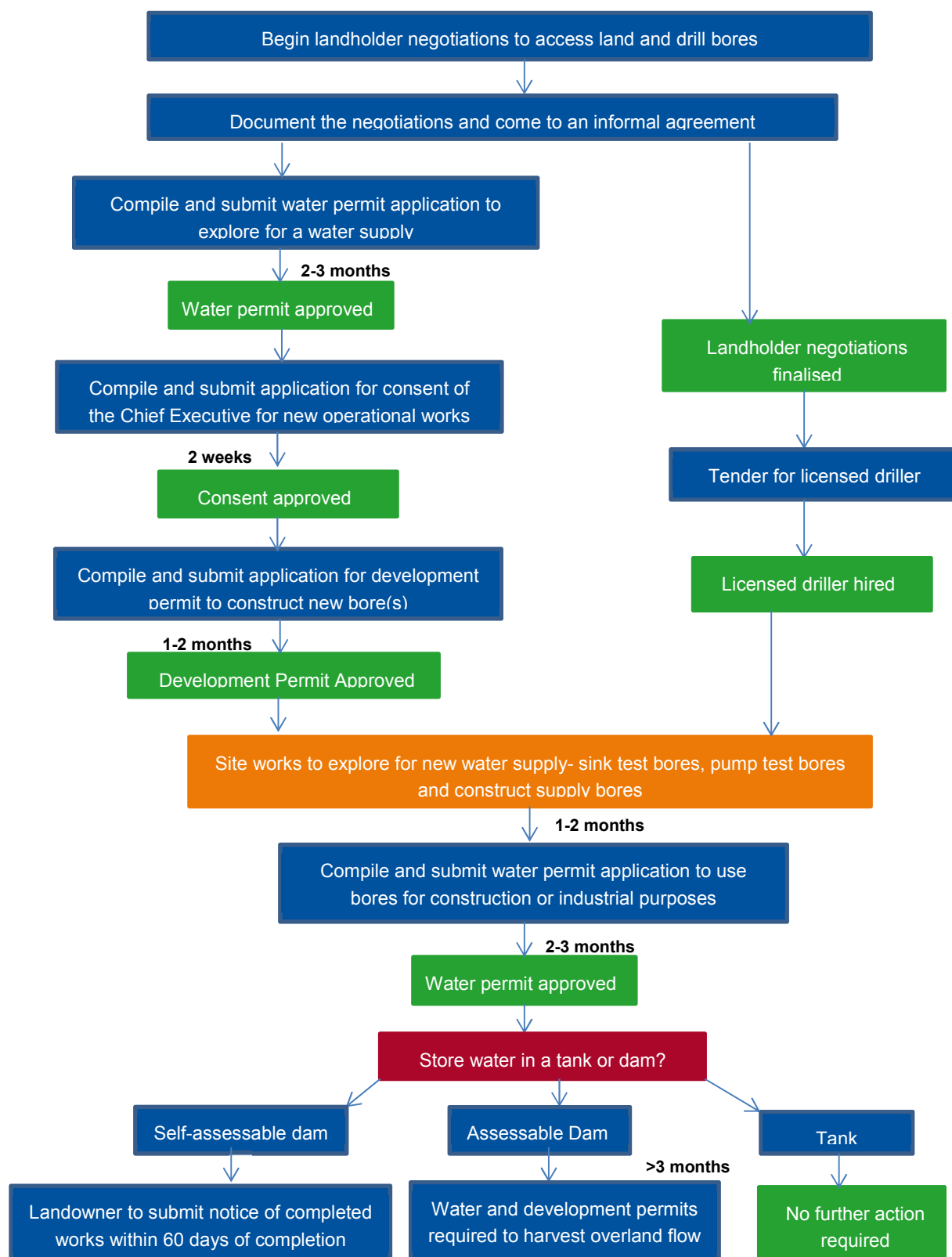


Figure 6.1: Process to Use New Bores

6.2.3 NEW BORES IN AN UNDECLARED GROUNDWATER AREA

The extraction of groundwater in an area outside of a declared groundwater management area does not require a water authorisation under the Water Act. In addition, there is no formal requirement to obtain a development permit for the construction of the bore. However, while there is no formal regulatory process the approach would be to assess the availability of groundwater with the consent of local landowners.

Once the presence of a resource is established the DNRM should be approached as per a protocol for the authorised taking of water without a water entitlement under the Water Regulation 2002 (WAP/2011/4668 – Version 2). This protocol allows for the taking of water for temporary purposes such as the construction of utilities.

DNRM has supported the notion for Adani to initiate discussions with DNRM regarding the proposed exploration and taking of groundwater, as well as the construction of the new bores in these unmanaged areas.

In these discussions DNRM may request Adani to provide details of the proposed take of groundwater, including the total volume, rate of extraction and the time period over which extraction will take place. Adani should undertake these discussions with DNRM prior to the extraction of groundwater.

It should be emphasised that all groundwater bores, both in and out of a managed area, must still be constructed and completed in accordance to Minimum Construction Requirements for Water Bores in Australia 2nd ed. (Land and Water Biodiversity Committee, 2003). This requirement applies to all constructed water bores.

Landholders' permission will be required to access the land on which the proposed bores are located.

6.2.4 USE OF EXISTING OFF-STREAM STORAGES

Off-stream storages capture water from a nearby waterway (via pumps or a diversion channel) and are generally attached to a water licence extraction. For any existing off-stream storages, Adani does not require any additional permitting or licencing to use the water as long as it is used within the bounds of the property. In this instance, Adani will only be responsible for making arrangements with the current owner of the off-stream storage and landholder.

If Adani needs to extract more water than is stored, and the required harvesting volume exceeds the maximum extraction entitlement in the licence, then the water harvester (landholder) will need to apply for an additional permit or licence to extract the additional water volume.

It is imperative that Adani do not exceed the maximum extraction volume allocated to the landholder, as under these circumstances the landholder would be in violation of the terms of their licence under the *Water Act 2000* Chapter 2.

Water cannot be taken from the off-stream storage and used at any location outside of the bounds of the property to which the landowner's water licence is attached without a separate permit to take water being applied for.

6.2.5 USE OF EXISTING IN-STREAM STORAGES

An existing in-stream storage is any existing storage located within a water course, from which water is required to be extracted under a water harvesting licence or temporary water permit. Adani will need to apply for a water permit in line with Chapter 2 Part 6 of the *Water Act 2000* and under the Burdekin Basin WRP to use any water from the existing in-stream storages and will also need to make arrangements with the landholders for the development of their own or use of the existing infrastructure.

The water permit applications for the extraction of water from in-stream storages need to include the following:

- Purpose for which the water is to be used;
- Date of activity (water extraction) commencement and completion;
- Source (surface water);
- Name of the watercourse;
- Location (lot on plan);
- Maximum rate at which water will be extracted;
- Volume required (ML/day); and
- Total volume required (ML over life of permit).

A map of the proposed locations of extraction will need to be attached to the permit application(s). This map also needs to show the location of local registered bores and other water facilities (storages, pump stations etc.), as well as the locations of watercourses, lakes and springs. The water permit applications are submitted to SARA and assessed under the Chapter 2 Part 6 of the Water Act.

If new infrastructure is required to be constructed, a development permit is required under SPA Chapter 6 Part 1. The application for a development permit to construct new operational works must include the following:

- Owners consent for the application. Liaison with all landowners will be required and third party agreements will need to be made;
- The watercourse;
- Location of the works; and
- Details of the works including pump sizes.

The development permit applications are assessed under SPA Chapter 6 Part 1 and can be lodged electronically using the IDAS forms 1 and 12 through “MyDAS” online.

Process Flowchart- Existing In-Stream Storages

The timeframes shown below are approximate and are for planning processes only.

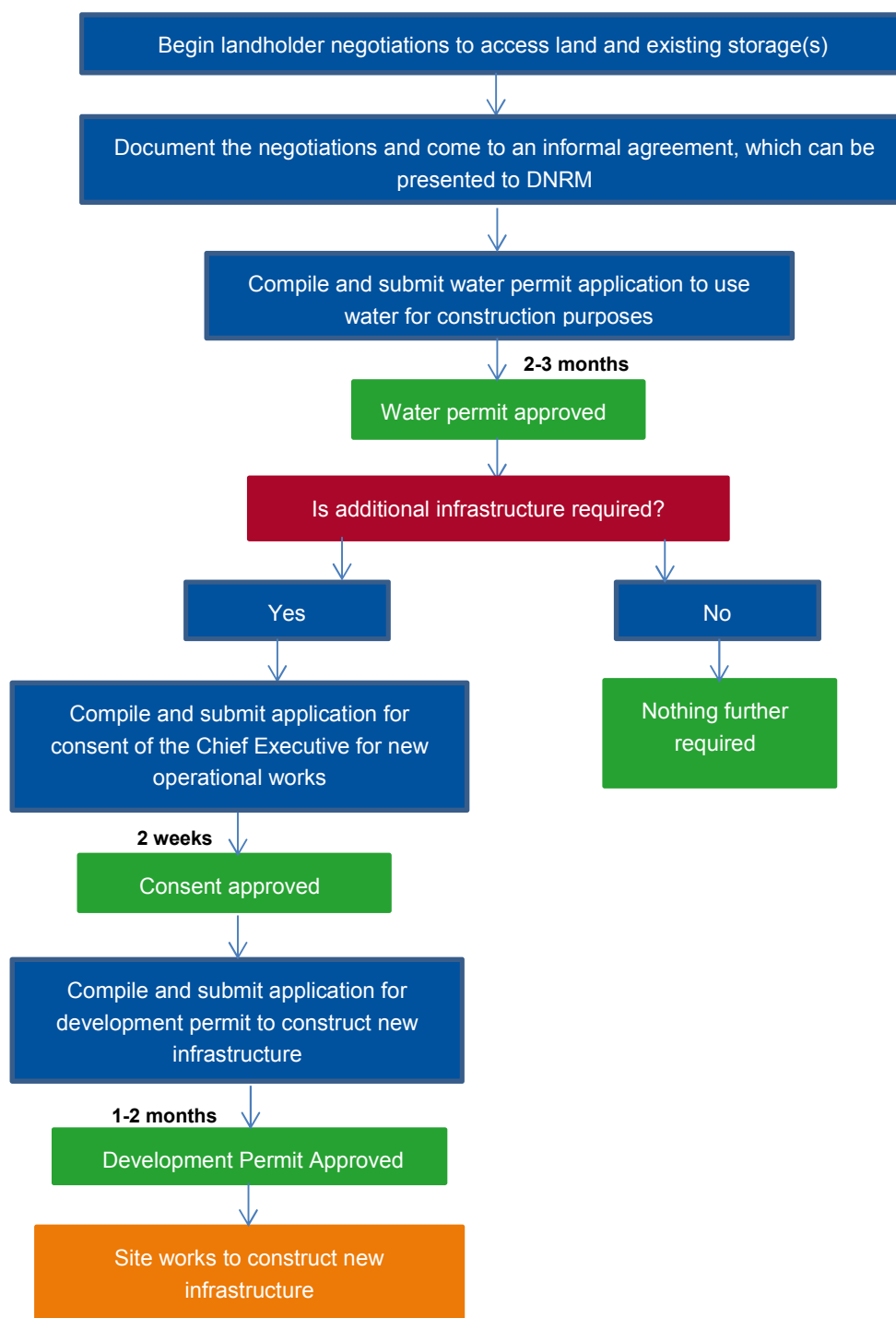


Figure 6.2: Process to Use Existing In-Stream Storages.

6.2.6 NEW IN-STREAM STORAGES

The construction of a new in-stream storage will require various regulatory approvals. Adani will need to apply for a water permit in line with Chapter 2 Part 6 of the *Water Act 2000* and under the Burdekin Basin WRP to take any water via in-stream storages and will also need to make arrangements with the landholders for the storage construction and development of associated infrastructure.

The water permit applications for the extraction of water from in-stream storages need to include the following:

- Purpose for which the water is to be used;
- Date of activity (water extraction) commencement and completion;
- Source (surface water);
- Name of the watercourse;
- Location (lot on plan);
- Maximum rate at which water will be extracted;
- Volume required (ML/day); and
- Total volume required (ML over life of permit).

A map of the proposed locations of extraction will need to be attached to the permit application(s). This map also needs to show the location of local registered bores and other water facilities (storages, pump stations etc.), as well as the locations of watercourses, lakes and springs. The water permit applications are submitted to DNRM and assessed under the Chapter 2 Part 6 of the *Water Act*.

A development permit is required under SPA Chapter 6 Part 1. The application for a development permit to construct new operational works must include the following:

- Owners consent for the application. Liaison with all landowners will be required and third party agreements will need to be made.
- Name of the watercourse
- Location of the works
- Details of the works including pump sizes

The development permit applications are assessed under SPA Chapter 6 Part 1 and can be lodged electronically using the IDAS forms 1 and 12 through “MyDAS” online.

In addition to the above, a riverine protection permit is also required under the *Water Act*, for any construction works inside of a watercourse. This application is made through DNRM, after receiving the water permit. The permit application must include the following:

- Owners consent for the application. Liaison with all landowners will be required and third party agreements will need to be made;
- Name of the watercourse;
- Duration of construction;
- Location of construction;
- Details of activity, including the type of vegetation that will be destroyed and the type of material that will be removed; and

- Method of operation.

Process Flowchart- New In-Stream Storages

The timeframes shown below are approximate and are for planning processes only.

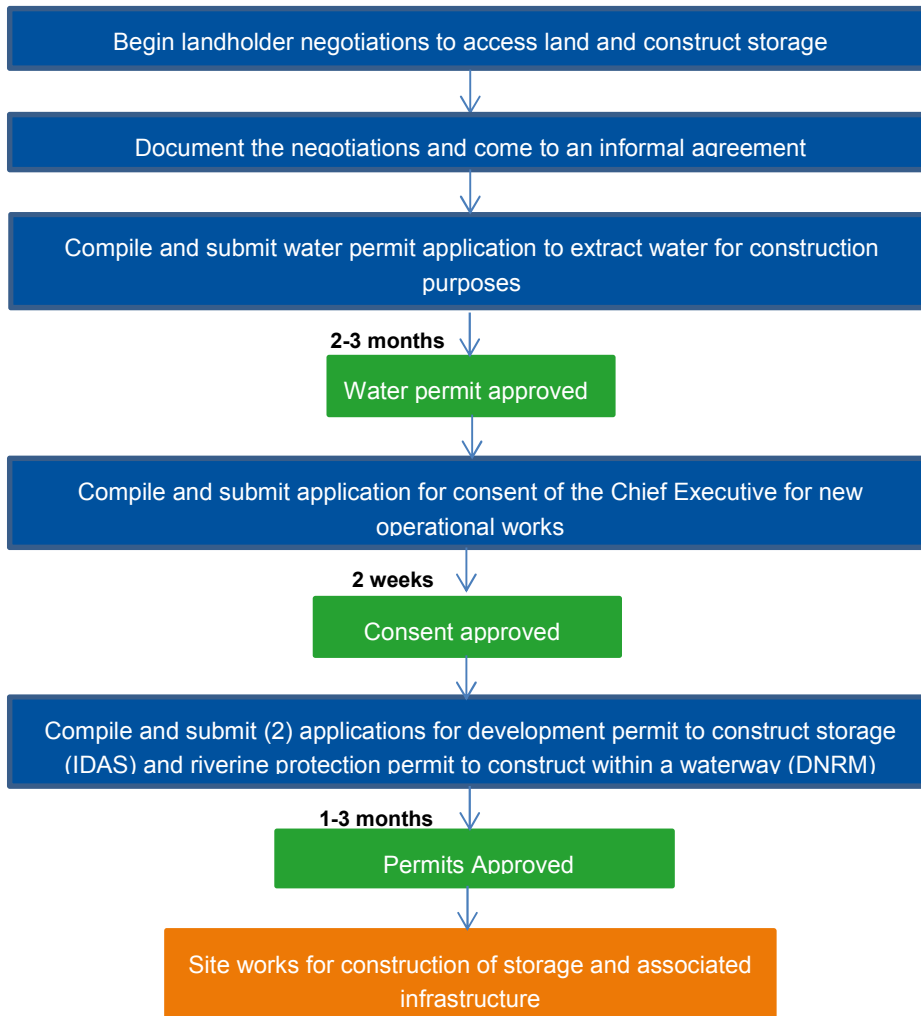


Figure 6.3: Process to develop new In-Stream Storages.

7 ALLOCATED WATER SUPPLY OPTIONS

As discussed in Section 3 of the report, 34 water supply hydrants will be required to supply water for the construction needs of the NGBR Project. Based on the surface water and groundwater assessments a number of different sources were identified as having the potential to supply the required water.

The method of extraction (water supply systems) from each source varies, and a generic discussion, design (Section 7.1) and cost analysis (Section 7.2) for each water supply extraction, storage, treatment and distribution type is provided below.

7.1 WATER SUPPLY SYSTEM

Whilst the characteristics of each water supply system will be specific to each water supply point (refer to Section 10), with varying bore depths, storage volumes and pipeline lengths, the concept and majority of each design type will remain reasonably uniform for each source type.

In some locations a combination of water supply options has been proposed, with a main supply and supplementary supply. This combination of supplies will be needed when water supply hydrant yield and reliability cannot be met by only one source alone.

Based on the water demand table provided in Section 3 of the report (refer to Table 3.7) indicative water requirements have been proposed and used in the generic design of the water supply systems. These indicative daily water requirements are presented in Tables 7.1, 7.2 and 7.3 below.

Table 7.1: Indicative Water demands for Earthworks

Demand type	Quality	Volume (kL/day)	Average Instantaneous Flow Rate (L/s)	Maximum Instantaneous Flow Rate (L/s)	Description
Earthworks	Raw water	1000	27.8*	41.7	Calculated for 10km intervals

*based on average daily demand

Table 7.2: Indicative water demands for concrete batching and camps

Demand type	Quality	Volume (kL/day)	Treatment rate (L/s)
Potable water	Drinking	50	1
Concrete mix	AS1379	85	1.45

Generic footprint measures for each water supply option are shown in table 7.1. Further details of footprint areas are given for each hydrant point in Appendix E.

Table 7.3 Footprint Unit areas for generic water supply options

Water Supply Option	Unit	Unit Footprint Areas (m ²)
Borefield	Per Bore	1600
Road/Pipeline/ extraction stations	Per m (length)	20

Water Supply Option	Unit	Unit Footprint Areas (m ²)
Storage Pond	Per pond (new ponds only)	22500
Storage tanks and water treatment infrastructure (adjacent to hydrant point)	Per Hydrant	1780

7.1.1 WATER SUPPLY FROM BOREHOLES

Boreholes, when compared to other water supply systems, are seen to provide the most reliable water of the highest quality and can be extracted via low cost methods. Based on this, where possible, it is considered as a favourable supply and generally the primary option for each of the hydrants.

System Description

This water supply option centres on drilling and operation of boreholes at the vicinity of each of the hydrants. Water is pumped from the developed bores to the main storage tanks. The untreated water for earth work purposes is taken directly from the main storage tanks. For those water supply hydrants allocated to construction camps or batching plants, a fraction of the supplied water will be treated and used for drinking, yard and construction works (concrete). At the camp sites, two separate treatment systems for drinking and batching plants (AS1379) are proposed. In both systems raw water will be taken from the main storage tanks, treated in packaged mobile treatment plants and stored in separate tanks for potable and non-potable (batching plants) purposes. It should be noted that the batching plants will not form part of the camps.

At this stage, the locations of the boreholes and the available yield cannot be confirmed without site investigations including yield and pump tests.

A haul road will be constructed along the rail alignment. This can be used for truck access to the location of the bores and refuelling the generators. Each bore should be piped to the raw water tanks located at the supply point.

The package treatment plant operating hours will be based on each of the demand rates. As soon as the water level in the treated water storage tanks reaches a specified low level the treatment plant starts. In rare occasions of peak demands, both drinking and non-drinking treatment plants may continue to work based on a 24/7 basis.

The major components of a water supply system using boreholes would include:

- 1 to 6 boreholes each 30m to 250m deep
- Submerged pump for each bore with capacity of 1 to 6L/s
- 100m to 1600m pipe with 100mm to 200mm diameter to transfer water to the main storage tanks
- Two 125kL water tanks with total 250kL capacity for daily storage of raw water and equalisation purpose

The below water supply components will be required at the location of construction camps:

- A tank with 50kL capacity for daily storage of concrete mix and camp non-potable water
- A tank with 50kL capacity for supply of potable water
- Mobile water treatment plant with 1 L/s capacity for treatment of water to potable levels.

- Mobile water treatment plant with 1.5 L/s capacity for other water demands at camp and batching plant
- Control valves

Further detail of this supply system is provided in the drawings provided in Appendix B of the report:

Storage Tanks

The demand rate for each hydrant will be subject to hourly variations with instant demands significantly higher than the average demands. Provision of equalisation storage allows the system to be designed for the maximum daily demand values instead of the maximum instantaneous rates. Calculation of the required equalisation volume at main storage tanks, assumes:

- Construction works will be done in one shift of 10 hours a day
- The earthwork water will be delivered during 6 hours each day
- The required equalisation storage is calculated for two alternatives of a 24 hour day and a 10 hour day pumping from the bores to the main storage tanks

Figure 7.1 shows the equalisation storage required for each operation condition. If the alternative, which includes 10 hours pumping from the boreholes and 6 hours water demand, is selected, for a maximum demand of 1000kL per day, 235kL of storage will be required. Considering the dead storage volume and freeboard requirements, a total of 250kL is needed as a storage volume, which is provided by 2x125kL tanks.

For those supply points located at camps where other water supplies are required, the concrete mix water tank and drinking water tank will provide additional storage which will cover the extra storage requirements.

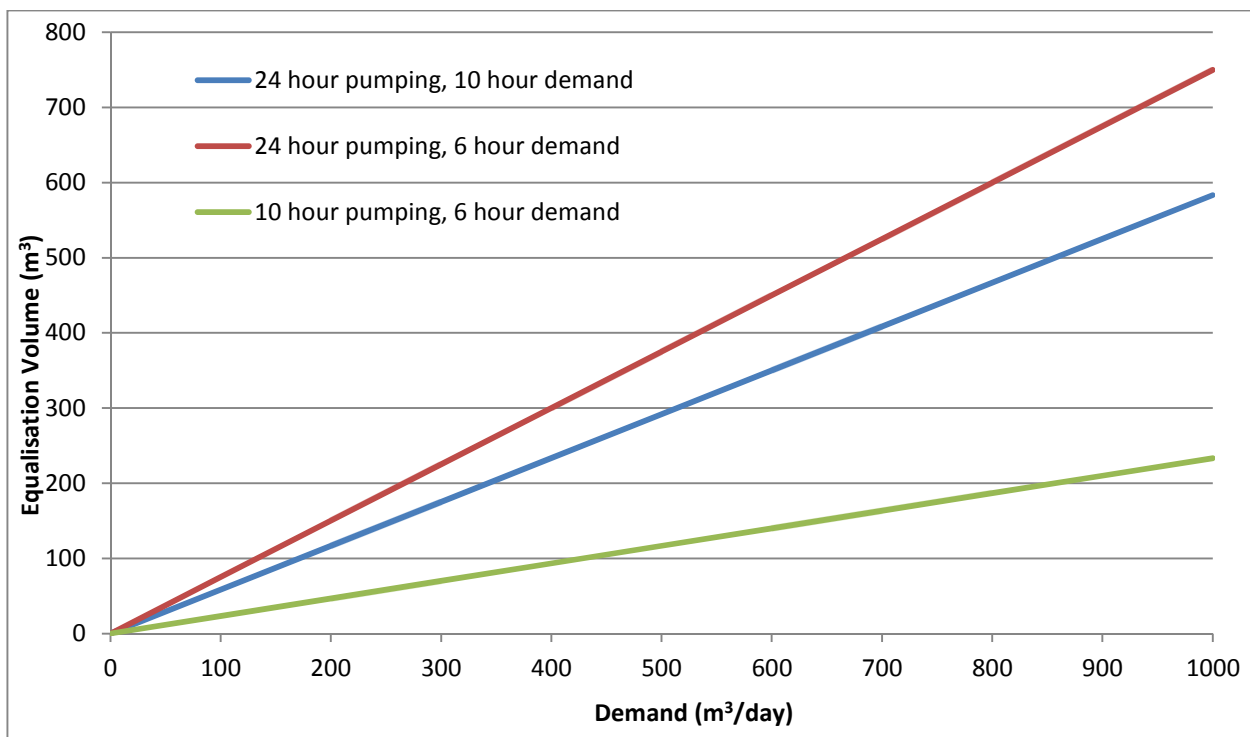


Figure 7.1: Equalisation Storage Volume Vs Daily Demand

Bores

Based on their location, it is expected that the bores will be able to perform at a yield rate of 1 to 6 L/s for a pumping duration of 60% to 90% of the day. The yield will be variable due to aquifer type, and is currently based on recorded yields from the DNRM database. To minimise the required raw water storage at the site it is important that pumping is continued during the working shift.

As a majority of the identified bores from the DNRM database are no longer active, it is proposed that no existing bores will be relied upon for extraction with all proposed boreholes to be sunk on-site with drilling rigs. The distance between bores should be selected to reduce cumulative drawdown and maintain the maximum potential yield. As a general recommendation, production bores will have a minimum separation of 100m however the final design of each borefield will be determined from aquifer properties based site specific drilling and pumping test results.

Pipelines

The pipelines from each individual borehole will connect to the main water supply tank(s). The pipe diameters have been selected based on the assumed flow rate and head losses and will be equal to 100mm. Based on the discharge rates, the velocity of water in 100mm pipes will be less than 1.5m/s which is below the maximum recommended values but high enough to allow for self-cleaning.

Valves

For each borehole 2x100mm gate and 1x100mm non-return valves will be provided to allow for isolation of the system for maintenance and testing.

Electrical and Control

Based on the nature of the work, it has been assumed that the required power will be supplied by mobile generators. For each bore with depths of 50-250m, an 8 kVA generator would provide for the pumping power demands.

7.1.2 IN-STREAM AND OFF-STREAM EXTRACTION

The majority of the defined water demand is for earthworks, where the required quality of water is low. Because of this, in-stream and off-stream extractions, which have lower water quality than boreholes, are seen as viable water supply options. Many existing storage ponds are available along the rail line, and if use can be negotiated with the landowners, they will provide a cost effective and accessible supplementary water supply source for the project.

If the storage pond is located close to the site, extracted water from the storage pond will be piped straight to the site raw water tanks for equalisation purposes. Otherwise, it will be delivered (extracted from the storage pond) directly to the location of the earthwork using tanker trucks.

Based on the identified water demands the below components have been considered for concept design and the cost assessment of a typical in-stream storage.

Proposed In-Stream Storage Ponds

The storage volume has to be provided by excavating below the natural ground surface to allow for surface flow current to enter the storage pond. The invert slope of the pond along the flow current can be considered as 1(V):20(H). The slope of the other earth walls can be assumed as 1(V):3(H). The pond can be created as in-stream storage along the watercourse flow path with

provisions for a spillway. The pond also can be excavated adjacent to the watercourse flow path as off-stream storage with flow channelled to the pond.

A 150mx150m pond with maximum depth of 5 meters provides 64000 kL of storage. Based on a daily evaporation rate of 5 mm and a water demand of 1000 kL/day, the stored water in such a pond would last for 60 days. Considering the frequency of the storm events such a pond provides an acceptable water supply source.

Lining

Stream storage pond should be lined to prevent leakage. Material such as Soil-Cement will provide a cheap and reliable liner for the stream storages.

Pump Stations

A pump station will be situated adjacent to each storage pond. It is proposed that centrifugal pumps with variable speed drives be considered. The capacity of the pump station should be calculated based on the daily volume of the water supply which should be provided from the storage ponds at each site.

Using surface water as a supplementary water supply option a 5L/s pump station with 2 pump (1 duty/ 1 stand by) is considered sufficient.

Using the storage ponds as the main water supply option, 4 pumps will need to be provided at each pump station and work as 3 duty/1 standby. To provide for the specified water demands, the required flow rate of the pump station is estimated to be 20 to 33 L/s. The pumped water will be stored in a 250 kL tank located at the camping area for equalisation purposes.

Pump stations will draw flow from the storage ponds via suction pipelines installed at the dam invert to maximise the drawdown volume. Each pump will have a dedicated 100mm suction pipe. The pumps will discharge into a 200mm common manifold and a pipeline with the same size which is attached to the main storage tanks located at the site.

Refer to drawings in Appendix 'C' for further details.

7.1.3 RIVER EXTRACTION

Nine major waterways have been identified along the rail line. Capture and delivery of water from those major water ways will require the below items.

River Extraction Pump Station

To provide a temporary river extraction inlet, a precast pump intake well will be located close to the river bed with the flow channelled to the well. The pump station will be located at the river banks as far as possible from the main flow path. The distance between the pumps and the wet well is limited to the pump suction head requirements.

One 200mm diameter suction pipe will be set up between the pump well and the pump station. The suction pipework will draw flow from the upper part of the well to provide enough sedimentation room inside the pump well. The suction pipe should be embedded across the river bed. Based on the temporary usage of the system a shallow backfill on the suction pipe will be enough. The suction pipe will be distributed to the pumps via 100mm connections.

4 pumps will be installed in the pump station to work as 3 duty/1 standby. The pumps will discharge into a common 200mm water delivery pipe. Water will be delivered and stored in a 250kL tank located at the site.

In some circumstances the pump station may not be able to be located outside of the river bank. In such a condition the pump station may be flooded and/or not be accessible, therefore, in this instance, a wet well submersible pump is recommended.

Flood harvesting

The flow quantities of the major waterways and the reliabilities were discussed in section 4.1 of the report. Provision of a storage pond next to the waterways and flood harvesting during the flood events would significantly increase the reliability of this water supply option. This option would require a high rate low head variable speed drive pump station to be constructed next to the river with capacity of pumping a large volume of water to the storage pond during the short duration of the flood event. Another pumping system will deliver the water to the main storage tanks at the site.

Due to the high costs for construction of the pump stations and the storage pond, flood harvesting will only be feasible, if the water demands cannot be supplied by any other option. Costs associated with flood harvesting are not included in the analysis provided in section 7.2 for river extraction.

Concept design drawings are provided in appendix 'C'.

7.1.4 STORAGE, TREATMENT AND DISTRIBUTION SYSTEMS

Water Treatment

For those supply points with earthwork water demands only, no treatment will be required.

Five water supply hydrants along the alignment have demands coming from construction camps and batching plants which will need treatment, as both potable water and concrete quality water should be provided.

The potable water demand is the smaller portion of the water requirement at the camp, and requires a very high level of treatment (UV disinfection etc.). Therefore, two separate treatment systems are proposed at each camp. A low capacity treatment plant can provide for potable water and another larger capacity treatment plant can provide for other water demands such as concrete mix, sanitary water and other water requirements in the camping areas.

Packaged water treatment plants can be used for both demand types. These treatment systems can be moved from one camp to another with progress of the project. A potable water treatment plant with 1 L/s capacity can provide for more than 400 people. Potable water will be piped to particular consumption points such as kitchen and showers. The potable water treatment plant will be feed from the main storage tanks and charge a 50 kL potable water tank.

A 1.5 L/s treatment plant can provide for all other water requirements in the camp including the concrete mix and camp yards.

Combined supply systems

For those supply points with existing water storage ponds or for those sites with scarce underground water resources, a part of the water demand can be provided from surface water to reduce the number of the boreholes. For these mixed source supply systems the pumped water from the boreholes can charge the water ponds to reduce the raw water storage requirement at the supply point.

System Reuse

After completion of the construction works at each segment of the rail line, some of the water supply components including the pumps, treatment plants, tanks, valves and a part of the pipe

work can be disassembled and reused in other site set ups. Those bores with no further use may have to be filled, or an agreement entered into with nearby landowners.

7.2 COST ANALYSIS

At this level of design the cost has been estimated with an accuracy of $\pm 40\%$. The cost estimate is primarily intended to support Hyder's recommendation of the preferred option and provide Adani with suitable cost to support the concept design to proceed to the next stage of the Project. This pricing is based on enquiries made with equipment suppliers and Hyder's previous experience on projects (BFS and SP1/SP2).

It should be noted that:

- Increased costs related to remoteness of the supply points and cost reductions related to size of the project has been allowed for in the unit prices.
- No allowance has been made in these estimates for treatment of the supplied water when being used for earthworks.
- This analysis only covers the capital costs associated with extraction, capture and delivery of the water to the supply point. Other costs related to distribution of water in the camping sites or delivery of the water from the supply point to the location of the earthwork has not been covered in this analysis.
- The costs associated with operation of the water supply system during the construction works are not covered.
- Some components of each water supply option including pump rooms, package water treatment plants, generators and storage tanks can be removed from each supply point and reused in other locations. The estimated value of recoverable assets has been provided in this cost analysis.
- There have been discussions with Adani regarding the possibilities of using aboveground pipes for delivery of water from the supply point to the hydrant. The costing tables provided in this report consider a site setup with embedded pipes in which the fees associated with embedding the proposed 100mm and 200mm HPDE pipes are \$20/m and \$25/m for pipes respectively. These indicative fees can easily be deducted when estimating the water supply costs for aboveground pipes.

Table 7.3 provides lump sum unit costs for each component of different water supply options. The unit costs provided in the Table have been used for site specific cost estimations in Appendix 'B' of the report.

Table 7.3: Unit costs for components of water supply system

Supply Method	Infrastructure	Unit Cost (\$)	Value of Recoverable Assets (\$)
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000
	Pump station for earthwork and camps including civil works, connections, valves, electrical and generator	60,000	45,000
	Pump station for earthwork including civil works, connections, valves, electrical and generator	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electrical and generator	30,000	25,000
	Tanker truck loading pipe stand	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0
	100mx100mx4m lined storage dam	300,000	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipework, installation hard stand and protecting shed including 20kVA generator	70,000	50,000
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipework, installation hard stand and protecting shed including 20kVA generator	20,000	15,000
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipework, installation hard stand and protecting shed including 20kVA generator	15,000	10,000

Supply Method	Infrastructure	Unit Cost (\$)	Value of Recoverable
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0
	Tanker truck loading pipe stand	15,000	5,000
River extraction	Intake structure	30,000	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipework, installation hard stand and protecting shed including 20kVA generator	70,000	50,000
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipework, installation hard stand and protecting shed including 20kVA generator	20,000	15,000
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electrical and borehole compound piping	150,000	30,000
	Lined Borehole and Pump to Depth 150m plus generator, electrical and borehole compound piping	120,000	25,000
	Lined Borehole and Pump to Depth 100m plus generator, electrical and borehole compound piping	90,000	20,000
	Lined Borehole and Pump to Depth 50m plus generator, electrical and borehole compound piping	70,000	15,000
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000
	Drinking water from Council	120,000	25,000

8 SITE RECONNAISSANCE - VERIFICATION OF DESKTOP STUDIES

A site flyover was conducted on the second of July 2013, via helicopter along the entire 306.9km alignment, to confirm; identified surface and groundwater options, key environmental and constructability constraints and current antecedent conditions.

Key outcomes of the site visit included the following:

- **Current dryness/wetness of catchment.** To the west of the great dividing range (chainage 80km-305km), Catchments were found to be wetter than average for July, indicating a wetter than average period. This is supported by the bureau of meteorology assessment of a higher than average Southern Oscillation Index for the current period. This may result in higher than average rainfall in this region for the next several years. This increase confidence in the use of surface water supply options in this area.
- **Rain shadow – chainage 80-45.** There exists an area within the Great Dividing Range that suffers from limited rainfall and was seen to be significantly drier than areas to the west and east. The limited rainfall and elevated topography indicates increased risk to reliabilities and yield for both surface water and groundwater supply options. Whilst water supply options have been identified for this area, this risk should be noted for hydrants N008-N011.
- **Verification of geological formation assessment.**
- **Verification of spatial locations of flora (endangered/protected)**
- **Existence of logged boreholes based on DNRM database.** A number of logged government boreholes taken from the provided database, were unable to be located, either abandoned or discontinued (for construction of roads etc.). This reduces confidence in available yields for existing bores, and emphasises the fact that to provide any comprehensive assessment of yields and reliabilities, site work including pump and yield tests are required at each of the proposed borefield sites.
- **Viability of existing in-stream storages** (catchment area, storage condition etc).

The above provides a general discussion for the entire route, however, particular findings for each hydrant is given in Section 10 of this report.

9 ENVIRONMENTAL ASSESSMENT

9.1 INTRODUCTION

Extraction of water from groundwater and surface water sources can have adverse impacts on stream flows and groundwater levels. This in turn can impact the flora and fauna that rely on the natural stream flow patterns and groundwater, as well as downstream users of the watercourses or groundwater systems which require a minimal flow to occur before they can extract water.

The potential environmental impacts of water extraction and the construction of infrastructure are discussed in this section of the report. The section does not cover the recharge time of aquifers, as a high-level estimate is included in the hydrogeology study in Section 4 and requires yield testing at each bore location for an accurate estimation to be made.

9.2 ENVIRONMENTAL CONSTRAINTS

Environmental constraints of the water sources examined previously in this report predominantly relate to the intended use of the water for construction activities. In general construction water is required of varying quantities and quality for:

- earthworks (raw);
- batching plants (AS 1379);
- construction depots (raw/potable);
- construction camps (potable/AS1379);
- maintenance yards (potable and raw).

In general the key environmental constraints highlighted via the desktop study were around vegetation types, land use (other water users), water quality (surface water and groundwater) in the footprint of the supply points. The Figure 9.1 illustrates environmental mapping layers available in the public domain (as outlined in Section 2.2.3) used to assist the identification of potential environmental impacts of water supply options.

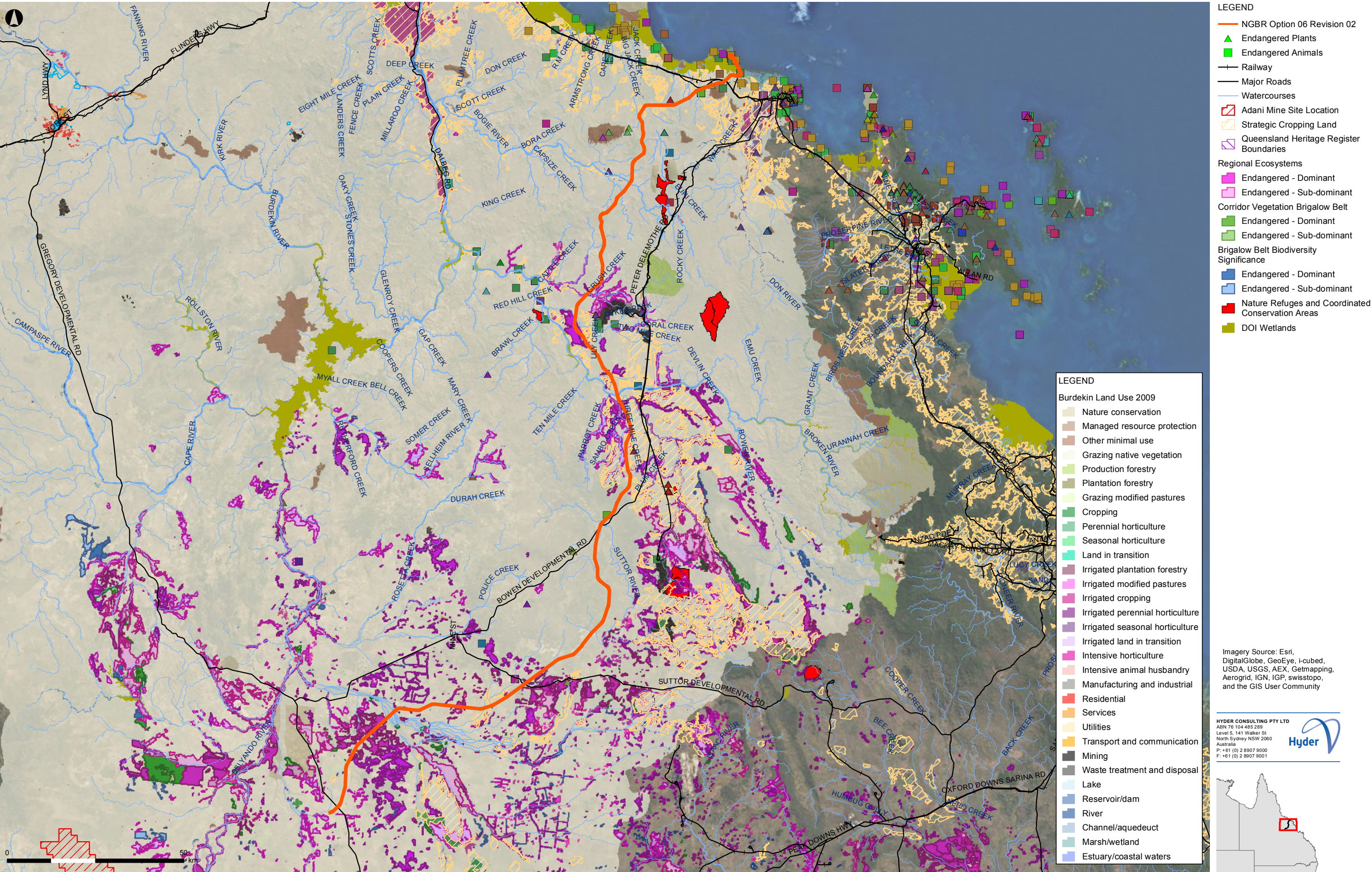


Figure 9.1: Environmental Constraints Along The NGBR Line

9.2.1 OVERVIEW OF IMPACTS

Previous investigations for similar projects have identified the following key possible impacts of water supply infrastructure for rail construction:

- Reduction in groundwater levels;
- Effects from harvesting surface water;
- Effects on vegetation and aquatic habitats.

The environmental assessment of water supply options predominately focuses on these key areas, ensuring that selected options minimise (where possible) the above impacts. Where possible, this assessment also gives consideration to potential impacts on other identified environmental values along the rail route, such as other water uses (irrigation, stock watering, farm use), geology, topography, land use.

This section provides a high level review of the likely environmental impacts associated with the proposed water supply infrastructure for construction of the proposed rail line. This is a desktop only assessment utilising available information as outlined above.

Effects on groundwater resources

There is currently no available detailed assessment or technical report on groundwater resources along the proposed rail alignment. It is assumed that this will be undertaken as a part of the project EIS and design development. A high level hydrogeological assessment was undertaken for the purposes of this report, based on a desktop study of available information related to a 20km buffer zone along the NGBR alignment (see Section 4 of this report).

Existing bores have been assessed through a desktop study of publicly available data to source information on availability of groundwater as a part of the water supply assessment. However this is preliminary in nature and provides minimal quantitative detail at this stage. Potential impacts on groundwater resources (hydrogeology) due to the construction and operation of water supply options for construction of the proposed rail line have also been assessed where possible, through this process. The objectives of the desktop study were to describe the existing hydrogeological environment, identify suitable volumes of groundwater and to determine what impacts the use of groundwater, for the construction and operation of water supply options, may have on groundwater resources. The groundwater assessment area is defined by a study area of a 10km radius buffer placed either side of the proposed route.

Previous rail environmental assessments for Adani have outlined that it is not likely that establishment of groundwater bores and abstraction of groundwater for construction purposes would result in a decrease in the local resource for other users. However to fully justify this would require consultation with landholders and appropriate testing in the field to ensure local resources are appropriately managed to minimise impact on other users.

It is not likely that water usage will rely solely on groundwater sources however many of the 34 water supply points outlined will focus on a primary source (or preliminary option) of groundwater from bores. Varying quantities of water are required at each of the supply points. Further groundwater development and exploration programs need to be progressed in order to identify and assess groundwater resources on a local and regional scale. This will help to determine if sufficient groundwater extraction can occur for the construction of the proposed rail line works, and so that short and long-term impacts based on groundwater use for water supply during construction can be fully quantified and appropriately managed. Various permits and licences will also be required via regulatory authorities. The process of applying for permits and licences will require more specific assessment of the quantity and quality of groundwater resources, and assessment of associated impacts to environmental values for the hydrogeological catchments of the study area.

It should be emphasised that the proposed locations of bores are indicative and actual bore locations may be within 1 to 3km of the location nominated based on a hydrogeological site.

Groundwater resources are likely to be most vulnerable to impact in the vicinity of major creeks/ rivers and other areas characterised by relatively shallow depths to groundwater. This has been taken into consideration during assessment of suitable locations for bores, and supply points have been located at a distance from major creeks and rivers where possible. It is expected however, that if drawdown occurs in the natural wet season recharge will occur and any potential impact to groundwater resources would be negligible at these locations.

Construction of water supply infrastructure such as bores, associated storages and pumping stations, has the potential to result in short-term, localised impacts on shallow groundwater, however no significant impacts on groundwater resources and groundwater quality are expected given the following:

- No long-term lowering of groundwater levels in alluvial and tertiary aquifers due to construction activities is anticipated due to the short-term nature of water use through construction (generally it is expected that these aquifers would recover within one or two wet seasons, i.e. 2 to 3 years);
- The majority of the rail alignment area does not contain well developed or extensive alluvial aquifers and is within a currently undeclared groundwater area (apart from the Bowen groundwater management area and the Highlands declared subartesian area). Groundwater is therefore not considered threatened or vulnerable as a resource;
- Outside of the main river corridors groundwater and surface water connectivity is thought to be limited.

The hydrogeological desktop study undertaken for this report has identified that there are potentially suitable aquifers to extract groundwater from depths of up to 250 m.

Environmental values to be protected in terms of hydrogeological impacts are:

- Groundwater Dependent Ecosystems (GDEs); and
- Current and potential users.

Mitigation of impacts to groundwater levels due to extraction of water include designing groundwater borefields with a focus on reducing potential impacts on any GDEs, and groundwater users. This is predominately achieved by allowing for a suitable distance between the abstraction bores and any known GDE sites or other user extraction points or sensitive environmental sites such as wetlands or watercourses. Bore locations need to take into consideration the expected cone of influence associated with the groundwater drawdown. Bore pumping times and desired flow rates also need to be managed to ensure that the aquifer, in particular confined aquifers, are not over utilised.

Based on the level of assessment and public information available around GDE's, there was no known GDE's identified near any of the water supply hydrants.

Further groundwater development and exploration programs need to be progressed in order to identify and assess groundwater resources on a local and regional scale, and to enable a more quantifiable assessment of potential associated impacts to environmental values due to proposed water supply options.

Effects from harvesting surface water

Surface water provides a water source from localised rainfall and water that enters the local area via in bank, over bank and overland flow from the greater upstream catchments. In bank flow is flow within the stream channel, whilst over bank flow is when the stream is in flood and breaks its banks. Overland flow is any water flowing over the ground surface.

Parts of the initial rail route are within an un-supplemented area of the Burdekin Basin, meaning the security of supply from surface water sources is lowered. The sources of surface water available along the route are made up of flowing and ephemeral waterways, offline storages filled from watercourses, inline storages and overland flow collection dams, however a majority of the creeks and rivers within the study area are ephemeral or drainage lines that only run with a sustainable amount of flow in the wet months.

The 7 major waterways assessed in terms of providing a potential source for water supply are Elliot River, Bogie River, Sandy Creek, Strathmore Creek, Pelican Creek, Bowen River, Suttor River (9 major crossings). Flow statistics for these waterways are provided in Section 4.4.1 Catchment Description and have informed the location of supply points. A number of the supply points (Section 10) outlined overland flow harvesting as a viable option for supplementing water supply for the construction phase of the rail.

Department of Natural Resources and Mines (DNRM) defines overland flow as “water that runs across the land after rainfall, either before it enters a watercourse, after it leaves a watercourse as floodwater, or after it rises to the surface naturally from the underground”. However due to the geology and topography of the proposed route, a number of ephemeral drainage lines may or may not be defined as waterways, resulting in the potential for inconsistent definition of overland flow versus in-stream storages. It is recommended that unless a clearly defined waterway (waterway on GIS layer or waterway name provided) the ephemeral drainage lines be defined on a case by case basis via liaison with DNRM. This will clearly help define in-stream extraction versus overland flow.

DNRM outlines that under the Water Act any activity capturing overland flow water requires a plan to manage the take and harvesting of that water, to ensure a balance between environmental flow needs and long-term water security for water users. The type of plan required to manage this activity depends on the volume of water taken, the purpose and nature of the works and the relevant WRP in the area of the works. Works that would increase the amount of water taken from, or interfere with overland flow, cannot commence without approval from DEWS in areas where WRPs or moratoriums are in place.

As most of the water that enters waterways and underground reserves originates as overland flow, there are implications if too much water or floodwater is intercepted before it reaches or returns to a watercourse. With this in mind, overland flow harvesting has the potential to impact on downstream townships, industries and farmlands that rely on watercourses for their water supply, landholders who rely on flood events to source water, maintenance of healthy waterways, and recharge of groundwater and ecosystems that rely on periodic inundation with water (DEHP website).

Environmental assessment of the proposed rail will need to discuss the potential impacts of the construction and operation of the rail in terms of adverse effects on the nominated surface water environmental values in detail (project EIS). These will likely be predominantly around stock watering and farm use. Assessments should take into consideration catchments, beds, banks and water columns associated with all waterways crossed by the proposed rail line. Generally it is not expected that the construction phase of the rail will adversely impact on water quantity or quality associated with stock watering and farm use due to its temporary nature. However depending on volumes required at varying locations, construction water supply sourced from harvesting surface water may have localised impacts, specifically dependent on seasonal availability of water.

The NGBR alignment lies in the central-eastern segment of the Burdekin Basin. Overland flow harvesting needs to be planned and managed in accordance with the Water Resource (Burdekin Basin) Plan 2007 (WRP).

The objectives of the Burdekin Basin WRP are as follows:

- to define the availability of water in the plan area;
- to provide a framework for sustainably managing water and the taking of water;
- to identify priorities and mechanisms for dealing with future water requirements;
- to provide a framework for establishing water allocations;
- to provide a framework for reversing, where practicable, degradation that has occurred in natural ecosystems; and
- to regulate the taking of overland flow water.

The Burdekin Basin WRP has defined specific environmental values within the connected surface water system that makes up the Basin. These values are associated with the hydrologic characteristics (low, high and medium flows, velocities, flood extents etc.) of the systems streams which affect both terrestrial and aquatic flora and fauna. These values have been quantified by the basin's Technical Advisory Panel (TAP) with a set of Environmental Flow Objectives (EFOs). Overland flow harvesting and waterway extraction have been proposed as supplementary water supply options for many of the supply points. At relevant supply points, this option will need to be developed in accordance with the EFOs for the Burdekin Basin as outlined in the WRP, however due to the short term nature of use, and the small amounts, the impact to EFOs will likely be minimal.

It is anticipated that impacts to surface water environmental values based on water supply options for the construction phase are likely to be negligible, given they are temporary, and will be minor in comparison to effects of the overall construction and operation of the rail line.

A thorough analysis of the flood regime at each supply point will be required in order to optimise the overland flow harvesting in terms of yield and in terms of minimising impact to EFO's. Monitoring of surrounding waterways should be undertaken prior to and during construction activities where overland flow is being harvested. This will enable adequate management of capture in order to minimise impact to waterways and aquatic ecosystems in terms of EFO's.

The proposed infrastructure required to capture overland flow incorporates construction of below ground lined dams with the excess excavated material being utilised to construct horseshoe shaped above ground embankments to direct overland flow to a storage area. Construction of dams could have temporary impacts to groundwater, dependent on the depth to groundwater tables.

It is anticipated that hydrants and associated infrastructure will be located within the nominally 100m wide final rail corridor (which will be approved for construction works as an outcome of the project EIS). However, water source or supply points are in some instances located outside of the 100m rail corridor and associated supply infrastructure such as pipelines will also be outside of this corridor in some areas. Therefore in some instances the hydrant footprint covers a greater area than can be incorporated inside the 100m rail corridor. Impacts to the surrounding ecosystem due to construction of required infrastructure need to be carefully managed in accordance with a site specific Environmental Management Plan (EMP). This would include ensuring infrastructure is constructed outside of sensitive ecological areas and waterways, and managing construction activities to minimise required clearing. Where infrastructure is required outside of the 100m corridor, additional permits and approvals may be required.

It should be emphasised that the proposed locations of supply points shown in Figure 5.14, Appendix D, and Tables 4.18 and 3.7 are indicative and actual locations of infrastructure may vary following further assessment.

Effects on vegetation and waterways

As a result of the use of raw and potable water during the construction of the rail line, there is the potential for impacts to surrounding vegetation and aquatic habitats due to the varying quality of water. Both raw and potable water is required at varying supply points along the rail corridor. Potable water is not of concern in terms of effects of any runoff on vegetation and aquatic habitats, however the use of raw water, particularly from groundwater sources, could potentially affect surrounding sensitive vegetation and could also have potential impacts on the water quality of any nearby waterways due to any increased runoff volumes from the construction site. Methodologies for raw water use during construction should limit runoff and be controlled so as to avoid impacts to surrounding vegetation and aquatic habitats.

Pumping tests undertaken to verify the yield of a drilled groundwater bore, should also capture water quality data for each groundwater source. The groundwater is likely to be saline and a suite of groundwater testing should be undertaken so that the key parameters can be assessed during and after drilling of the bores. Should the groundwater quality not be satisfactory, then appropriate treatment shall be developed to meet the requirements of the water supply point. This will help avoid unnecessary impacts to the surrounding ecosystem (e.g due to runoff on sensitive vegetation or runoff entering waterways).

As a result of construction of water supply infrastructure, there may be impacts to vegetation in terms of clearing requirements, and construction methodologies for access tracks, storage dams, boreholes and associated water supply infrastructure required for construction. Whilst no specific assessment is being undertaken in terms of conducting ecological assessments at and around supply point locations with the rail corridor, assessments being undertaken for the project EIS can better inform the management of construction impacts due to water supply options. An initial site assessment was undertaken by an ecologist for the EIS, to inform detailed ecological assessments along the rail route. Outcomes of the initial assessment highlighted areas for additional field work specific to properties along the rail route, but were not specific to hydrant footprints. It is recommended that an ecologist ground-truth each hydrant footprint prior to commencement of construction .

The desktop assessment included mapping of Regional Ecosystems and Regrowth Vegetation. Two hydrant footprints were found to include remnant vegetation (Endangered –Dominant), containing at least one endangered Regional Ecosystem (HYD-025 and HYD-030, See section 10 for further discussion).

The clearing of native vegetation in Queensland is regulated by the *Vegetation Management Act 1999*. This Act regulates clearing of remnant vegetation on a regional ecosystem and remnant map on freehold and Indigenous land and state tenures. Queensland has a vegetation management framework which also regulates the clearing of certain regrowth vegetation and its high biodiversity values. Clearing permits will need to be obtained for the purposes of constructing the NGBR. These clearing permits should include for clearing of vegetation associated with water supply options. Where the hydrant footprint is outside the 100m corridor incorporated within the EIS for construction of the rail line, further permits may be required. Vegetation clearing permits can take between 3 to 5 months to obtain.

There are large areas of Brigalow belt that is identified by the Brigalow Belt Biodiversity Significance mapping V1.3 along the rail route which will require consideration in terms of location and construction of water supply points.

The clearing of remnant Brigalow is prohibited in Queensland. The clearing of regrowth Brigalow must be addressed in a vegetation clearing application in accordance with the *Vegetation Management Act 1999*, and assessment against the relevant performance requirements stipulated in Part S of the Regional Vegetation Management Code for Brigalow Belt and New England Tableland Bioregions (Version 2) (DERM 2009) would be required. Furthermore, it is

acknowledged that the Brigalow ecological community is listed as a threatened (endangered) ecological community under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). An activity that could have a significant impact on regrowth Brigalow ecological community needs to be referred to the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (SEWPaC). As a part of the EIS process, an EPBC Referral has already been submitted and the project declared a controlled action (EPBC 2013/6885).

An EPBC Act Protected Matters search was undertaken for all hydrant footprints. The EPBC searches were run using a buffer of the footprint ranging from about 0.2km to 2.5km. The reports outlining the results of these searches are included in Volume 2 to this report, and results at each hydrant location are included in section 10. Note that searches were not undertaken for HYD-N001, HYD-N002 and HYD-N003 as there are no footprints at these locations.

Searches using Wildlife Online were undertaken using a minimum buffer of 1km around the hydrant footprints. Results of these searches are also included in Volume 2 to this report.

Extensive clearing of vegetation can cause increased erosion and sedimentation issues, particularly across floodplains and sensitive geological environments. Increases to sediment loads in runoff can impact on the water quality values of associated waterways, and in turn can impact on sensitive aquatic ecosystems.

There is also the potential to uncover areas of acid sulfate soils (ASS) given the requirement to work within and around water logged areas to construct water supply infrastructure. ASS are naturally occurring soils, sediments or organic substrates, formed under waterlogged conditions. Iron sulfide minerals contained in the soils react with oxygen when the soils are exposed (due to drainage or disturbance), forming sulfuric acid. Release of sulfuric acid can in turn release iron, aluminium and other heavy metals. Once this acid and metals are mobilised they can impact vegetation, surface and groundwater and even structures. ASS are more commonly found near the coastline, less than 5m above sea level. They can also be associated with freshwater wetlands and saline, sulfate-rich groundwater in some agricultural areas. Hydrant footprints associated with HYD-N007, HYD-N008 and HYD-N016 overlay river systems and therefore are considered to have a high probability of ASS, confirmed through desktop assessment. The proposed area for HYD-N001 and HYD-N002 are also on soil of high ASS probability, however no construction is planned in this area. All other hydrant footprints are considered to have an ASS probability of low or extremely low. Associated impacts as a result of construction of water supply infrastructure should be managed in accordance with a site specific EMP, implemented throughout the construction phase of the project. This would include locating infrastructure away from sensitive ecological areas and waterways, and managing construction activities to minimise required clearing.

Supply points have been located, where possible, in consideration of existing and established access tracks and existing cleared areas. Although many of the supply points are adjacent to or within highly vegetated areas, they have been situated so as to avoid any additional clearing, and are all within the rail corridor (some of the storage dams may be outside this corridor and will be subject to further consideration and assessment when most viable locations are finalised). Once the rail haul road is constructed then access to supply point areas will allow for entry for refuelling of generators, and enable water tanker access to transport water along the rail construction path. Supply points have also been located away from major waterways where possible.

Other impacts

Effects on fauna values: Construction and operation of water supply infrastructure has the potential to impact on fauna in the vicinity, however with adequate monitoring and management

planning prior to construction, impacts should be avoided. This assessment does not quantify impacts to fauna values of the rail corridor or supply locations, however a variety of wildlife was observed on the flyover:

- Emu (*Dromaius novaehollandiae*)
- Red kangaroo (*Macropus rufus*)
- Eastern Grey kangaroo (*Macropus giganteus*)
- Pink breasted cockatoo (*Lophochroa leadbeateri*)
- Red-tailed Black cockatoo (*Calyptorhynchus banksii*)
- Dingo (*Canis lupus dingo*)
- Brahminy kite (*Haliastur indus*)
- Pelican (*Pelecanus onocrotalus*)
- Pheasant – unknown species type

EPBC searches also outlined where species of significance may occur within and around hydrant footprints.

Effects on heritage values: Construction of water supply infrastructure has the potential to impact on heritage values in the vicinity (most specifically Aboriginal heritage items of significance) however adequate management methodologies can be put in place prior to construction to ensure all construction staff are aware of the correct procedure should items of significance be uncovered. Further investigation of possible sites of significance should be undertaken to inform final locations of infrastructure and construction methodologies. Where hydrant occur outside the nominal 100m corridor as assessed within the EIS, further consideration and assessment of heritage matters should be undertaken.

Discussion of environmental considerations and management measures to reduce and avoid impacts as outlined above, specific to each individual water supply hydrant is provided in Section 10.

10 WATER SUPPLY

10.1 INTRODUCTION

Based on the water demands for construction of the NGBR Project, 34 water supply hydrants are required. These hydrants will be sourced from either ground or surface water, and extracted via a number of different supply systems discussed in Section 7 of this report.

Based on the desktop studies (surface, ground, environmental, regulatory, cost) and site flyover, a primary, supplementary or alternative water supply option has been chosen for each hydrant.

For referencing purposes, Table 3.7 provides a summary of hydrant numbers, locations and the quality and quantity of water demands.

The footprint areas, and their justification, for the water infrastructure for each of the hydrants, including a short description of what each foot print contains, are presented in Appendix E.

10.1.1 DISCUSSION

Water Supply Hydrants

The hydrants have been divided up via 10km segments of alignment. It has been assumed that the best location to provide water supply is at the middle of each 10km segment, or nearest to the water supply if storages are used. However, based on the availability of the water supplies (and cost to transport) for some of the segments additional water supply points have been proposed.

Where available, groundwater (borefield) has been chosen as the main water supply option for each water supply hydrant. This preference is based upon the reliability and water quality of groundwater as a permanent water source during all seasonal conditions. A maximum number of six boreholes (additional bores were seen to increase costs significantly due to increased pipe lengths and pumping heads) has been proposed for each site.

For some of the water supply hydrants, six boreholes cannot provide the specified water requirements and as such surface water sources have been proposed as supplementary water supply.

Where there is limited confidence in the groundwater yields from existing information, providing the water supply hydrants requirements, an alternative option of surface water has been provided.

The available water supply and groundwater options for each site are summarised in the tables found in Section 4 – Table 2.18 and Appendix D (surface water). A number of assumptions and caveats that support the above tables and the water supply options selection process and are given below:

Surface water

- The surface water sources available along the rail line are located for every 10km segment of the rail line.
- The surface water table (Appendix D) table shows the available surface water sources for each supply point. However, assigning a surface water supply option to a point does not necessarily indicate that the surface water option can cover all the demands at that point. The adequacy of water supply options is discussed for each hydrant site in the rest of this section.

- As shown in the surface water table (Appendix D) in the table, many existing storage ponds are available along the rail line. However, the majority of those existing ponds do not have enough capacity and/or inflow to provide a reliable water supply for all the specified water demand at each site. Furthermore, the existing storage ponds have to be used inside the property boundary in which they are located.
- Where no suitable existing ponds are available, new ponds are proposed to be constructed. These new ponds are located with consideration given to both minimising the distance from the proposed pond to the water supply point at the centre of the site and the adequacy of the inflow to the pond.
- For the existing ponds both their distance to the supply point and to the closest chainage of the rail is identified. Based on these distances, the proposed hydrant should be moved accordingly, so that by shifting of the water supply points from their presumed locations to a chainage closer to the existing ponds the costs and environmental impacts associated with the transfer of the sourced water will be reduced.
- The location of both existing and proposed storage ponds are identified by their Easting and Northing. However, the coordinates provided in the surface water table (Appendix D) table have been extracted from Google Earth, and were verified on site, to be within - +300m. Due to this inaccuracy is recommended that detailed survey at the hydrant points be completed before any detailed design is completed. and contain inaccuracy.

Groundwater

- The discharge and duty cycle considered for the bores at each supply point is based on desktop studies only and still needs to be verified on site by sinking test bores.
- The number of the boreholes is estimated based on the average daily water demand information received for each supply points. The peak instantaneous demand will be provided by storage measures at each supply point as explained in section 6 of the report.

The proposed options for each water supply point have been discussed in the rest of this section, and include discussions on source, preferred supply options, regulatory requirements, environmental constraints (primary only), cost and design components.

10.2 SUPPLY POINT HYD-N001

HYD-N001 is located at chainage -5km of the rail line. Abbot Point Road traverses it and provides access. An average daily water demand of 996kL has been estimated. Refer to Figure 10.1.

Water Quality	Raw Water	Chainage (km)	-5
Average Daily Demand(kL)	996	Duration(days)	109

10.2.1 MAIN OPTION

Source

An existing 560ML storage pond (shown in the above photo) is located next to the rail loop at Abbots Point Coal Terminal. Sourcing the water required at this site from this storage pond has been arranged by Adani. The other users of the storage pond are unknown and as such reliability of this source cannot be clearly defined. However, based on the large volume of the pond, it is anticipated that except for very dry conditions this pond can be used as a reliable water source.

Regulatory Requirements

- Existing storage - no regulatory requirements
- Extraction infrastructure maybe required if nothing exists, will require DA approval etc.

Water supply components

It is assumed that the storage pond is already equipped with pumps and a tanker truck loading stand pipe. Water can be trucked directly from the pond to the location of the earthwork along the rail line. Therefore, set up of the raw water storage tanks at the site will not be required.

No additional water supply infrastructure is required for this water supply option

Estimated Capital Cost

No major capital expenditure for this option

10.2.2 ALTERNATIVE OPTION

Source

If sourcing part or all of the required water demands from the primary water supply option is not possible, groundwater can be used as an alternative water supply option for this hydrant. The hydrant is located on a rich alluvium aquifer, and It is expected that each borehole will yield 4L/s, with four boreholes providing the required water demand

The bores can be sunk close to the water supply point at chainage -5km within the construction easement. The suitable aquifers are located at 20-50m depths. The Abbots Point Road can be used for truck access to the location of the bores. Each bore should be piped to the raw water tanks located at the supply point.

Regulatory Requirements

4 new Bores

- water permit- exploratory (2-3months)

- consent of chief executive- 4 new bores (2 weeks)
- development permit- 4 new bores (2 months)
- site works and testing (2 months)
- water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option would be as follows:

- 4 lined boreholes with pump to maximum depth of 50m and dedicated 5kVA generators.
- 600m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for tanker truck loading.

Estimated Capital Cost

- At the location of hydrant: \$120,000
- For the borefield: \$310,000
- Recoverable assets: \$147,000

10.2.3 ENVIRONMENTAL CONSIDERATIONS

HYD-N001 is within an extremely sensitive wetland and marine environment, however the desktop assessment indicated no key environmental considerations at this location apart from the potential for acid sulphate soils. The existing storage pond location is accessible. As it is proposed to truck water from this location to the hydrant, there should be minimal impact to the surrounding environment outside of the effects of additional truck movements to and from the site (exhaust, carbon emissions, noise). Avoidance and minimisation of additional infrastructure at the supply location is essential. If bores adjacent to the hydrant are necessary, a detailed assessment of impacts should be undertaken and management plans developed.

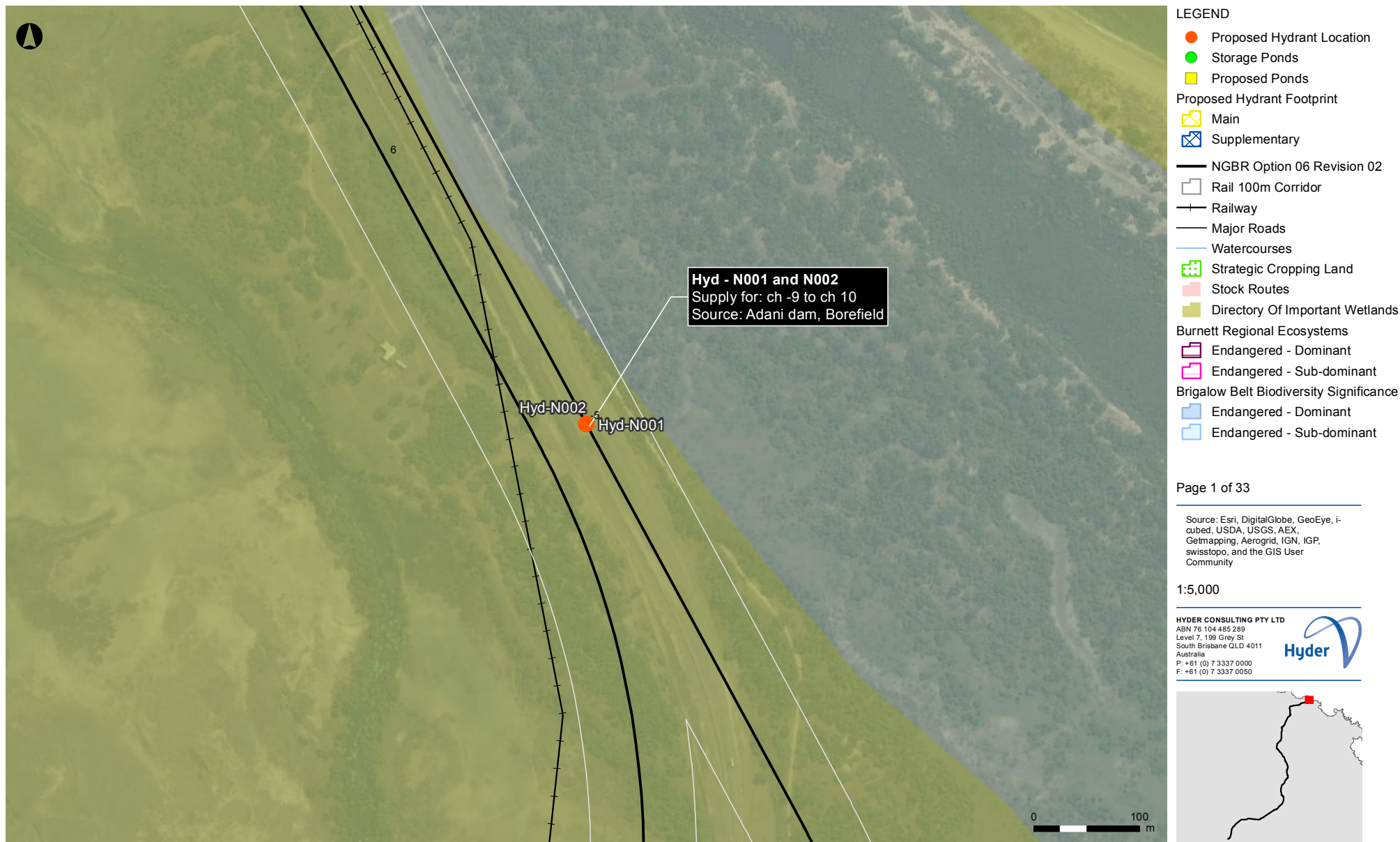


Figure 10.1: NGBR Water Hydrant Hyd-N001, Hyd-N002, Proposed Hydrant Footprint and Environmental Constraints

10.3 SUPPLY POINT HYD-N002

HYD-N002 is located at chainage 5km, adjacent to Abbot Point Road on the rail loop opposite to the HYD-N001. An average daily demand of 996kL has been estimated. Refer to Figure 10.1.

Water Quality	Raw Water	Chainage (km)	5
Average Daily Demand(kL)	996	Duration(days)	42

10.3.1 MAIN OPTION

Source

The same existing 560ML storage pond utilised for HYD-N001 can be used as the water supply source for this site. However, simultaneous commencement of the construction work at both sites HYD-N001 and HYD-N002 with double the project demand from the storage pond. The increase of project demand along with likely other users of the pond will increase the risk of inadequacy of this water supply.

Regulatory Requirements

- Existing storage - no regulatory requirements
- Extraction infrastructure maybe required if nothing exists which will require DA approval etc.

Water supply components

No water supply infra-structure is expected to be required for this water source.

Estimated Capital Cost

No major capital expenditure for this option

10.3.2 ALTERNATIVE OPTION

Source

This hydrant is located on the rail loop at Abbot Point opposite to HYD- N001 at chainage - 5km. Boreholes from this hydrant may be utilised if work is carried out during different time periods.

Regulatory Requirements

5 new Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 4 new bores (2 weeks)
- development permit- 4 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option would be as follows:

- Use the boreholes sunk for chainage -5km.

Estimated Capital Cost

Use the borefield for HYD-N001

10.3.3 ENVIRONMENTAL CONSIDERATIONS

HYD-N001 is within an extremely sensitive wetland and marine environment, however the desktop assessment indicated no key environmental considerations at this location apart from the potential for acid sulphate soils. The existing storage pond location is accessible. As it is proposed to truck water from this location to the hydrant, there should be minimal impact to the surrounding environment outside of the effects of additional truck movements to and from the site (exhaust, carbon emissions, noise). Avoidance and minimisation of additional infrastructure at the supply location is essential. If bores adjacent to the hydrant are necessary, a detailed assessment of impacts should be undertaken and management plans developed.

10.4 SUPPLY POINT HYD-N003

HYD-N003 is located at chainage 15km, a kilometre to the south of Bruce Highway and is accessible via an existing dirt road. This hydrant will supply one of five rail line construction camps. Therefore, both raw water for earthwork and treated water for the camp will be needed. An average daily demand of 1003kL has been estimated for this hydrant of which 112kL is treated water for the camp. Refer to Figure 10.2.

Water Quality	Raw water for Earthworks, Treated water for the camp	Chainage (km)	15
Average Daily Demand(kL)	1002kL from which 890kL will be for Earthwork	Duration(days)	171 days for earthwork 730 days for the camp

10.4.1 MAIN OPTION

Source

The existing 560ML storage pond located at the Abbot Point Coal Terminal site can be used to supply for this Hydrant. However, this pond should not be relied upon as the only water source for HYD-N001 to HYD-N003 in case construction work occurs simultaneously at these three hydrants.

The required water for the camp including drinking, yards and batching plant can be purchased from Whitsunday Regional Council. The Council provides drinking quality water at Merinda Standpipe which can be trucked to the camp via Sealed Road, Abbot Point access road and Bruce Highway.

Regulatory Requirements

- Existing storage - no regulatory requirements
- Extraction infrastructure maybe required if nothing exists which will require DA approval etc

Water Supply Components

In case the existing pond is going to be used for this site, placement of no water supply infrastructure will be required.

If the camp's water is going to be purchased from Whitsunday Regional Council, separation of the drinking water and concrete mix water will not be necessary with no treatment component at the hydrant. Concrete mix water can be trucked directly to the batching plant during the working shift and the camp water stored in a 50kL tank within the camp for 24/7 usage, and be pumped to the site reticulation system.

The infrastructure required for this option would be as follows:

- A small 10kL water storage tank at the location of the batching plant.
- A 50kL drinking water tank
- A 5L/s pump station to supply for instantaneous peak demand water demand at camp
- Site internal water reticulation

Estimated Capital Cost

No major capital expenditure for this option

10.4.2 ALTERNATIVE OPTION

Source

To reduce the dependency of the project on the water from the existing 560kL pond, groundwater supplies can be used as a replacement or supplementary water source for this water supply hydrant. The site is located on a rich alluvium aquifer, and each borehole is expected to yield 4L/s, with four boreholes providing the required water.

The hydrogeological desktop study has identified that there are potentially suitable aquifers in the area at 20-50m depth.

Regulatory Requirements

Potable purchase of water at \$5/KL from the Whitsundays Regional Council

Water Supply Components

The infrastructure required for this option would be as follows:

- 4 lined borehole with pump to maximum depth of 50m and dedicated 5kVA generators.
- 600m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.
- Separate 50kL storage tanks for drinking water and other camp water demands
- Separate treatment plant and distribution system for concrete mix and yards water and potable water.

Estimated Capital Cost

- At the location of hydrant: \$155,000
- For the borefield: \$390,000
- Recoverable assets: \$187,000

10.4.3 ENVIRONMENTAL CONSIDERATIONS

There is minimal vegetation at HYD-N003. Use of existing access to this hydrant will minimise the need for further clearing. The desktop review identified no environmental constraints based on available data within or surrounding the hydrant footprint. As the main supply option entails trucking in water from other supply points, minimal impact to the environment based on water supply is anticipated. If boreholes are required as an alternative, careful siting to avoid vegetation in surrounding areas is required. Impacts to the alluvium aquifer should be quantified based on yields if boreholes are required.

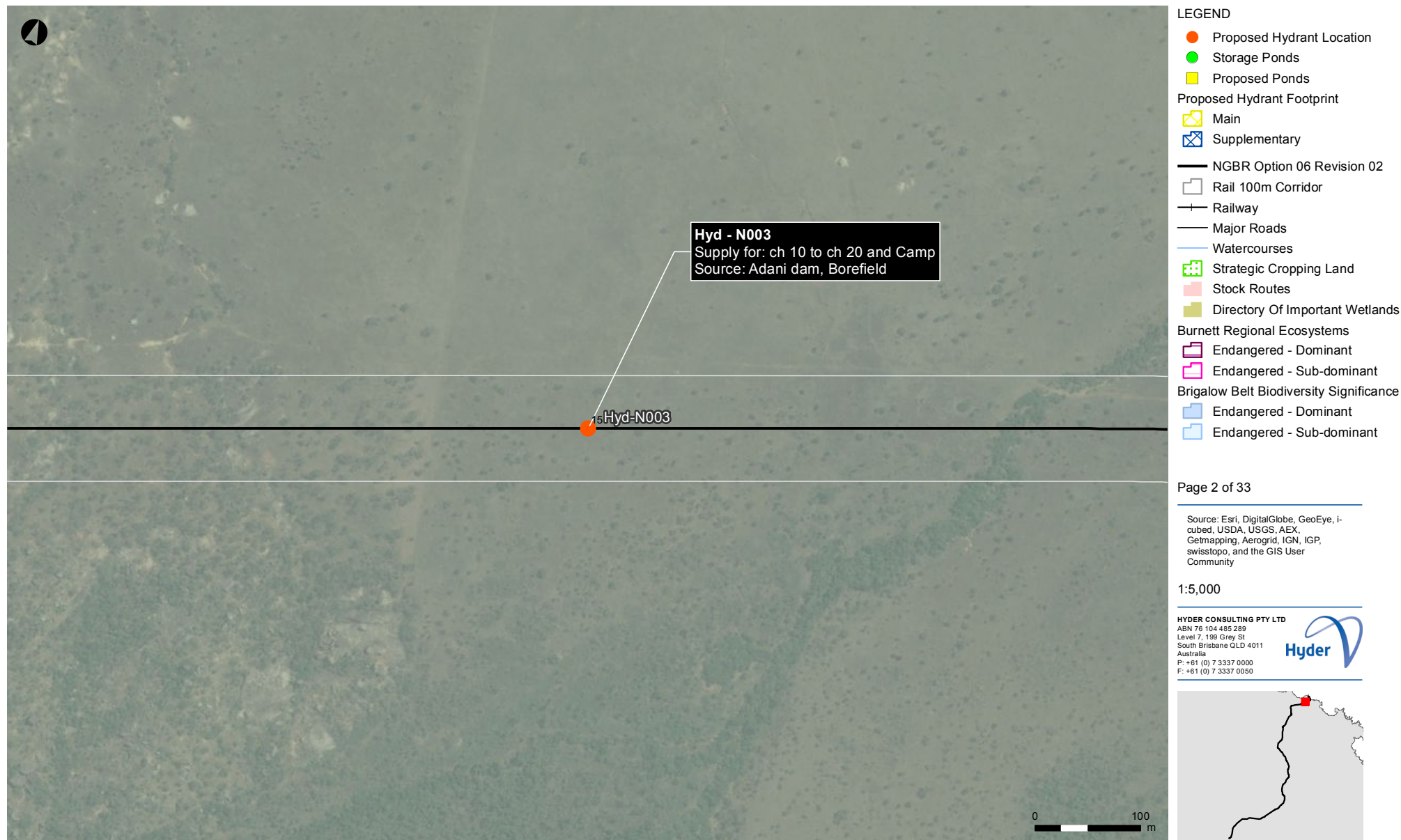


Figure 10.2: NGBR Water Hydrant Hyd-N003, Proposed Hydrant Footprint and Environmental Constraints

10.5 SUPPLY POINT HYD-N004

HYD-N004 is located at chainage 25km, 6.5km off the Bruce Highway and is accessible via an existing dirt road. An average daily demand of 903kL has been estimated. Refer to Figure 10.3.

Water Quality	Raw Water	Chainage (km)	25
Average Daily Demand(kL)	903	Duration(days)	86

10.5.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply all of the water demands for this water supply hydrant. The site is located on a relatively rich alluvium aquifer, with an expected borehole yield of 3.5 L/s, with four boreholes providing the required water. The bores can be sunk close to the site within the rail construction easement, and at a depth of 20-100m (where a suitable aquifer is located). The area is vegetated however it is likely that minimal additional clearing will be required for the boreholes if they are located within the construction easement.

Regulatory Requirements

4 new Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 4 new bores (2 weeks)
- development permit- 4 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 4 lined borehole with pump to maximum depth of 100m and dedicated 8kVA generators.
- 600m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At the location of hydrant: \$165,000
- For the borefield: \$310,000
- Recoverable assets: \$175,000

10.5.2 SUPPLEMENTARY OPTION

No supplementary option is required for this option, based on nearby yields from existing bores.

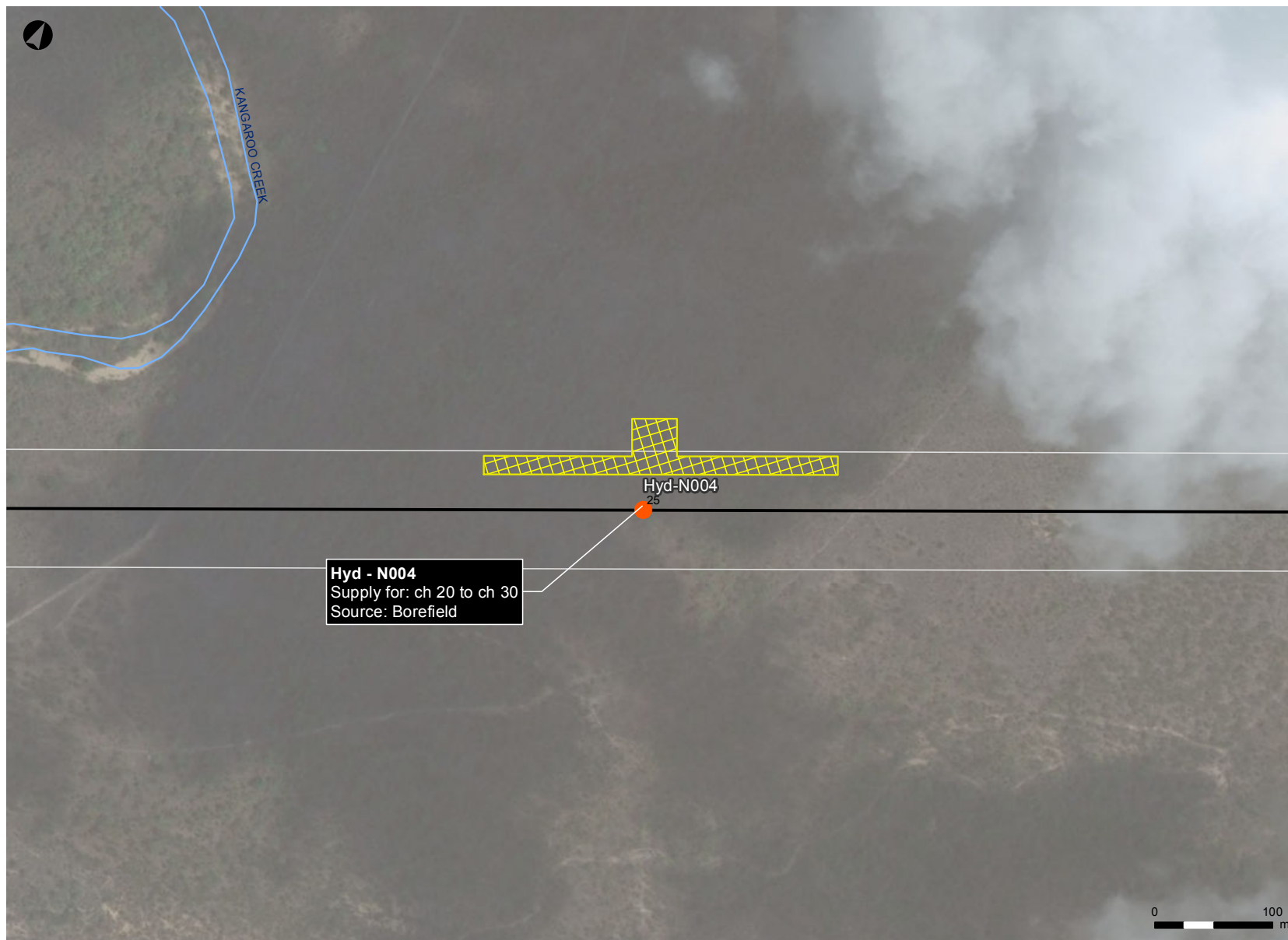
10.5.3 ENVIRONMENTAL CONSIDERATIONS

There is an existing dirt road to HYD-N004, minimising the need for further clearing for access purposes. This hydrant is located within the Don Basin/ Don River sub-basin, however the desktop assessment identified no key environmental considerations within the hydrant footprint based on available data. The area is vegetated; however, minimal additional clearing would be required for the boreholes if they are located within the construction easement.

The EPBC search tool outlined that within a 200m buffer of the hydrant footprint there are 12 listed threatened species or species habitat likely to/may occur within the area. One of these is listed as critically endangered (Bare-rumped Sheath-tail Bat) and 4 are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, Siah's Backbone).

14 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is a creek system (Kangaroo Creek) approximately 400 m to the west of this location. Erosion and sediment control during construction of bores will be required to minimise runoff to the creek.



LEGEND

- Proposed Hydrant Location
- Storage Ponds
- Proposed Ponds
- Proposed Hydrant Footprint
 - Main
 - Supplementary
- NGBR Option 06 Revision 02
- Rail 100m Corridor
- Railway
- Major Roads
- Watercourses
- Strategic Cropping Land
- Stock Routes
- Directory Of Important Wetlands
- Burnett Regional Ecosystems
 - Endangered - Dominant
 - Endangered - Sub-dominant
- Brigalow Belt Biodiversity Significance
 - Endangered - Dominant
 - Endangered - Sub-dominant

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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

1:5,000

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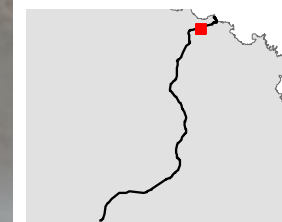


Figure 10.3: NGBR Water Hydrant Hyd-N004, Proposed Hydrant Footprint and Environmental Constraints

10.6 SUPPLY POINT HYD-N005

HYD-N005 is located at chainage 35km in Guthalungra, 12km to the south of Bruce Highway and is accessible via Glenore Road which is an established dirt road branching from the highway. An average daily demand of 785kL has been estimated. Refer to Figure 10.4.

Water Quality	Raw Water	Chainage (km)	35
Average Daily Demand(kL)	785	Duration(days)	96

10.6.1 MAIN OPTION

Source

It is anticipated that boreholes can provide the total amount of water required at this hydrant. If the estimated yield of 2L/s per bore is not met, an existing storage pond located close to the site can be used as supplementary source. Up to six, 150m deep boreholes should be sunk close to the site within the rail construction easement. The area is vegetated however minimal additional clearing will be required for the boreholes if they are located within the construction easement.

Regulatory Requirements

6 new Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 150m and dedicated 8kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At the location of hydrant: \$125,000
- For the borefield: \$780,000
- Recoverable assets: \$235,000

10.6.2 SUPPLEMENTARY OPTION

Source

Surface water stored in a 30ML existing pond (Pond 3) is located 1.9km from the hydrant and can be utilised as a supplementary water source. This will involve construction of a small pump station with 5L/s pumping capacity next to the storage pond and 2km of embedded 100mm HPDE pipeline from the pump station to the hydrant.

As an alternative, water can be loaded from the pond into the trucks and delivered directly to the rail line construction area for the earthwork.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- water permit for temporary use (2-3 months)
- development permit for any new infrastructure required (2-3 months)

Water Supply Components

The additional components operating for extraction and delivery of water from this supplementary water source to the raw water tanks are as follows:

- Pumping and generator facility located next to the existing pond with 5L/s pumping rate
- 100mm diameter embedded HPDE pipe with 2km length

10.6.3 ENVIRONMENTAL CONSIDERATIONS

The terrain at HYD-N005 is relatively flat and vegetation is scattered. Access via Glenmore Road (established dirt road off the highway) will avoid further clearing. The area around the hydrant is vegetated; however, minimal additional clearing would be required for the boreholes if they are located within the construction easement.

The EPBC search outlined within a 300m buffer of the hydrant footprint 11 listed threatened species or species habitat likely to/may occur within the area. One of these is listed as critically endangered (Bare-rumped Sheath-tail Bat) and 4 are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, Siah's Backbone).

14 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

The hydrant is located directly adjacent to a creek system/drainage line, including vegetated areas. If the supplementary option is required, careful consideration should be given to the location and construction of infrastructure as the existing pond is 1.9km away, outside of the 100m rail corridor. Erosion and sediment control during construction of bores and infrastructure will be required to minimise runoff to the creek.

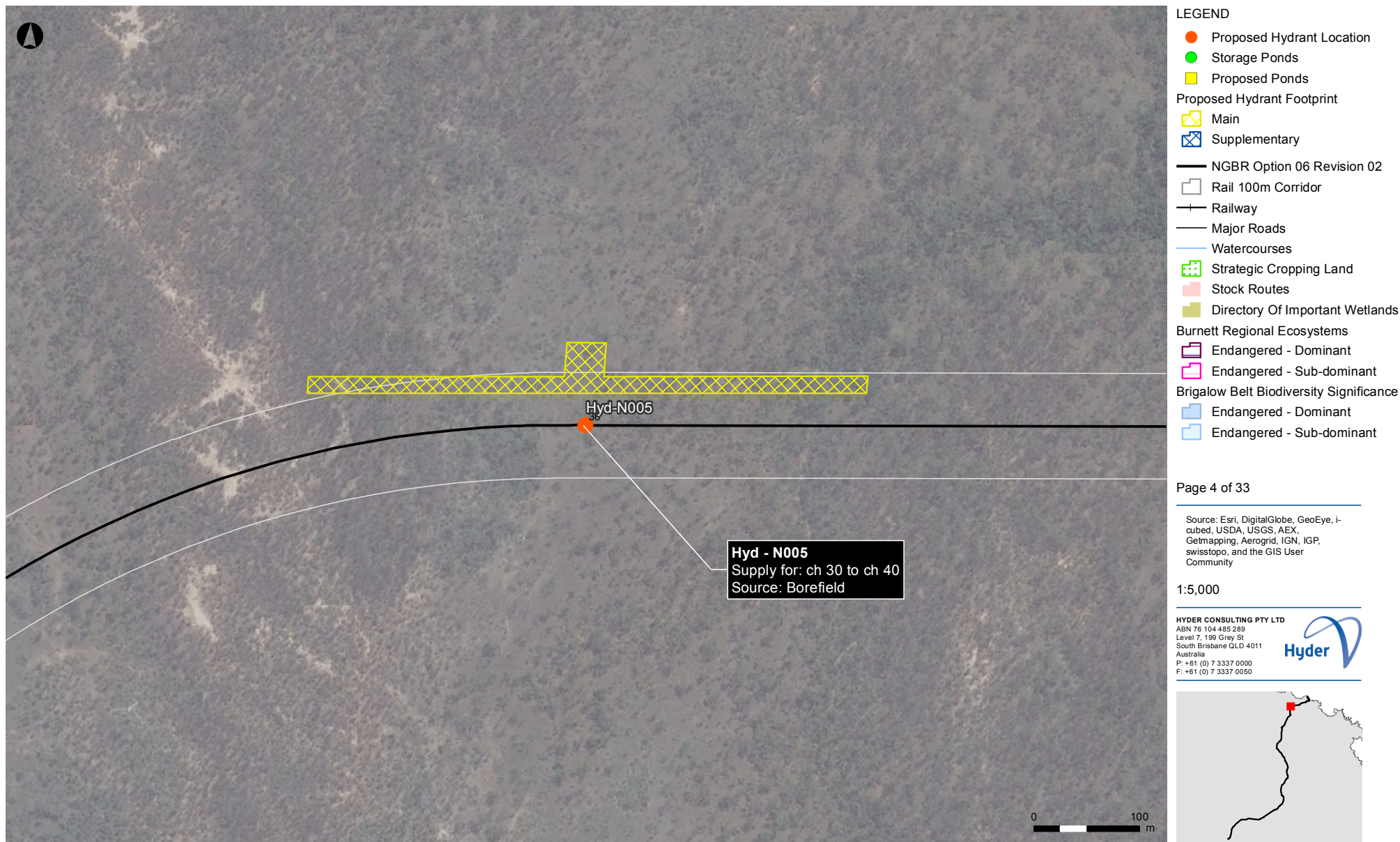


Figure 10.4: NGBR Water Hydrant Hyd-N005, Proposed Hydrant Footprint and Environmental Constraints

10.7 SUPPLY POINT HYD-N006

HYD-N006 is located at chainage 45km. It is accessible from Bowen Development Road and then 20km on Thurso Road which is a formed dirt road. An average daily demand of 935kL has been estimated. Refer to Figure 10.5.

Water Quality	Raw Water	Chainage (km)	45
Average Daily Demand(kL)	935	Duration(days)	521

10.7.1 MAIN OPTION

Source

Based on the available information from the existing bores in the area, the site is located on a aquifer which provides poor yields of up to 1L/s. Therefore it is recommended that estimated discharge should be verified and checked via yield tests at the first excavated bore. Based on the existing information, It is unlikely that boreholes alone can provide the total amount of water required. Therefore, surface flow sources would have to be used as supplementary option for this hydrant

To provide for a part of the site water demand, six bores up to 250m deep should be sunk. The bores should be located with a minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

6 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 250m and dedicated 5kVA generators.
- 1200m, 50mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At the location of hydrant: \$125,000
- For the borefield: \$960,000
- Recoverable assets: \$265,000

10.7.2 SUPPLEMENTARY OPTION

Source

Surface water can be used as a supplementary water source for this hydrant. A small existing pond (Pond 6) is located 1.0 km from the hydrant and should be utilised, along with a proposed storage pond with 65ML capacity at either 495m west of the rail line at chainage 40 or 850m west of the rail line at chainage 50. It should be noted that a suitable location close to chainage 45 could not be identified for a new storage pond.

A way to prevent 5km piping or trucking of the water from the proposed pond to chainage 45 is to shift the water supply point to chainage 40 or 50. An alternative is to truck the water directly to the location of the earthwork along the rail line.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- water permit for temporary use (2-3 months)
- development permit for any new infrastructure required (2-3 months)

Water Supply Components

The additional components required for the supplementary option are as follows:

- The proposed 150mx150mx 5m storage pond with 65ML operating capacity
- Pumping facility at the pond with 5L/s pumping rate and truck loading pipe stand

Estimated Capital Cost

- For the storage pond: \$841,500
- Recoverable assets: \$55,000

10.7.3 ENVIRONMENTAL CONSIDERATIONS

The terrain at HYD-N006 is relatively flat with scattered vegetation. The area appears to be out of the rain shadow of the mountains. Access is available via Thurso Road (dirt road). Drainage lines and access tracks are largely visible, with scattered vegetation. In some areas the vegetation is more dense.

The EPBC search outlined within a 1.1km buffer of the hydrant footprint 14 listed threatened species or species habitat likely to/may occur within the area. One of these is listed as critically endangered (Bare-rumped Shearwater) and 4 are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, Siah's Backbone).

13 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Clearing for bores should consider locations in semi-cleared areas where practicable. Construction of approximately 1200 m of embedded pipe will require clearing additional to that required for construction of the two proposed ponds (if required). Careful siting of infrastructure should help to minimise impacts to vegetation and wildlife in this area.

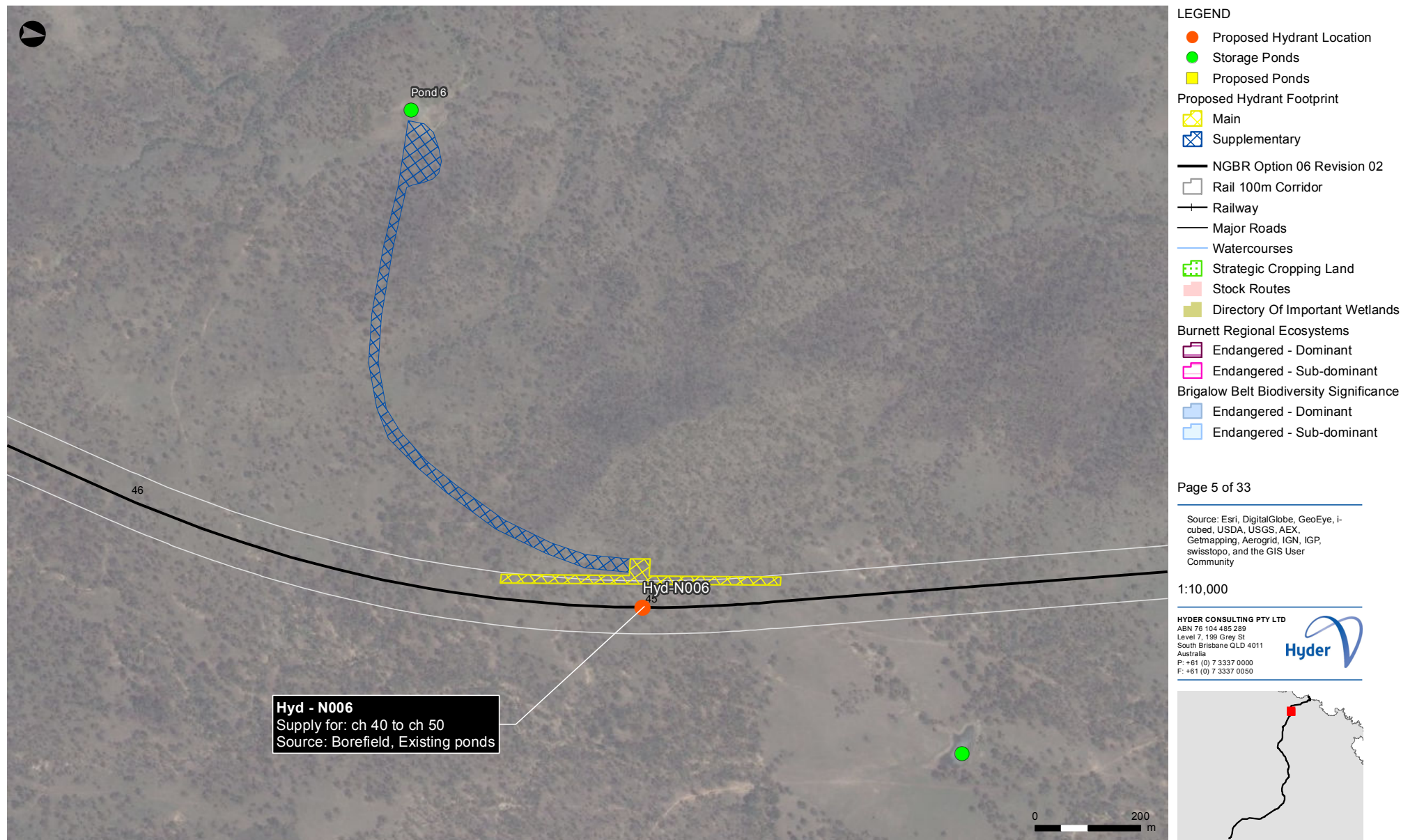


Figure 10.5: NGBR Water Hydrant Hyd-N006, Proposed Hydrant Footprint and Environmental Constraints

10.8 SUPPLY POINT HYD-N007

HYD-N007 is located at chainage 55km of the rail line in the Bogie region and is 17 km to the west of Bowen Development Road. Existing dirt tracks across the area can be used for access to the site. An average daily demand of 935kL has been estimated. Refer to Figure 10.6.

Water Quality	Raw Water	Chainage (km)	59
Average Daily Demand(kL)	935	Duration(days)	319

10.8.1 MAIN OPTION

Source

Based on the limited available information the site is located on an aquifer with poor yields, max extractions estimated to be no more than 1L/s. The estimated discharge should be verified by yield test of the first drilled bore, however It is unlikely that the boreholes can provide the total amount of water required, therefore, surface water sources will need to be used as a supplementary option for this hydrant.

To provide for a part of the hydrant's water demand, six boreholes with the depths up to 250m will be required to be sunk in the area. The bores should be located with a minimum distance of 100m from each other, and as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

6 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 250m and dedicated 5kVA generators.
- 1200m, 50mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with a total storage volume of 250kL, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$960,000
- Recoverable assets: \$265,000

10.8.2 SUPPLEMENTARY OPTION

Source

Surface water has to be used as the supplementary water source for this site. Bogie River is located at chainage 61km, 6km to the south of the hydrant. Water can be extracted from Bogie Creek via river harvesting.

To prevent delivery of water between Bogie River and the site, the site can be relocated to an area closer to Bogie River or as an alternative the extracted water from the river can be directly trucked to the location of the earthwork along the rail line.

Based on the data from the studies desktop studies, the Bogie River may not be able to provide the required water during the dry period of July to November. A storage pond (off-stream) can be constructed next to the creek for storage of the extracted water from the River after each rainfall event to provide more reliability to this water supply option.

Regulatory Requirements

River Extraction

- water permit for temporary take of water for construction purposes (2-3 months)
- consent of the chief executive (2 weeks)
- development permit for construction of (temporary) infrastructure (2-3 months)
- Riverine Protection Permit for construction within a waterway (2-3 months)

Water supply components

The additional components required for the supplementary option are as follows:

- River intake structure and pump station
- Truck loading pipe stand
- 150m x150m x 5m storage pond for more reliability of the option.

Estimated Capital Cost

- For river extraction: \$63,000
- For the storage pond: \$315,000
- Recoverable assets: \$20,000

10.8.3 ENVIRONMENTAL CONSIDERATIONS

The terrain at HYD-N007 is undulating hills with extensive drainage lines with scattered trees. The landscape is somewhat dry with minimal groundcover, located within the rain shadow of nearby mountains.

The EPBC search outlined within a 2.5km buffer of the hydrant footprint 14 listed threatened species or species habitat likely to/may occur within the area. Five of these are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, [55797], Siah's Backbone).

13 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Access via the existing dirt track at this location is possible however some improvements may be required to get to the hydrant location. If supplementary supply is required, the proposed pond is almost 2 km from the hydrant location, and is situated on the Bogie River. As it is located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach the hydrant location.

Changes to the waterway during construction of off-stream storage and pipes should be avoided wherever practical, with careful consideration and management during construction so as to not impact on water quality and aquatic ecosystems. Extraction of water from the creek/drainage line (and Bogie River) and associated impacts to other users utilising this water source, such as stock watering, need to be considered.

Due to the proposed pond being in close proximity of a watercourse, consideration should be given to construction methodologies and infrastructure as the probability of ASS is high in this location.

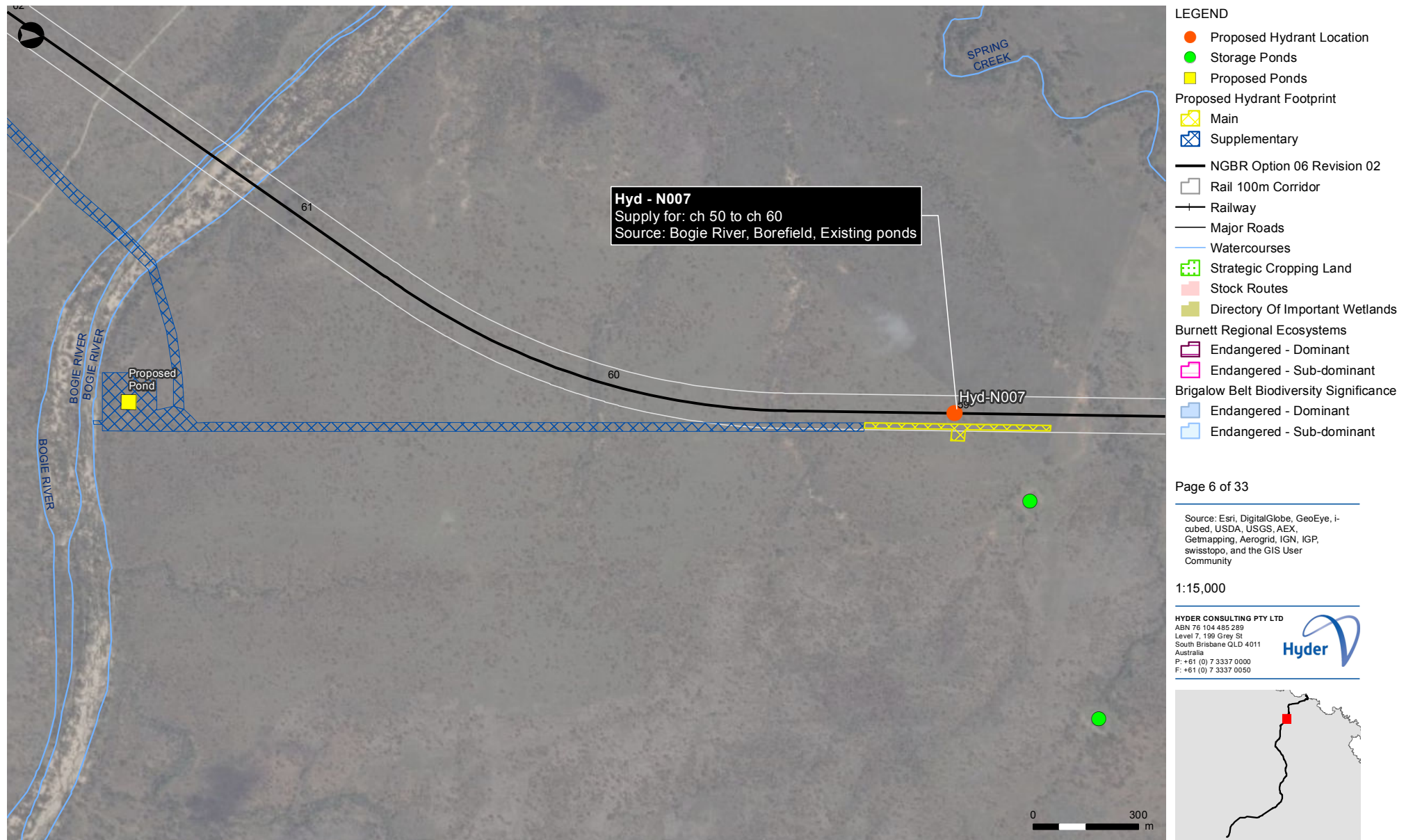


Figure 10.6: NGBR Water Hydrant Hyd-N007, Proposed Hydrant Footprint and Environmental Constraints

10.9 SUPPLY POINT HYD-N008

HYD-008 is located at chainage 63km and is accessible from Bowen Development Road and then 20 km on the Strathalbyn Road. This hydrant has been selected as the rail construction camp. To minimise the costs associated for water supply of the project, it is proposed that this hydrant also be used for supply of the water required for earthwork between chainages 60 to 70km. If the water of earthwork is incorporated, an average daily water demand of 749kL can be estimated for this supply point from which 132kL is for the camp and should be provided for a longer period of time. Refer to Figure 10.7.

Water Quality	Raw Water for earthwork Treated water for the camp	Chainage (km)	63
Average Daily Demand(kL)	749	Duration(days)	297 for the earthwork 600 for the camp

10.9.1 MAIN OPTION

Source

Based on the limited available information the hydrant is located on a poor fractured rock with minor alluvium aquifer. The yield from each bore is not anticipated to be more than 1L/s, therefore It is unlikely that boreholes alone will be able to provide water required for both earthworks and the camp. Surface flow sources would have to be used as supplementary option for this site.

To provide for a part of the hydrant's water demand, six boreholes with up to 250m depth should be sunk in the area. The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

It is recommended, however, that water from the boreholes be used for the camps drinking water (less treatment required, as groundwater is generally of a higher quality than surface water).

Regulatory Requirements

6 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 250m and dedicated 5kVA generators.
- 1200m, 50mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$455,000
- For the borefield: \$960,000
- Recoverable assets: \$540,000

10.9.2 SUPPLEMENTARY OPTION

Source

As a supplementary water supply, the river extraction setup for hydrant HYD-N007 can be used for trucking the extracted water from Bogie River to this hydrant. As above, It is recommended that the water required for the earthwork between chainage 60km to 70 km be provided at the location of the camp at chainage 63 km – HYD-N008.

The supplementary surface water supply option should be used for earthworks, as no treatment will be required. Bogie River is located at chainage 61kms, 2km to the north east of the site.

An option for the design of the supply system will be that extracted water from Bogie Creek is delivered to the raw water tanks located at the site. Another option will be that facilities which are to be located next to the Bogie Creek for supply point HYD-N007 are used for loading the tanker trucks and delivery of the water directly to the zone of earthwork along the rail line.

Regulatory Requirements

As per HYD-N007

Water Supply Components

The additional components required for the supplementary option are as follows:

To transfer the extracted water to the site:

- Upgrade the pump station discussed in section 10.8.2
- 2km long 200mm embedded HPDE pipe

To truck water to the hydrant:

- No water supply infra-structure in addition to those ones discussed in section 7.7.2 will be required

10.9.3 ENVIRONMENTAL CONSIDERATIONS

Access to HYD-N008 is good, via Strathalbyn Road. There are large cleared areas surrounding this hydrant which will assist in minimising further clearing requirements for the construction of water supply infrastructure.

The EPBC search outlined within a 2km buffer of the hydrant footprint 13 listed threatened species or species habitat likely to/may occur within the area. Five of these are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, [55797], Siah's Backbone).

13 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Extraction of water from the Bogie River and associated impacts to other users utilising this water source, such as stock watering, need to be considered. There is a stock route directly adjacent to the hydrant location which should be maintained.

As the supplementary option includes activities in close proximity of a watercourse, consideration should be given to construction methodologies and infrastructure as the probability of ASS is high in this location.

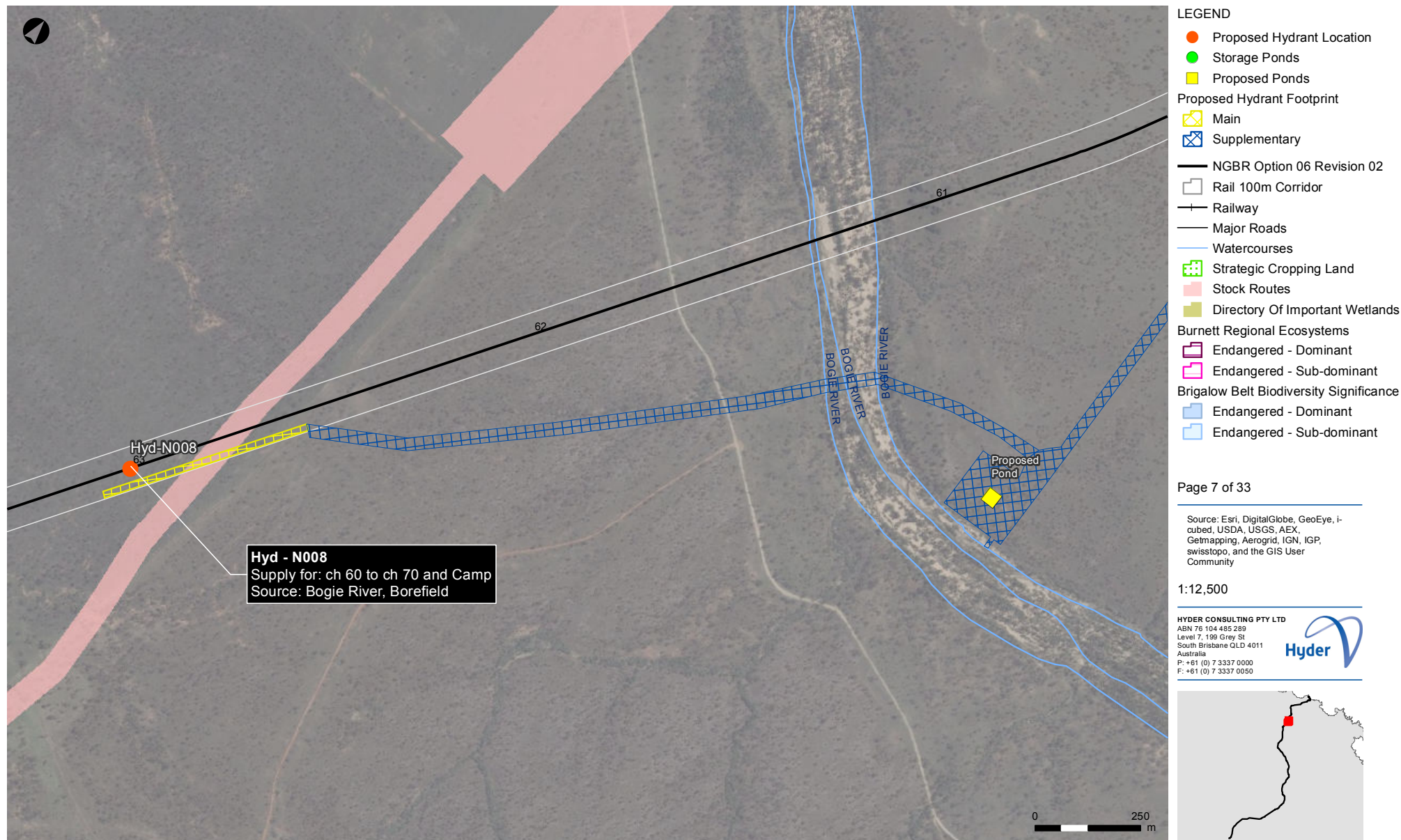


Figure 10.7: NGBR Water Hydrant Hyd-N008, Proposed Hydrant Footprint and Environmental Constraints

10.10 SUPPLY POINT HYD-N009

HYD-N009 is located at chainage 75km. Un-established dirt roads (farm tracks) exist across the hydrant area which will need to be upgraded for access. To minimise the environmental impact of upgrading the existing tracks, the rail line construction haul road can be used as the only access point to the site. An average daily demand of 755kL has been estimated for earthwork requirements. Refer to Figure 10.8.

Water Quality	Raw Water	Chainage (km)	75
Average Daily Demand(kL)	755	Duration(days)	489

10.10.1 MAIN OPTION

Source

Based on the limited available information the hydrant is located on a poor aquifer, with estimated yields at around 1L/s, and It is unlikely that boreholes will be able to provide the total amount of water required at this hydrant. Therefore, surface flow sources would have to be used as supplementary option for this site. To provide for a part of the site water demand, six boreholes with the depths up to 250m should be sunk in the area. The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 250m and dedicated 5kVA generators.
- 1200m, 50mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$960,000
- Recoverable assets: \$265,000

10.10.2 SUPPLEMENTARY OPTION

Source

Surface water would have to be used as the supplementary water source for this hydrant. No existing pond with enough storage capacity is available nearby, therefore a storage pond with 65ML capacity will need to be constructed 200m to the east of the site. The collected water at the proposed pond should be transferred to the site raw water tanks for the earthwork water supply.

Regulatory Requirements

New 64ML In-Stream Storage

- Water permit for temporary take of water (2-3 months)
- Consent of Chief Executive (2 weeks)
- Development permit to construct (2-3 months)
- Riverine Protection Permit for construction within a waterway (2-3 months)

Water Supply Components

The additional components required for the supplementary option are as follows:

- The proposed 150m x150m x 5m storage pond with 65ML operating capacity
- Pumping facility at the pond with 5L/s pumping rate and truck loading pipe stand

Estimated Capital Cost

- For the storage pond: \$783,000
- Recoverable assets: \$15,000

10.10.3 ENVIRONMENTAL CONSIDERATIONS

Unestablished dirt roads exist across the area, however these would require an upgrade to be able to service the construction of proposed infrastructure required for the hydrant. To minimise the environmental impacts associated with access (and avoid upgrading these existing roads) it is recommended that the rail line construction haul road should be used as the only access point to the hydrant.

The terrain consists of mixed volcanic and sedimentary rock, steep terrain and well-defined catchments. The proposed pond (Pond 12) is only 230 m from the hydrant location; however, because terrain is steep and vegetation is dense, impacts due to clearing need to be carefully managed. Erosion and sediment controls should be developed prior to construction. Infrastructure should be limited to within the rail corridor where practical to avoid additional clearing.

Although the desktop assessment did not identify any key environmental considerations based on available data, this is a sensitive area which is undulating with relatively dense groundcover and access limitations.

The EPBC search outlined within a 350m buffer of the hydrant footprint 11 listed threatened species or species habitat likely to/may occur within the area. Four of these are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, [55797]).

13 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Construction of boreholes, proposed pond and infrastructure at this chainage should consider erosion and sedimentation control, as well as minimising vegetation clearing, where practical. There is a station 750 m to the north.

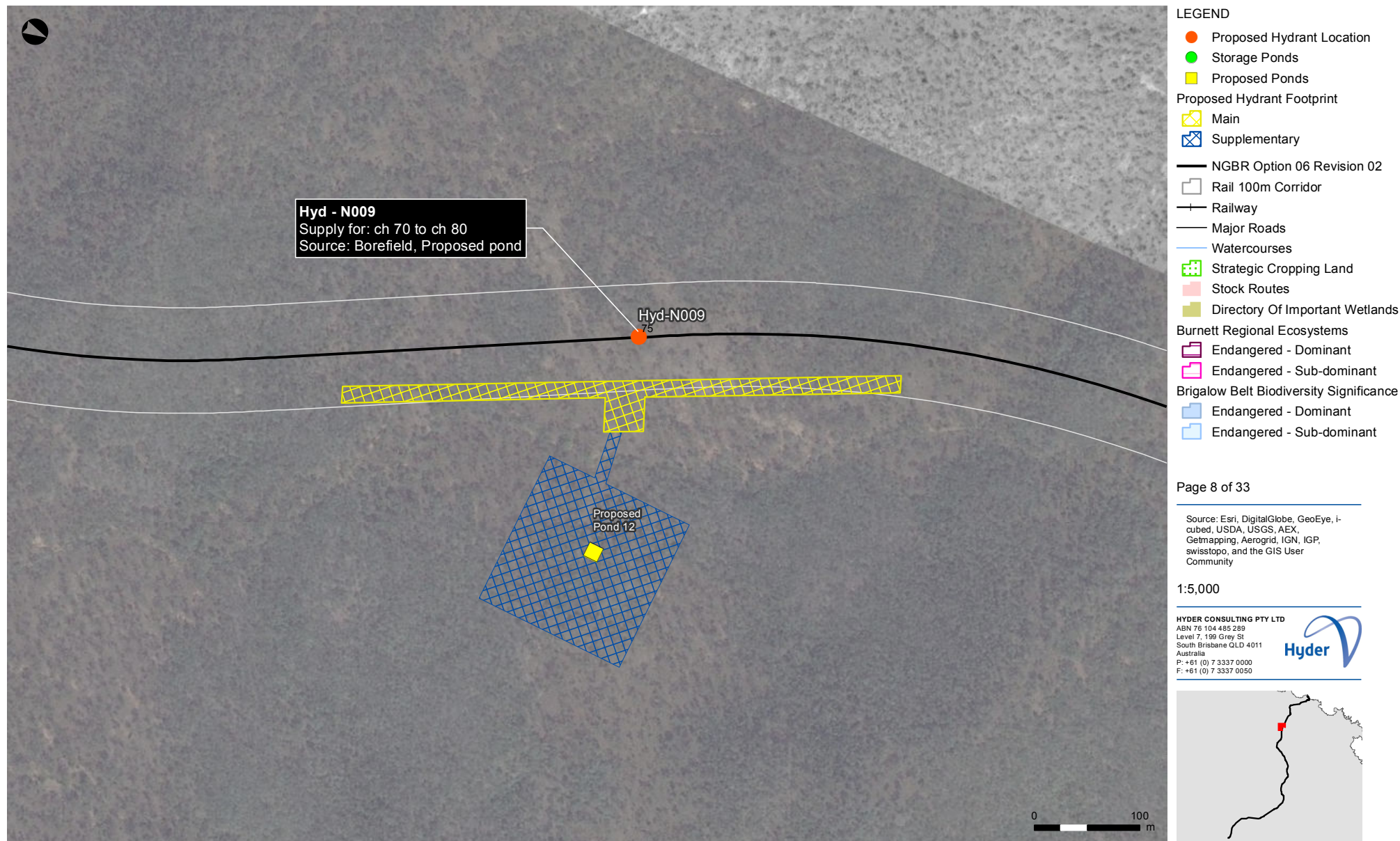


Figure 10.8: NGBR Water Hydrant Hyd-N009, Proposed Hydrant Footprint and Environmental Constraints

10.11 SUPPLY POINT HYD-N010

HYD-N010 is located at chainage 85km. Un-established dirt roads (farm tracks) exist in the vicinity of the site area. However, these roads will have to be upgraded if they are to be used for access. To minimise environmental impact of the project the rail line construction haul road can be used as the only access point to the site. An average daily demand of 882kL has been estimated at this supply point for the earthwork. Refer to Figure 10.9.

Water Quality	Raw Water	Chainage (km)	85
Average Daily Demand(kL)	882	Duration(days)	289

10.11.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this site. The site is located on a fractured volcanic aquifer. It is expected that each borehole will yield 2.5 L/s with six boreholes providing all of the required water demands. The bores can be sunk close to the site within the rail construction easement. It is expected that the suitable aquifers in the area are located at the maximum depth of 100m.

The area is vegetated however it is likely that minimal additional clearing will be required for the boreholes if they are located within the construction easement.

Regulatory Requirements

6 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 6 lined borehole with pump to maximum depth of 100m and dedicated 5kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$600,000
- Recoverable assets: \$205,000

10.11.2 SUPPLEMENTARY OPTION

Source

No supplementary option is required for this hydrant.

Several existing ponds, (i.e. pond 1) with significant storage capacity are located near the hydrant, which will be able to provide supplementary or alternative supplies if the boreholes are limited in yield or reliability.

To use each of these existing ponds a pipe stand should be installed next to them. When required, a portable pump can be located next to each pond with connections to both storage pond and the pipe stand for tanker truck loading. Raw water can be directly delivered to the location of the earthwork demand.

Regulatory Requirements

Existing In/off Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- water permit for temporary use (2-3 months)
- development permit for any new infrastructure required (2-3 months)

Water Supply Component

The additional components required for the supplementary option are as follows:

- Pipe stands next to each pond
- Portable pump with 3L/s pumping rate

10.11.3 ENVIRONMENTAL CONSIDERATIONS

The terrain at this location is flat, with no defined access to the supply point. To minimise the environmental impacts associated with access it is recommended that the rail line construction haul road should be used as the only access point to the hydrant. Ground conditions are dry; however, the catchments are well defined.

The EPBC search outlined within a 300m buffer of the hydrant footprint 9 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll).

11 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is a stock route 2 km southeast of the hydrant location. The area is scarcely vegetated; therefore, minimal additional clearing should be required for the boreholes, especially if they can be located within the construction easement. If the existing storage ponds at this hydrant are to be used, the infrastructure should be sited to minimise impacts to vegetation and drainage lines due to construction of infrastructure.



Figure 10.9: NGBR Water Hydrant Hyd-N010, Proposed Hydrant Footprint and Environmental Constraints

10.12 SUPPLY POINT HYD-N011

HYD-N011 is located at chainage 95km of the rail line in Springlands region. The hydrant is accessible from Bowen Development Road and then 13km on Strathmore Road. An average daily demand of 607kL has been estimated at this supply point for earthwork. Refer to Figure 10.10.

Water Quality	Raw Water	Chainage (km)	95
Average Daily Demand(kL)	607	Duration(days)	118

10.12.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this site. The site is located on indurated and un-indurated sediment aquifer. It is expected that each borehole will yield 6.5 L/s only requiring two boreholes to provide the required water demand. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that the suitable aquifers in the area are at the maximum depth of 100m. The rail line construction haul road can be used for truck access to the location of the bores. Each bore should be piped to the raw water tanks located at the supply point.

Regulatory Requirements

2 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 2 new bores (2 weeks)
- development permit- 2 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 2 lined borehole with pump to maximum depth of 100m and dedicated 20kVA generators.
- 200m, 200mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$193,000
- Recoverable assets: \$125,000

10.12.2 ALTERNATIVE OPTION

Source

Groundwater can provide all the required water supply for this site and supplementary option is required.

Reliable surface water supply options are also available in this area if required. A large existing storage pond (pond 2) is located close to chainage 99km. By shifting the water supply point to this chainage, this pond can be used as an alternative water supply option for the chainages 98 to site 105km. Chainages 95 to 98 are located outside of property boundary for this pond. However, other existing ponds with significant storage volume are located with reasonable distance from chainages 97.5 and 90 which can also be used.

Regulatory Requirements

Existing In/off Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- water permit for temporary use (2-3 months)
- development permit for any new infrastructure required (2-3 months)

Water Supply Components

For pond 2 as the hydrant's water supply

- A pump station with 30L/s capacity with the detail discussed in section 6 of the report.
- 200m, 200mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

For pond 90 as the hydrant s source for chainage 95 to 98:

- Pipe stand
- Pump station with 5L/s pumping rate

10.12.3 ENVIRONMENTAL CONSIDERATIONS

The terrain at this location is a mixture of steep and flat areas. There is good access to the hydrant location which should require minimal clearing of vegetation to link with Strathmore Road. The hydrant is located within a floodplain, and has minimal vegetation other than scattered trees and grassland. There is a stock route crossing the hydrant footprint which should be maintained. Endangered - Dominant vegetation under Brigalow Belt Biodiversity Significance lies approximately 200m to the east of the hydrant footprint.

The EPBC search outlined within a 130m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Black-throated Finch, Australian Painted Snipe, Northern Quoll, [55797], Siah's Backbone).

11 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

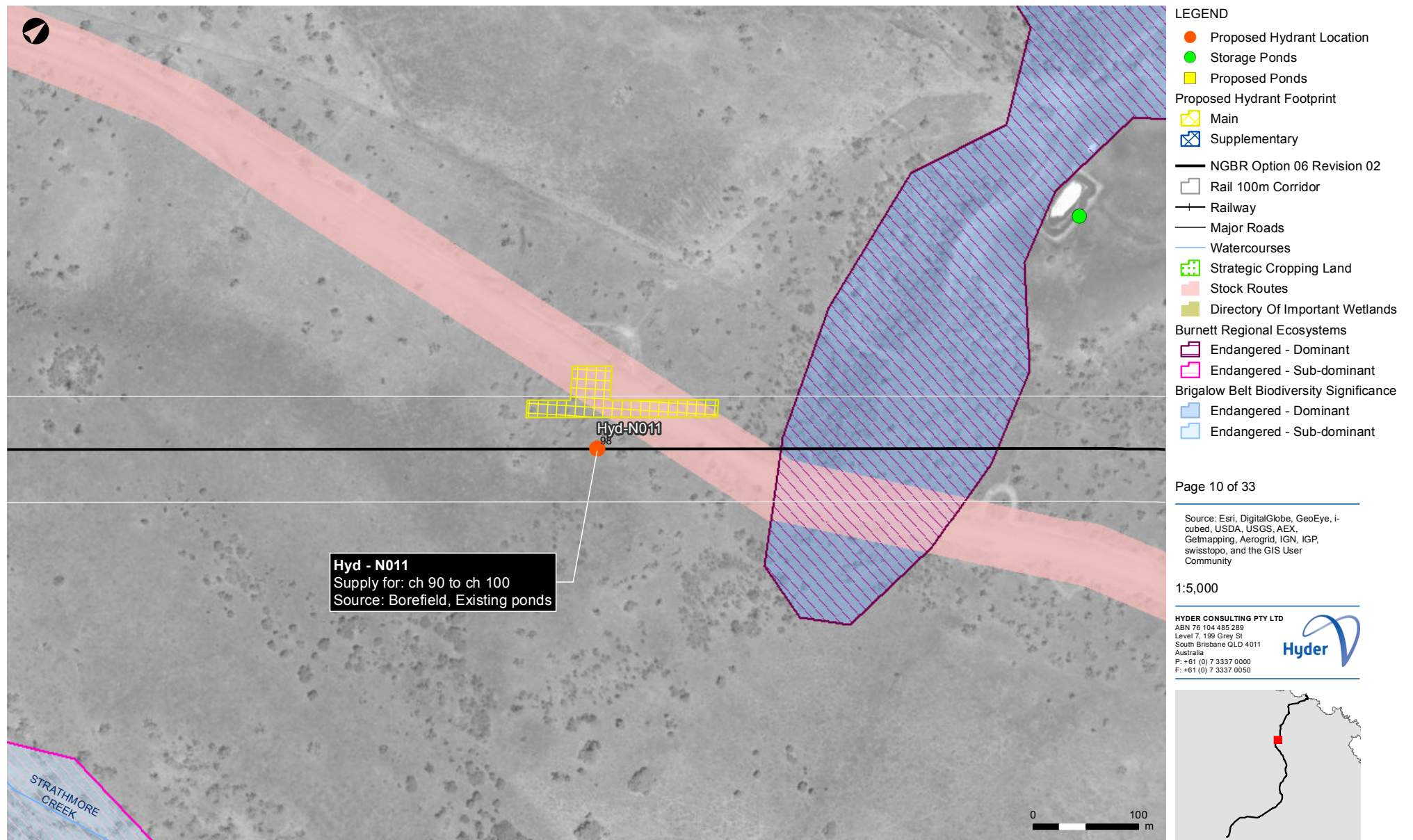


Figure 10.10: NGBR Water Hydrant Hyd-N011, Proposed Hydrant Footprint and Environmental Constraints

10.13 SUPPLY POINT HYD-N012

HYD-N012 is located at chainage 105km of the rail line in Collinsville region. Whilst there is minimal vegetation, no formed access road to the hydrant has been identified. To access the hydrant location a new road will have to be developed. An alternative (to lessen environmental impact and costs), the rail line construction haul road could be used as the only access point. An average daily demand of 760kL has been estimated at this supply point for earthworks. Refer to Figure 10.11.

Water Quality	Raw Water	Chainage (km)	105
Average Daily Demand(kL)	760	Duration(days)	163

10.13.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this site. The site is located on a fractured volcanic aquifer. It is expected that each borehole will yield 2.0 L/s and as such six boreholes will be enough to provide all the required water. The bores can be sunk close to the site within the rail construction easement. It is expected that the suitable aquifers in the area are at the maximum depth of 100m.

Regulatory Requirements

6 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 6 lined borehole with pump to maximum depth of 100m and dedicated 5kVA generators.
- 200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$600,000
- Recoverable assets: \$205,000

10.13.2 ALTERNATIVE OPTION

Source

No supplementary source is required for this site. However, the site is located next to Strathmore Creek and river extraction can be used as an alternative water supply option if required. The creek does not have a reliable flow during the months of July to November. Therefore, for the river extraction to be used as an alternative water supply option in the dry season, a storage pond has to be constructed next to the creek for flood harvesting.

Regulatory Requirements

River extraction if required

- water permit for temporary take of water for construction purposes (2-3 months)
- consent of the chief executive (2 weeks)
- development permit for construction of (temporary) infrastructure (2-3 months)
- Riverine Protection Permit for construction within a waterway (2-3 months)

Water Supply Components

The additional components required for the supplementary option are as follows:

- River intake structure and pump station
- Truck loading pipe stand
- 150mx150mx 5m storage pond for more reliability of the option.

10.13.3 ENVIRONMENTAL CONSIDERATIONS

This hydrant is within a dry floodplain and the terrain is flat with some small hills. Pelican Creek is approximately 1km to the south. There is limited vegetation and no formed access road. To access this hydrant, a new road would be required. To minimise vegetation clearing, the rail line construction haul road should be used as the only access point to the hydrant.

The EPBC search outlined within a 300m buffer of the hydrant footprint 11 listed threatened species or species habitat likely to/may occur within the area. Four of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe, Northern Quoll).

10 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Strategic Cropping Land (SCL) surrounds the hydrant footprint from the north, south and west, and part of the southern end of the footprint crosses into this area. Boreholes need to be located outside of the SCL and careful consideration should be given to the yield of bores given the importance of this agricultural land. Erosion and sediment controls should be developed prior to construction of the water supply infrastructure to minimise runoff to the creek system.

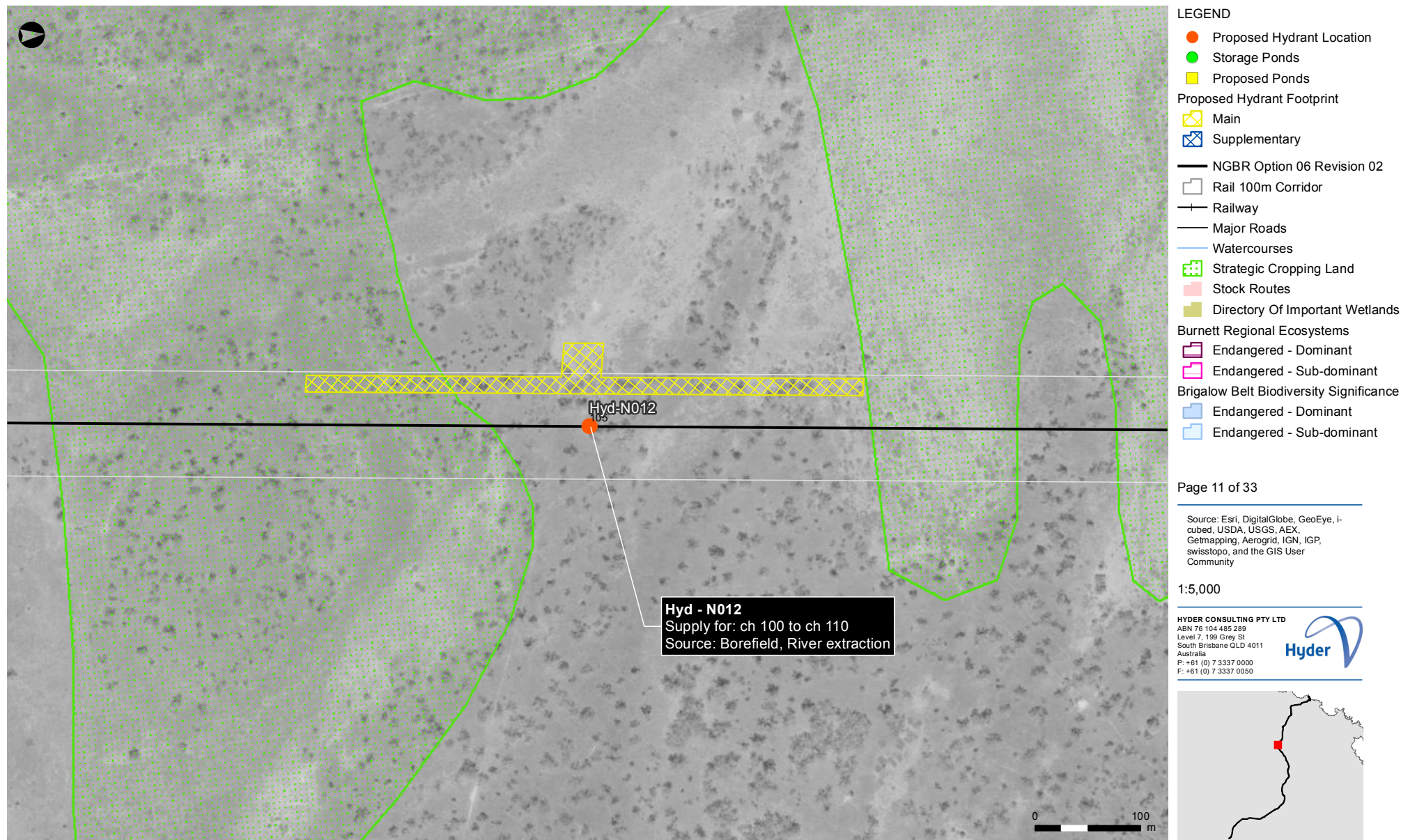


Figure 10.11: NGBR Water Hydrant Hyd-N012, Proposed Hydrant Footprint and Environmental Constraints

10.14 SUPPLY POINT HYD-N013

HYD-N013 is located at chainage 115km in Collinsville area. The hydrant is located 19km to the west of Bowen Development Road. Myuna Road which branches from the Bowen Development Road and intersect the rail line at chainage 120.5km is the nearest established access road to the site. An average daily demand of 704kL has been estimated for earthworks. Refer to Figure 10.12.

Water Quality	Raw Water	Chainage (km)	115
Average Daily Demand(kL)	704	Duration(days)	161

10.14.1 MAIN OPTION

Source

Six boreholes with the depth of up to 100m are proposed to be sunk in the site area. The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Based on the limited available information the site is located on a volcanic aquifer with relatively low potential yield. The yield from each bore is estimated to be about 1.5L/s, and It is unlikely that boreholes will be able to provide the total amount of water required at this hydrant. It is proposed that surface flow sources be adopted as a supplementary option to provide for a small portion of water supply.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of chief executive- 6 new bores (2 weeks)
- Development permit- 6 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 100m and dedicated 5kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$600,000
- Recoverable assets: \$205,000

10.14.2 SUPPLEMENTARY OPTION

Source

An existing pond with 20ML storage volume (pond 22) is located 1.2km from the hydrant close to chainage 116. If use of this existing pond can be negotiated with the owner, it will provide as a supplementary source for this site.

The supply system will involve construction of a small pump station with 5L/s pumping capacity next to the storage pond and 1.2km of embedded 100mm HPDE pipeline from the pump station to the water supply hydrant.

As an alternative, water can be loaded from the pond into the trucks and delivered directly to the rail line construction area for the earthwork.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- water permit for temporary use (2-3 months)
- development permit for any new infrastructure required (2-3 months)

Capital Estimates

The conveyed water from this supply point will feed the raw water tanks located at the supply point, as discussed in section 7. The additional components required for this supplementary option are as follows:

- Pumping and generator facility located next to the existing pond with 5L/s pumping rate
- 100mm diameter embedded HPDE pipe with 1.2km length

Estimated Capital Cost

- At the storage pond: \$98,000
- Recoverable assets: \$15,000

10.14.3 ENVIRONMENTAL CONSIDERATIONS

This location is within a dry floodplain with minimal vegetation. The desktop assessment identified no key environmental considerations based on available data.

The EPBC search outlined within a 300m buffer of the hydrant footprint 11 listed threatened species or species habitat likely to/may occur within the area. Four of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe, Northern Quoll).

10 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is no defined access so development of access roads to link with Myuna Road approximately 5 km away or storage ponds needs to carefully consider clearing requirements. As bores are the primary option, associated clearing for infrastructure should be minimised. The Bowen Bar is approximately 3 km to the southwest.

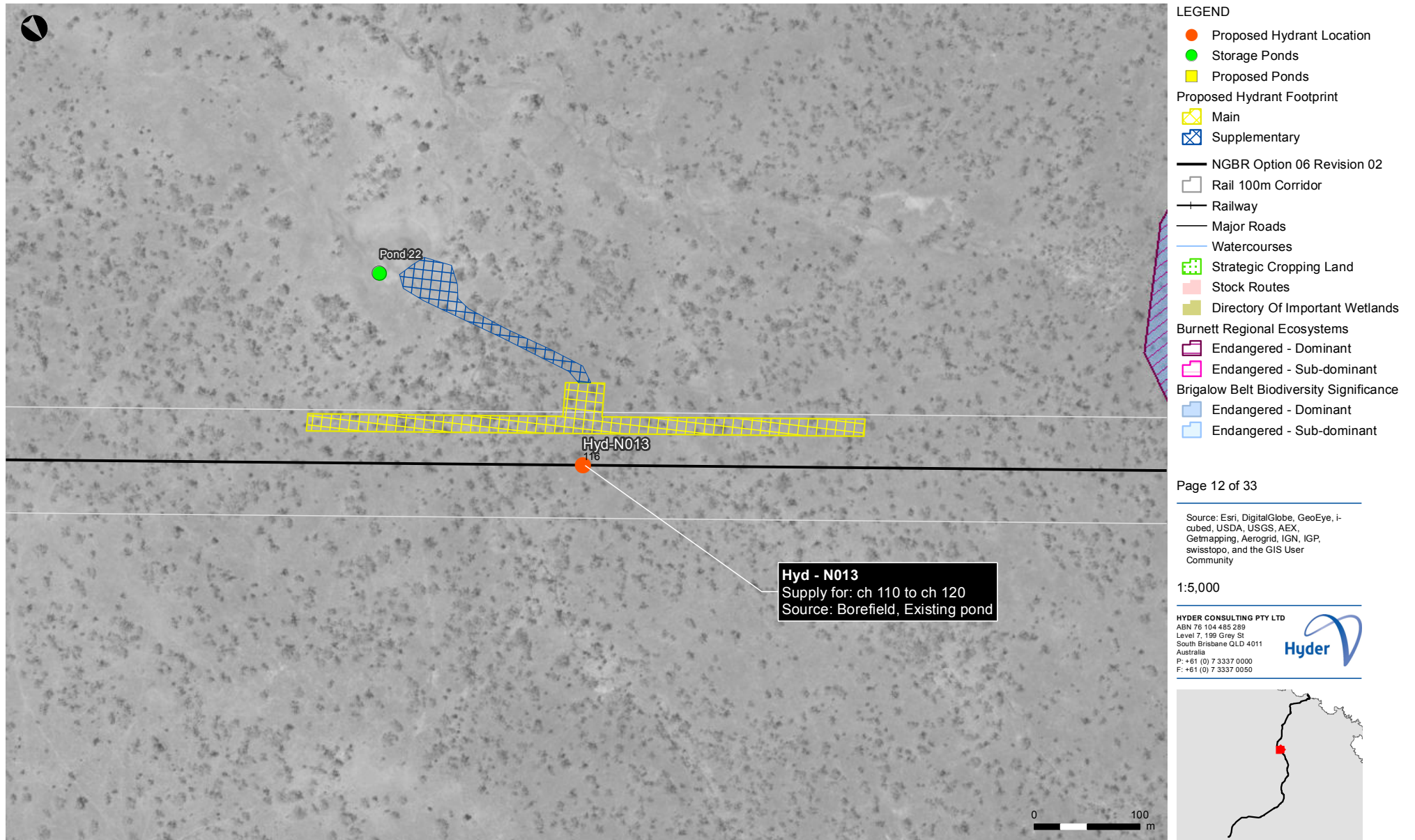


Figure 10.12: NGBR Water Hydrant Hyd-N013, Proposed Hydrant Footprint and Environmental Constraints

10.15 SUPPLY POINT HYD-N014

HYD-N014 is located at chainage 125km in Collinsville area. It is 11km west of Bowen Development Road. Myuna Road is the nearest established access road. It branches from the Bowen Development Road and intersects the rail at chainage 120.5km. An average daily demand of 557kL has been estimated for earthwork. Refer to Figure 10.13.

Water Quality	Raw Water	Chainage (km)	125
Average Daily Demand(kL)	557	Duration(days)	212

10.15.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply all the water requirements at this hydrant. The site is located on indurated sediments aquifer. It is expected that each borehole can yield 2L/s and as such 5 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the site within the rail construction easement. It is expected that the suitable aquifers in the area are at the maximum depth of 100m.

Regulatory Requirements

5 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 5 lined borehole with pump to maximum depth of 150m and dedicated 5kVA generators.
- 900m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in Section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$645,000
- Recoverable assets: \$210,000

10.15.2 SUPPLEMENTARY OPTION

Source

No supplementary option is required at this hydrant. However, a number of existing ponds including 'Pond 23' are located along the rail line within a property between chainages 120 to 130km. These storage ponds can be used to replace some of the boreholes. A pipe stand must be installed next to each pond in order to use them. When required, a portable pump can be located next to each pond with connections to both the storage pond and the pipe stand for tanker truck loading. Raw water can be directly delivered to the location of the earthworks.

Regulatory Requirements

N/A

Water Supply Components

The additional components required for the supplementary option are as follows:

- Pipe stands next to each pond
- Portable pump with 3L/s pumping rate

Estimated Capital Cost

- At the storage pond: \$79,500
- Recoverable assets: \$25,000

10.15.3 ENVIRONMENTAL CONSIDERATIONS

This area is within a drainage line/floodplain and vegetation is minimal with scattered ground cover only. There is no defined access so development of access roads to link with Myana Road approximately 5 km away needs to consider clearing requirements. The desktop assessment did not identify any key environmental considerations based on available data, however as bores are the primary option, associated clearing for infrastructure should be minimised. The Bowen River is approximately 3 km to the south west.

The EPBC search outlined within a 300m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

10 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).



LEGEND

- Proposed Hydrant Location
- Storage Ponds
- Proposed Ponds
- Proposed Hydrant Footprint
 - Main
 - Supplementary
- NGBR Option 06 Revision 02
- Rail 100m Corridor
- Railway
- Major Roads
- Watercourses
- Strategic Cropping Land
- Stock Routes
- Directory Of Important Wetlands
- Burnett Regional Ecosystems
 - Endangered - Dominant
 - Endangered - Sub-dominant
- Brigalow Belt Biodiversity Significance
 - Endangered - Dominant
 - Endangered - Sub-dominant

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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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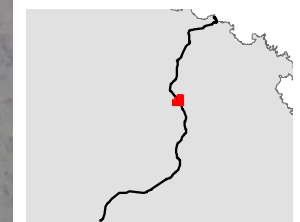


Figure 10.13: NGBR Water Hydrant Hyd-N014, Proposed Hydrant Footprint and Environmental Constraints

10.16 SUPPLY POINT HYD-N015

HYD-N015 is located at chainage 130km and is 8km west of Bowen Development Road. No established track connects the site to the road. The hydrant has been selected as a rail line construction camp. The average daily demand of the camp is estimated as 112kL; 36kL for drinking water and the rest for mixing concrete. Refer to Figure 10.14.

Water Quality	Treated water	Chainage (km)	130
Average Daily Demand(kL)	112	Duration(days)	1050

10.16.1 MAIN OPTION

Source

It is anticipated that a borehole can yield 2L/s which will be enough for the camp supply water. The maximum expected bore depth will be 150m.

The bore can be sunk within the construction easement close to the camp. The extracted water should be treated to drinking or concrete mix quality and distributed in different networks as described in Section 6 of the report.

Regulatory Requirements

2 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 1 lined borehole with pump to maximum depth of 150m and dedicated 7kVA generators.
- 1200m, 50mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tank with 50kL storage volume and pump station
- Separate 50kL storage tanks for drinking water and other camp water demands
- Separate treatment plant and distribution system for concrete mix and yards water and potable water as described in Section 6.

Estimated Capital Cost

- At location of hydrant: \$340,000
- For the borefield: \$125,000
- Recoverable assets: \$310,000

10.16.2 ALTERNATIVE OPTION

To reduce the capital costs as an alternative to using boreholes, the camp water can be purchased from Whitsunday Regional Council. The Council provides drinking quality water at Collinsville. Water can be trucked to the hydrant via Bowen Development road or Myuna Road. However, no formed road is available to the exact location of the camp from any of these roads. The concrete mix can be directly delivered to the batching plant. The water for the camp and yards should be stored in a 50kl tank for non-working shift demands.

Regulatory Requirements

Potable water purchase - \$5/KL – open to negotiation

Water Supply Components

The infrastructure required for the alternative water supply option will be as follows:

- A 50kL storage tank for camp and yards water
- Site water distributing system

10.16.3 ENVIRONMENTAL CONSIDERATIONS

There is no established track access to HYD-N015 and vegetation clearing will be required. The terrain is steep in some areas; however, generally the area is a dry floodplain adjacent to the Bowen River. Construction of access tracks and borehole infrastructure needs to consider minimising clearing and erosion and sediment control.

The EPBC search outlined within a 150m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

10 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is SCL located to the north and west of the hydrant footprint.

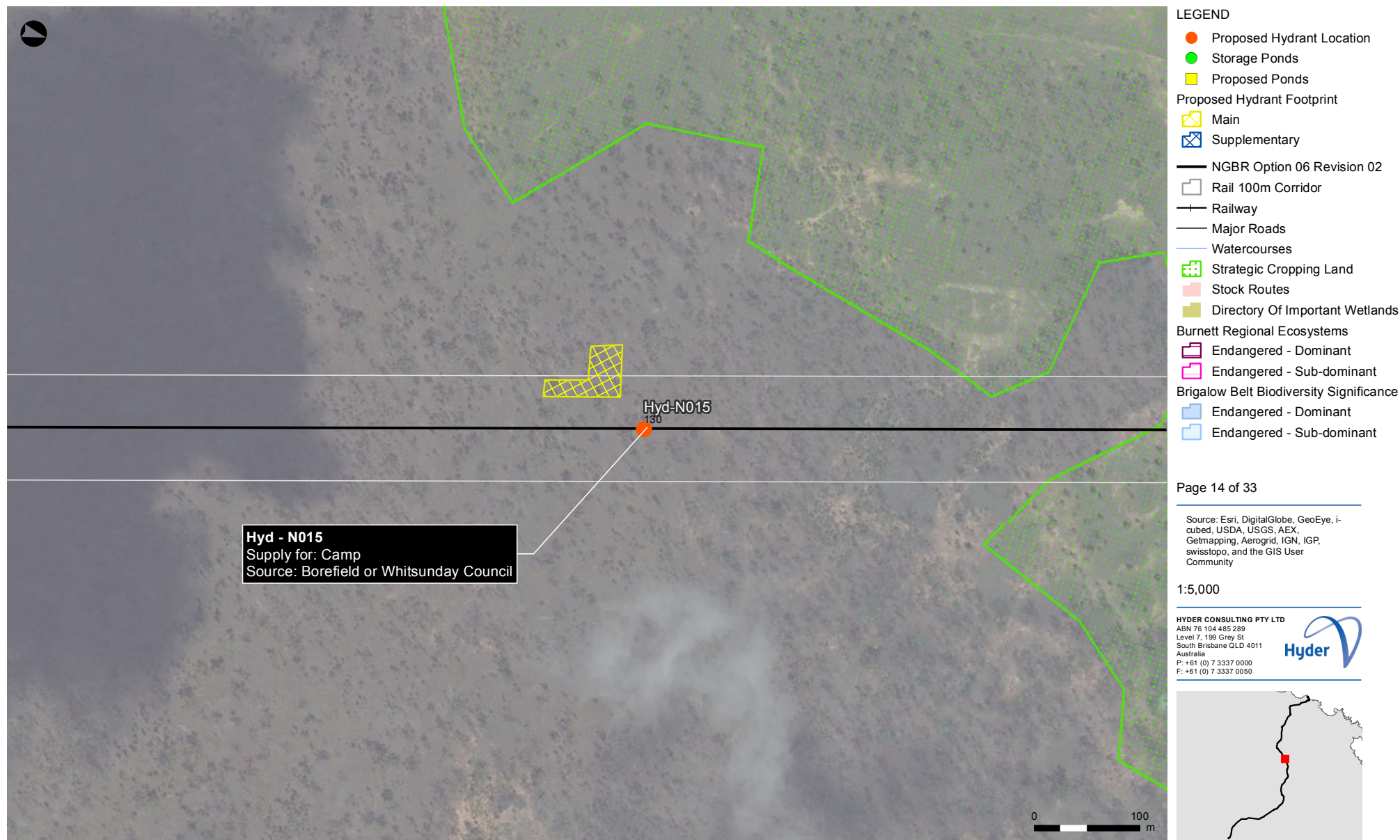


Figure 10.14: NGBR Water Hydrant Hyd-N015, Proposed Hydrant Footprint and Environmental Constraints

10.17 SUPPLY POINT HYD-N016

HYD-N016 is located at chainage 135km in the Collinsville region and is 5.5km west of Bowen Development Road. No existing formed access road to the site is available. An average daily demand of 624kL has been estimated at this supply point for earthwork. Refer to Figure 10.15.

Water Quality	Raw Water	Chainage (km)	135
Average Daily Demand(kL)	624	Duration(days)	143

10.17.1 MAIN OPTION

Source

Based on the limited available information the hydrant is located on indurated sediments with a low yield rate. The estimated yield from each bore is not more than 1.5L/s. Therefore, it is unlikely that boreholes can provide the total amount of water required at this site and surface flow sources would have to be used as supplementary option.

Six boreholes with the depths up to 150m should be sunk in the area to provide a portion of the supply. The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 150m and dedicated 7kVA generators.
- 1200m, 50mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with a total storage volume of 250kL, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$780,000
- Recoverable assets: \$235,000

10.17.2 SUPPLEMENTARY OPTION

Source

Surface water should be used as the supplementary water source for this hydrant. Bowen River is located at chainage 132km, 3km north of the site. Water can be extracted from the River with the details discussed in Section 6 of the report.

To prevent delivery of water between Bowen River and the hydrant, the hydrant can be relocated to an area closer to Bowen River. As an alternative, the extracted water from the river can be directly trucked to the location of the earthwork along the rail line.

Based on the data from section 4.1 of the report, Bowen River may not be able to provide the required water in a period of the year between months July to November. A storage pond can be constructed next to the creek for storage of the extracted water from the river after each rainfall event to give more reliability to this option.

Regulatory Requirements

River Extraction

- Water permit for temporary take of water for construction purposes (2-3 months)
- Consent of the chief executive (2 weeks)
- Development permit for construction of (temporary) infrastructure (2-3 months)
- Riverine Protection Permit for construction within a waterway (2-3 months)

Water Supply Components

The additional components required for the supplementary option are as follows:

- River intake structure and pump station
- Truck loading pipe stand
- 150mx150mx 5m storage pond for more reliability of the option.

Estimated Capital Cost

- For river extraction: \$45,000
- Recoverable assets: \$5,000

10.17.3 ENVIRONMENTAL CONSIDERATIONS

HYD-N016 is located with a floodplain on flat terrain. There is no established track access to this site and vegetation clearing will be required. Scattered areas of Brigalow belt exist within a 2.5 km radius of hydrant location. The EPBC search outlined within a 700m buffer of the hydrant footprint 2 listed threatened ecological community (endangered) which may occur within the area (Brigalow, Natural Grasslands of Queensland Central Highlands and the northern Fitzroy Basin) and 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

10 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe). The hydrant is located close to the Bowen River and Rosella Creek and options for water supply to this hydrant include bores and extraction from the Bowen River. Bores and supply infrastructure need to be carefully located to avoid vegetation and minimise clearing. Erosion and sediment control needs to be incorporated into all

construction methodologies, minimising runoff and avoiding impacts to water quality and aquatic ecosystems. Impacts to other users of water from the Bowen River should also be considered if the supplementary option is required

As the supplementary option requires activity in close proximity of a watercourse, consideration should be given to construction methodologies and infrastructure as the probability of ASS is high in this location.

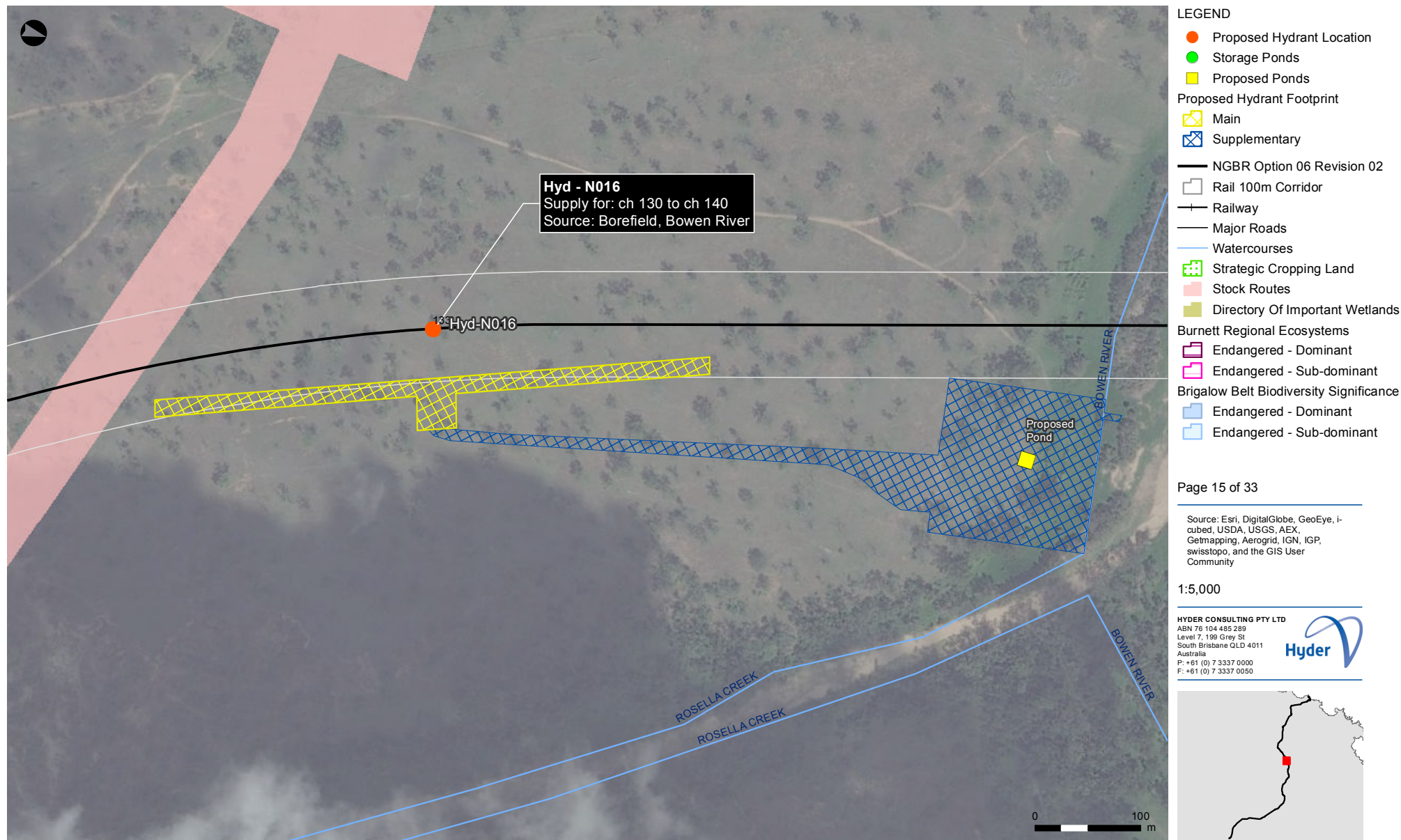


Figure 10.15: NGBR Water Hydrant Hyd-N016, Proposed Hydrant Footprint and Environmental Constraints

10.18 SUPPLY POINT HYD-N017

The supply point is located at chainage 145km, 5.5km west of Bowen Development Road. No existing access road to the site is available. An average daily demand of 805kL has been estimated at this supply point for earthwork. Refer to Figure 10.16.

Water Quality	Raw Water	Chainage (km)	145
Average Daily Demand(kL)	805	Duration(days)	83

10.18.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply all the water requirements at HYD-N017. The site is located on indurated sediment aquifer. It is expected that each borehole can yield 2L/s and as such 7 boreholes would have to be sunk to provide all the required water. The bores can be sunk close to the site within the rail construction easement. It is expected that the suitable aquifers in the area are at the maximum depth of 100m.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 7 lined borehole with pump to maximum depth of 150m and dedicated 8kVA generators.
- 1600m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$920,000
- Recoverable assets: \$260,000

10.18.2 SUPPLEMENTARY OPTION

Source

Using surface flow as a supplementary water supply option is not required at this hydrant. However, a number of existing ponds are located along the site which can replace some of the required boreholes. Pond 28 is located 360m from chainage 148.5. Ponds 27 and 26 are situated 1200m from chainage 145. Pond 25 is located next to chainage 141. Based on the

extent of the property boundaries, these ponds can be used for water supply of all the rail line close to the hydrant.

To use each of these existing ponds a pipe stand should be installed next to them. When required, a portable pump can be located next to each pond with connections to both storage pond and the pipe stand for tanker truck loading. Raw water can be directly delivered to the location of the earthwork.

Regulatory Requirements

N/A

Water Supply Components

The additional components required for the supplementary option are as follows:

- Pipe stands next to each pond
- Portable pump with 3L/s pumping rate

10.18.3 ENVIRONMENTAL CONSIDERATIONS

HYD-N017 is located with a floodplain on flat terrain. Vegetation is limited; however, there is no established track access to this site and vegetation clearing will be required. Scattered Brigalow belt exists within a radius of 2.5 km around hydrant location and the hydrant footprint lies within SCL.

The EPBC search outlined within a 450m buffer of the hydrant footprint 1 listed threatened ecological community (endangered) which may occur within the area (Natural Grasslands of Queensland Central Highlands and the northern Fitzroy Basin) and 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

9 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Boreholes should be located outside of the SCL where possible and careful consideration should be given to the yield of bores given the importance of this agricultural land. Construction of access tracks and borehole infrastructure needs to consider minimising clearing. If supply from existing ponds is required, location and construction of required infrastructure should also consider minimising clearing.

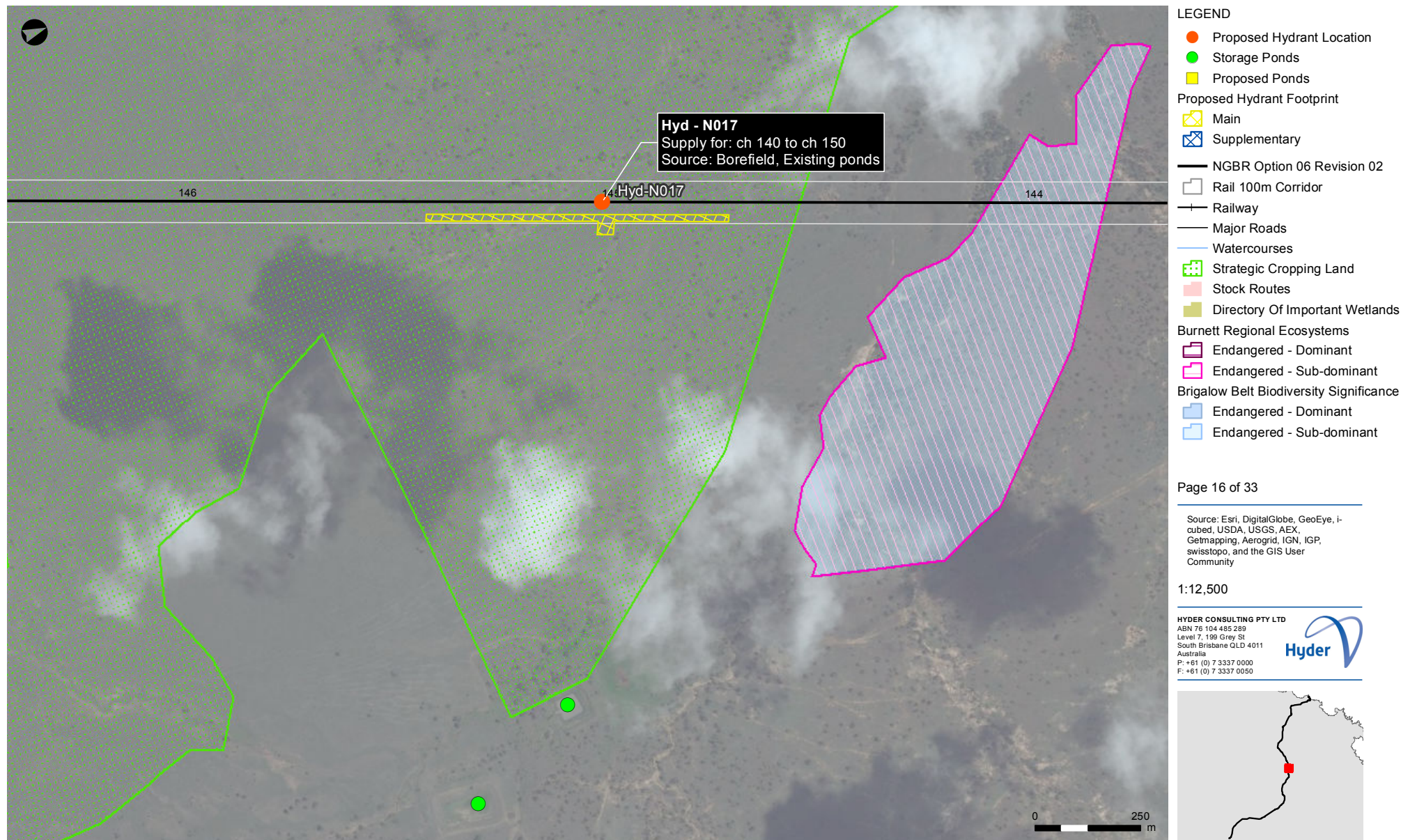


Figure 10.16: NGBR Water Hydrant Hyd-N017, Proposed Hydrant Footprint and Environmental Constraints

10.19 SUPPLY POINT HYD-N018

HYD-N018 is located at chainage 155km, 5.5km west of the intersection of Bowen Development Road and Collinsville-Elphinstowe Road. An existing unnamed road is available from Bowen Development Road to chainage 154. An average daily demand of 651kL for earthwork has been estimated at this supply point. Refer to Figure 10.17.

Water Quality	Raw Water	Chainage (km)	155
Average Daily Demand(kL)	651	Duration(days)	679

10.19.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this hydrant. The site is located on indurated sediment aquifer. It is expected that each borehole can yield 2.5L/s and as such 5 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that the suitable aquifers in the area are at a maximum depth of 100m.

Regulatory Requirements

5 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 5 lined borehole with pump to maximum depth of 100m and dedicated 6kVA generators.
- 900m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$495,000
- Recoverable assets: \$185,000

10.19.2 SUPPLEMENTARY OPTION

No supplementary option is required at this site.

10.19.3 ENVIRONMENTAL CONSIDERATIONS

HYD-N018 is located with a floodplain on flat terrain with extensive cleared areas and minimal vegetation. There is acceptable access to this area. The desktop assessment did not identify any key environmental considerations based on available data, however the EPBC search outlined within a 300m buffer of the hydrant footprint 1 listed threatened ecological community (endangered) which may occur within the area (Natural Grasslands of Queensland Central Highlands and the northern Fitzroy Basin) and 9 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

9 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).



Figure 10.17: NGBR Water Hydrant Hyd-N018, Proposed Hydrant Footprint and Environmental Constraints

10.20 SUPPLY POINT HYD-N019

The HYD-N019 is located at chainage 170km in Newlands Region, 1km west of Bowen Development Road. An unnamed access road to the proximity of the hydrant at chainage 169.5 exists. This site has been selected as the rail construction camp. To minimise the costs associated with water supply, it is proposed that this supply point also be used for earthwork water supply of the rail line segment between chainages 160 and 170. Therefore, an average daily demand of 737kL has been estimated for this supply point from which 132kL is the treated water required for the camp and should be provided for a longer period of time. Refer to Figure 10.20.

Water Quality	Raw Water for earthwork	Chainage (km)	170
	Treated water for the camp		
Average Daily Demand(kL)	605 for earthwork	Duration(days)	360 for earthwork
	132 for the camp		1850 for the camp

10.20.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this hydrant. It is located on indurated and unindurated sediment aquifer. It is expected that each borehole can yield 2.5L/s and as such 4 boreholes would have to be sunk to provide the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that the suitable aquifers in the area are at the maximum depth of 100m.

Regulatory Requirements

4 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 4 lined borehole with pump to maximum depth of 100m and dedicated 8kVA generators.
- 600m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.
- Separate 50kL storage tanks for drinking water and other camp water demands
- Separate treatment plant and distribution system for concrete mix and yards water and potable water as described in Section 6.

Estimated Capital Cost

- At location of hydrant: \$455,000
- For the borefield: \$390,000
- Recoverable assets: \$440,000

10.20.2 SUPPLEMENTARY OPTION

No supplementary option is required at this site.

10.20.3 ENVIRONMENTAL CONSIDERATIONS

Linkage to an existing road at chainage 169.5 km means that minimal clearing should be required to provide access to this hydrant (approximately 500 m to the east). The desktop assessment did not identify any key environmental considerations based on available data, however Brigalow belt exists 1.5 km east of hydrant location.

The EPBC search outlined within a 200m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

The hydrant footprint crosses a drainage line. Development and operation of bores and infrastructure should be placed outside of the drainage line and consider erosion and sediment control.



Figure 10.18: NGBR Water Hydrant Hyd-N019, Proposed Hydrant Footprint and Environmental Constraints

10.21 SUPPLY POINT HYD-N020

HYD-N020 is located at chainage 175km, 0.5km east of Bowen Development Road. Based on the distance from the road, access to the site can be provided from this road without significant environmental impact. An average daily demand of 591kL for earthwork has been estimated at this supply point. Refer to Figure 10.19.

Water Quality	Raw Water	Chainage (km)	175
Average Daily Demand(kL)	591	Duration(days)	173

10.21.1 MAIN OPTION

Source

The hydrant is located at chainage 175km of the rail line and provides the water supply of the segment of the rail line between chainages 170km and 180km. If the construction work at this hydrant starts after the work between chainages 160km and 170km is finished, the water supply system setup at chainage 170km may be used as the water supply for this segment. Otherwise, a separate water supply system should be provided for this segment of the rail line.

To setup a separate water supply boreholes can be used. The hydrant is located on indurated sediment aquifer. It is expected that each borehole can yield 3L/s and as such 3 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the site within the rail construction easement. It is expected that the suitable aquifers in the area are a maximum depth of 100m.

Regulatory Requirements

3 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 3 lined borehole with pump to maximum depth of 100m and dedicated 10kVA generators.
- 400m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$296,000
- Recoverable assets: \$145,000

10.21.2 SUPPLEMENTARY OPTION

No supplementary option is seems to be required at this site.

10.21.3 ENVIRONMENTAL CONSIDERATIONS

The desktop assessment did not identify any key environmental considerations based on available data for this hydrant footprint however the EPBC search outlined within a 200m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

The terrain in this location is quite undulating with varied but dense vegetation. Access can be provided with minimal impact to vegetation due to clearing requirements due to the close proximity of the Bowen Development Road (approximately 500 m). As bores are the primary option, associated clearing for infrastructure should be minimised.

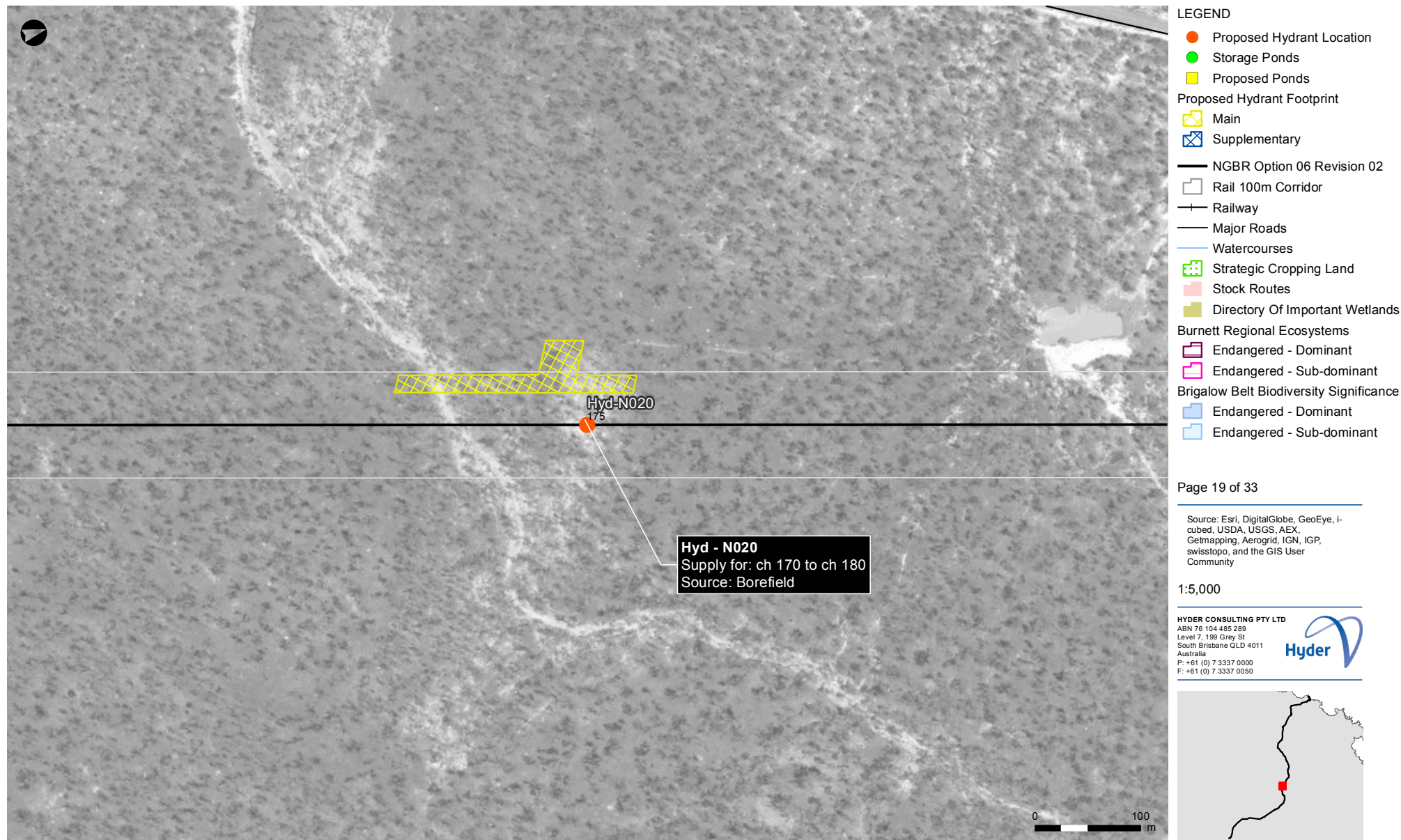


Figure 10.19: NGBR Water Hydrant Hyd-N020, Proposed Hydrant Footprint and Environmental Constraints

10.22 SUPPLY POINT HYD-N021

HYD-N021 is located at chainage 185km, 8.5km east of Bowen Development Road. No existing access road to the site is available. An average daily demand of 745kL for earthwork has been estimated at this supply point. Refer to Figure 10.20.

Water Quality	Raw Water	Chainage (km)	185
Average Daily Demand(kL)	745	Duration(days)	318

10.22.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply all the water requirements at this hydrant. It is located on indurated and unindurated sediment aquifer. It is expected that each borehole can yield 4L/s and as such 3 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that the suitable aquifers in the area are at the maximum depth of 150m.

Regulatory Requirements

3 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 3 lined borehole with pump to maximum depth of 150m and dedicated 20kVA generators.
- 400m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$296,000
- Recoverable assets: \$145,000

10.22.2 SUPPLEMENTARY OPTION

No supplementary option is seems to be required at this site.

10.22.3 ENVIRONMENTAL CONSIDERATIONS

The desktop assessment did not identify any key environmental considerations based on available data for this hydrant footprint, however the EPBC search outlined within a 200m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Northern Quoll).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

The terrain and access in this location provide difficulties and as the area is densely vegetated, extensive clearing is likely to be required in order to provide reliable access. As bores are the primary option, associated clearing for infrastructure should be minimised.

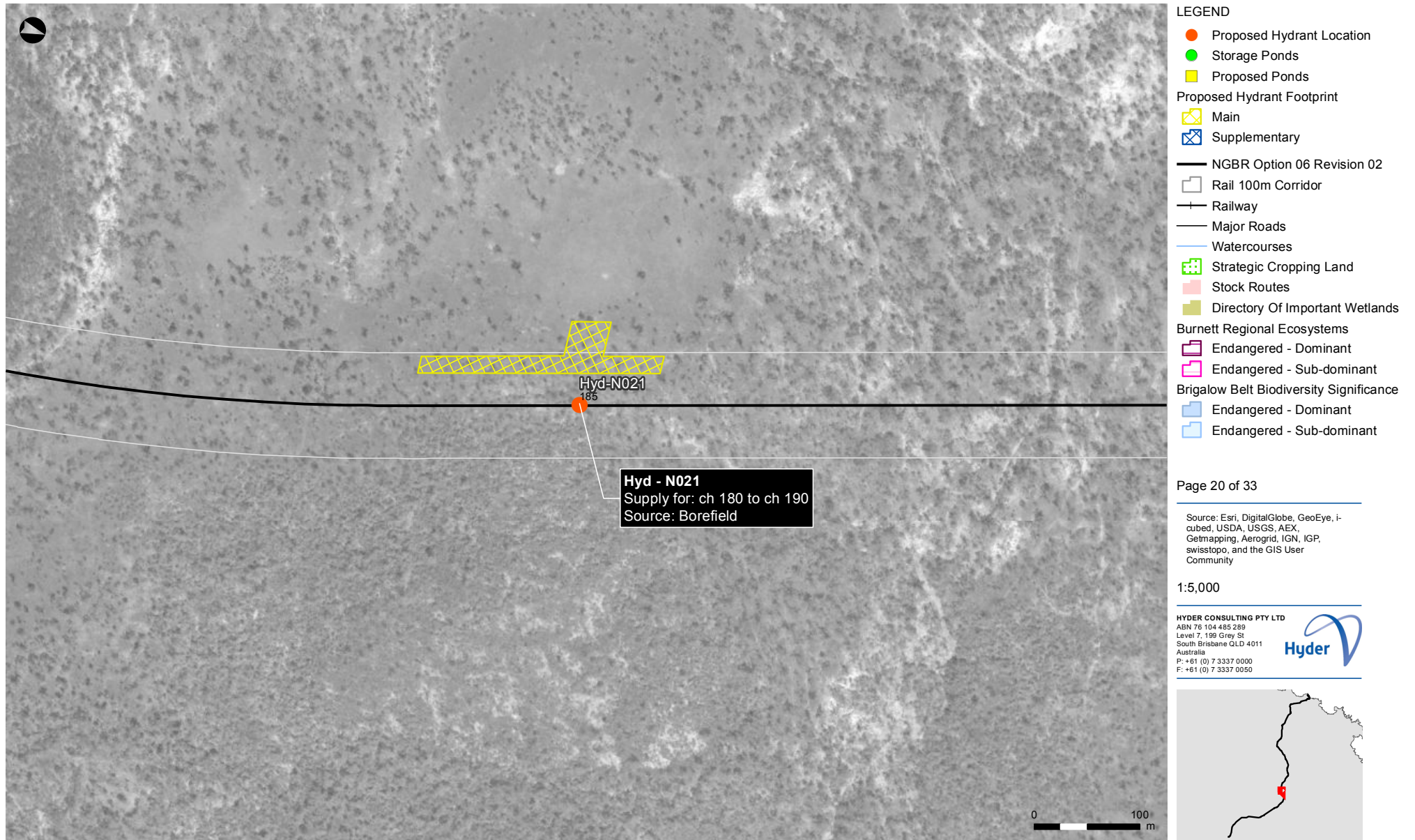


Figure 10.20: NGBR Water Hydrant Hyd-N021, Proposed Hydrant Footprint and Environmental Constraints

10.23 SUPPLY POINT HYD-N022

HYD-N022 is located at chainage 195km, in the Suttor region 25km north of Suttor Development Road. An existing unnamed dirt road branches from Suttor Road traversing 3 km from the hydrant which can be used for access. An average daily demand of 580kL has been estimated at this supply point. Refer to Figure 10.21.

Water Quality	Raw Water	Chainage (km)	195
Average Daily Demand(kL)	580	Duration(days)	170

10.23.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply all the water requirements at this hydrant. The hydrant is located on indurated and unindurated sediment aquifer. It is expected that each borehole can yield 5L/s and as such 2 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that suitable aquifers in the area are up to 150m deep.

Regulatory Requirements

2 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 2 lined borehole with pump to maximum depth of 150m and dedicated 20kVA generators.
- 200m, 200mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$253,000
- Recoverable assets: \$135,000

10.23.2 SUPPLEMENTARY OPTION

No supplementary option is seems to be required at this hydrant.

10.23.3 ENVIRONMENTAL CONSIDERATIONS

Due to the distance of existing dirt access track, extensive clearing is likely to be required in order to provide reliable access. The desktop assessment did not identify any key environmental considerations based on available data however the area around the hydrant footprint has dense ground cover vegetation.

The EPBC search outlined within a 100m buffer of the hydrant footprint 9 listed threatened species or species habitat likely to/may occur within the area. Two of these are listed as endangered (Star Finch, Australian Painted Snipe).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is a stock route 300 m north of hydrant location and Rockingham Creek lies 450m south-east. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control.

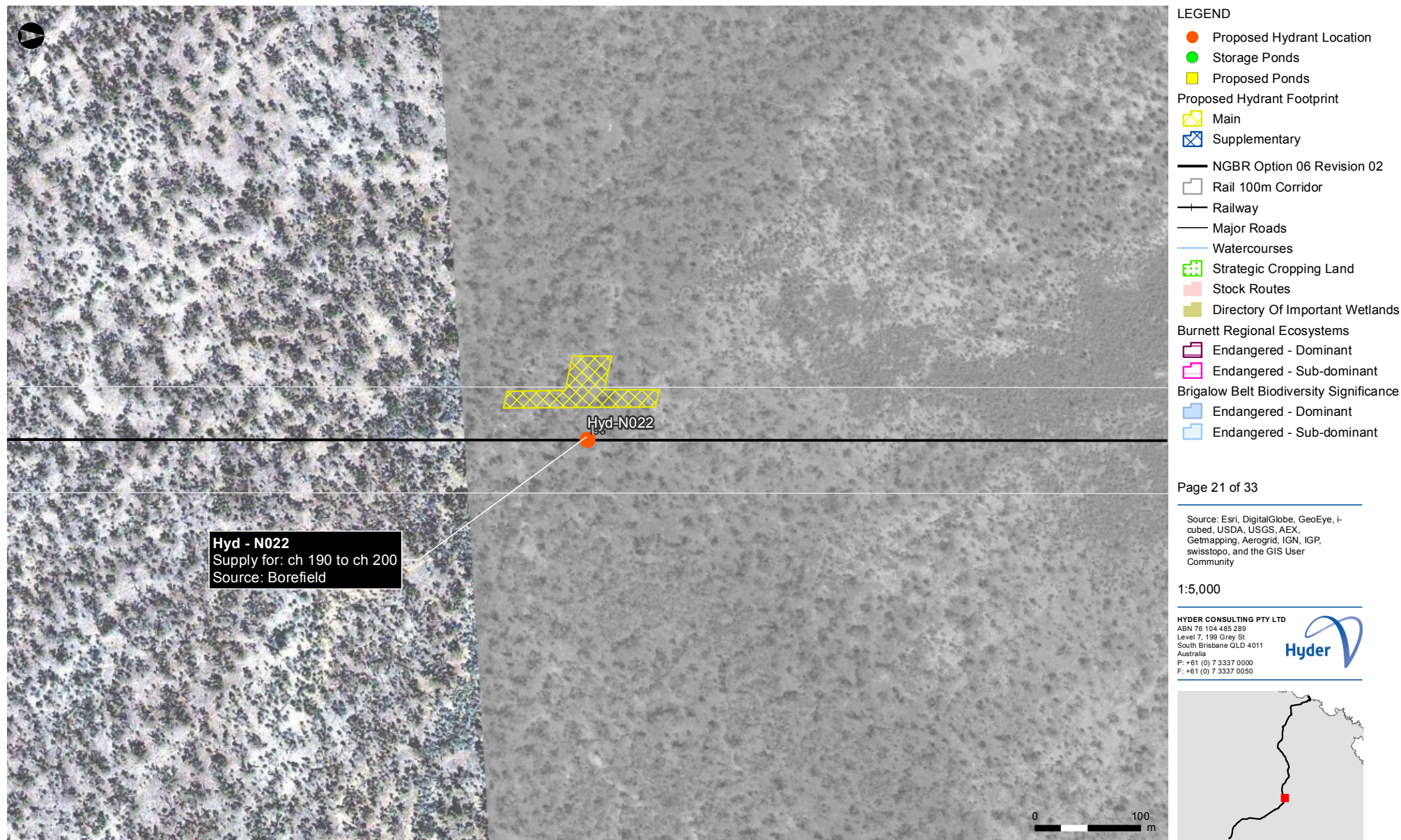


Figure 10.21: NGBR Water Hydrant Hyd-N022, Proposed Hydrant Footprint and Environmental Constraints

10.24 SUPPLY POINT HYD-N023

HYD-N023 is located at chainage 205km in the Suttor region, 13km north of Suttor Development Road. No existing formed access road to the hydrant has been detected. An average daily demand of 503kL for earthwork has been estimated at this supply point. Refer to Figure 10.22.

Water Quality	Raw Water	Chainage (km)	205
Average Daily Demand(kL)	503	Duration(days)	288

10.24.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this hydrant. The hydrant is located on fractured rock aquifer. It is expected that each borehole can yield 2L/s and as such 5 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that the suitable aquifers in the area are up to 150m deep.

Regulatory Requirements

5 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 5 lined borehole with pump to maximum depth of 150m and dedicated 7kVA generators.
- 900m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$645,000
- Recoverable assets: \$210,000

10.24.2 SUPPLEMENTARY OPTION

No supplementary option is seems to be required at this hydrant.

10.24.3 ENVIRONMENTAL CONSIDERATIONS

The desktop assessment did not identify any key environmental considerations based on available data, however the EPBC search outlined within a 300m buffer of the hydrant footprint 9 listed threatened species or species habitat likely to/may occur within the area. Two of these are listed as endangered (Star Finch, Australian Painted Snipe).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is no defined access to HYD-N023 and the area is heavily vegetated. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible.

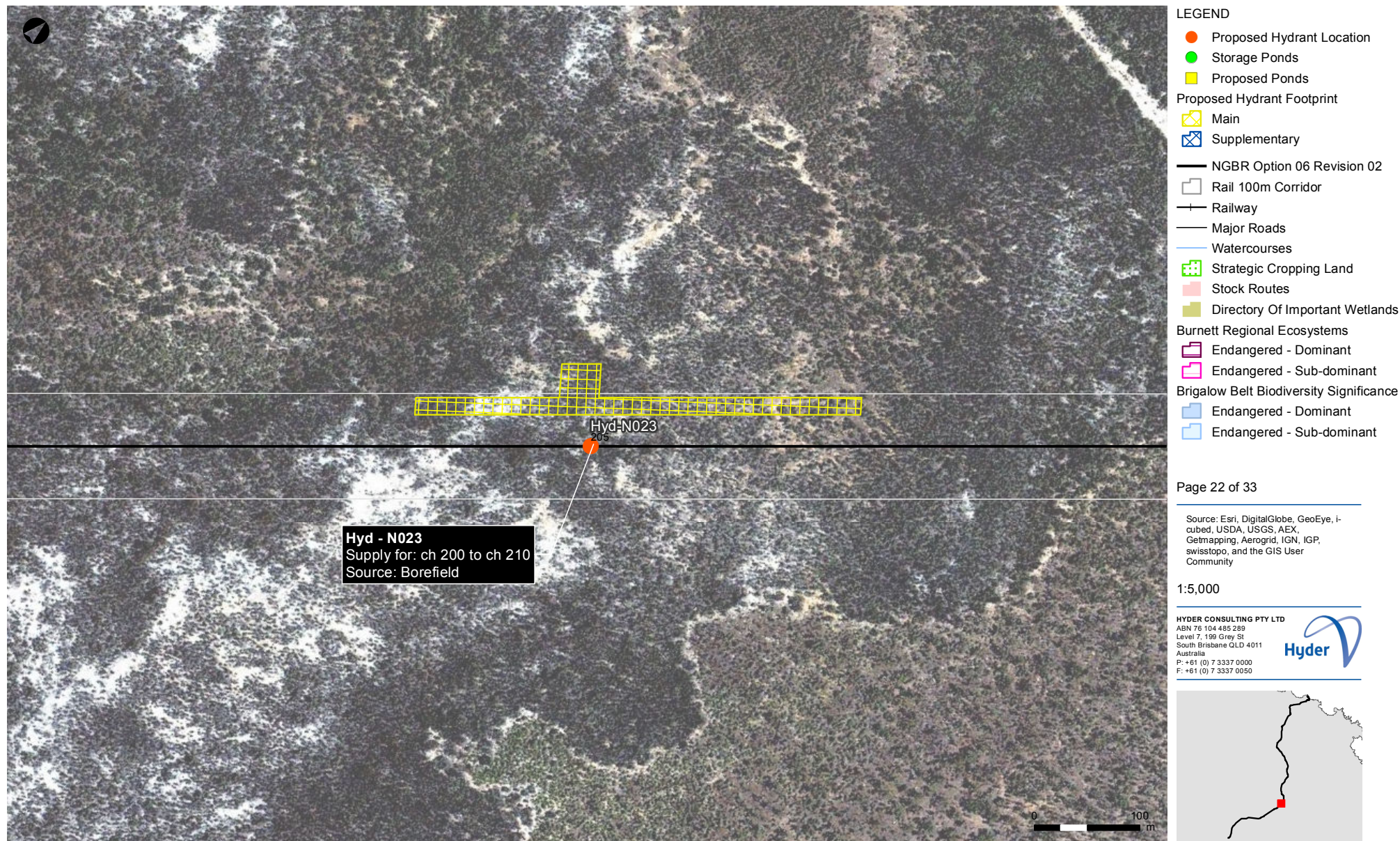


Figure 10.22: NGBR Water Hydrant Hyd-N023, Proposed Hydrant Footprint and Environmental Constraints

10.25 SUPPLY POINT HYD-N024

HYD-N024 is located at chainage 215km in Suttor region, 7km north of Suttor Development Road. No formed access road to the hydrant is available. An average daily demand of 654kL for earthwork has been estimated at this supply point. Refer to Figure 10.23.

Water Quality	Raw Water	Chainage (km)	215
Average Daily Demand(kL)	654	Duration(days)	135

10.25.1 MAIN OPTION

Source

It is unlikely that boreholes can provide the total amount of the water required at this hydrant. The anticipated yield from each bore is 1.5L/s. It is proposed that six boreholes with A maximum depth of 250m should be sunk to provide for the majority of the required water. The rest of the demand can be supplied from supplementary surface water resources.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 250m and dedicated 10kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$960,000
- Recoverable assets: \$295,000

10.25.2 SUPPLEMENTARY OPTION

Source

A small existing storage pond (Pond 58) is located 700m to the east of the supply point. Another larger pond named 'Pond 34' is situated next to the rail line at chainage 211.5km. These ponds may be used as a supplementary source for the hydrant. This will involve construction of a small pump station with 5L/s pumping capacity next to each of the storage ponds. A 700m embedded

100mm HPDE pipeline can be used to connect Pond 58 to the raw water tanks at the water supply point. Water extracted from Pond 34 can be directly delivered to the location of the earthwork.

Regulatory Requirements

New In-Stream Storage

- Water permit for temporary take of water (2-3 months)
- Consent of Chief Executive (2 weeks)
- Development permit to construct (2-3 months)
- Riverine Protection Permit for construction within a waterway (2-3 months)

Water Supply Components

The conveyed water from this supply point will feed the raw water tanks located at the supply point. These tanks are discussed in section 7.5.1. The additional components needed to operate this supplementary option are as follows:

For pond 58:

- Pumping and generator facility located next to the existing pond with 5L/s pumping rate
- 100mm diameter embedded HPDE pipe with 700m length

For pond 34:

- Pipe stands next to each pond
- Pump with 3L/s pumping rate

Estimated Capital Cost

- At the storage ponds: \$63,000

10.25.3 ENVIRONMENTAL CONSIDERATIONS

There is no defined access to HYD-N024 and the terrain is very rocky. The area is treed but cleared heavily in areas. The desktop assessment did not identify any key environmental considerations based on available data, however the EPBC search outlined within an 800m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, Allan's Lerista/Retro Slider).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible. As existing storage ponds are located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location in order to minimise clearing requirements.

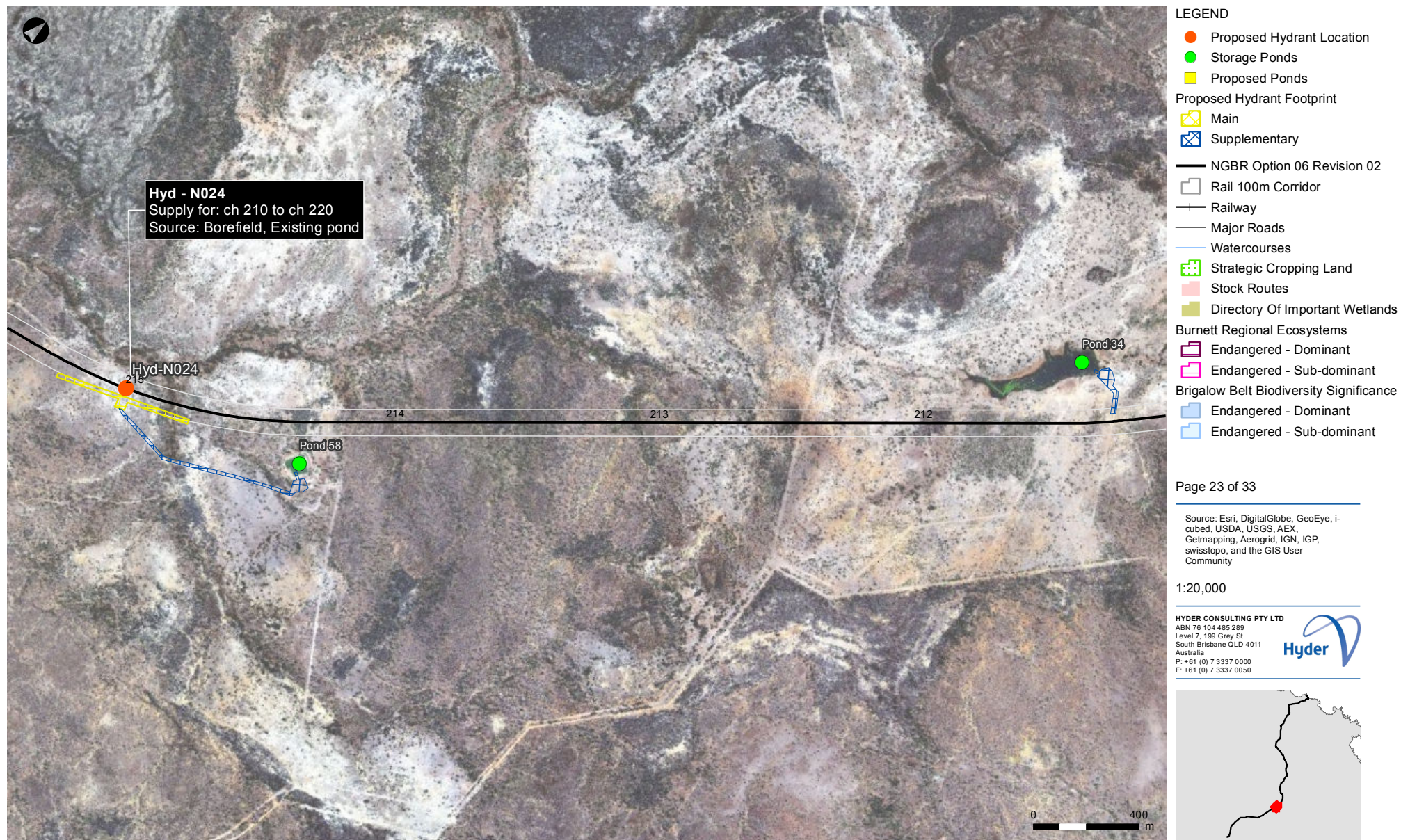


Figure 10.23: NGBR Water Hydrant Hyd-N024, Proposed Hydrant Footprint and Environmental Constraints

10.26 SUPPLY POINT HYD-N025

HYD-N025 is located at chainage 225km in Suttor region, 4km to the north of Suttor Development Road. An unnamed access road with 7km length connects the hydrant to the Suttor Development Road. An average daily demand of 980kL for earthwork has been estimated at this supply point. Refer to Figure 10.24.

Water Quality	Raw Water	Chainage (km)	225
Average Daily Demand(kL)	980	Duration(days)	59

10.26.1 MAIN OPTION

Source

It is unlikely that boreholes can provide the total amount of the water required at this hydrant. The anticipated yield from each bore is 1.5L/s. It is proposed that six boreholes with maximum depth of 150m should be sunk to provide for the majority of the required water. The rest of the demand can be supplied from supplementary surface water resources.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 150m and dedicated 5kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$780,000
- Recoverable assets: \$235,000

10.26.2 SUPPLEMENTARY OPTION

Source

A small existing storage pond named pond 35 is located 550m to the west of the supply point. In addition, two medium size storage ponds named pond 70 and pond 36 are located 860m to the west of chainage 220 and 1900m to the west of chainage 230 respectively. These ponds may be used as supplementary source for the project. This will involve construction of a small pump

station with 5L/s pumping capacity next each storage pond or using of these ponds in turns by temporary setup of portable pumps.

It is proposed to load tanker trucks at the location of the existing ponds and deliver the water to the location of the earthwork.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

The additional components operating of this supplementary option are as follows:

- Three pipe stands one at the location of each existing pond
- A portable pump to be temporarily set up at the location of each existing pond.

Estimated Capital Cost

- For the storage ponds: \$94,500
- Recoverable assets: \$35,000

10.26.3 ENVIRONMENTAL CONSIDERATIONS

Access to HYD-N025 is possible via existing dirt tracks which connect to the Suttor Development Road. The area is a floodplain with minimal trees; however some clearing will be required to accommodate for bores and other infrastructure. Brigalow belt biodiversity significance areas exist within and around the hydrant footprint, including endangered – dominant vegetation, containing at least one endangered Regional Ecosystem.

The EPBC search outlined within a 650m buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe).

8 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

As existing storage ponds are located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location in order to minimise clearing requirements.

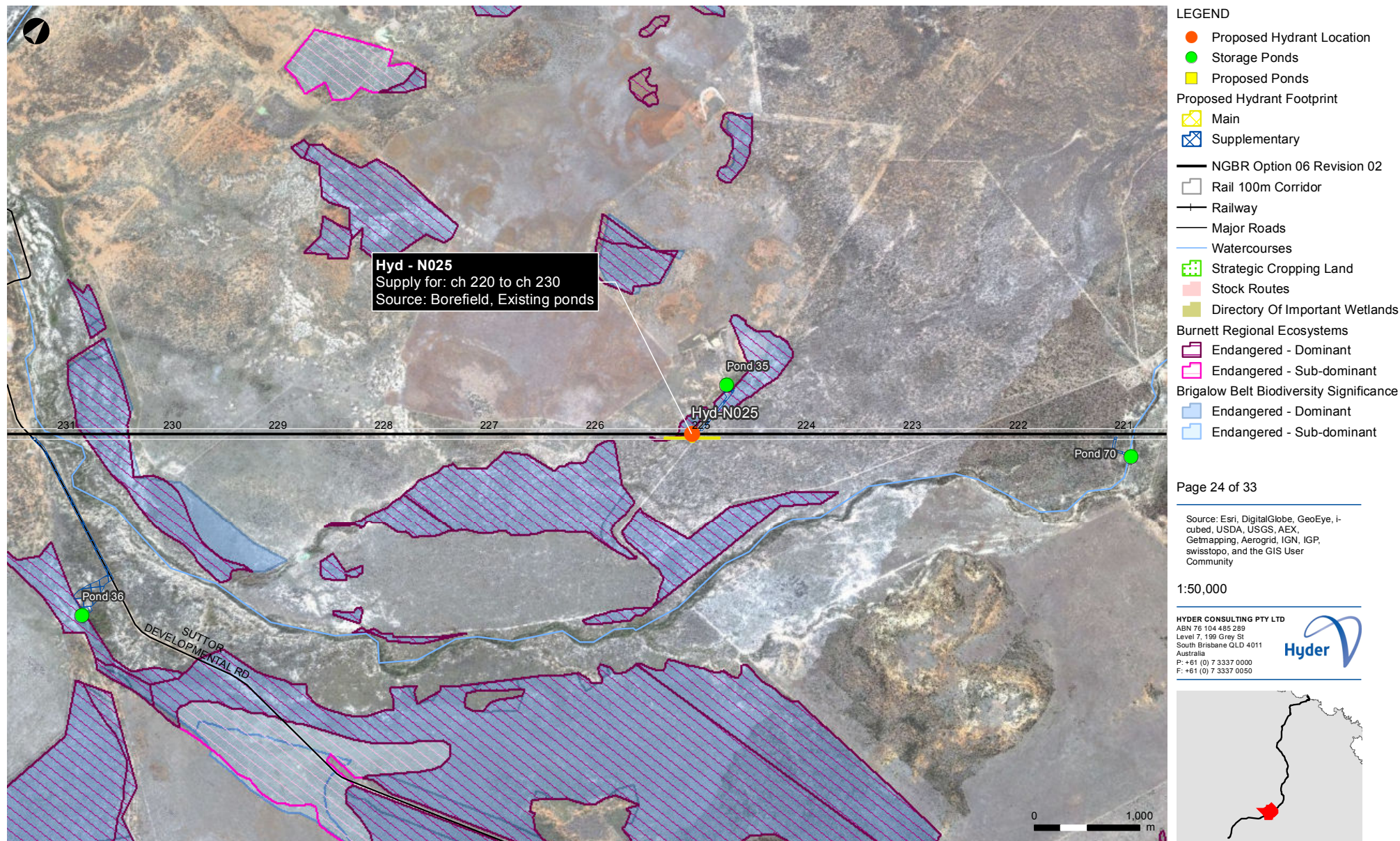


Figure 10.24: NGBR Water Hydrant Hyd-N025, Proposed Hydrant Footprint and Environmental Constraints

10.27 SUPPLY POINT HYD-N026

HYD-N026 is located at chainage 235km, in Mount Coolon region 4km south west of Suttor Development Road. An existing unnamed dirt track connects the Suttor Road to the hydrant. An average daily demand of 534kL for earthwork has been estimated at this supply point. Refer to Figure 10.25.

Water Quality	Raw Water	Chainage (km)	235
Average Daily Demand(kL)	534	Duration(days)	107

10.27.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply all the water requirements at this hydrant. The hydrant is located on indurated and unindurated sediment aquifer. It is expected that each borehole can yield 2L/s and as such 5 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that suitable aquifers in the area are up to 150m deep.

Regulatory Requirements

5 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 5 lined borehole with pump to maximum depth of 150m and dedicated 8kVA generators.
- 900m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$645,000
- Recoverable assets: \$210,000

10.27.2 SUPPLEMENTARY OPTION

Source

Using of surface water is not required for this hydrant. However, by incorporating the existing storage ponds located along the rail line the number of the boreholes can be reduced. Storage pond 36 is located 1500m to the east of chainage 231. Another larger pond named as 'Pond

69 is situated next to the rail line at chainage 238. Pond 68 with considerable storage capacity is placed at chainage 240km. These ponds may be used as a supplementary source for the hydrant. This will involve construction of a small pump station with 3L/s pumping capacity and tanker truck loading facility next to each of the storage ponds. Extracted water from these Ponds can be directly delivered to the location of the earthwork.

Regulatory Requirements

N/A

Water Supply Components

The conveyed water from this supply point will feed the raw water tanks located at the supply point. These tanks are discussed in section 7.5.1. The additional components required to operate this option are as follows:

- 3 Pipe stands next to each pond
- 3 Pump with 3L/s pumping rate

10.27.3 ENVIRONMENTAL CONSIDERATIONS

Access to HYD-N026 is possible via existing dirt tracks which connect to the Suttor Development Road. The area is a floodplain with minimal trees; however, some clearing will be required to accommodate for bores and other infrastructure. The desktop assessment did not identify any key environmental considerations based on available data, however SCL lies to the north-east of the hydrant footprint.

The EPBC search outlined within a 300m buffer of the hydrant footprint 9 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Australian Painted Snipe, King Blue-grass).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

If Pond 69 is to be used as a supplementary source, consideration needs to be given to other users of this supply, cattle, native wildlife, and vegetation clearing for pipe infrastructure to the hydrant. Emu were sited at Pond 69, as well as Pelican and Brahminy Kite.

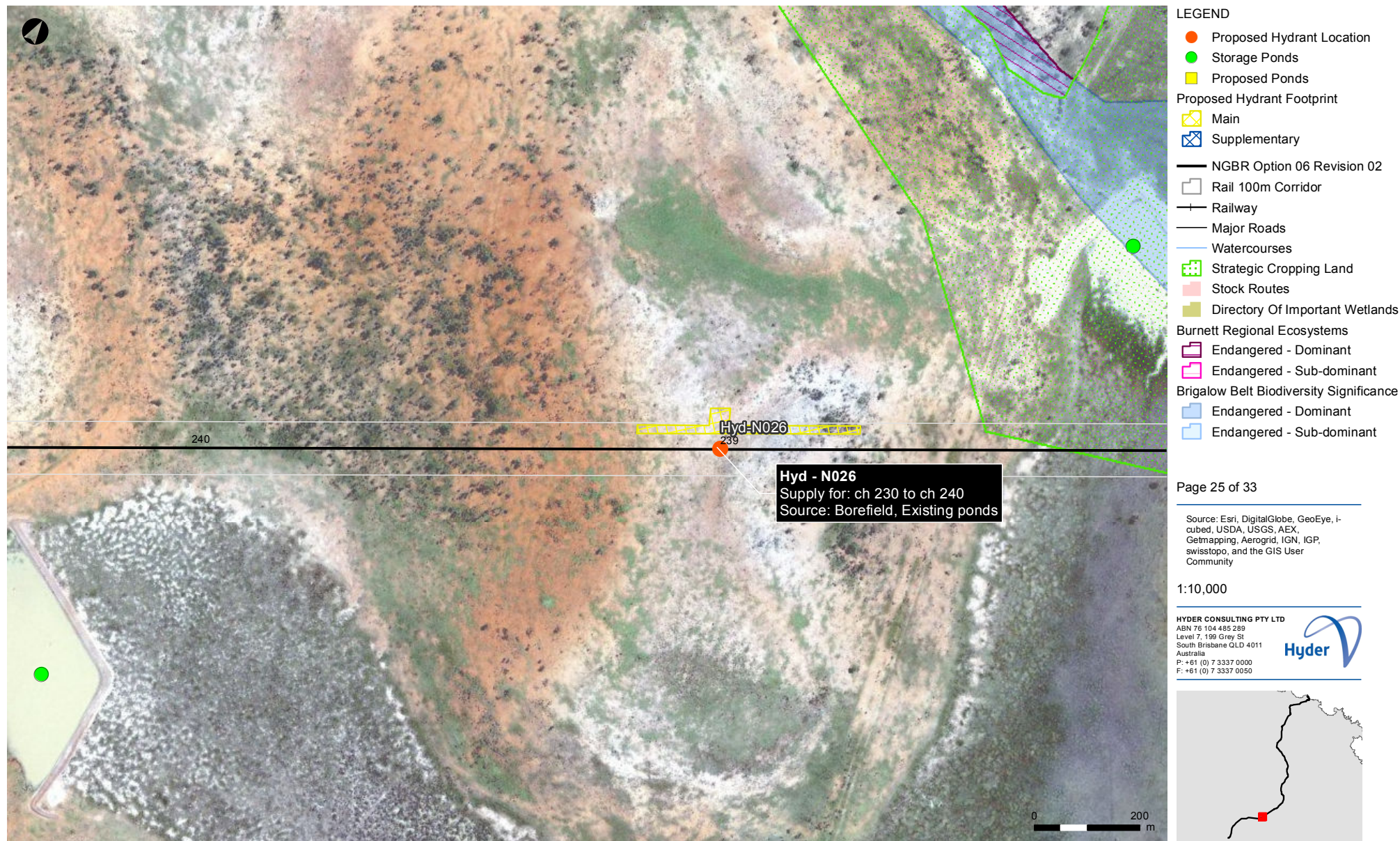


Figure 10.25: NGBR Water Hydrant Hyd-N026, Proposed Hydrant Footprint and Environmental Constraints

10.28 SUPPLY POINT HYD-N027

HYD-N027 is located at chainage 245km, in Mount Coolon region 12km to the south of Suttor Development Road. The hydrant is accessible via Kilcummin- Diamond Downs Road. An average daily demand of 584kL for earthwork has been estimated at this supply point. Refer to Figure 10.26.

Water Quality	Raw Water	Chainage (km)	245
Average Daily Demand(kL)	584	Duration(days)	130

10.28.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply the water requirements at this hydrant. The hydrant is located on an alluvial aquifer. It is expected that each borehole can yield 2L/s and as such 5 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that suitable aquifers in the area are up to 150m deep.

Regulatory Requirements

5 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 5 lined borehole with pump to maximum depth of 150m and dedicated 8kVA generators.
- 900m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$645,000
- Recoverable assets: \$210,000

10.28.2 SUPPLEMENTARY OPTION

Source

No supplementary option is seems to be required at this hydrant. However, using available surface water supplies can reduce the number of boreholes. 'Pond 38' is located 1km from the

supply point. The pond size is not relatively large but is located on a major waterway with a large flow catchment which increases the reliability of this water supply.

To use this existing pond a pipe stand should be installed next to them. When required, a portable pump can be located next to each pond with connections to both storage pond and the pipe stand for tanker truck loading. Raw water can be directly delivered to the location of the earthwork.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

The additional components required for the supplementary option are as follows:

- Pipe stands next to the pond
- Pump station with 5L/s pumping rate

10.28.3 ENVIRONMENTAL CONSIDERATIONS

Access to HYD-N027 is possible via existing dirt tracks which connect to the Kilcummin-Diamond Downs Road. The area is a floodplain with minimal trees; however, some clearing will be required to accommodate for bores and other infrastructure. The desktop assessment did not identify any key environmental considerations within the hydrant footprint based on available data, however SCL exists 1 km west, and Brigalow belt 900 m west.

The EPBC search outlined within a 350m buffer of the hydrant footprint 1 listed endangered threatened Ecological Community (Brigalow) and 9 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

If Pond 38 is required for supplementary supply, consideration needs to be given to clearing, erosion and sediment control. Runoff from construction and operation of the hydrant and infrastructure needs to be carefully contained so as to avoid impacts to the adjacent waterway and aquatic ecosystems.



Figure 10.26: NGBR Water Hydrant Hyd-N027, Proposed Hydrant Footprint and Environmental Constraints

10.29 SUPPLY POINT HYD-N028

HYD-N028 is located at chainage 255km, in Mount Coolon region 20km south of Bowen Development Road and Suttor Development Road junction. No access road to the hydrant exists. An average daily demand of 809kL for construction camps and earthwork has been estimated at this supply point. Refer to Figure 10.27.

Water Quality	Raw Water	Chainage (km)	255
Average Daily Demand(kL)	809	Duration(days)	39

10.29.1 MAIN OPTION

Source

It is anticipated that groundwater can be used to supply for all the water requirements at this hydrant. The hydrant is located on an alluvial aquifer. It is expected that each borehole can yield 2L/s and as such 6 boreholes would have to be sunk to provide for all the required water. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that suitable aquifers in the area are up to 150m deep.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 6 lined borehole with pump to maximum depth of 150m and dedicated 8kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$780,000
- Recoverable assets: \$235,000

10.29.2 SUPPLEMENTARY OPTION

Source

No supplementary option is seems to be required at this hydrant. However, a number of existing ponds including 'Pond 39', 'Pond 41' and 'Pond 42' are located along the rail line a reasonable

distance from the rail line. These storage ponds can be used to replace a part of the boreholes or to provide more reliability to the hydrant water supply.

To use each of these existing ponds a pipe stand should be installed next to them. When required, a portable pump can be located next to each pond with connections to both storage pond and the pipe stand for tanker truck loading. Raw water can be directly delivered to the location of the earthwork.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

The additional components required for the supplementary option are as follows:

- Pipe stands next to each pond
- Portable pump with 3L/s pumping rate

10.29.3 ENVIRONMENTAL CONSIDERATIONS

The area associated with this hydrant footprint is within a floodplain with minimal trees. Although there is no existing access, little to no clearing would be required and could follow existing property fence lines where practical. The desktop assessment did not identify any key environmental considerations based on available data, however Serpentine Creek lies 2.1km to east and there is Strategic Cropping Land 1.6km to the east and Brigalow belt 1.7km east.

The EPBC search outlined within a 300m buffer of the hydrant footprint 7 listed threatened species or species habitat likely to/may occur within the area. Two of these are listed as endangered (Star Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible. If Pond 69 is to be used as a supplementary source, consideration needs to be given to vegetation clearing for pipe infrastructure to the hydrant.

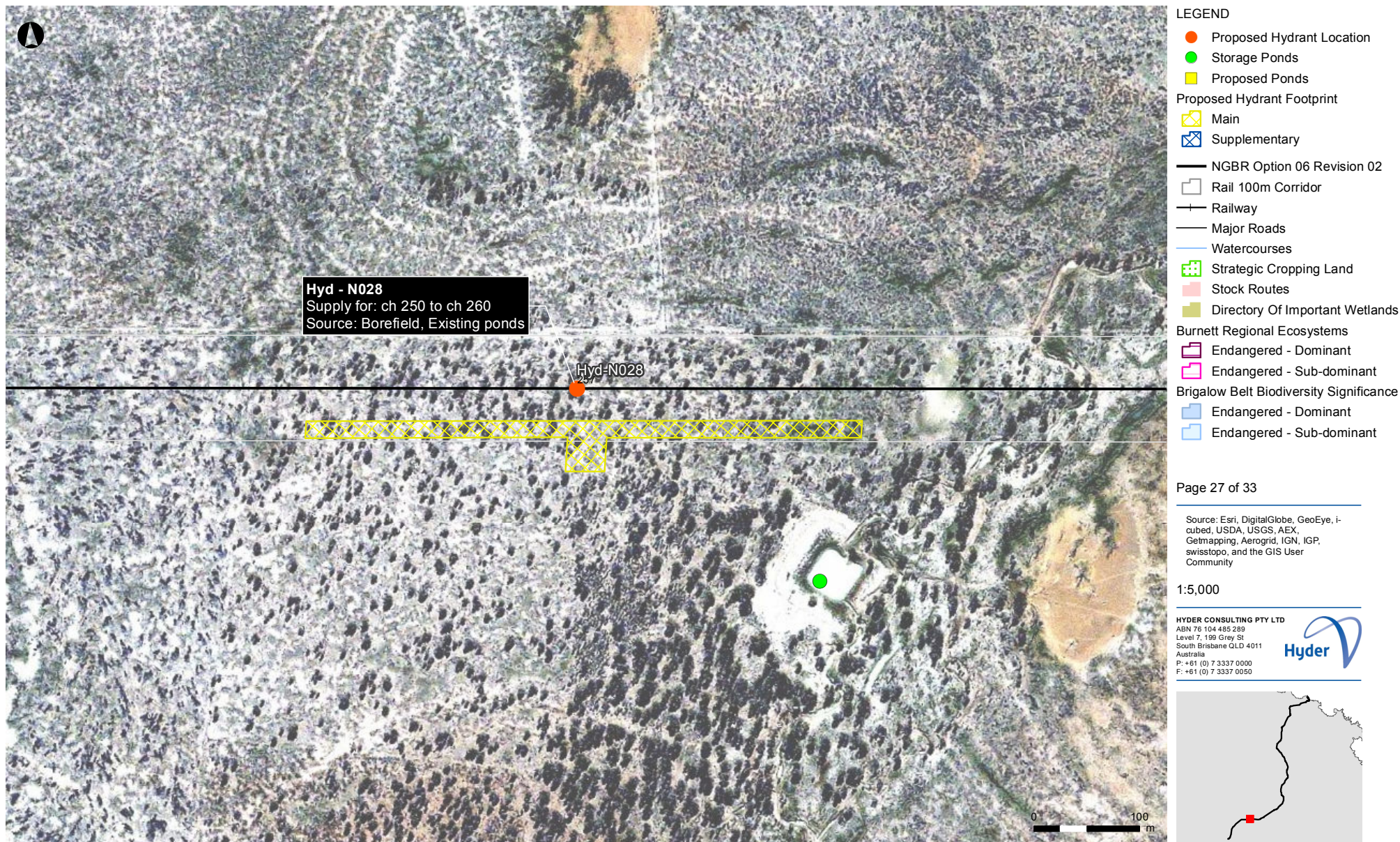


Figure 10.27: NGBR Water Hydrant Hyd-N028, Proposed Hydrant Footprint and Environmental Constraints

10.30 SUPPLY POINT HYD-N029

HYD-N029 is located at chainage 262km, 15.5km to the south of Bowen Development Road. To existing access road to the hydrant has been detected. This hydrant has been selected as the rail construction camp. To minimise the costs associated to the water supply of the project, it is proposed that this supply point is also be used for earthwork water supply of the rail line segment between chainages 260 and 270. Therefore, the total average daily demand at the hydrant will be 1112kL from which 112kL is the treated water required for the camp and should be provided for a longer period of time. Refer to Figure 10.28.

Water Quality	Raw Water for earthwork	Chainage (km)	262
	Treated water for the camp		
Average Daily Demand(kL)	1000 for earthwork	Duration(days)	23 for earthwork
	112 for the camp		600 for the camp

10.30.1 MAIN OPTION

Source

Groundwater cannot supply all the water required at this hydrant. Each borehole can yield 2.0L/s. It is proposed to excavate 7 boreholes to provide a reliable source for the water demand. The bores can be sunk close to the hydrant within the rail construction easement. It is expected that suitable aquifers in the area are up to 150m deep.

Regulatory Requirements

7 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for this option will be as follows:

- 7 lined borehole with pump to maximum depth of 150m and dedicated 5kVA generators.
- 1600m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.
- Separate 50kL storage tanks for drinking water and other camp water demands
- Separate treatment plant and distribution system for concrete mix and yards water and potable water as described in section 6.

Estimated Capital Cost

- At location of hydrant: \$455,000
- For the borefield: \$920,000

- Recoverable assets: \$555,000

10.30.2 SUPPLEMENTARY OPTION

An existing storage pond with considerable storage volume is located 780m to the north of the chainage 270. The pond may be used as a supplementary source for the project. This will involve construction of a small pump station with 5L/s pumping capacity and a pipe stand for truck loading next to the storage pond. Water can be trucked from this point to the location of the earthwork along the rail line.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

The conveyed water from this supply point will feed the raw water tanks located at the supply point. These tanks discussed in section 7.5.1. The additional components operating of this supplementary option are as follows:

- Pumping and generator facility located next to the existing pond with 5L/s pumping rate
- Tanker loading pipe stand

Estimated Capital Cost

- At the storage pond: \$48,000

10.30.3 ENVIRONMENTAL CONSIDERATIONS

This area is floodplain within the Lake Suttor catchment. There is minimal vegetation in the area. The desktop assessment did not identify any key environmental considerations within the hydrant footprint based on available data however there is Brigalow belt at Chainage 260km.

The EPBC search outlined within a 400m buffer of the hydrant footprint 7 listed threatened species or species habitat likely to/may occur within the area. Two of these are listed as endangered (Star Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Although there is no existing access, little to no clearing would be required and could follow existing property fence lines where practical. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible. If a new pond is going to be constructed for supplementary supply, consideration needs to be given to location to minimise clearing and access requirements.

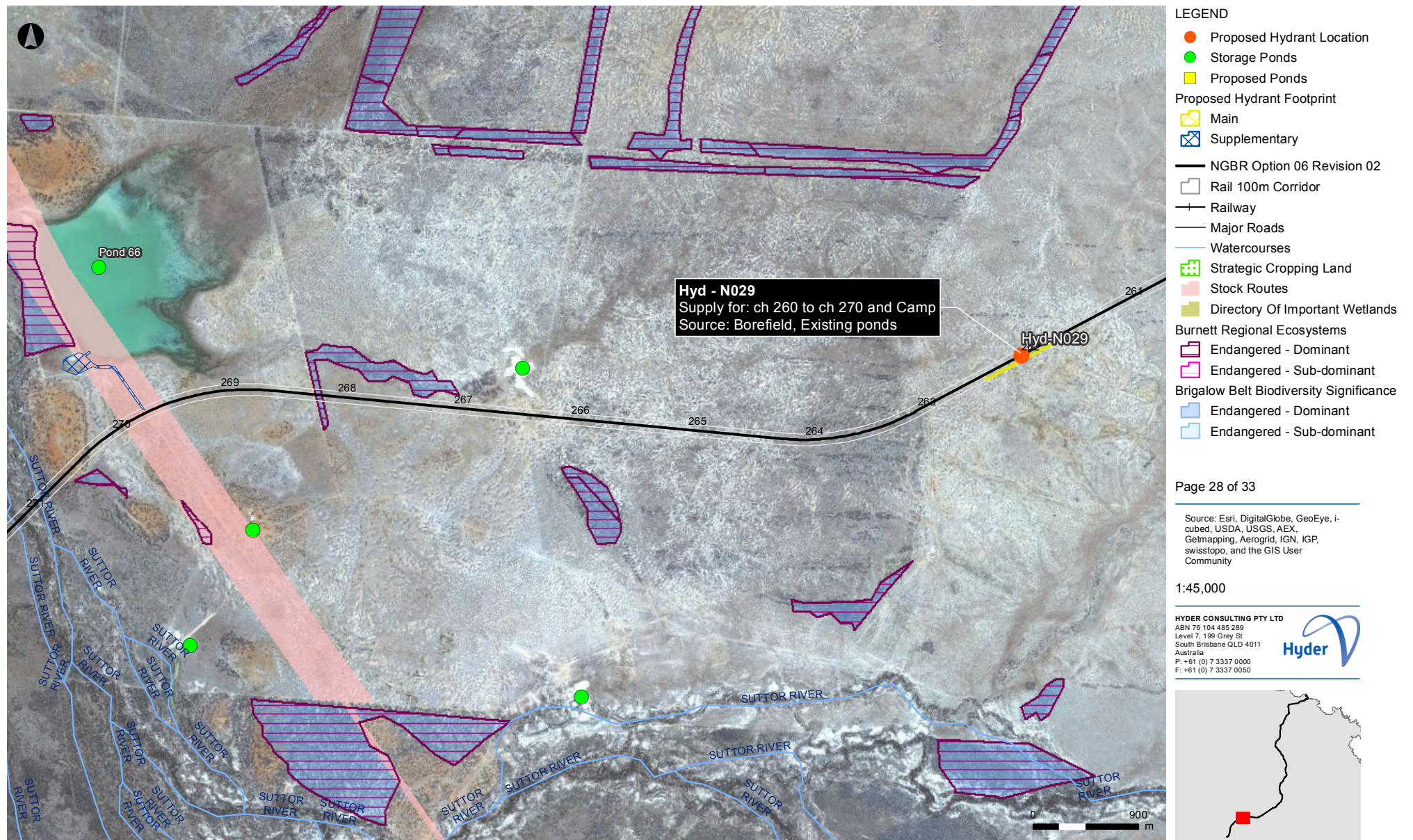


Figure 10.28: NGBR Water Hydrant Hyd-N029, Proposed Hydrant Footprint and Environmental Constraints

10.31 SUPPLY POINT HYD-N030

HYD-N030 is located at chainage 275km, 3km to the north of Lake Suttor. The hydrant is located 13km to the south of Bowen Development Road. An average daily demand of 947kL has been estimated for earthworks. Refer to Figure 10.29.

Water Quality	Raw Water	Chainage (km)	275
Average Daily Demand(kL)	947	Duration(days)	49

10.31.1 MAIN OPTION

Source

Six boreholes with the depth of up to 150m are proposed to be sunk in the site area. The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

The hydrant is located on sediment aquifer with a relatively low potential yield of 1.5L/s. It is unlikely that boreholes alone can provide the total amount of water required at this hydrant.

Surface water sources would have to be used as a supplementary option to provide for a small portion of water supply.

Regulatory Requirements

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 150m and dedicated 5kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$780,000
- Recoverable assets: \$235,000

10.31.2 SUPPLEMENTARY OPTION

Source

No existing pond with enough storage capacity is located in proximity of the hydrant location, therefore it is proposed that a new storage pond (proposed pond 2) is built at a location 1050m to the south of the site.

Incorporating the proposed storage pond to the water supply system would require a small pump station with 5L/s pumping capacity and 1050m of embedded 100mm HPDE pipeline from the pump station to the water supply point at the site.

As an alternative, water can be loaded from the pond into the trucks and delivered directly to the rail line construction area for the earthwork.

Regulatory Requirements

- New Off-Stream Storage
- Landholder negotiations (1-2 months)
- notice to DNRM within 60 days of construction completion

Water Supply Components

The conveyed water from this hydrant will feed the raw water tanks located at the supply point. These tanks were discussed in section 7. The additional components required for this supplementary option are as follows:

- 150mx150mx 5m storage pond for more reliability of the option.
- Pumping and generator facility located next to the existing pond with 5L/s pumping rate
- 100mm diameter embedded HPDE pipe with 1.2km length

Estimated Capital Cost

- For the storage pond: \$908,000
- Recoverable assets: \$50,000

10.31.3 ENVIRONMENTAL CONSIDERATIONS

The area surrounding HYD-N030 consists of flat terrain and scattered scrubby vegetation. There are two homesteads 2 km south and south-west of this location. Access is good via existing dirt tracks; however, links to this access need to be provided requiring approximately 1km of clearing. Brigalow belt biodiversity significance areas exist within and around the hydrant footprint, including endangered – dominant vegetation, containing at least one endangered Regional Ecosystem.

The EPBC search outlined within a 1.2km buffer of the hydrant footprint 7 listed threatened species or species habitat likely to/may occur within the area. Two of these are listed as endangered (Star Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

This area is within the Lake Suttor catchment. Extensive birdlife was evident. Development of bores should focus on minimising clearing where possible. As proposed pond 2 is located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location in order to minimise clearing requirements.

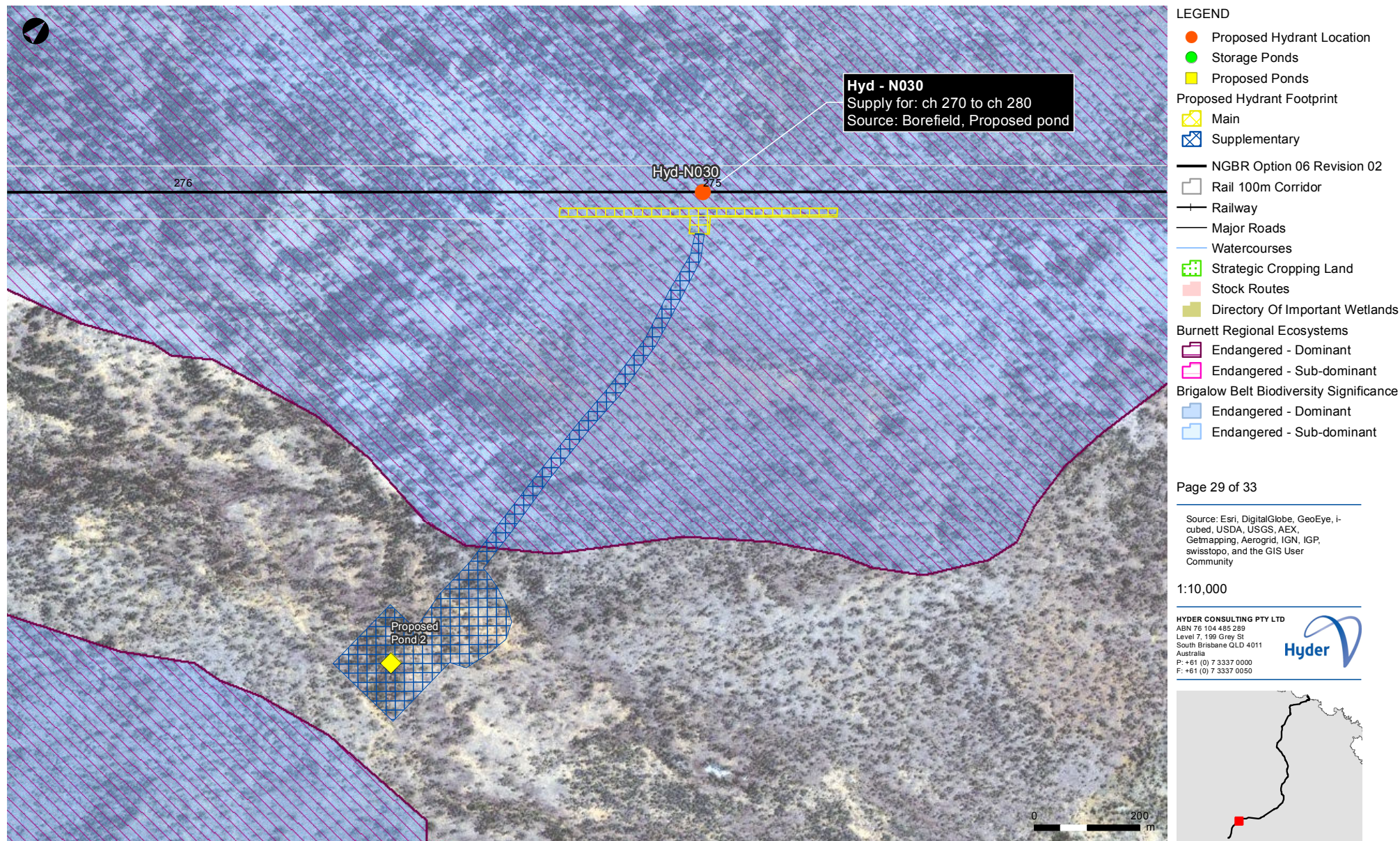


Figure 10.29: NGBR Water Hydrant Hyd-N030, Proposed Hydrant Footprint and Environmental Constraints

10.32 SUPPLY POINT HYD-N031

HYD-N032 is located at chainage 285km, 14km to the east of Gregory Developmental Road. An existing unnamed dirt road to the vicinity of the hydrant is available. An average daily demand of 743kL for earthwork has been estimated at this supply point. Refer to Figure 10.30.

Water Quality	Raw Water	Chainage (km)	285
Average Daily Demand(kL)	743	Duration(days)	56

10.32.1 MAIN OPTION

Source

Based on the limited available information the hydrant is located on alluvial sediment with relatively low yield of 1.5L/s from each borehole. It is unlikely that boreholes can provide the total amount of water required at this hydrant. Therefore, surface flow sources would have to be used as a supplementary option to provide a small portion of the water supply. Six boreholes with the depth of up to 230m are proposed to be sunk in the hydrant area.

The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required for the main water supply option will be as follows:

- 6 lined boreholes with pump to maximum depth of 230m and dedicated 8kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$780,000
- Recoverable assets: \$235,000

10.32.2 SUPPLEMENTARY OPTION

Source

Existing ponds 67 and 56 are located with reasonable distance from the chainages 285km and 290km respectively. Use of these existing ponds can be negotiated with the owner as the supplementary source for this hydrant. This will involve construction of a small pump station with 5L/s pumping capacity next to each storage pond. Extracted water from the ponds can be loaded into the tanker trucks and delivered directly to the location of the earthwork along the rail line.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

- Two pumping and generator facility located next to the existing pond with 5L/s pumping rate
- Two tanker loading pipe stands

Estimated Capital Cost

- At the storage ponds: \$96,000
- Recoverable assets: \$40,000

10.32.3 ENVIRONMENTAL CONSIDERATIONS

An existing dirt road within the vicinity of the site is available at HYD-N031, which reduces the requirement for clearing. Pond 67 is just outside the one km buffer, resulting in increased impacts for access and pipe construction and implications for approvals. Vegetation in this area is substantial although predominantly low lying scrub.

The EPBC search outlined within a 1.5km buffer of the hydrant footprint 1 listed endangered threatened ecological community (Brigalow) and 8 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

There is no cleared area surrounding Pond 67 and vegetation clearing could also be extensive between the pond and the hydrant. There is a Brigalow belt biodiversity significant zone surrounding the pond location, which starts 50 m north and 500 m south. Consideration needs to be given to minimising clearing for infrastructure and access where possible. Expansion of the Pond 67 should be avoided if possible so as to minimise impacts to vegetation.

Location of bores should also consider minimising impacts to vegetation due to clearing requirements.

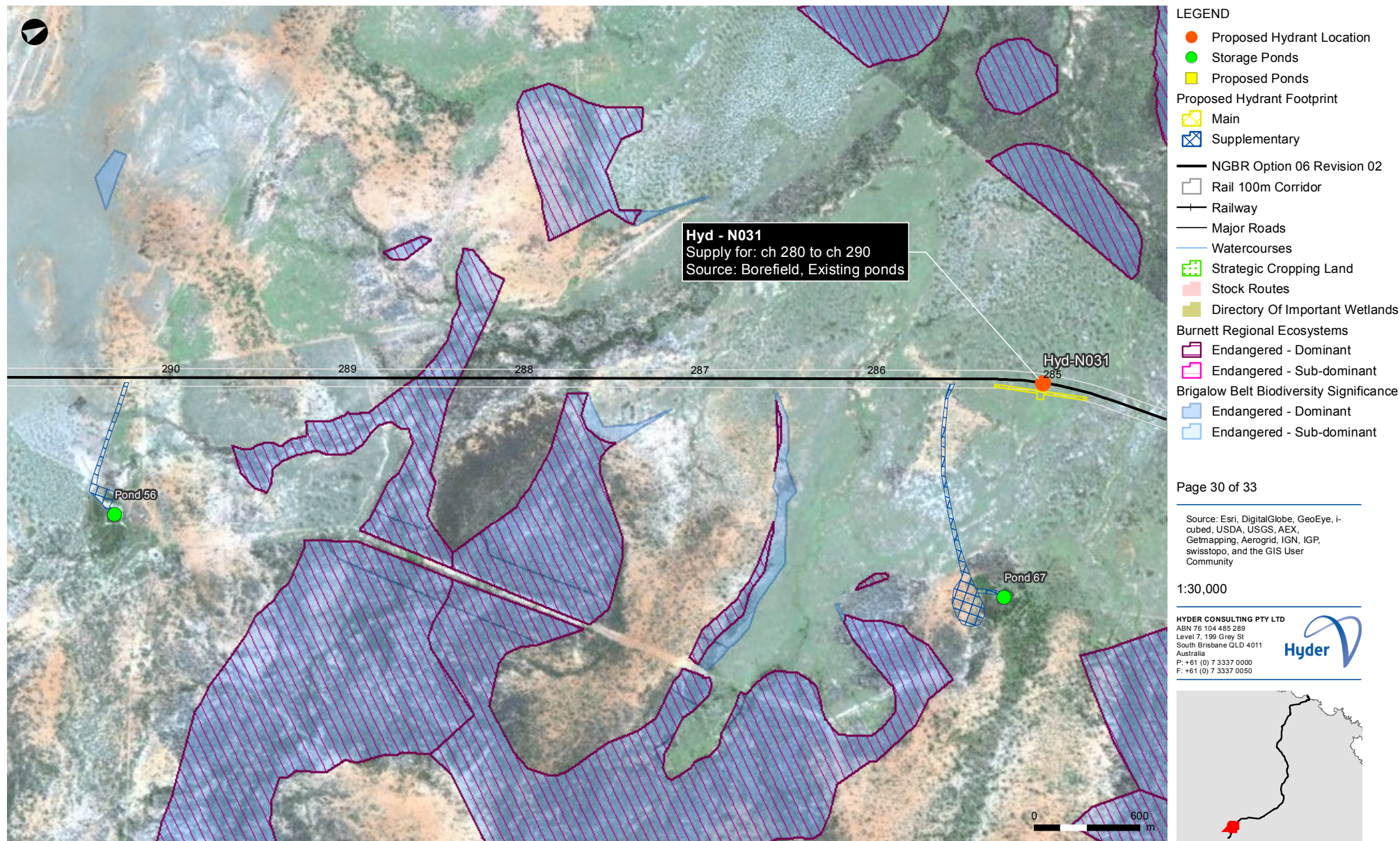


Figure 10.30: NGBR Water Hydrant Hyd-N031, Proposed Hydrant Footprint and Environmental Constraints

10.33 SUPPLY POINT HYD-N032

HYD-N032 is located at chainage 295km, 14km to the east of Gregory Developmental Road. An existing unnamed dirt road to the vicinity of the hydrant is available. An average daily demand of 743kL for earthwork has been estimated at this supply point. Refer to Figure 10.31.

Water Quality	Raw Water	Chainage (km)	295
Average Daily Demand(kL)	743	Duration(days)	56

10.33.1 MAIN OPTION

Source

Based on the limited available information the hydrant is located on alluvial sediment with relatively low yield of 1.5L/s from each Borehole. Although, the estimated discharge can be verified by yield test of the first excavated bore. It is unlikely that boreholes can provide the total amount of water required at this hydrant. Therefore, surface flow sources would have to be incorporated as supplementary option to provide for water supply. In case the yields of the boreholes are not sufficient, one of two below approach can be taken:

- The estimated construction period at this hydrant is relatively short. Therefore, reduce the rate of the daily earthwork to decrease the daily water demand
- Setup two water supply point at chainage 290km and 295km

Six boreholes with a maximum depth of 230m should be sunk for each supply point. The bores should be located with a minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The infrastructure required at chainage 295km are listed below. As discussed above similar set up may have to be arranged at chainage 290km.

- 6 lined boreholes with pump to maximum depth of 230m and dedicated 8kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.

Estimated Capital Cost

- At location of hydrant: \$125,000
- For the borefield: \$780,000

- Recoverable assets: \$235,000

10.33.2 SUPPLEMENTARY OPTION

Source

Pond 56, discussed in section 7.31.2, can be continued to be used for this segment of the rail line. Another existing pond is located at chainage 295km which can be used as a supplementary water resource option for chainage 290km to 300km.

Water extraction from each of the existing ponds would require a small pump station with 5L/s pumping capacity to be constructed next to them. Extracted water from pond 51 can be piped to the raw water tanks at the hydrant. Water from pond 56 should be trucked directly to the location of the earthwork.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

For pond 51:

- Pumping and generator facility located next to the existing pond with 5L/s pumping rate
- 500m, 100mm HPDE Pipe

For pond 56:

- Use the system setup for HYD-N031

Estimated Capital Cost

- At the storage ponds: \$124,500
- Recoverable assets: \$60,000

10.33.3 ENVIRONMENTAL CONSIDERATIONS

To obtain the required water volumes at HYD-N032, supply points need to be dispersed over a great area (approximately 12 km):

- Pond 51 will be the supply point at Chainage 295km.
- Pond 52 will be the supply point at Chainage 302km.
- Pond 56 will be the supply point at Chainage 290km.

Pond 52 is some distance from the hydrant location would result in increased impacts for access and pipe construction as well as additional permitting and approval requirements should it be required. Vegetation across the area at HYD-N032 is scarce and consists of predominantly low-lying scrub and floodplain grasslands with scattered drainage lines. Land identified in the Brigalow Belt Biodiversity Significance Mapping V1.3 (DERM 2009) is located approximately 300 m northwest of hydrant.

The EPBC search outlined within a 750m buffer of the hydrant footprint 8 listed threatened species or species habitat likely to/may occur within the area. Three of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

The sensitivity of these areas needs to be carefully considered during construction of infrastructure. Access to this hydrant is good, with an existing dirt road in the vicinity of the site, minimising the need for extensive additional clearing. A proposed haul road will link the supply from Chainage 290km to 295km. Consideration needs to be given to the location and construction of this haul road given the proximity to Brigalow Belt. Erosion is evident in some areas; therefore, erosion and sediment control during construction of pipelines and associated water supply infrastructure is required. Boreholes and supply infrastructure should be within a one km buffer where possible.

Erosion is evident in some areas, therefore erosion and sediment control during construction of pipelines and associated water supply infrastructure is required.

Boreholes and supply infrastructure should be within 1km buffer where possible.

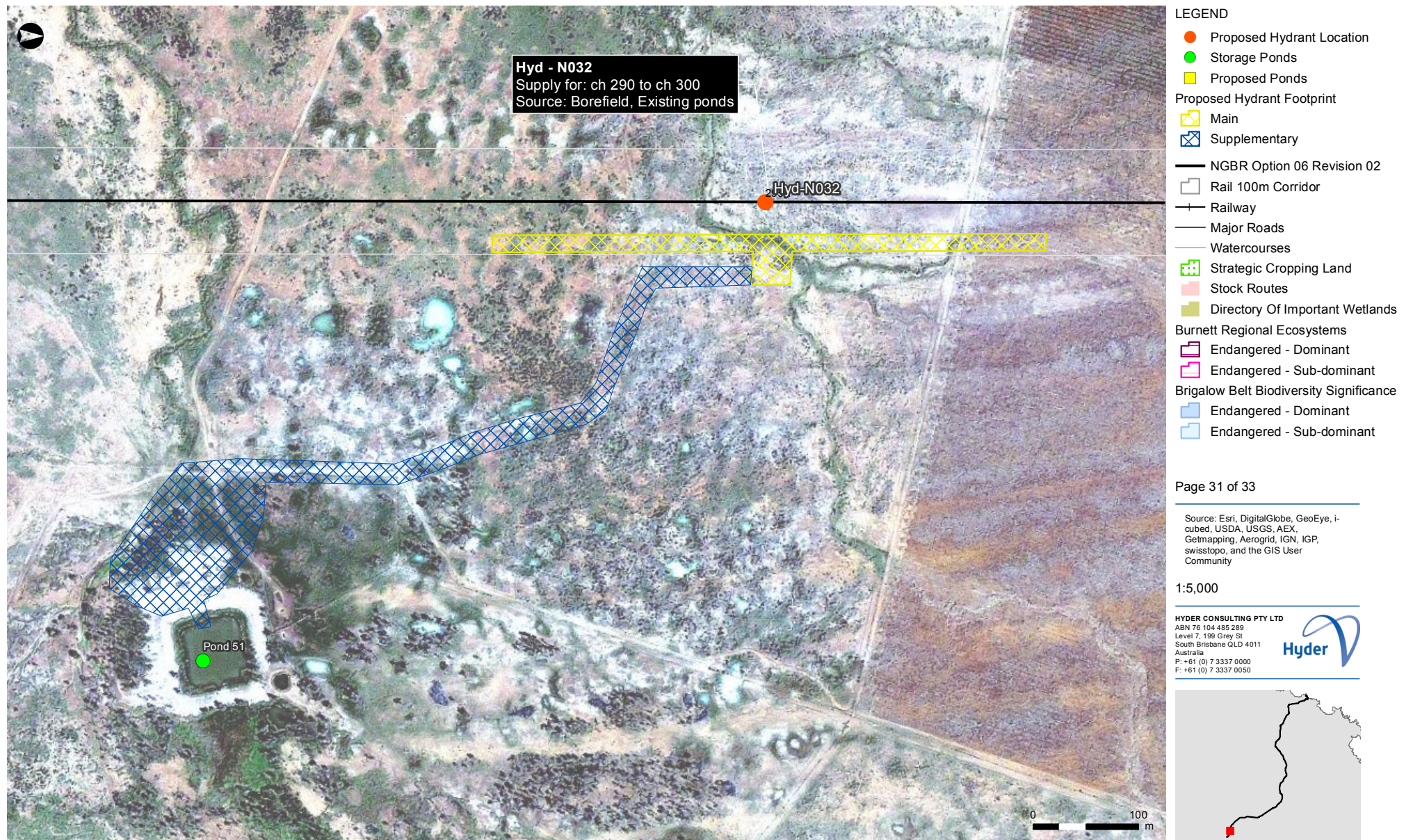


Figure 10.31: NGBR Water Hydrant Hyd-N032, Proposed Hydrant Footprint and Environmental Constraints

10.34 SUPPLY POINT HYD-N033

HYD-N033 is located at chainage 302km, 2km to the north of Gregory Developmental Road. No existing formed road to the hydrant is available. An average daily demand of 1692kL for the construction camp and earthwork has been estimated at this supply point. Refer to Figure 10.32.

Water Quality	Raw Water	Chainage (km)	302
	Treated Water		
Average Daily Demand(kL)	1692	Duration(days)	

10.34.1 MAIN OPTION

Source

This hydrant has been allocated as the construction depot. Based on the scarcity of the underground water resources, surface water may have to be used as the main water resource option. Existing Pond 54 located 1.4km to the east of the hydrant have significant storage volume. No information regarding the current users of this storage is available. In case the water from this pond is not already allocated to other users, it can be used as the main water supply for the construction depot.

The general arrangement of the water supply components from this surface water source are discussed in section 6 of the report.

Regulatory Requirements

6 New Bores

- Water permit- exploratory (2-3months)
- Consent of Chief Executive- 5 new bores (2 weeks)
- Development permit- 5 new bores (2 months)
- Hydrant works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

- Pump station with 40L/s pumping rate and 30 kVA generator located next to the existing pond
- 1400m, 200mm HPDE Pipe
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 6.
- Storage tanks for supply of drinking water and yards water
- Separate treatment plant and distribution system for yards water and potable water

Estimated Capital Cost

- At location of hydrant: \$440,000
- At the storage ponds: \$182,000
- Recoverable assets: \$405,000

10.34.2 SUPPLEMENTARY OPTION

Source

It is expected that a yield of 1L/s is achievable from each borehole. Based on the water demand at this hydrant, at least six boreholes with a maximum depth of 230m should be sunk to provide for a portion of the water demand. The bores should be located with a minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- Water permit for temporary use (2-3 months)
- Development permit for any new infrastructure required (2-3 months)

Water Supply Components

The infrastructure required is listed below.

- 6 lined boreholes with pump to maximum depth of 230m and dedicated 5kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks

Estimated Capital Cost

- For the borefield: \$960,000
- Recoverable assets: \$180,000

10.34.3 ENVIRONMENTAL CONSIDERATIONS

Overland flow capture of water across this floodplain and drainage line is proposed at HYD-N033 using Pond 54. Access to HYD-N033 is good with existing largely cleared areas surrounding Pond 54, although no existing formed road to the hydrant exists. Expansion of the Pond 54 structure would have minimal impact to surrounding vegetation.

The EPBC search outlined within a 1.5km buffer of the hydrant footprint 10 listed threatened species or species habitat likely to/may occur within the area. Four of these are listed as endangered (Star Finch, Black-throated Finch, Australian Painted Snipe, King Blue-grass).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

As the hydrant is located some distance from the rail line, consideration needs to be given to pipe locations and associated construction for access. The area between Pond 54 and HYD-N033 follows a drainage line. Construction impacts to the drainage line should be avoided where possible during construction of pipes. Pond 54 is outside the one km buffer meaning increased impacts for access and pipe construction and implications for approvals. This is currently a stagnant water source; therefore, water quality for end use must be considered. Siting of boreholes needs to avoid further vegetation clearance. A variety of birdlife was observed at this location.

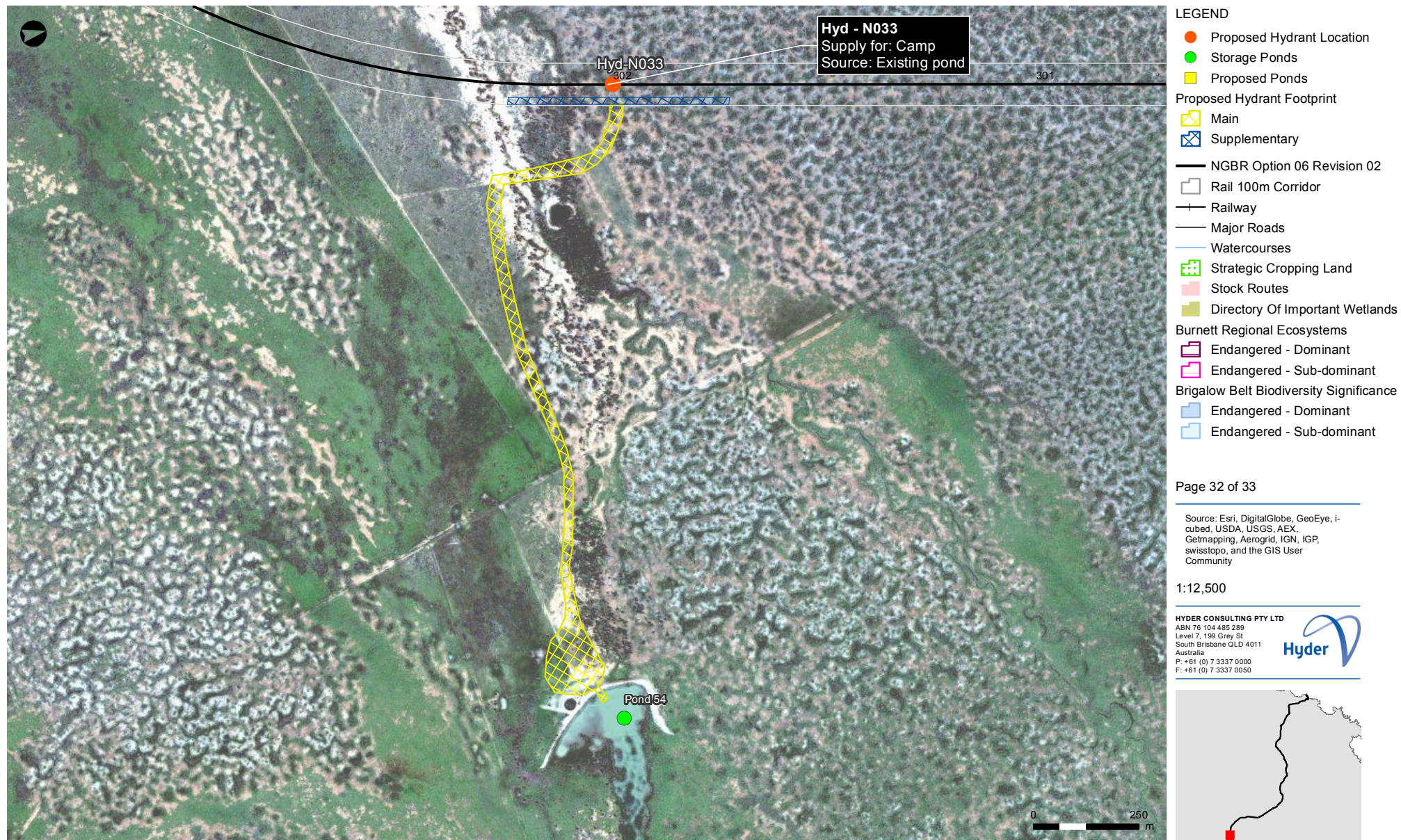


Figure 10.32: NGBR Water Hydrant Hyd-N033, Proposed Hydrant Footprint and Environmental Constraints

10.35 SUPPLY POINT HYD-N034

HYD-N034 is located at chainage 305km, 1.5km to the south west of Gregory Developmental Road. No existing access road to the location of the site is available. An average daily demand of 684kL has been estimated for this supply point. Refer to Figure 10.33.

Water Quality	Raw Water	Chainage (km)	305
Average Daily Demand(kL)	684	Duration(days)	46

10.35.1 MAIN OPTION

Source

Based on the scarcity of groundwater (based on DERM borelogs) and the also existence of two major storage ponds, surface water may be used as the main water supply option. Existing Ponds 55 and 70 are located 840m to the north-west and 1600m to the south of the site.

No information regarding the current users of these storage ponds are available, however is water is available from either, they will be able to be used as the main water supply for the construction depot.

The general arrangement of the water supply components from these surface water sources are discussed in section 7 of the report.

Regulatory Requirements

6 New Bores

- water permit- exploratory (2-3months)
- consent of chief executive- 6 new bores (2 weeks)
- development permit- 6 new bores (2 months)
- site works and testing (2 months)
- Water permit for temporary use for construction purposes (3 months)

Water Supply Components

The components of the water supply system are:

- Pump station with 40L/s pumping rate and 30 kVA generator located next to each of the existing ponds
- In total 2500m, 200mm HPDE Pipe
- Raw water tanks with 250kL storage volume, pump station and stand pipe for truck loading as explained in section 7.
- Storage tanks for supply of drinking water and yards water
- Separate treatment plant and distribution system for yards water and potable water

Estimated Capital Cost

- At location of hydrant: \$125,000
- At the storage ponds: \$335,000
- Recoverable assets: \$190,000

10.35.2 SUPPLEMENTARY OPTION

Source

In case using of one of the above existing ponds cannot be negotiated with the owners, Groundwater can be used as a supplementary option for this site. It is expected that yield of 1L/s is achievable from each borehole. Six boreholes with maximum depth of 230m may have to be sunk to provide for a portion of the water demand. The bores should be located with minimum distance of 100m from each other as close as possible to the supply point within the rail construction easement.

Regulatory Requirements

Existing In-Stream Storage

- No restrictions on where water is used (will be specified on the new water permit)
- Landholder negotiations (1-2 months)
- water permit for temporary use (2-3 months)
- development permit for any new infrastructure required (2-3 months)

Water Supply Components and Capital Estimates

The infrastructure required is listed below.

- 6 lined boreholes with pump to maximum depth of 230m and dedicated 5kVA generators.
- 1200m, 100mm HDPE embedded pipes connecting the boreholes to the raw water tanks

10.35.3 ENVIRONMENTAL CONSIDERATIONS

Pond 70 and Pond 55 are located some distance from HYD-N034 and a drainage line connects the two. Pond 70 is less preferable as it is located outside the one km buffer meaning increased impacts for access and pipe construction and implications for approvals. There is no existing access at this location. The hydrant is located within a floodplain with a number of evident drainage lines. Vegetation comprises low-lying scrub and grassland with minimal trees. The desktop assessment identified no key environmental considerations within this hydrant footprint however land identified in the Brigalow Belt Biodiversity Significance Mapping V1.3 (DERM 2009) is located approximately 1.6 km southeast.

The EPBC search outlined within a 1.6km buffer of the hydrant footprint 8 listed threatened species or species habitat likely to/may occur within the area. Two of these are listed as endangered (Star Finch, Australian Painted Snipe).

7 listed migratory species or species habitat likely to/may occur within the area, one of which is listed as endangered (Painted Snipe).

Erosion and sediment controls should be considered prior to construction of pipes and associated water supply infrastructure, particularly to safeguard during wetter periods. A variety of birdlife was observed at this location. Boreholes should be located inside the one km buffer where possible.

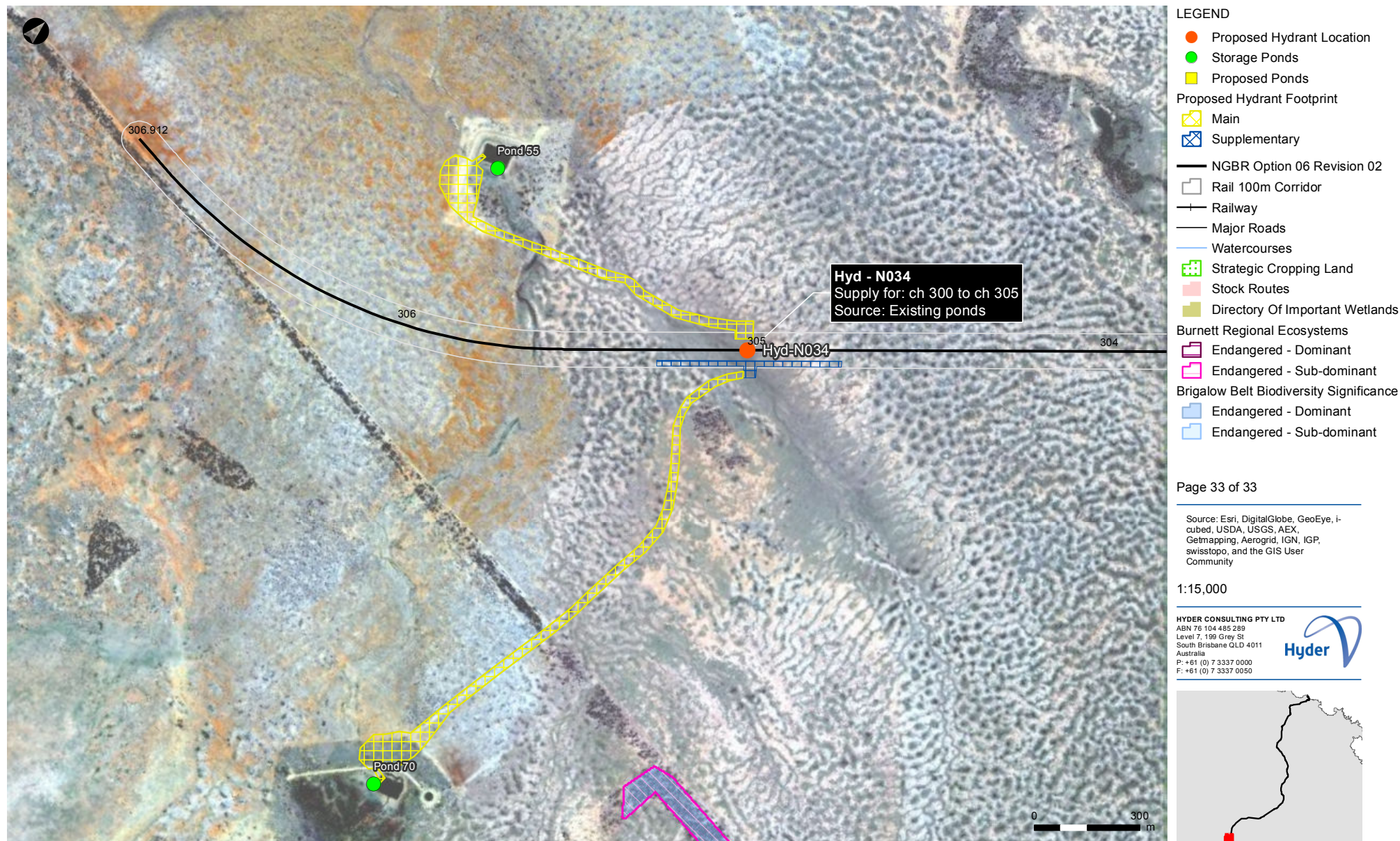


Figure 10.33: NGBR Water Hydrant Hyd-N034, Proposed Hydrant Footprint and Environmental Constraints

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 CONCLUSIONS

Table 11.1 below provides a summary of the given options. Where possible, priority of water supply has been given to groundwater from a reliability, yield, cost and regulatory perspective.

The proposed water supply options in this report would have to be confirmed with site specific investigations such as bore tests and flow quantifications.

Table 11.1: Summary of Options

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N001	Raw Water	-5	996	Surface Water Storage supported by Groundwater Large existing 560ML storage at the Adani Coal Terminal site. Approximately 4 bores with 4 (L/s/bore), pumping cycle 90% (duty/day) can be developed as a secondary option.	Water supply can be provided by the 560ML storage on Adani coal terminal. Also, hydrogeology desktop study indicates supplementary water can be provided by up to 4 boreholes with the depth of up to 50m if required.	Extremely sensitive wetland and marine environment associated with this location. Existing storage pond location is accessible. Minimisation/avoidance of additional infrastructure at this location is essential. If bores are necessary/unavoidable, detailed assessment of impacts should be undertaken and management plans developed.
HYD-N002	Raw Water	5	996	Surface Water Storage supported by Groundwater Large existing 560ML storage at the Adani Coal Terminal. Same Boreholes used for HYD-N001	Water supply can be provided by the large 560ML storage on site. As an alternative those bores sunk for HYD-N001 can be used for water supply of this site.	As above
HYD-N003	Raw and Treated Water	15	1003	Surface Water Storage supported by Local Council purchase of potable water Large existing 560ML storage at the Adani Coal Terminal. Potable water can be supplied from the local council at Merinda. As an alternative option, approximately 4 bores with 4 (L/s/bore), pumping cycle 90% (duty/day)	Water supply can be provided by the large 560ML storage on site. Potable water supply required for this site can be supplied from a local council standpipe at Merinda (water cartage approximately 10kms south at \$4KL). As an alternative 4 boreholes with the depth of up to 50m can be used for water supply.	There is minimal vegetation at this location. Existing access to this location will minimise the need for further clearing to access the site. As the supply main supply option entails trucking in water from other supply points, minimal impact to the environment based on water supply is anticipated. If boreholes are required as an alternative, careful selection of location to avoid vegetation in surrounding areas is required.
HYD-N004	Raw Water	25	903	Groundwater approximately 4 bores with 3.5 (L/s/bore), pumping cycle 80% (duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 4 boreholes with the depth of up to 100m.	There is an existing dirt road to this supply point, minimising the need for further clearing for access purposes. This location is with the Don Basin / Don River sub-basin. CSIRO recorded acid sulphate soils at this location therefore borehole development should consider appropriate monitoring and management. The area is vegetated however it is likely that minimal additional clearing will be required for the boreholes if they are located within the construction easement. There is a creek system (Kangaroo Creek) approximately 400 m to the west of this location. Erosion and sediment control during construction of bores will be required to minimise runoff to the creek.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N005	Raw Water	35	785	Groundwater and Surface Water Storage approximately 6 bores with 2(L/s/bore), pumping cycle 80%(duty/day) Existing storage ponds as supplementary option (if required)	Based on the hydrogeology desktop study, it is unlikely that the boreholes will be able to provide the total amount of the required water. Therefore a combination of surface water and groundwater sources is proposed for this supply point. An existing pond with an estimated 30 ML storage capacity is located 1.890km from the supply point. With permission of the land owner, it can be used as a supplementary water source from rail line chainages 35kms (property boundary) onwards. This storage and the proposed 6 bores with average depth of 100m, should be able to provide the water supply required for hydrant 5.	The terrain in this area is relatively flat and vegetation is scattered. Accessibility via Glenmore Road (established dirt road off the highway) will avoid further clearing for access. The area is vegetated however it is likely that minimal additional clearing will be required for the boreholes if they are located within the construction easement. The supply point hydrant lies directly adjacent to a creek system/drainage line including vegetated areas. Erosion and sediment control during construction of bores will be required to minimise runoff to the creek.
HYD-N006	Raw Water	45	935	Groundwater and Surface Water Storages - approximately 6 bores with 1(L/s/bore), pumping cycle 60%(duty/day) Existing storage ponds Construct new in-stream storages if required	Based on the hydrogeology desktop study, it is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources are required for this supply point. A small existing pond (Pond 6) is located 1.000km from the supply point. Alone, it will not provide the storage volume required to support the borefield. It also has limited range to the rail line with common boundaries from chainage 42.5kms to 47kms. Therefore it is proposed to construct a new storage within a small water way (in-stream storage) at either 495m west of the rail line at chainage 40kms (proposed pond 17) or 850m west of the rail line at chainage 50kms (proposed pond 16). With the proposed and existing storages, and a supporting borefield of up to 6 bores with average depth of 150m in conjunction it is anticipated that the water supply requirements for Hydrant 6 can be met.	The terrain in this area is relatively flat with scattered vegetation. The area appears to be out of the rain shadow of the mountains. Access is available via Thurso road (dirt road). Drainage lines and access tracks visible, with scattered but in some areas dense vegetation. Clearing for bores should consider locations in semi cleared areas where practicable. Construction of approximately 1200 m of embedded pipe will require clearing, additional to that required for construction of 2 proposed ponds (if required). Careful location of infrastructure should avoid high impact to vegetation and wildlife in this area.
HYD-N007	Raw Water	55	533	Groundwater, and river extraction approximately 6 bores with 1(L/s/bore), pumping cycle 60%(duty/day) River extraction from Bogie River	Based on the hydrogeology desktop study, it is unlikely that the boreholes can provide the total amount of the required water, therefore a combination of surface water and groundwater sources are proposed for this supply point. Water supply will come from, proposed river extraction from Bogie River at chainage 60km, a new in-stream storage constructed 950m west from rail line chainage 55km (proposed pond 15), and a borefield of up to 6 bores with an average depth of 150m.	The terrain in this area is undulating hills with extensive drainage lines and scattered trees. The landscape is somewhat dry and within a rainshadow area, with minimal ground cover vegetation. Access is available via a dirt track, however improvements to access may be required. Proposed new pond (pond 15, instream storage and extraction) is almost 1km from the hydrant location, and sits on a drainage line. As it is located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location. The area between proposed pond 15 and hydrant 7 follows a drainage line. Construction impacts in terms of changes to the creek/drainage line should be avoided where possible during construction of instream storage and pipes. Extraction of water from the creek/drainage line (and Bogie River) and associated impacts on other users utilising this water source need to be considered (stock watering).

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N008	Treated Water	63	132	Groundwater supported by water extraction from Bogie River and Potable water purchased from Whitsunday Regional Council at Collinsvale and approximately 3 bores with 1(L/s/bore), pumping cycle 60%(duty/day) As an option purchase camp water from Council	Based on the hydrogeology desktop study, it is anticipated that the required water for the camp, yard and batching plant can be supplied from 3 boreholes with an average depth of 150m. It is also recommended that the water required for earthworks between chainage 60kms to 70kms be provided at the location of the camp at Hydrant 8. As another option, potable water for the camp, can be purchased from Whitsunday Regional Council at Collinsville and trucked 59km on the Bogie gravel Road and Bowen Development Road to the camp. This also negates the need for a potable water treatment plant on site.	Accessability is good at this location, via Strathalbyn Road. There are large cleared areas surrounding this site which will assist in minimising further clearing requirements due to construction of water supply infrastructure. Extraction of water from Bogie creek (and/or Bogie River) and associated impacts on other users utilising this water source need to be considered (stock watering).
HYD-N008	Raw Water	65	617	Groundwater and River Extraction approximately 6 bores with 1(L/s/bore), pumping cycle 60%(duty/day) River extraction from Bogie River	It is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources would have to be used for this supply point. As a supplementary water supply, the river extraction setup for hydrant HYD-N007 can be used for trucking the extracted water from Bogie River to this site. As above, It is recommended that the water required for the earthwork between chainage 60km to 70km be provided at the location of the camp at chainage 63 - Hydrant 8.	As above. Site lies adjacent to Sandy Creek. Sensitive area, therefore any construction required at this chainage needs to consider erosion and sedimentation, and vegetation. There is a station 750m to north, usage of water sources in this area needs to consider other users.
HYD-N009	Raw Water	75	755	Groundwater and Surface Water Storages approximately 6 bores with 1(L/s/bore), pumping cycle 60%(duty/day) Existing storage ponds Construct new in-stream storages if required	It is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources are proposed for this supply point. The water supply will come from; An in-stream storage (proposed pond 12) constructed 200m west from the supply point at a chainage 75, and 6 bores with average depth of 150m.	Unestablished dirt roads exist across the site area. However as this would have to be upgraded for access to the site to minimise the environmental impact of upgrading the existing tracks, the rail line construction haul road should be used as the only access point to the site. The terrain consists of mixed volcanic and sedimentary rock, steep terrain and well defined catchments. The proposed pond (pnd 12) is only 230 m from the supply hydrant location, however as terrain is steep and vegetation is dense, impacts due to clearing need to be carefully managed. Erosion and sediment control management should be developed prior to construction. Vegetation in this area is quite dense and infrastructure should be limited to within the rail corridor where possible to avoid additional clearing.
HYD-N010	Raw Water	85	882	Groundwater and Surface Water Storages as replacement option approximately 6 bores with 2.5 (L/s/bore), pumping cycle 70%(duty/day) Existing storage ponds to replace a number of boreholes	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 6 boreholes with an average depth of 100m. No supplementary option is required for this site. However, surface water from existing ponds can replace a number of boreholes.	The terrain in this area is flat, with no defined access to the supply point. To minimise the environmental impact of the project the rail line construction haul road should be used as the only access point to the site. Ground conditions are dry however the catchments are well defined. There is a stock route 2km south east of the hydrant location. The area is scarcely vegetated therefore minimal additional clearing should be required for the boreholes, especially if they can be located within the construction easement. If existing storage ponds are to be used, consideration should be given to minimising impact to vegetation and drainage lines due to construction of infrastructure.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N011	Raw Water	95	607	Groundwater and Surface Water Storages as alternative option approximately 2 bores with 6.5 (L/s/bore), pumping cycle 80%(duty/day) Existing storage ponds to be used as alternative water supply option	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 2 boreholes with maximum depth of 100m. No supplementary option is required for this site. However, surface water from existing ponds can be used as alternative water supply option.	The terrain in this areas is a mixture of steep and flat areas. There is good access to the site which should requiring minimal clearing of vegetation to link with Strathmore Road. The area is within a floodplain, and has minimal vegetation apart from scattered trees and grassland.
HYD-N012	Raw Water	105	760	Groundwater and River Extraction as supplementary option approximately 6 bores with 2 (L/s/bore), pumping cycle 80%(duty/day) River extraction from Strathmore Creek to replace a number of boreholes	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 6 boreholes with maximum depth of 100m. No supplementary water supply option is required for this site. However, river extraction from Strathmore River can be used to replace a number of the boreholes	This area is within a dry floodplain, and the terrain is flat with some small hills. There is a stock route 80m to the east and Brigalow belt 950m west, 1.3km east and 1.1km south of hydrant location. Pelican Creek is approximately 1km to the south. There is minimal vegetation and no formed access road. To access the site a new road would have to be developed. To prevent further clearing, the rail line construction haul road should be used as the only access to the site. Erosion and sediment control management should be developed prior to construction of water supply infrastructure to minimise runoff to the creek system.
HYD-N013	Raw Water	115	704	Groundwater and surface water storage approximately 6 bores with 1.5 (L/s/bore), pumping cycle 80%(duty/day) Existing storage ponds	The majority of water demand can be supplied from up to 6 boreholes with maximum depth of 100m. A small existing pond is located 1200m (pond 22) from the water supply point which can be used as a supplementary water supply option.	This areas is a dry floodplain with very flat terrain. Vegetation is minimal however this site is within Brigalow belt therefore clearing needs to be minimised. There is no defined access so development of access roads to link with Myuna Road approximately 5km away and to storage pond (pond 22) approximately 1.2km away needs to carefully consider clearing requirements. As bores are the primary option, associated clearing for infrastructure should be minimised.
HYD-N014	Raw Water	125	557	Groundwater and surface water storage as replacement option approximately 5 bores with 2 (L/s/bore), pumping cycle 70%(duty/day) Existing storage ponds to replace a number of boreholes	It is anticipated that the required water can be supplied from up to 5 boreholes with the depth of up to 150m. It is recommended that the water supply required at this chainage is provided at the location of the camp and trucked from the camp area. No supplementary water supply option is required for this site. However, the existing ponds along the rail line can be used to replace a number of boreholes.	The area is with a drainage line/floodplain. Vegetation is minimal at the site, however there is Brigalow belt located 400m north west of the hydrant location. There is no defined access so development of access roads to link with Myuna Road approximately 5km away or storage ponds needs to carefully consider clearing requirements. As bores are the primary option, associated clearing for infrastructure should be minimised. The Bowen River is approximately 3km to the south west.
HYD-N015	Treated Water	130	112	Groundwater or potable supply from Whitsundays Regional Council approximately 1 bores with 2 (L/s/bore), pumping cycle 70%(duty/day) As an alternative option purchase camp water from Council	Based on the hydrogeology desktop study it is anticipated that the required water for the camp, yard and batching plant can be supplied from 2 boreholes with a depth of up to 150m. As an alternate option, potable water for the camp can be purchased from the Whitsundays Regional Council at Collinsville and trucked 19km on Myuna Road to the camp. This eliminates the need for a potable water treatment plant at the camp, reducing Capex.	There is no established track access to this site and vegetation clearing will be required. The terrain is steep in some areas, however generally the area is a dry floodplain adjacent to the Bowen River. Construction of access tracks and borehole infrastructure needs to consider minimising clearing and erosion and sediment control.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N016	Raw Water	135	624	Groundwater and River extraction approximately 6 bores with 1.5 (L/s/bore), pumping cycle 70%(duty/day) supplementary river extraction from Bowen River	Based on the hydrogeology desktop study a major part of the required water can be supplied from up to 6 boreholes with the maximum depth of 150m. A supplementary supply is also proposed if the bore yields are low via a river extraction from the Bowen River.	This hydrant is located with a floodplain on flat terrain. There is no established track access to this site and vegetation clearing will be required. Scattered areas of Brigalow belt exist within a 850m - 2.5km radius of hydrant location. Options for this hydrant include bores and extraction from the Bowen River or the adjacent creek. (Cockatoo Creek) Bores and supply infrastructure need to be carefully located to avoid vegetation and minimise clearing. Impacts to other users of water from the Bowen River and Cockatoo Creek should also be considered.
HYD-N017	Raw Water	145	805	Groundwater and surface water as replacement option approximately 7 bores with 2 (L/s/bore), pumping cycle 70%(duty/day) Existing storage ponds to replace a number of boreholes	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 7 boreholes with the maximum depth of 150m. Surface water from the existing storages along the rail line can be used to replace a number of boreholes.	This hydrant is located with a floodplain on flat terrain. Vegetation is minimal at the site however there is no established track access to this site and vegetation clearing will be required. Scattered Brigalow belt exists 500 m -2.5km around hydrant location. Construction of access tracks and borehole infrastructure needs to consider minimising clearing. If supply from existing ponds is required, location and construction of required infrastructure should also consider minimising clearing. Note existing ponds 26 and 27 are located outside the 1km buffer zone.
HYD-N018	Raw Water	155	651	Groundwater approximately 5 bores with 2.5 (L/s/bore), pumping cycle 70%(duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 5 boreholes with maximum depth of 100m.	This hydrant is located with a floodplain on flat terrain. There is acceptable access to this area. The hydrant lies on Strategic Cropping Land and there is a homestead 1.3km north west. Borehole development usage should consider impacts to Strategic Cropping Land and surrounding users.
HYD-N019	Raw Water	165	605	Groundwater approximately 4 bores with 2.5 (L/s/bore), pumping cycle 80%(duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 4 boreholes with maximum depth of 100m. It is recommended that the water supply required at this chainage be provided at the location of the camp (chainage 170km) and trucked from the camp area.	Access to this site can be obtained via an existing road at chainage 169.5, however this area is densely vegetated and significant clearing will be required over approximately 4km to link with this road. This location is within Strategic Cropping Land, however the hydrant will be located at chainage 170 and water trucked to this site. Infrastructure and access at this location should consider impacts to Strategic Cropping Land and surrounding users.
HYD-N019	Treated Water	170	132	Groundwater approximately 1 bores with 2.5 (L/s/bore), pumping cycle 80%(duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water for the camps and yards and batching plant can be supplied from 1 borehole with a depth of up to 100m. It is recommended that in total 5 bores are sunk and the water supply required at chainage 165km for earthworks is provided at the camp (chainage 170km) and trucked for construction purposes.	Linkage to an existing road at chainage 169.5 means that minimal clearing should be required to provide access to this hydrant (approximately 500m to the east). Brigalow belt exists 1.5km east of hydrant location. Minimal cleared areas, 4wd access only. The hydrant location sits within a drainage line. Development and operation of bores and infrastructure should be placed outside of the drainage line and consider erosion and sediment control.
HYD-N020	Raw Water	175	591	Groundwater approximately 3 bores with 3 (L/s/bore), pumping cycle 80%(duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 3 boreholes with maximum depth of 100m.	The terrain in this location is quite undulating with varied but dense vegetation. Access can be provided with minimal impact to vegetation due to clearing requirements due to the close proximity of the Bowen Development Road (approximately 500m). As bores are the primary option, associated clearing for infrastructure should be minimised.
HYD-N021	Raw Water	185	745	Groundwater approximately 3 bores with 4 (L/s/bore), pumping cycle 80%(duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 3 boreholes with maximum depth of 150m.	The terrain and access in this location provide difficulties and as the area is densely vegetated, extensive clearing is likely to be required in order to provide reliable access. As bores are the primary option, associated clearing for infrastructure should be minimised.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N022	Raw Water	195	580	Groundwater approximately 6 bores with 1.5 (L/s/bore), pumping cycle 80%(duty/day)	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 6 boreholes with maximum depth of 150m.	Due to the distance of existing dirt access track, extensive clearing is likely to be required in order to provide reliable access. There area is heavily vegetated. There is a stock route 300m north of hydrant location and Rockingham creek lies 450m south east. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control.
HYD-N023	Raw Water	205	503	Groundwater approximately 5 bores with 2 (L/s/bore), pumping cycle 60%(duty/day)	It is anticipated that the required water can be supplied from up to 5 boreholes with the depth of up to 150m.	There is no defined access to this location and the area is heavily vegetated. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible.
HYD-N024	Raw Water	215	654	Groundwater and Surface Water Storages approximately 6 bores with 1.5 (L/s/bore), pumping cycle 60%(duty/day) Existing storage ponds	Based on the hydrogeology desktop study it is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources are proposed for this supply point. Available water supply options include: enlargement of an existing in-stream storage (pond 58) 700m west of the supply point and a borefield of 6 bores with an average depth of 150m.	There is no defined access to this location and the terrain is very rocky. There is treed but cleared heavily in areas. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible. As existing storage ponds are located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location in order to minimise clearing requirements.
HYD-N025	Raw Water	225	980	Groundwater and Surface Water Storages approximately 6 bores with 1.5 (L/s/bore), pumping cycle 70%(duty/day) Existing storage ponds	Based on the hydrogeology desktop study It is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources are proposed for this supply point. The supply options include: a small existing in-stream storage (pond 35) located 550m west of the supply point, and two medium sized existing storages located 860m west (pond 70) of chainage 220 and 1900m west (pond 36) from chainage 230 and a borefield of up to 6 bores with maximum depth of 150m.	Access to this site is possible via existing dirt tracks which connect to the Suttor Development Road. The area is a floodplain with minimal trees however some clearing will be required to accommodate for bores and other infrastructure. As existing storage ponds are located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location in order to minimise clearing requirements.
HYD-N026	Raw Water	235	534	Groundwater and existing ponds as replacement option approximately 5 bores with 2 (L/s/bore), pumping cycle 70%(duty/day) Use existing storage ponds to replace a number of boreholes	Based on the hydrogeology desktop study it is anticipated that the required water can be supplied from up to 5 boreholes with maximum depth of 150m. Surface water from the existing storages along the rail line can be used to replace a number of boreholes.	Access to this site is possible via existing dirt tracks which connect to the Suttor Development Road. The area is a floodplain with minimal trees however some clearing will be required to accommodate for bores and other infrastructure. If pond 69 is to be used as a supplementary source, consideration needs to be given to other users of this supply, cattle, native wildlife, and vegetation clearing for pipe infrastructure to the hydrant. There is a Brigalow belt 100m - 3km around water supply point. Emu were site at pond 69, as well as Pelican and Brahminy Kite waterhole.
HYD-N027	Raw Water	245	584	Groundwater and existing off-stream storage approximately 5 bores with 2 (L/s/bore), pumping cycle 80%(duty/day) Use existing storage ponds to replace a number of boreholes	The majority of water demand can be supplied from up to 5 boreholes with the average depth of 100m. Surface water from the existing storages along the rail line can be used to replace a number of boreholes.	Access to this site is possible via existing dirt tracks which connect to the Kilcummin-Diamond Downs Road. The area is a floodplain with minimal trees however some clearing will be required to accommodate for bores and other infrastructure. Strategic cropping land exists 1km west, and Brigalow belt 900m west. If pond 38 is required for supplementary supply, consideration needs to be given to clearing, erosion and sediment control. Pond 38 is located adjacent to a drainage line.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N028	Raw Water	255	809	Groundwater and existing in-stream storage approximately 6 bores with 2 (L/s/bore), pumping cycle 80%(duty/day) Use existing storage ponds to replace a number of boreholes	It is expected that the majority of water demand can be supplied from up to 6 boreholes with the average depth of 100m. Several small existing in-stream storages are located within a reasonable distance from chainages 250km (Pond 40) , 255km (pond 41) and 260km (pond 42) which can be used as a replacement to a number of boreholes	The area is a floodplain with minimal trees. Although there is no existing access, little to no clearing would be required and could follow existing property fence lines where practical. Serpentine Creek lies 2.1km to east and there is Strategic Cropping Land 1.6km to the east and Brigalow belt 1.7km east. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible. If pond 69 is to be used as a supplementary source, consideration needs to be given to vegetation clearing for pipe infrastructure to the hydrant.
HYD-N029	Treated Water	262	112	Groundwater approximately 1 bores with 2 (L/s/bore), pumping cycle 80%(duty/day)	Based on the hydrogeology desktop study It is anticipated that the required water for the camps and yards and batching plant can be supplied from 1 boreholes with an average depth of 100m.	The area is a floodplain with minimal trees. Although there is no existing access, little to no clearing would be required and could follow existing property fence lines where practical. There is Brigalow belt at chainage 260. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible.
HYD-N029	Raw Water	265	1000	Groundwater and Surface Water Storages approximately 6 bores with 2 (L/s/bore), pumping cycle 80%(duty/day) Existing storage ponds	It is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources would have to be used for this supply point. The required water supplies will come from: A large existing in-storage located 780m north (pond 66) from chainage 270km and a borefield of 6 bores with an average depth of 100m. Due to the proximity to the construction camp at chainage 262, the earthwork water requirements for chainage 265 will also be located at the camp (chainage 262) - Hydrant 28. This will increase the borefield to 7 bores (which covers camp, batching plant and earthwork requirements)	This area is floodplain within the Lake Suttor catchment. There is minimal vegetation in the area. Water supply to this hydrant will come from bores at hydrant 29. Consideration needs to be given to clearing for infrastructure construction. Development and operation of bores and infrastructure should be placed outside of drainage lines and consider erosion and sediment control and minimising clearing where possible. If a new pond is going to be constructed for supplementary supply, consideration needs to be given to location to minimise clearing and access requirements.
HYD-N030	Raw Water	275	947	Groundwater and Surface Water Storages approximately 6 bores with 1.5 (L/s/bore), pumping cycle 80%(duty/day) Proposed storage ponds	It is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources would have to be used for this supply point. the proposed supply options include: An off-stream storage (proposed pond 2) can be constructed at a location 1050m west of the supply point at chainage 270km and a borefield of up to 6 bores with an average depth of 100m.	This area consists of flat terrain and scattered scrubby vegetation. There are 2 homesteads 2km south and south-west of this location. Access is good via existing dirt tracks, however links to this access need to be provided requiring approximately 1km of clearing. There are patches of Brigalow belt within a 2km radius. This area is within the Lake Suttor catchment. Extensive birdlife was evident.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N031	Raw Water	285	743	Groundwater and Surface Water Storages approximately 6 bores with 1.5 (L/s/bore), pumping cycle 70%(duty/day) Existing storage ponds	It is unlikely that the boreholes can provide the total amount of the required water. A combination of surface water and groundwater sources would have to be used for this supply point. the proposed water supply options include: Existing in-stream storage (ponds 67, 56) are available within a reasonable distance from the supply point and chainage 290km which can be used as supplementary water supply option.	An existing dirt road to the vicinity of the site is available which reduces the requirement for clearing. Pond 67 is just outside the 1km buffer is outside the 1km buffer meaning increased impacts for access and pipe construction and implications for approvals. Vegetation in this area is substantial although predominantly low lying scrub. There is no cleared area surrounding Pond 67 and vegetation clearing could also be extensive between the pond and the hydrant. There is a Brigalow belt biodiversity significant zone surrounding the pond location, which starts 50m north and 500m south Consideration needs to be given to minimising clearing for infrastructure and access where possible. Expansion of the Pond 67 should be avoided if possible so as to minimise impacts to vegetation. Location of bores should also consider minimising impacts to vegetation due to clearing requirements.
HYD-N032	Raw Water	295	928	Groundwater and Surface water 6bores at chainage 290, 6 bores at chainage 295, Existing storage ponds as supplementary source	It is unlikely that the boreholes can provide enough water for construction of the project. Also no single existing in or off stream storage with enough capacity is located in the vicinity. It is proposed that instead of concentrating the water supply point at chainage 295km,two supply point at chainages 290km and 295km is provided. To do this utilisation of the existing storages (ponds 51,52 and 56) near these chainages is recommended. A combination of 6 boreholes at each proposed supply point with water from the existing storages can provide the required water.	To obtain the required water volumes at this point, the supply points need to be dispersed over a great area (approximately 12 km). 51 - supply point at chainage 295 52 - supply point at chainage 302? 56 - supply point at chainage 290 Pond 52 is outside the 1km buffer meaning increased impacts for access and pipe construction and implications for approvals Vegetation is scarce across this area, being predominantly low lying scrub and flood plain grasslands with scattered drainage lines. There is however a Brigalow belt biodiversity significant zone 300m N/W and surrounding the water supply. The sensitivity of these areas needs to be carefully considered during construction of infrastructure. Access is good within this area of the alignment minimising the need for extensive additional clearing and an existing dirt road to the vicinity of the site is available. A proposed haul road will link the supply from chainage 290 to 295, consideration needs to be given to the location and construction of this haul road given the Brigalow belt biodiversity significant zone. Erosion is evident in some areas, therefore erosion and sediment control during construction of pipelines and associated water supply infrastructure is required. Boreholes and supply infrastructure should be within 1km buffer where possible.

Hydrant Number	Water Quality Requirement	Supply Point Chainage (km)	Daily Water Demand (kL)	Water Supply Option(s)	Option Discussion	Environmental Considerations
HYD-N033	Raw and Treated Water	302	1692	Surface water and Groundwater Existing stream storage pond approximately 6 bores with 1 (L/s/bore), pumping cycle 70%(duty/day)pump: 10 h/d	Boreholes cannot be used as the main water supply option at the construction depot. The proposed options include: A large in-stream storage (pond 54) located 1450m to the east of the rail line and a borefield of up to 6 boreholes.	Overland flow capture of water across flood plain and drainage line. Access to this location is good with existing largely cleared areas surrounding pond 54, although no existing formed road to the site exists. Extension of the structure if necessary will likely have minimal impact to surrounding vegetation. As it is located some distance from the rail line, consideration needs to be given to pipe locations and associated construction to reach hydrant location. The area between pond 54 and hydrant 33 follows a drainage line. Construction impacts in terms of changes to the drainage line should be avoided where possible during construction of pipes. Pond 54 is outside the 1km buffer meaning increased impacts for access and pipe construction and implications for approvals This is currently a stagnant water source, therefore water quality for end use must be considered. Boreholes need to be located to avoid further vegetation clearance A variety of birdlife was observed at this location.
HYD-N034	Raw Water	305	684	Groundwater and Surface Water Storages approximately 6 bores with 1 (L/s/bore), pumping cycle 70%(duty/day) Existing storage ponds	Boreholes cannot be used as the main water supply option at this point. The proposed supply options include: Two large in-stream storage ponds are located 840m north-west and 1600m south from the water supply point and a borefield with up to 6 bores with an average depth of 150m.	Pond 70 and Pond 55. Ponds are located some distance from the Hydrant location and a drainage line connects the two. Pond 70 is less preferable due to being located outside the 1km buffer meaning increased impacts for access and pipe construction and implications for approvals. There is no existing access at this location. The area is essentially a floodplain with a number of drainage lines evident. Vegetation is low lying scrub and grassland, minimal trees. There is a Brigalow belt biodiversity significant zone 1.6km S/E of this hydrant. Erosion and sediment control during construction of pipes and associated water supply infrastructure will be required, particularly during wetter periods. A variety of birdlife was observed at this location. Boreholes should be located inside the 1km buffer where possible.

11.2 RECOMMENDATIONS

The following list provides key recommendations as to what the next steps should be:

- Groundwater investigations to verify the estimated potential yields in this report;
- Site specific surface flow quantity study to ensure reliability of Adani storage pond in Abbot Point;
- Site specific surface flow quantity study to ensure reliability of ponds 54, 55 and 70 for water supply of construction camp at chainage 302 and earthwork at chainage 305;
- Commencement of water supply negotiations with the regulator and land owners prior to start of the construction works;
- Review the site selections, progress rates and construction commencement day of the rail line at each site in construction programme based on the outcome of this study regarding the water supply points; and
- Detailed environmental site investigation for selected water supply options, to include flora, fauna, and any other environmental values identified in the assessment in section 10 of this report.

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13 TABLE OF ACRONYMS

Acronym	Term
ANZECC	Australia and New Zealand Environment and Conservation Council
ASS	Acid Sulfate Soils
BFS	Bankable Feasibility Study
CSG	Coal Seam Gas
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Department of Environment and Heritage Protection
DEWS	Department of Energy and Water Supply
DNRM	Department of Natural Resources and Mining
EIS	Environmental Impact Statement
EFO	Environmental Flow Objectives
EP	Equivalent Persons
EPBC	Environment Protection and Biodiversity Conservation
FIA	Failure Impact Assessment
IDAS	Integrated Development Assessment System
mBGL	Metres below ground level
NATA	National Association of Testing Authorities
NGBR	North Galilee Basin Rail
NUDLC	National Uniform Drillers Licensing Committee
ROP	Resource Operations Plan
SARA	State Assessment and Referral Agency
SCL	Strategic Cropping Land
SEWPaC	Sustainability, Environment, Water, Population and Communities
SoW	Scope of Works
SP1	Separable Portion 1
SP2	Separable Portion 2
SPA	Sustainable Planning Act
TAP	Technical Advisory Panel
WRP	Water Resource Plan

APPENDIX A

COST ESTIMATION TABLES

Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N001			Hyd-N002			Hyd-N003			Hyd-N004			Hyd-N005		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
				Water to be supplied from Adani Pond or Boreholes			Water supply system at Hyd-N001 can be used for this site			Raw water not to be supplied from Adani Pond if construction work begins at hydrants N001 to N003 simultaneously, Camp water can be purchased from the council						Existing ponds can be used as replacement for a number of boreholes which is not included in cost analysis		
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000	1	10,000	7,000	1	10,000	7,000	1	10,000	7,000		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0	1	20,000	15,000	2	40,000	30,000		0	0
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	0	0	0	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0		0	0		0	0		0	0
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0		0	0		0	0		0	0
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0		0	0		0	0		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	0	0	0	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000								0	0						
	Tanker truck loading pipe stand	15,000	5,000		0	0		0	0	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0		0	0		0	0		0	0		0	0		0	0
	100mx100mx4m lined storage dam	300,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000		0	0		0	0		0	0		0	0		0	0
River extraction	Intake structure	30,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000		0	0		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000		0	0		0	0		0	0		0	0	6	720,000	150,000
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000		0	0		0	0	4	360,000	80,000		0	0		0	0
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000	4	280,000	60,000	0	0	0		0	0	4	280,000	60,000		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0	0	0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0	6	30,000	0	0	0	0	6	30,000	0	6	30,000	0	12	60,000	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000	Water Supply Alternative			Water Supply Alternative			Water Supply Alternative								
	Drinking water from Council	120,000	25,000							Water Supply Alternative								
Total					430,000	147,000		10,000	7,000		545,000	187,000		475,000	175,000		905,000	235,000

Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N006			Hyd-N007			Hyd-N008			Hyd-N009			Hyd-N010		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
										Use river extraction components of Hyd-N007 for this supply point						Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis		
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000		0	0		0	0		0	0		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0	2	40,000	30,000		0	0		0	0
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0	1	150,000	130,000		0	0		0	0
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0	1	120,000	100,000		0	0		0	0
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0	1	60,000	45,000		0	0		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	1	40,000	30,000		0	0	1	40,000	30,000	1	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000								0	0						
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0	1	750,000	0		0	0		0	0	1	750,000	0		0	0
	100mx100mx4m lined storage dam	300,000	0				1	300,000	0		0	0					0	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000	1	70,000	50,000		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0	1	20,000	15,000		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0	1	6,500	0		0	0		0	0	2	13,000	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000		0	0		0	0		0	0
River extraction	Intake structure	30,000	0		0	0	1	30,000	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0	1	20,000	15,000		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0	2	13,000	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000	6	900,000	180,000	6	900,000	180,000	6	900,000	180,000	6	900,000	180,000		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000		0	0		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000		0	0		0	0		0	0		0	0	6	540,000	120,000
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0	12	60,000	0	12	60,000	0	12	60,000	0	12	60,000	0	12	60,000	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000															
	Drinking water from Council	120,000	25,000															
Total					1,926,500	320,000		1,463,000	285,000		1,415,000	540,000		1,868,000	280,000		725,000	205,000

Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N011			Hyd-N012			Hyd-N013			Hyd-N014			Hyd-N015		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
				Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis			River extraction to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis						Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis			As an alternative water can be purchased from Council		
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000		0	0		0	0		0	0		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0		0	0		0	0	2	40,000	30,000
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000		0	0
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0			0		0	0	1	150,000	130,000
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0		0	0		0	0	1	120,000	100,000
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0		0	0		0	0		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000		0	0
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000													1	30,000	25,000
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000		0	0
Storage pond	150mx150mx5m lined storage dam	750,000	0		0	0		0	0		0	0		0	0		0	0
	100mx100mx4m lined storage dam	300,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0	1	20,000	15,000		0	0		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0	1	15,000	10,000		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0	12	78,000	0	3	19,500	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000		0	0		0	0		0	0	3	45,000	15,000		0	0
River extraction	Intake structure	30,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000		0	0		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000		0	0		0	0		0	0	5	600,000	125,000	1	120,000	25,000
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000	2	180,000	40,000	6	540,000	120,000	6	540,000	120,000		0	0		0	0
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0	2	13,000	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0		0	0	12	60,000	0	12	60,000	0	9	45,000	0	1	5,000	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000															
	Drinking water from Council	120,000	25,000															
Total					318,000	125,000		725,000	205,000		823,000	220,000		849,500	235,000		465,000	310,000

Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N016			Hyd-N017			Hyd-N018			Hyd-N019			Hyd-N020		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
							Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis											
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000		0	0		0	0		0	0		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0		0	0	2	40,000	30,000		0	0
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0		0	0	1	150,000	130,000		0	0
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0		0	0	1	120,000	100,000		0	0
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0		0	0	1	60,000	45,000		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000		0	0	1	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0		0	0		0	0		0	0		0	0		0	0
	100mx100mx4m lined storage dam	300,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000		0	0		0	0		0	0		0	0
River extraction	Intake structure	30,000	0	1	30,000	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000		0	0		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000	6	720,000	150,000	7	840,000	175,000		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000		0	0		0	0	5	450,000	100,000	4	360,000	80,000	3	270,000	60,000
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0	4	26,000	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0	12	60,000	0	16	80,000	0	9	45,000	0	6	30,000	0		0	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000															
	Drinking water from Council	120,000	25,000															
Total					950,000	240,000		1,045,000	260,000		620,000	185,000		845,000	440,000		421,000	145,000

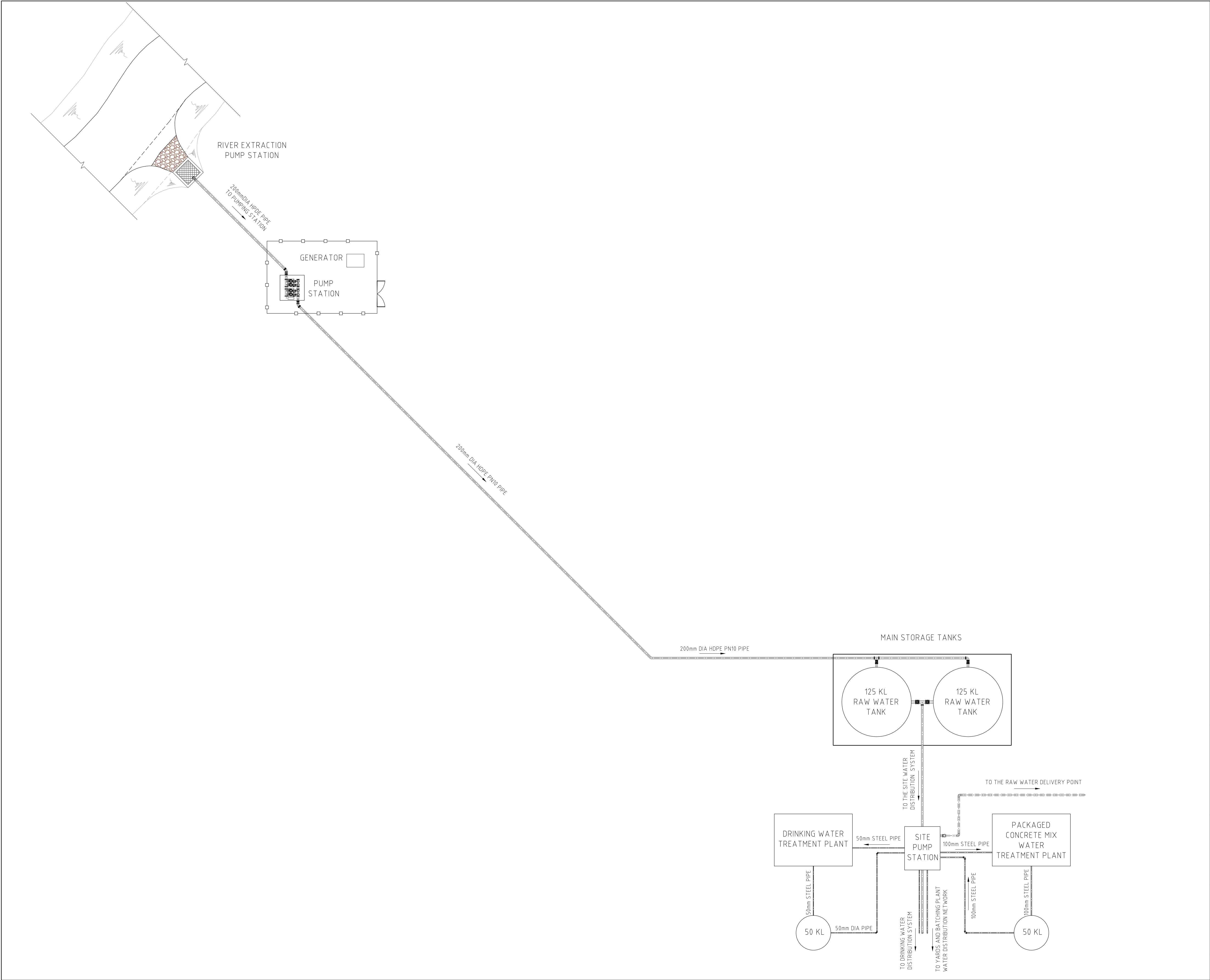
Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N021			Hyd-N022			Hyd-N023			Hyd-N024			Hyd-N025		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000		0	0		0	0		0	0		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0		0	0		0	0		0	0
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0		0	0		0	0		0	0
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0		0	0		0	0		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0		0	0		0	0		0	0		0	0		0	0
	100mx100mx4m lined storage dam	300,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0	1	20,000	15,000		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0	1	15,000	10,000	2	30,000	20,000
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0	2	13,000	0	3	19,500	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000		0	0		0	0		0	0	1	15,000	5,000	3	45,000	15,000
River extraction	Intake structure	30,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000		0	0		0	0		0	0	6	900,000	180,000		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000		0	0	2	240,000	50,000	5	600,000	125,000		0	0	6	720,000	150,000
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000	3	270,000	60,000		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0	4	26,000	0	2	13,000	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0		0	0		0	0	9	45,000	0	12	60,000	0	12	60,000	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000															
	Drinking water from Council	120,000	25,000															
Total					421,000	145,000		378,000	135,000		770,000	210,000		1,148,000	295,000		999,500	270,000

Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N026			Hyd-N027			Hyd-N028			Hyd-N029			Hyd-N030		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
				Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis			Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis			Existing ponds to be incorporated in water supply and replace a number of boreholes which is not included in cost analysis								
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000		0	0		0	0		0	0		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0		0	0	2	40,000	30,000		0	0
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0		0	0	1	150,000	130,000		0	0
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0		0	0	1	120,000	100,000		0	0
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0		0	0	1	60,000	45,000		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	1	40,000	30,000	1	40,000	30,000		0	0	1	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000		0	0		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000	1	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0		0	0		0	0		0	0		0	0	1	750,000	0
	100mx100mx4m lined storage dam	300,000	0		0	0		0	0		0	0		0	0			
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0	1	70,000	50,000
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0	1	20,000	15,000		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0	2	13,000	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0	11	88,000	0
	Tanker truck loading pipe stand	15,000	5,000		0	0		0	0		0	0	1	15,000	5,000		0	0
River extraction	Intake structure	30,000	0		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000		0	0		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000	5	600,000	125,000	5	600,000	125,000	6	720,000	150,000	7	840,000	175,000	6	720,000	150,000
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000		0	0		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0	9	45,000	0	9	45,000	0	12	60,000	0	16	80,000	0	12	60,000	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000															
	Drinking water from Council	120,000	25,000															
Total					770,000	210,000		770,000	210,000		905,000	235,000		1,423,000	555,000		1,813,000	285,000

Supply Method	Infrastructure	Unit Cost (\$)	Recoverable Assets (\$)	Hyd-N031			Hyd-N032			Hyd-N033			Hyd-N034		
				Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)	Quantity	Total Cost (\$)	Recoverable assets value (\$)
Site water supply system	Supply, delivery, foundation and installation of 10,000 litre water tank and connections	10,000	7,000		0	0		0	0		0	0		0	0
	Supply, delivery, foundation and installation of 50,000 litre ZinkAlume water tank and connections	20,000	15,000		0	0		0	0	2	40,000	30,000		0	0
	250m3 litre storage capacity consist of 2x 125,000 litre ZinkAlume water tank including supply and installation	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000	1	70,000	50,000
	Supply and installation of 1.5 L/s Water treatment plant for concrete batching to raise water quality to the requirements of AS 1379	150,000	130,000		0	0		0	0	1	150,000	130,000		0	0
	Supply and installation of 1 L/s water treatment plant to attain potable quality water	120,000	100,000		0	0		0	0	1	120,000	100,000		0	0
	Pump station for earthwork and camps including civil works, connections, valves, electraicals and generator	60,000	45,000		0	0		0	0	1	60,000	45,000		0	0
	Pump station for earthwork including civil works, connections, valves, electraicals and generator	40,000	30,000	1	40,000	30,000	1	40,000	30,000		0	0	1	40,000	30,000
	Pump station for camp water supply including civil works, connections, valves, electraicals and generator	30,000	25,000		0	0		0	0		0	0		0	0
	Tanker truck loading pipe stand	15,000	5,000	1	15,000	5,000	1	15,000	5,000		0	0	1	15,000	5,000
Storage pond	150mx150mx5m lined storage dam	750,000	0		0	0		0	0		0	0		0	0
	100mx100mx4m lined storage dam	300,000	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0	1	70,000	50,000	2	140,000	100,000
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000	2	40,000	30,000	3	60,000	45,000		0	0		0	0
	Pump station arrangement including 2x 3L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	15,000	10,000		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0	4	26,000	0	3	19,500	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0	14	112,000	0	25	200,000	0
	Tanker truck loading pipe stand	15,000	5,000	2	30,000	10,000	3	45,000	15,000		0	0	1	15,000	5,000
River extraction	Intake structure	30,000	0		0	0		0	0		0	0		0	0
	Pump station arrangement including 4x 10L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	70,000	50,000		0	0		0	0		0	0		0	0
	Pump station arrangement including 2x 5L/s capacity pumps, valves, pipeworks, installation hard stand and protecting shed including 20kVA generator	20,000	15,000		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100metres of 200mm dia HDPE- PE100 pipework	8,000	0		0	0		0	0		0	0		0	0
Borefield	Lined Borehole and Pump to Depth 250m plus generator, electricals and borehole compound pipings	150,000	30,000		0	0		0	0	6	900,000	180,000		0	0
	Lined Borehole and Pump to Depth 150m plus generator, electricals and borehole compound pipings	120,000	25,000	6	720,000	150,000	6	720,000	150,000		0	0		0	0
	Lined Borehole and Pump to Depth 100m plus generator, electricals and borehole compound pipings	90,000	20,000		0	0		0	0		0	0		0	0
	Lined Borehole and Pump to Depth 50m plus generator, electricals and borehole compound pipings	70,000	15,000		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 100mm dia HDPE- PE100 pipework	6,500	0		0	0		0	0		0	0		0	0
	Supply, trenching, installation and cover of 100 metres of 50mm dia HDPE- PE100 pipework	5,000	0	12	60,000	0	12	60,000	0	12	60,000	0		0	0
Purchase of water	Raw water from Adani Dam at Abbot Point	150,000	30,000												
	Drinking water from Council	120,000	25,000												
Total					1,001,000	275,000		1,029,500	295,000		1,582,000	585,000		480,000	190,000

APPENDIX B

DRAWINGS



NOTES:

1. ALL DIMENSIONS IN MILLIMETRES.

2. ALL EMBEDDED PIPES ARE HDPE PN10.

3. ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PN10.

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date

Status

CONCEPT DESIGN

NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 200	Current Issue Signatures	
		Author	Shashidhar
Original Size	A1	Checker	P. Ghasemzadeh
Datum	-	Approver	S. Pollard
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Filename: 0001-AA005967-01DWG

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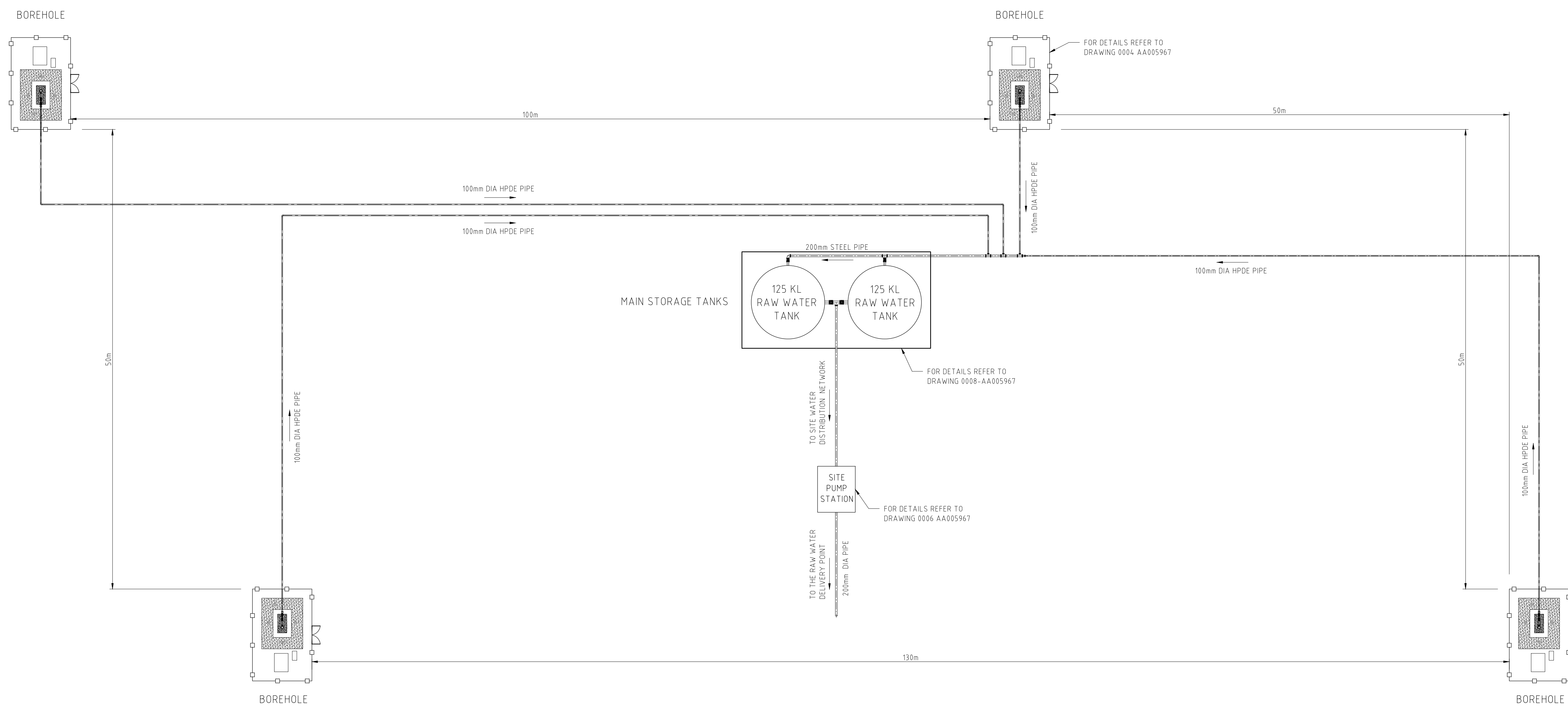
Project

NORTH GALILEE BASIN RAIL
[NGBR]

Title

RIVER EXTRACTION
GENERAL LAYOUT PLAN

Drawing No.	Project No.	Issue
0001 -	AA005967 - AU	D - 01



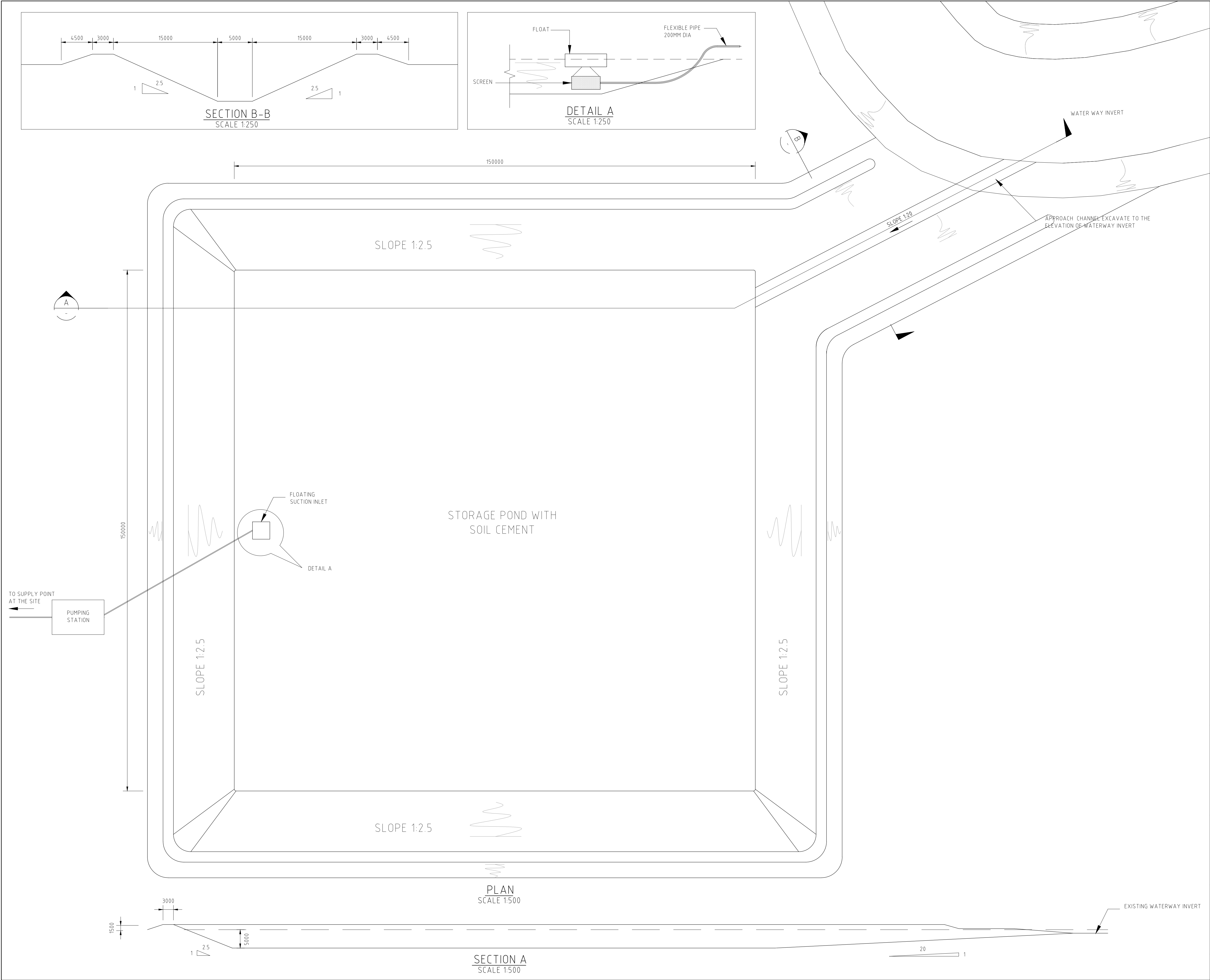
NOTES:

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Issue	Description	Date	
Scale CONCEPT DESIGN NOT TO BE USED FOR CONSTRUCTION			
Scales	1 : 200	Current Issue Signatures	
		Author	Shashidhar
Original Size	A1	Checker	P. Ghasemzadeh
Datum	-	Approver	S. Pollard
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Project	NORTH GALILEE BASIN RAIL [NGBR]
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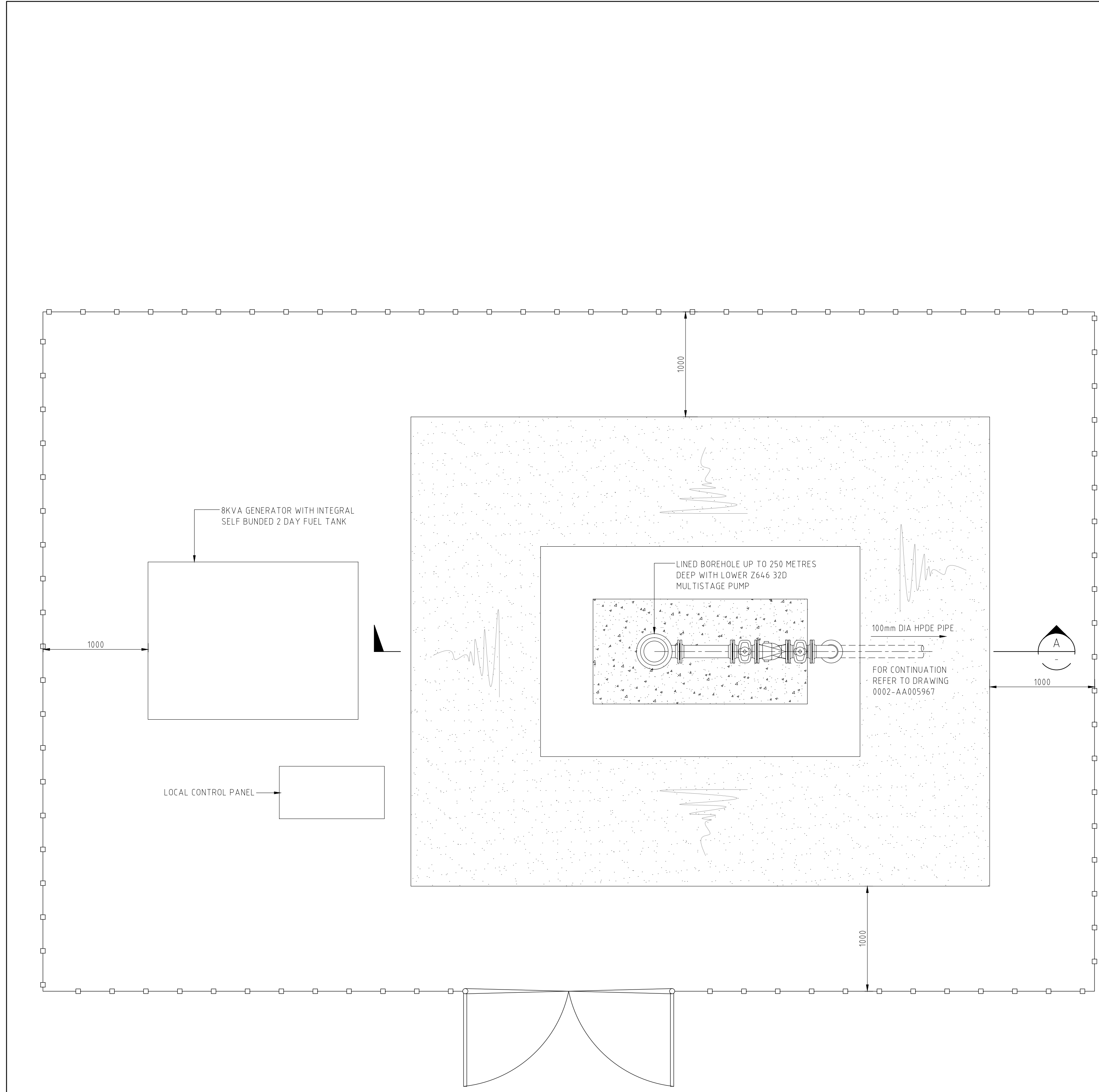
Drawing No.	Project No.	Issue
0002 -	AA005967- AU -	D - 01



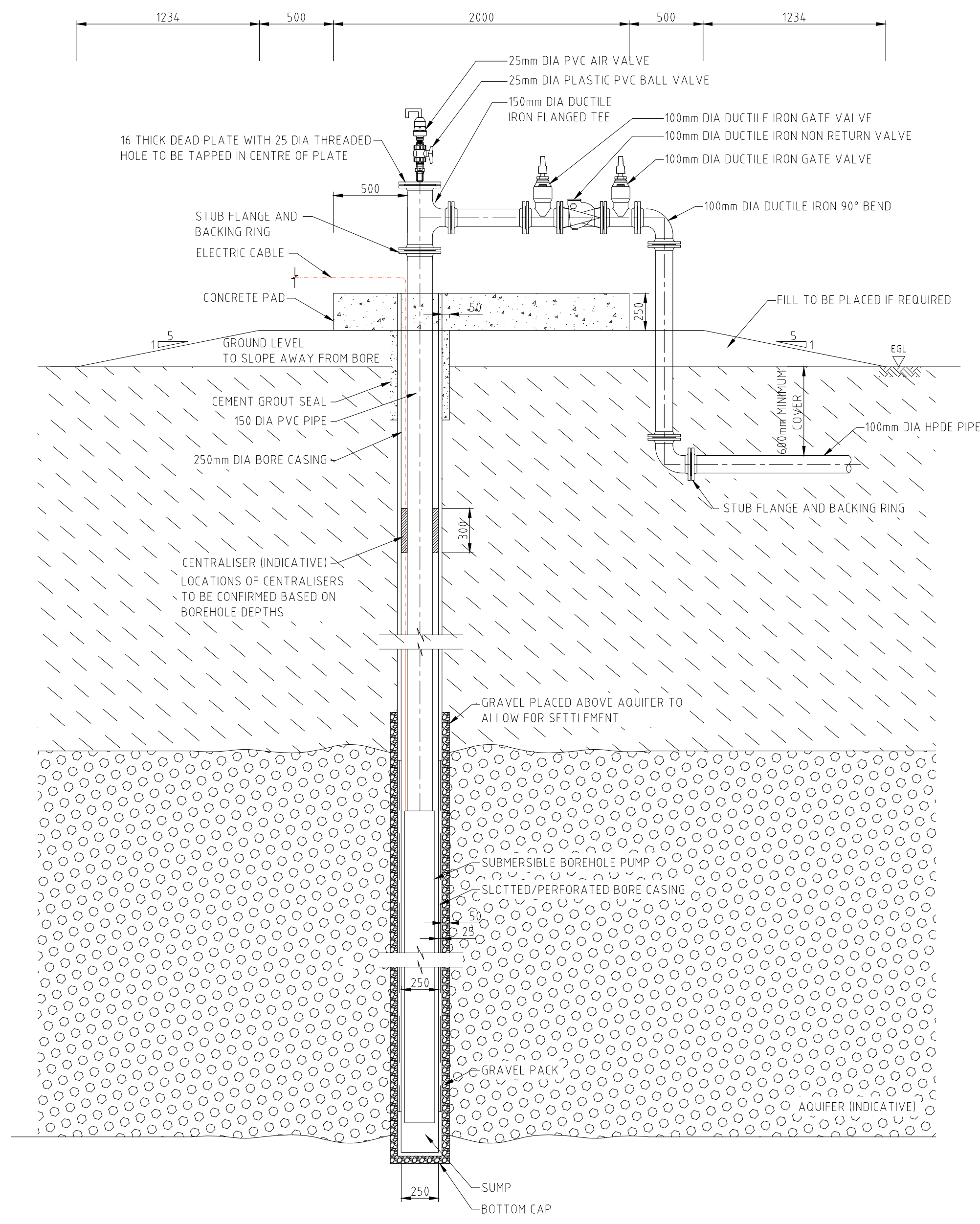
NOTES:

- ALL DIMENSIONS IN MILLIMETRES.
- ALL EMBEDDED PIPES ARE HDPE PN10
- ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PN10

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date
Status	CONCEPT DESIGN NOT TO BE USED FOR CONSTRUCTION	
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		Author Shashidhar
Original Size	A1	Checker P. Ghasemzadeh
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Client		
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Project		
NORTH GALILEE BASIN RAIL [NGBR]		
Title		
OFF-STREAM STORAGE POND		
Drawing No.	Project No.	Issue
0003 -	AA005967- AU -	D - 01



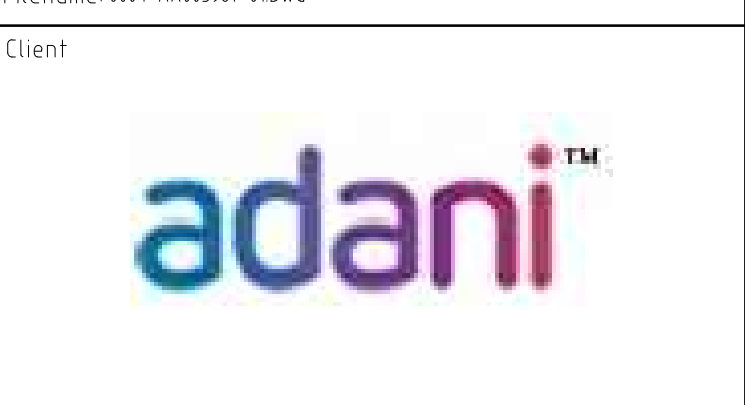
PLAN
SCALE 1:25



SECTION - A TYPICAL BOREHOLE DETAILS
SCALE 1:25

- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES.
 2. ALL EMBEDDED PIPES ARE HDPE PN10.
 3. ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PN10.
 4. SIZE OF COMPOUND TO BE DESIGNED BY INTERNAL REQUIREMENTS.

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date
Status		
CONCEPT DESIGN		
NOT TO BE USED FOR CONSTRUCTION		
Scales	1 : 25	Current Issue Signatures
		Author Shashidhar
Original Size	A1	Checker P. Ghasemzadeh
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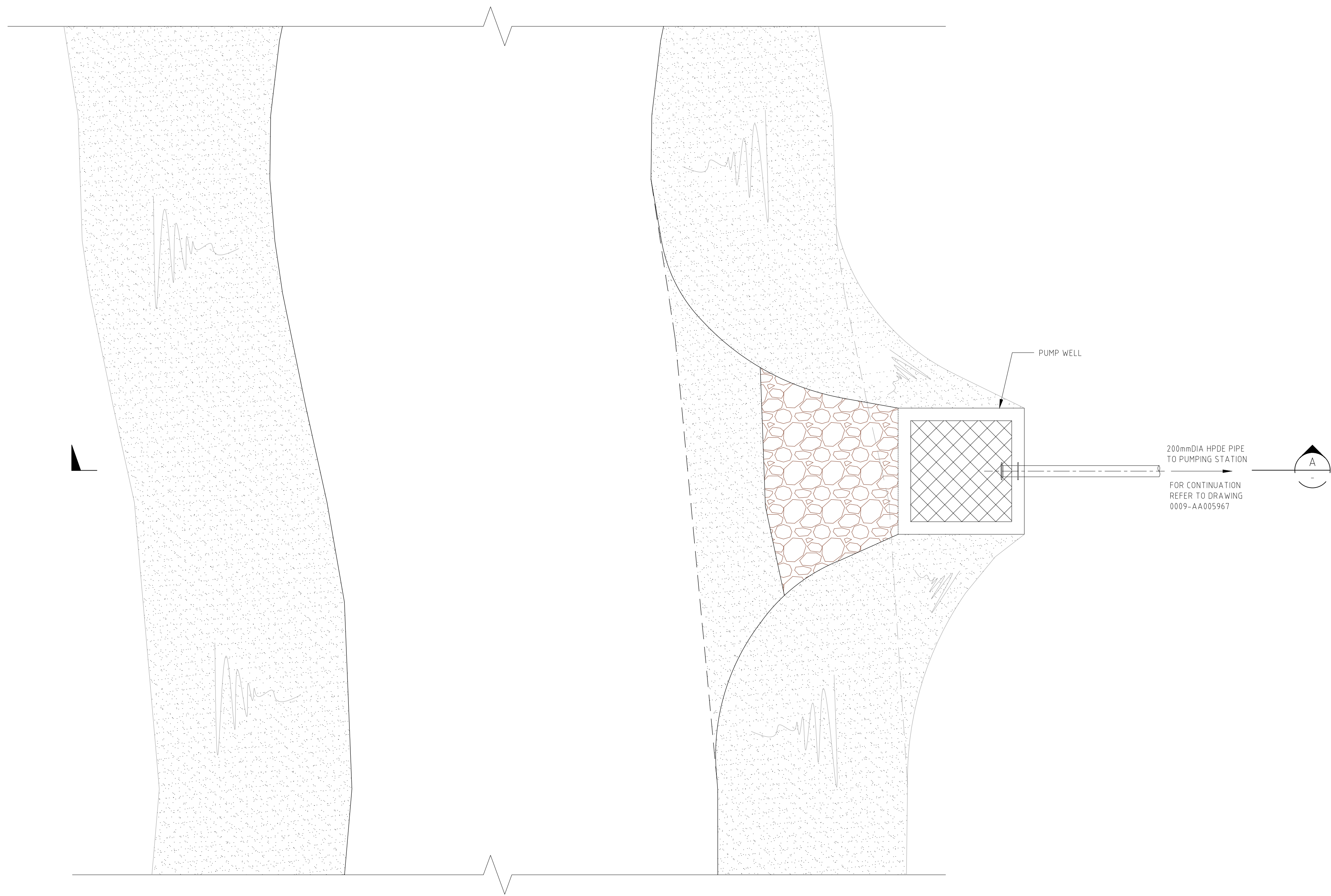
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NORTH GALILEE BASIN RAIL
[NGBR]

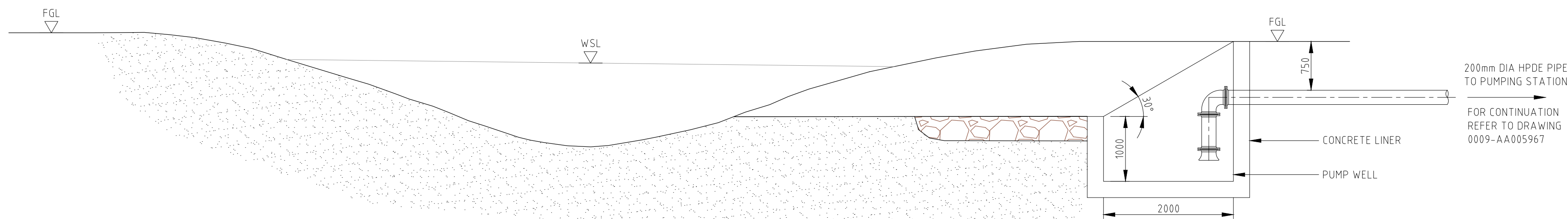
Title

TYPICAL LAYOUT
BOREHOLE COMPOUND

Drawing No.	Project No.	Issue
0004 -	AA005967- AU	- D - 01



PLAN
SCALE 1:50



SECTION A-A
SCALE 1:50

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES.
2. THE PIPE COVER NOT TO BE MORE THAN 750mm.
3. THE INTAKE SHOULD NOT BLOCK THE MAIN WATERWAY

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date

Status
CONCEPT DESIGN
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 50	Current Issue Signatures	
		Author	Shashidhar
Original Size	A1	Checker	P. Ghasemzadeh
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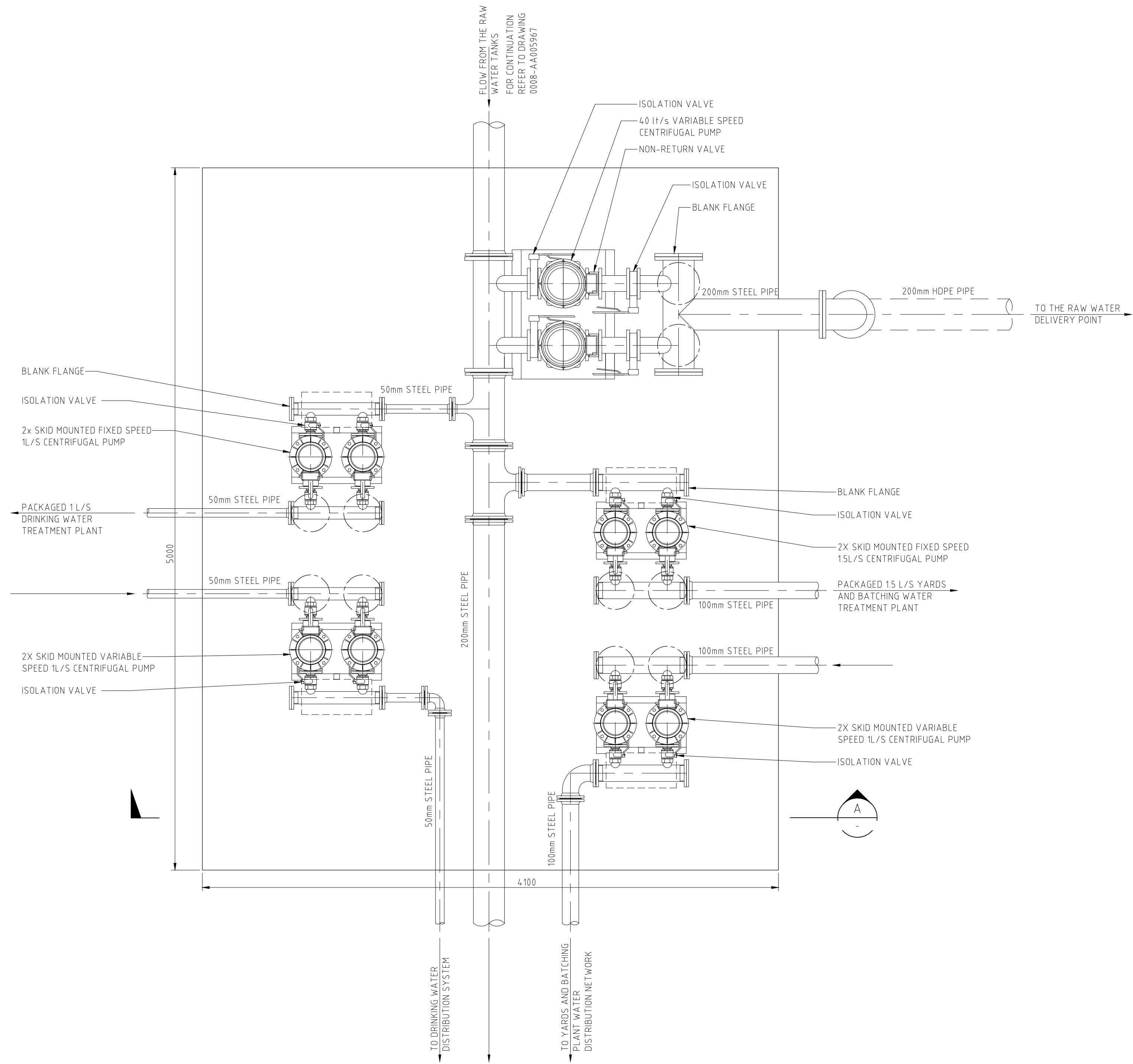


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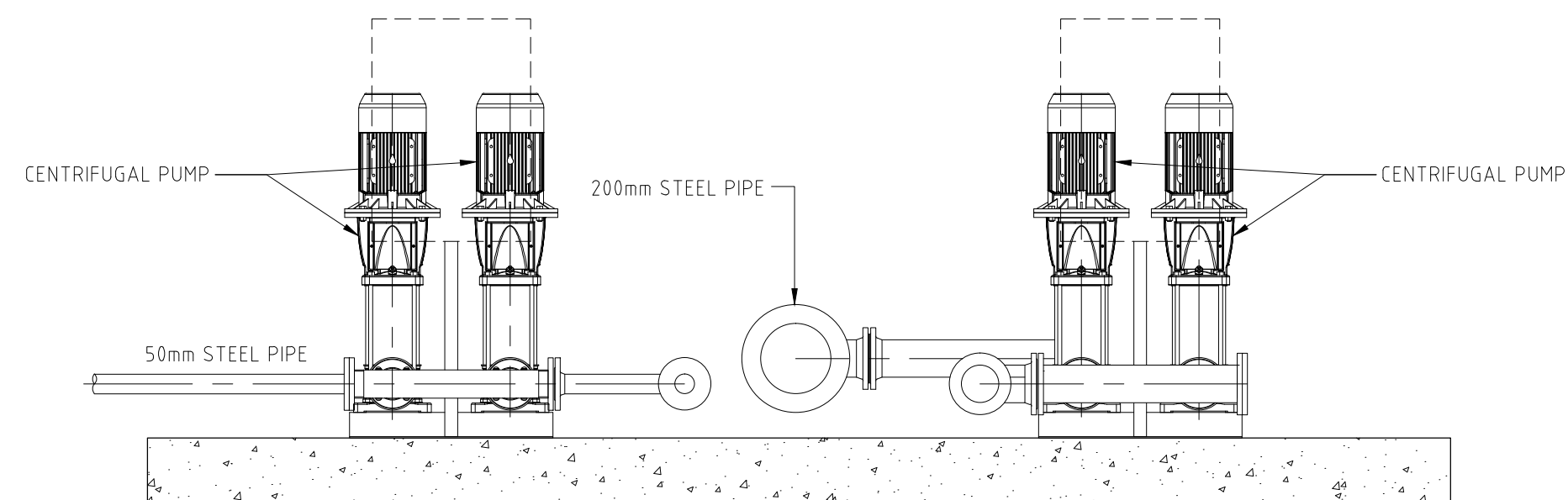
Project
**NORTH GALILEE BASIN RAIL
[NGBR]**

Title
**RIVER EXTRACTION
PUMP STATION
INTAKE**

Drawing No.	Project No.	Issue
0005 - AA005967- AU - D - 01		



PLAN
SCALE 1:20



SECTION A-A
SCALE 1:20

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES.
2. ALL EMBEDDED PIPES ARE HDPE PN10
3. ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PN10

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date
Status CONCEPT DESIGN NOT TO BE USED FOR CONSTRUCTION		
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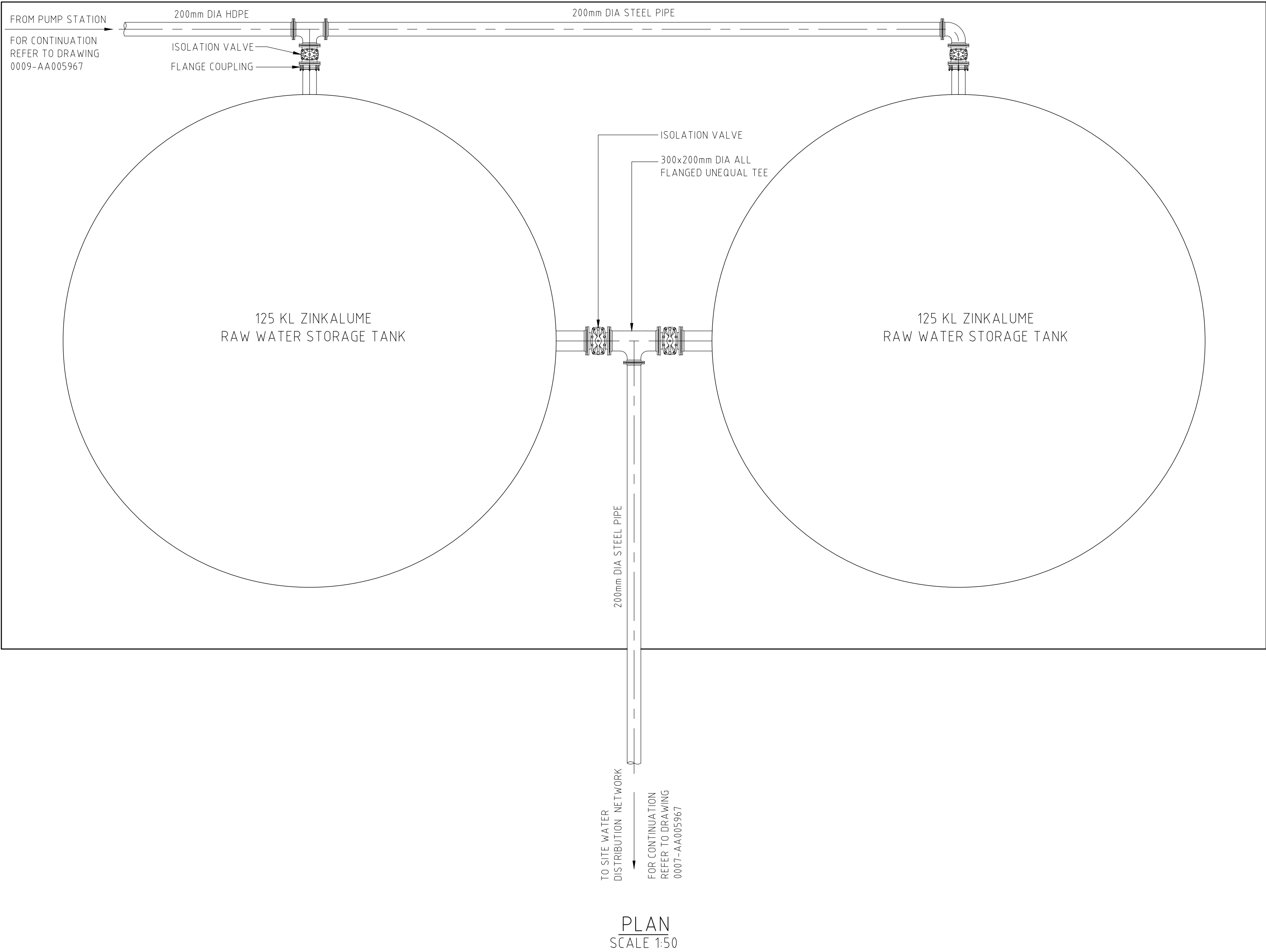
Project

NORTH GALILEE BASIN RAIL
[NGBR]

Title

WATER DISTRIBUTION
PUMPING SYSTEM
PLAN AND SECTION

Drawing No.	Project No.	Issue
0006 - AA005967- AU - D - 01		



- NOTES:
- 1. ALL DIMENSIONS IN MILLIMETRES.
 - 2. ALL EMBEDDED PIPES ARE HDPE PN10.
 - 3. ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PN10.

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date
Status		
CONCEPT DESIGN		
NOT TO BE USED FOR CONSTRUCTION		
Scales	1 : 50	Current Issue Signatures
		Author Shashidhar
Original Size	A1	Checker P. Ghasemzadeh
Datum	-	Approver S. Pollard
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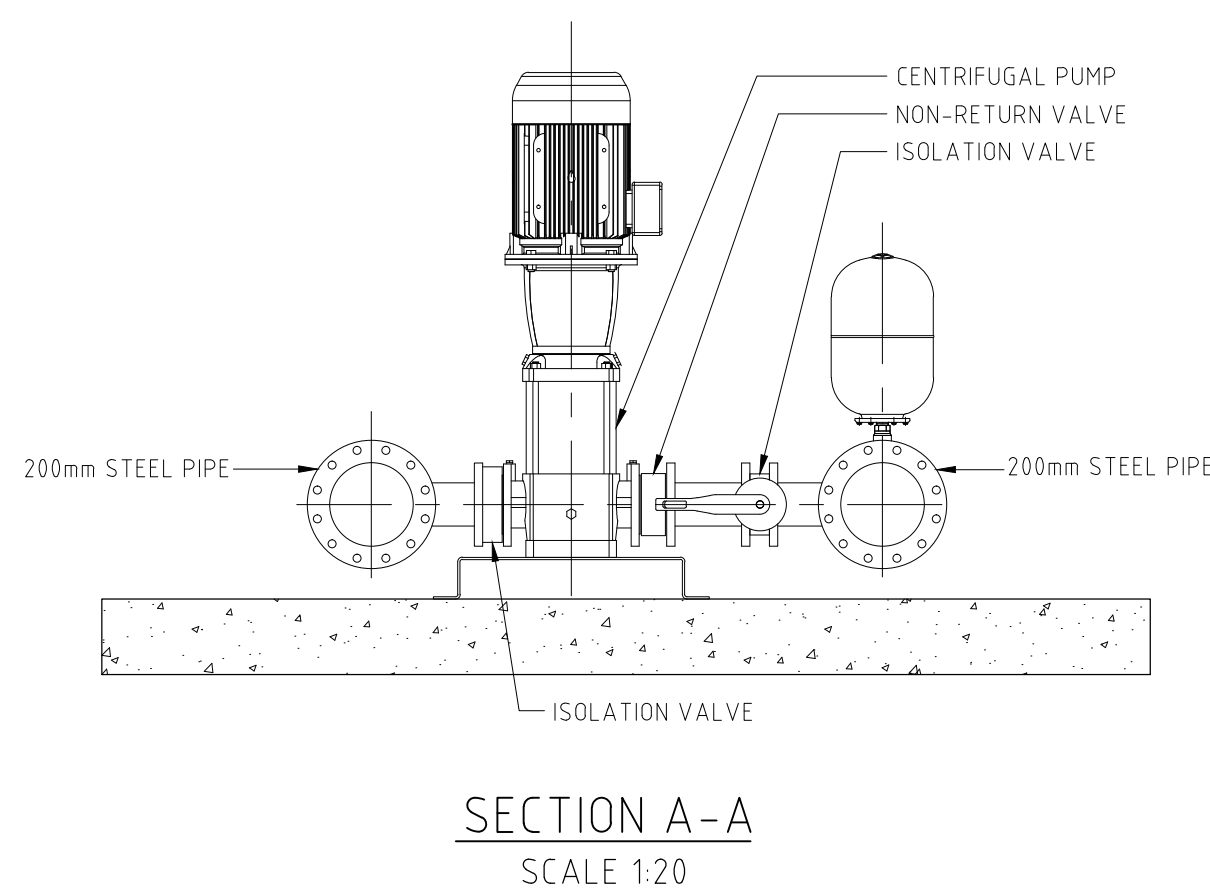
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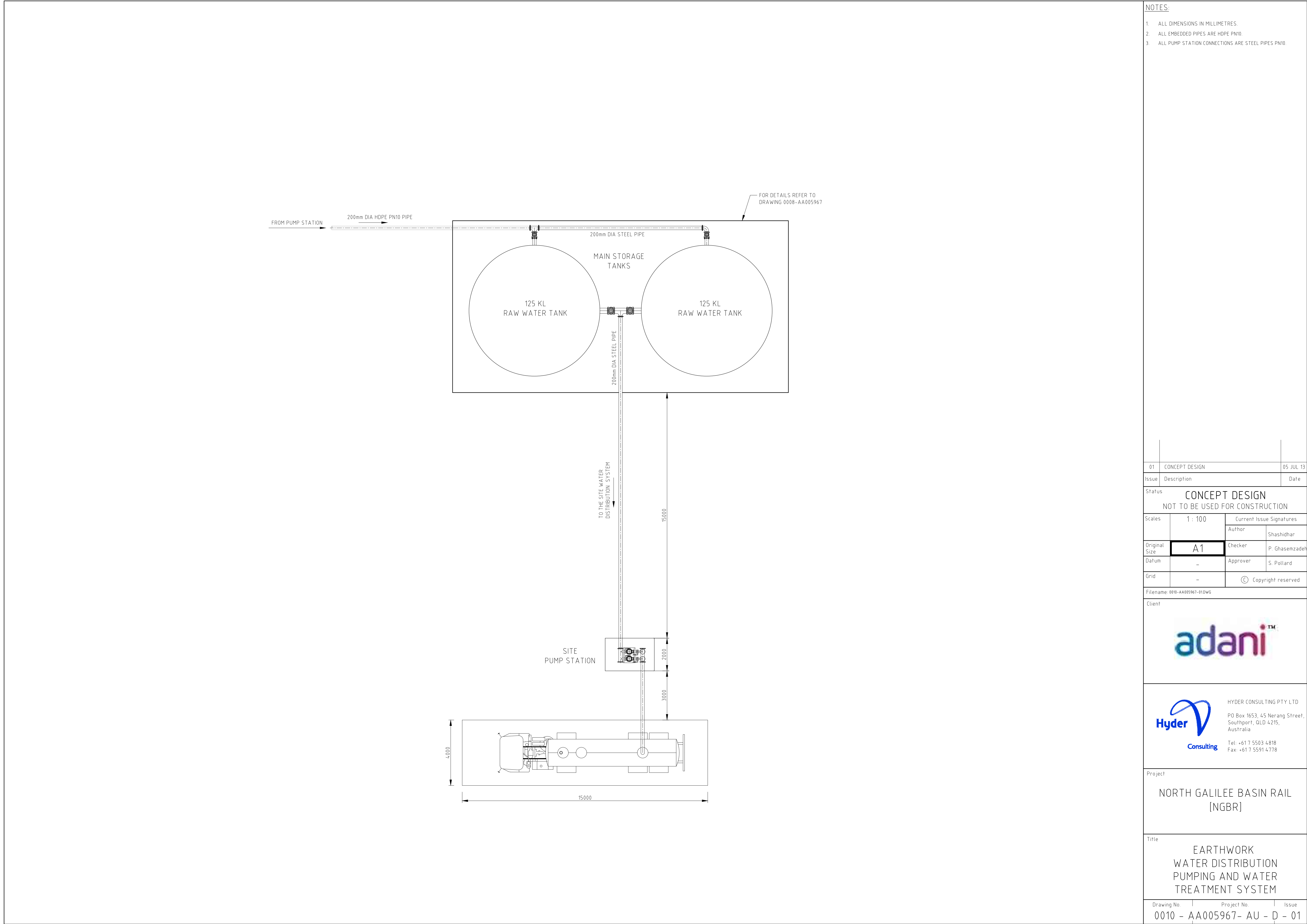
NORTH GALILEE BASIN RAIL
[NGBR]

Title

RAW WATER STORAGE TANKS

Drawing No.	Project No.	Issue
0008 - AA005967-	AU - D - 01	





- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES.
 2. ALL EMBEDDED PIPES ARE HDPE PN10.
 3. ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PN10.

01	CONCEPT DESIGN	05 JUL 13
Issue	Description	Date
Status		
CONCEPT DESIGN		
NOT TO BE USED FOR CONSTRUCTION		
Scales	1 : 100	Current Issue Signatures
		Author Shashidhar
Original Size	A1	Checker P. Ghasemzadeh
Datum	-	Approver S. Pollard
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Filename: 0010-AA005967-01DWG		



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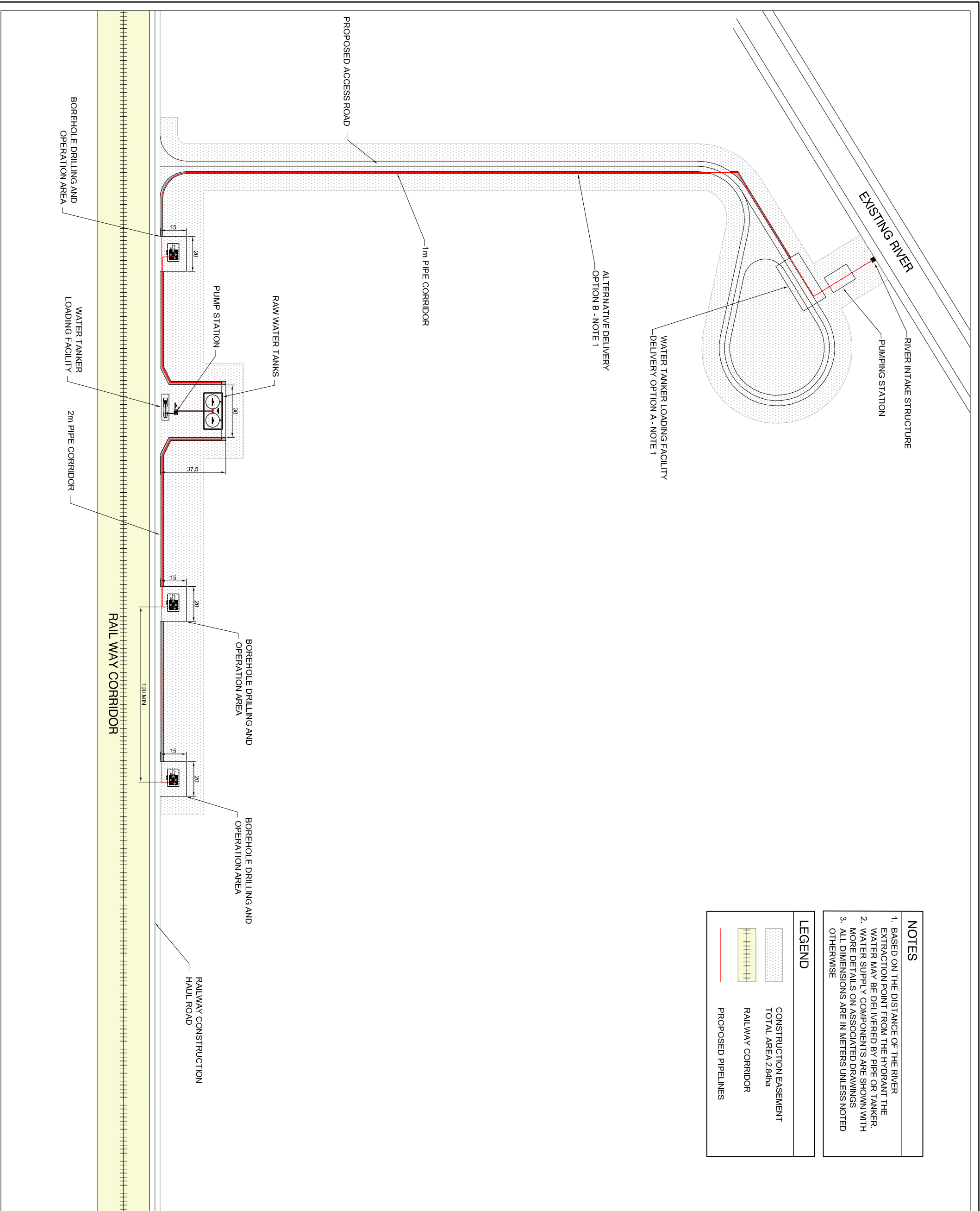
Project

NORTH GALILEE BASIN RAIL
[NGBR]

Title

EARTHWORK
WATER DISTRIBUTION
PUMPING AND WATER
TREATMENT SYSTEM

Drawing No.	Project No.	Issue
0010 -	AA005967- AU	D - 01



NOTES:

- ALL DIMENSIONS IN MILLIMETRES.
- ALL EMBEDDED PIPES ARE HOPE PHU0.
- ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PHU0.

01	CONCEPT DESIGN			18 JUL 13	
Issue	Description			Date	
Status					
CONCEPT DESIGN					
NOT TO BE USED FOR CONSTRUCTION					
Scales		Current Issue Signatures			
1 : 1000		Author	Shashidhar		
Original		Checker	P. Ghasemzadeh		
Site	A1	Approver	S. Pollard		
Datum	-	© Copyright reserved			
Grid	-				
Filename: 0011-AA005967-1010W6					



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Project
NORTH GALILEE BASIN RAIL
[INGBR]

Title
RAILWAY CONSTRUCTION
GENERAL ARRANGEMENT
WATER SUPPLY FROM
RIVER EXTRACTION & BOREHOLES

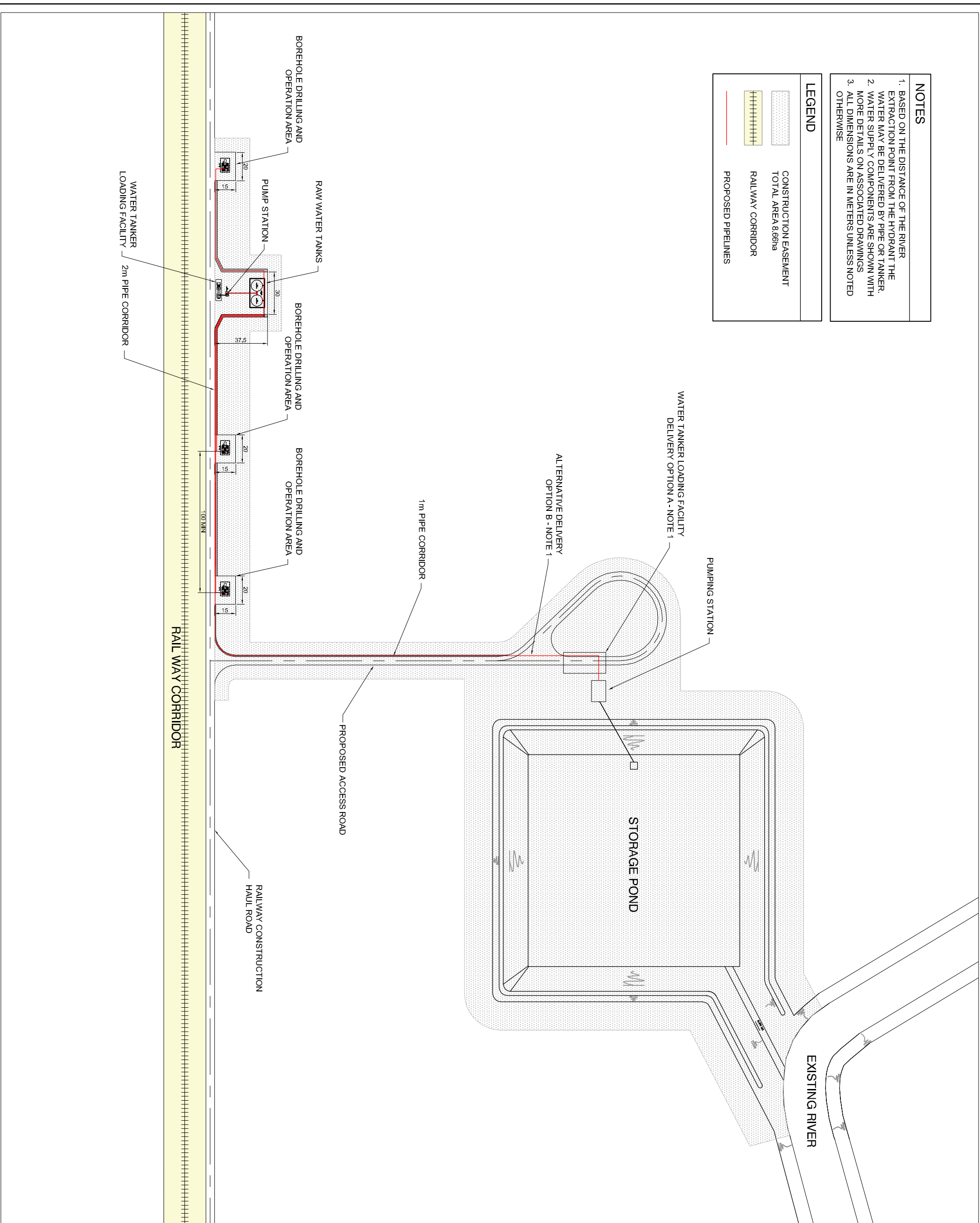
Drawing No. 0012 - AA005967 - AU - D - 01
Project No.
Issue

NOTES:

- 1. ALL DIMENSIONS IN MILLIMETRES.
- 2. ALL EMBEDDED PIPES ARE HOPE PH00.
- 3. ALL PUMP STATION CONNECTIONS ARE STEEL PIPES PH00.

- NOTES
- 1. BASED ON THE DISTANCE OF THE RIVER EXTRACTION POINT FROM THE HYDRANT THE WATER MAY BE DELIVERED BY PIPE OR TANKER.
 - 2. WATER SUPPLY COMPONENTS ARE SHOWN WITH MORE DETAILS ON ASSOCIATED DRAWINGS
 - 3. ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE

LEGEND	
	CONSTRUCTION EASEMENT
	TOTAL AREA 8.66ha
	RAILWAY CORRIDOR
	PROPOSED PIPELINES



01	CONCEPT DESIGN	18 JUL 13
Issue	Description	Date

Status	
CONCEPT DESIGN	
NOT TO BE USED FOR CONSTRUCTION	
Scales	
1 : 800	Current Issue Signatures
Original Size	Author
	Shashidhar
	Checker
	P. Ghasemzadeh
Datum	Approver
	S. Pollard
Grid	-
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Project

NORTH GALILEE BASIN RAIL
[INGBR]

RAILWAY CONSTRUCTION
GENERAL ARRANGEMENT
WATER SUPPLY FROM
STORAGE POND & BOREHOLES

Drawing No. 0011 - AA005967 - AU - D - 01
Project No.
Issue

APPENDIX C

EXPECTED DAILY FLOWS IN MAJOR WATERWAYS

Expected Mean Flows (ML/day)

Crossing Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Suttor River 2	8	5	7	2	4	21	52	123	140	103	24	20
Suttor River 3	22	14	20	6	11	56	142	335	380	280	65	54
Bowen River	261	161	239	74	128	661	1663	3934	4466	3291	759	640
Pelican Creek	44	27	40	12	22	112	281	665	755	556	128	108
Strathmore Creek	12	8	11	4	6	31	79	187	213	157	36	30
Sandy Creek	13	8	12	4	6	32	81	191	216	159	37	31
Bogie River	37	23	34	10	18	93	235	555	630	464	107	90
Elliot River	12	7	11	3	6	31	77	182	206	152	35	30
Suttor River 1	259	188	84	13	3	2631	6451	3963	7869	4467	435	131

Expected Flows, 25% Reliability (ML/day)

Crossing Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Suttor River 2	9	6	8	3	4	23	57	135	153	113	26	22
Suttor River 3	24	15	22	7	12	62	156	368	418	308	71	60
Bowen River	375	232	342	106	184	949	2387	5646	6410	4723	1090	919
Pelican Creek	50	31	45	14	24	125	316	747	848	625	144	121
Strathmore Creek	14	8	12	4	7	35	87	206	233	172	40	33
Sandy Creek	14	9	13	4	7	35	89	209	238	175	40	34
Bogie River	40	25	37	11	20	102	258	610	692	510	118	99
Elliot River	13	8	12	4	7	34	84	200	227	167	39	32
Suttor River 1	680	420	621	192	334	1720	4326	10233	11618	8560	1976	1665

Expected Flows, 50% Reliability (Median) (ML/day)

Crossing Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Suttor River 2	4	2	3	1	2	9	24	56	64	47	11	9
Suttor River 3	10	6	9	3	5	26	65	153	174	128	30	25
Bowen River	169	104	154	48	83	427	1074	2540	2884	2125	490	413
Pelican Creek	21	13	19	6	10	53	133	314	356	262	61	51
Strathmore Creek	6	4	5	2	3	14	36	86	97	72	17	14
Sandy Creek	6	4	5	2	3	15	37	87	99	73	17	14
Bogie River	17	10	15	5	8	43	107	254	289	213	49	41
Elliot River	6	3	5	2	3	14	35	83	95	70	16	14
Suttor River 1	307	190	280	87	151	777	1956	4626	5252	3869	893	753

Expected Flows, 75% Reliability (ML/day)

Crossing Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Suttor River 2	1	1	1	0	1	3	8	18	21	15	4	3
Suttor River 3	3	2	3	1	2	8	21	50	57	42	10	8
Bowen River	60	37	55	17	30	152	383	907	1030	759	175	148
Pelican Creek	7	4	6	2	3	17	43	103	117	86	20	17
Strathmore Creek	2	1	2	1	1	5	12	28	32	23	5	5
Sandy Creek	2	1	2	1	1	5	12	28	32	24	5	5
Bogie River	5	3	5	2	3	14	35	82	94	69	16	13
Elliot River	2	1	2	1	1	5	11	27	31	23	5	4
Suttor River 1	110	68	101	31	54	279	702	1660	1885	1389	320	270

Expected Flows, 90% Reliability (ML/day)

Crossing Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Suttor River 2	1	1	1	0	1	3	7	16	18	14	3	3
Suttor River 3	3	2	3	1	1	7	19	44	50	37	8	7
Bowen River	37	23	34	10	18	94	236	557	633	466	108	91
Pelican Creek	6	4	5	2	3	15	37	88	100	73	17	14
Strathmore Creek	2	1	1	0	1	4	10	25	28	21	5	4
Sandy Creek	2	1	2	0	1	4	11	25	28	21	5	4
Bogie River	5	3	4	1	2	12	31	73	83	61	14	12
Elliot River	2	1	1	0	1	4	10	24	27	20	5	4
Suttor River 1	66	41	60	19	33	168	422	997	1132	834	193	162

APPENDIX D

SURFACE WATER SOURCE OPTIONS

Water Supply Chainage (m)	Storages	E	N	Estimated Pond Area (m ²)	Elevation (m AHD)	Distance to Supply Point (m)	Elevation at Supply Point (m AHD)	Distance to Nearest Chainage (m)	Nearest Chainage (km)	Elevation at nearest chainage (m AHD)	Comment
-5											
0											
5											
10											
15	Pond 1	608853.63	7792146.31		21	1170	48				
20	Pond 2	608370.05	7792113.64		22	1200	48				
20	Proposed Pond 20	604020.27	7789126.62		17	100	17				Construct as in-stream storage on the tributary
25	Proposed Pond 19	599541.21	7786483.53		31	425	32				Construct as off-stream storage and channel the water to the pond.
30	Proposed Pond 18	593986.97	7786266.7		31	1300	45				
35	Pond 3	588410.62	7785193.84	8000	40	1890	43	515	36.5	46	
40	Proposed Pond 17	586556.3	7781389.6		63	495	65				
45	Pond 6	587303.35	7776558.53	3000	109	1010	107				
50	Proposed Pond 16	589276.33	7772437.18		128	850	167				Requires high pumping head
55	Proposed Pond 15	584967.27	7769222.49		153	950	177				
60	Pond 7	585261.96	7764966.46	4000	162	1200	152	283	59	167	Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
65	Proposed Pond 14	582162.7	7759230.72		147	595	147				
70	Proposed Pond 13	578765.08	7756537.57		175	785	192				
75	Proposed Pond 12	576317.97	7752519.08		205	195	206				
80	Pond 13	577852.92	7747366.51	5000	183	1020	175				
85	Pond 17	575788.16	7742666.87	2000	155	400	157				
90	Storage 1	574899.67	7737920.26	40000	138	1620	154				
95	Pond 18	572713.67	7732131.41	6000	123	2500	131	185	97.5	125	
100	Storage 2	571405.84	7731522.57	90000	115	1220	112	690	99	113	
105											Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
110	Pond 21	571293.53	7719377.15	5600	143	2540	130	112	112.5	140	
110	Pond 20	570650.53	7720742.23	4000	127	1150	130	630	111	128	
115	Pond 22	573064.61	7716143.49	4000	142	1180	147	250	116	148	
120	Pond 23	574197.84	7712548.68	8000	128	1550	138				
125	Pond 24	576341.06	7710193.58	2500	157	2070	131	600	123	158	
125	Proposed Pond 11	577985.18	7708172.61		129	1000	131				

130											Use River Extraction
135	Proposed Pond 10	581494.62	7699342.44		131	905	153				
140	Pond 25	584058.71	7694501.99	14000	157	1000	160	260	141	161	
145	Pond 26	585049.03	7690252.57	6000	180	1200	172				
145	Pond 27	585177.95	7689963.83	20000	185	1400	172				
150	Pond 29	583941.68	7684191.43	22000	211	1830	213	545	152	216	
155	Proposed Pond 9	586268.81	7682005.41		220	2400	241				
160	Proposed Pond 8	585049.3	7676159.88		271	1340	314				
165	Proposed Pond 7	579979.59	7672347.68		315	740	352				
170											Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
175	Pond 31	574308.45	7664339.51	15000	330	1100	329				Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
180											The catchment may not be enough- More Research
185											Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
190	Pond 32	578370.55	7650448.54	3000	306	2020	332				
190	Existing Pond										This pond is not visible in Google Earth
195	Proposed Pond 5	578312.89	7645041.63		314	695	317				
200	Pond 33	577752.42	7640619.22	18000	295	360	298				
205											Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
210	Pond 34	570606.4	7632052.93	40000	301	1360	293	250	211	302	Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
215	Pond 58	568874.8	7629617.23	4000	305	700	298	200	214.3	303	
220	Pond 70	563009.28	7626920.17	12000	271	860	277	200	221	275	
225	Pond 35	559518.67	7625212.83	8000	261	550	258				
230	Pond 36	555875.35	7619860.47	30000	246	1870	245				
235	Pond 69	547052.28	7617745.08	20000	231	3150	250	440	238	232	
240	Pond 68	547227.62	7615522.04	900000	234	470	236				
245	Pond 38	543353.79	7614820.03	6400	228	950	229				
250	Pond 39	537726.1	7614608.47	2500	216	150	217				
250	Pond 40	536558.63	7613134.18	4500	215	157	217				

255	Pond 41	530960.24	7614959.84	2500	209	1760	211	185	256.8	208	
255	Pond 42	530495.27	7614483.08	4000	207	2200	211	720	257	207	
260	Pond 43	527687.48	7613549.61	10000	202	1475	205				
265	Pond 44	521761.86	7614239.87	10000	197	1430	201	400	266.4	197	
270	Pond 66	517923.43	7615197.95	600000	189	780	193				Use River Extraction. To provide for dry periods construct storage next to the river and use flood harvesting
275	Proposed Pond 2	514700.98	7609424.62		201	1050	203				
280	Proposed Pond 1	510538.21	7607362.82		226	390	237				
285	Pond 67	508148.42	7602944.23	6000	241	1200	233				
290	Pond 56	505371.36	7598705.76	11000	246	825	245				
295	Pond 51	504283.67	7593942.67	6400	228	640	225				
300	Pond 52	504791.53	7590933.33	6400	224	2115	218				
302	Pond 54	503976.53	7587293.02	50000	214	1450	209				
305	Pond 55	499768.92	7585292.07	40000	199	838	202				
305	Pond 70	500698.79	7583773.54	60000	204	1580	202				

Adani Storage Pond at Abbot Point



Pond 54



Pond 33- West of Chainage 200



Pond 34-East of chainage 211



Pond 38- North of chainage 244



Pond 39- North of chainage 250



Pond 42- South of chainage 257



Pond 43- South of chainage 261



Pond 44- North of chainage 266



Pond 54- West of chainage 302



Pond 58- West of chainage 214



Pond 66- North of chainage 270



Pond 68- North of chainage 270



Pond 69- North of chainage 238



Suttor River



Pond 29, Chainage 152



Pond 21, Chainage 112.5



Pond 21, Chainage 112.5



Pond 20, Chainage 111



Pond 19, Chainage 102.5



Pond 13, Chainage 80.5



Existing pond, Chainage 79.7



Existing Pond, Chainage 42.5



APPENDIX E

WATER SOURCE HYDRANT INFRASTRUCTURE FOOTPRINTS

Table 13-2 shows the footprint areas for the water infrastructure for each hydrant. Justification for the choice of footprint area is also included.

Table 13-2 Hydrant footprint areas and justification

Hydrant Footprint	Area (ha)	Justification
Hyd-N001	0.00	Footprint of zero area as no infrastructure required
Hyd-N002	0.00	Footprint of zero area as no infrastructure required
Hyd-N003	0.00	Located on construction camp footprint therefor no additional footprint required
Hyd-N004	0.59	4 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N005	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N006 Part A	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N006 Part B	2.82	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N007 Part A	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N007 Part B	8.06	Based on approximate road corridor and storage pond on drawing (0011-AA005967-AU-D-01)
Hyd-N008 Part A	0.82	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01). Storage tanks located on construction camp footprint
Hyd-N008 Part B	5.37	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01)
Hyd-N009 Part A	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N009 Part B	2.27	Based on approximate road corridor and storage pond on drawing (0011-AA005967-AU-D-01)
Hyd-N010	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N011	0.41	2 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N012	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N013 Part A	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N013 Part B	0.34	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint

Hydrant Footprint	Area (ha)	Justification
Hyd-N014	0.74	5 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N015	0.21	1 bore. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01). Storage tanks and treatment plants located on construction camp footprint
Hyd-N016 Part A	0.96	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N016 Part B	3.04	Based on approximate road corridor and storage pond on drawing (0011-AA005967-AU-D-01)
Hyd-N017	1.24	7 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N018	0.80	5 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N019	0.51	4 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01). Storage tanks located on construction camp footprint
Hyd-N020	0.49	3 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N021	0.49	3 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N022	0.35	2 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N023	0.79	5 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N024 Part A	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N024 Part B(i)	1.21	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N024 Part B(ii)	0.53	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N025 Part A	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N025 Part B(i)	0.68	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N025 Part B(ii)	1.28	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N025 Part B(iii)	9.61	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint

Hydrant Footprint	Area (ha)	Justification
Hyd-N026	0.79	5 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N027	0.79	5 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N028	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N029 Part A	1.15	7 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01). Storage tanks located on construction camp footprint
Hyd-N029 Part B	4.62	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N030 Part A	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N030 Part B	6.51	Based on approximate road corridor and storage pond on drawing (0011-AA005967-AU-D-01)
Hyd-N031 Part A	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N031 Part B(i)	6.72	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N031 Part B(ii)	2.55	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N032 Part A	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01)
Hyd-N032 Part B	2.66	Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N033 Part A	5.61	Storage tanks and water infrastructure contained within construction camp footprint. Based on approximate road corridor on drawing (0011-AA005967-AU-D-01). Existing pond therefore no pond footprint
Hyd-N033 Part B	0.84	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01). Storage tanks and water infrastructure contained within construction camp footprint. Bore option will be required if water in Pond 54 allocated to other users
Hyd-N034 Part A(i)	5.08	Based on approximate road corridor and storage pond on drawing (0011-AA005967-AU-D-01). Storage tanks for this water source located on south side of rail line.
Hyd-N034 Part A(ii)	3.83	Based on approximate road corridor and storage pond on drawing (0011-AA005967-AU-D-01). Storage tanks for this water source located on north side of rail line.

Hydrant Footprint	Area (ha)	Justification
Hyd-N034 Part B	0.95	6 bores. Based on approximate size of borefield drawing (0011-AA005967-AU-D-01). Required if access to ponds cannot be negotiated with land owners.