Groundwater Assessment

477 Urliup Road BILAMBIL

Prepared for
Karlos Family Trust

November 2016

DOCUMENT TRACKING

Item	Detail
Project Name	Groundwater Assessment - 477 Urliup Road, Bilambil
Project Number	5735
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Status	FINAL
Version Number	1
Last saved on	3 December 2016
Cover photo	477 Urliup Road from Urliup Road looking south east, taken 10th November by ELA

This report should be cited as 'Eco Logical Australia November 2016. *477 Urliup Road Bilambil Groundwater Assessment*. Prepared for Karlos Family Trust.'

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Template 29/9/2015

Executive Summary

The Karlos Family Trust, operating out of 477 Urliup Road, New South Wales (NSW), has been abstracting water for commercial bottling purposes for the last 14 years. There are currently five working bores on site. Two are currently used for water abstraction for commercial purposes (bores BH2 and BH5). Currently the site is licensed to abstract a total of 60 ML/year across three bores and the Karlos Family Trust are seeking to increase their licensed abstraction allowance to 98 ML/year (the Proposal) incorporating abstracted water from the adjacent property 483 Urliup Road. An impact assessment of the potential impacts of the cumulative abstraction from 477 and 483 Urliup Road on the groundwater and surface water systems was required to satisfy client, Tweed Shire Council and the State Government.

The site currently abstracts from the Neranleigh-Fernvale Beds, a fractured rock aquifer consisting predominantly of grey wackes, with abstractions being assessable under the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources. Monitoring of groundwater levels in bores and in Bilambil Creek before during and after pumping provide information on the aquifer, suggesting it is highly permeable with little to no connection between bores due to its fractured nature. There is no evidence to suggest a connection between the surface and groundwater systems, with microbiological water quality analysis of the two systems suggesting a distinct disconnect.

An impact assessment was undertaken which did not identify sensitive receptors which may be impacted from the groundwater abstraction:

- Groundwater Dependent Ecosystems:
    - There are no groundwater dependent ecosystems within 1 km of the site. There is one present within 2 km however this is unlikely to be a receptor due to the lack of evidence suggesting a connection between the shallow groundwater/surface water system and the groundwater system;
- Other groundwater users:
    - There are no other bores abstracting water from the Neranleigh-Fernvale Beds within 2 km of the site. The nearest groundwater bore is 900 m to the south west and abstracts from the overlying Lamington Volcanics fractured rock aquifer. Which is not connected to the Neranleigh-Fernvale Beds; and
- Surface water systems:
    - Although the Bilambil Creek is present on the site, there is no evidence to suggest that the surface water and groundwater systems are connected. Abstraction of water from the Neranleigh-Fernvale Beds is very unlikely to have an impact on this surface water system. This has been evidenced by water quality analysis and water level observations within the creek during periods of pumping.

The impact assessment concluded that there is a potentially low risk of very minor to negligible impact on the surface water and groundwater system from an abstraction of groundwater from the Neranleigh-Fernvale Beds of up to 98 ML/year.

The evidence suggesting the lack of connection between the surface and groundwater systems means that additional bores taking from the Neranleigh-Fernvale Beds could be installed within 40 m of Bilambil Creek without causing detrimental impact to the system.

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Glossary

Term	Definition
Abstraction/ Extraction	The removal of water from a resource e.g. the pumping of groundwater from an aquifer.
Argillaceous	A sandstone that contains a significant amount of silt and/ or clay.
Alluvium	Sediments deposited by or in conjunction with running water, such as in rivers or streams.
Aquifer	A saturated, hydraulically conductive geological unit capable of yielding economic quantities of water from boreholes.
Aquifer system	Intercalated permeable and poorly permeable materials that comprise two or more permeable units separated by aquitards which impede vertical groundwater movement but do not affect the regional hydraulic continuity of the system.
Available drawdown	The height of water above the depth at which the pump is set in a borehole at the time of water level measurement.
Base flow	Part of the discharge which enters a stream channel mainly from groundwater (but also from lakes and glaciers) during long periods when no precipitation (or snowmelt) occurs.
Bedrock	A general term for the solid rock that lies underneath the soil and other unconsolidated material. Also referred to basement. When exposed at the surface it is referred to as rock outcrop.
Bore	An artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer. Interchangeable with boreholes or wells.
Catchment	(a) Area of land that collects rainfall and contributes to surface water (streams, rivers, wetlands) or to groundwater; or (b) The total area of land potentially contributing to water flowing through a particular point.
Contamination	The introduction of a noxious substance into the environment by human activities.
Discharge	Water that moves from a groundwater body to the ground surface (or into a surface water body such as a lake or the ocean). Discharge typically leaves aquifers directly through seepage (active discharge) or indirectly through capillary rise (passive discharge). The term is also used to describe the process of water movement from a body of groundwater.
Dissolved solids	Minerals and organic matter dissolved in water.
Drawdown	The lowering of a water table resulting from the removal of water from an aquifer or reduction in hydraulic pressure.
Ecosystem	An organic community of plants, animals and bacteria and the physical and chemical environment they inhabit.
Formation	(a) A unit in stratigraphy defining a succession of rocks of the same type. (b) A body of rock strata that consists of a certain lithology or combination of lithologies.
Greywacke	A dark coarse-grained argillaceous sandstone containing more than 12 per cent clay. Greywacke can look similar to basalt with the main difference being that it is commonly veined with quartz. Greywacke is commonly fractured.

Term	Definition
Groundwater	Water stored below the ground surface that saturates (in available openings) the soil or rock and is at greater than atmospheric pressure and will therefore flow freely into a bore or well. This term is most commonly applied to permanent bodies of water found under the ground.
Groundwater Dependent Ecosystems	Terrestrial or aquatic ecosystems whose ecological function and biodiversity are partially or entirely dependent on groundwater.
Groundwater flow	The movement of water through openings in sediment and rock that occurs in the zone of saturation. Lateral groundwater flow – movement of groundwater in a non-vertical direction. Lateral groundwater flows are usually, although not always, more or less parallel to the ground surface
Hydrology	The study of water and water movement in relation to the land. Deals with the properties, laws, geographical distribution and movement of water on the land or under the Earth's surface.
Intermittent stream	An intermittent stream is seasonally impacted, only flowing for part of the year.
Lithology	The physical and mineralogical characteristics of a rock. The characteristics, including grain size, of the strata of the subsurface media.
Megalitre	1 Million litres
Perennial Stream	A perennial stream has continuous flow in parts of its stream bed all year round under normal climatic conditions.
Permeability	A measure of the capacity of rock or stratum to allow water or other fluids or gases such as oil, gas or air to pass through it (i.e. the relative ease with which a porous medium can transmit a fluid or gas). Typically measured in darcies or millidarcies.
Permeable	Descriptor of a medium or material which permits liquids or gases to flow though with relative ease.
pH	A measure of the acidity or alkalinity of water. It is related to the free hydrogen ion concentration in solution pH = 7 is neutral; pH < 7 acidic; pH > 7 alkaline. Used as an indicator of acidity (pH < 7) or alkalinity (pH > 7).
Piper diagram	A graphical means of displaying the ratios of the principal ionic constituents in water. (Freeze and Cherry, 1979).
Pumping Test	A test made by pumping a bore for a period of time and observing the response/change in hydraulic head in the aquifer.
Recharge	The water that moves into a groundwater body and therefore replenishes or increases sub-surface storage. Recharge typically enters an aquifer by rainfall infiltrating the soil surface and then percolating through the zone of aeration (unsaturated soil). Recharge can also come via irrigation, the leakage of surface water storage or leakage from other aquifers. Recharge rate is expressed in units of depth per unit time (e.g. mm/year).
Recovery	The rate at which the water level in a pumped bore rises once abstraction has ceased.
Screen, slotted section	A section of casing, usually steel or PVC, with apertures or slots cut into the tubing to allow groundwater to flow through. Screen usually refers to machined sections with openings that can be sized appropriate to the aquifer matrix and filter pack grading.
Static Water Level (standing	The depth to groundwater measured at any given time when pumping or recovery is not occurring.

Term	Definition
water level)	
Total dissolved solids	An expression of the total soluble mineral content of water determined by either measuring the residue on evaporation or the sum of analysed chemical constituents. Usually quoted in milligrams per litre (mg/L) or the equivalent parts per million (ppm), TDS may also be approximated from electrical conductivity (EC) measurements using the conversion EC (µS/cm) x 0.68 = TDS (mg/L) (see Electrical Conductivity).
Water table	(a) The upper surface of a body of groundwater occurring in an unconfined aquifer. At the water table, pore water pressure equals the atmospheric pressure; or (b) The surface of a body of groundwater within an unconfined aquifer at which the pressure is atmospheric.
Yield	The quantity of water removed from a water resource e.g. yield of a borehole.

1 Introduction

1.1 Background

The Karlos Family Trust, operating out of 477 Urliup Road, New South Wales (NSW), has been abstracting water for commercial bottling purposes for the last 14 years. There are currently five working bores on site, of which two (BH2 and BH5) are currently used for commercial water abstraction and a third (BH4) is a stock and domestic source.

Current licensed abstraction allows for cumulative water take of a total of 60 ML/year across three bores at 477 Urliup Road, however the Development Application for the abstraction is limited to 28 ML/year until specific sections of Urliup Road are widened. The Karlos Family Trust is seeking to increase its commercial abstraction volume for bottling to the licensed cumulative volume of 98 ML/year which would include water abstracted from 483 Urliup Road (the Proposal). It is understood that a new abstraction bore may be sought at 477 Urliup Road to facilitate this proposed additional abstraction. It is likely that the additional bore will be drilled on the flat valley bottom and B1 will be converted into a monitoring bore. Water taken from 483 Urliup Road is under separate abstraction licence and DA conditions. Abstractions from both properties will be considered cumulatively in assessing any impacts to the groundwater and surface water systems and are cumulatively referred to as 'the site' in this report.

This report presents the approach to, and findings of, a groundwater assessment undertaken to consider the potential impact of the existing and proposed abstractions on other groundwater users (including groundwater dependent ecosystems) and the surface water system, with consideration for the *NSW Aquifer Interference Policy* (2012).

1.2 Report Objectives

The objectives of this report are to:

1. Provide a hydrogeological report to inform prospective commercial bottling clients.
2. Determine whether the groundwater system is connected to the surface water system to be able to assess whether any increase in groundwater abstraction will cause a negative impact on the surface water system and subsequently inform whether the drilling of further abstraction bores within 40 m of Bilambil Creek is acceptable.
3. Satisfy the needs of the Tweed Shire Council and State Government under the relevant Water Sharing Plan and *NSW Aquifer Interference Policy*, with regards to evidence that neither the current cumulative abstraction of 28 ML/year, nor the proposed cumulative abstraction of approximately 98 ML/year, is currently causing or is likely to cause detriment to the surface and groundwater environments.

1.3 Scope of Study

The scope of the report is as follows:

- A review of legislation including the relevant Water Sharing Plan and *NSW Aquifer Interference Policy* (2012);
- A description of the existing water environment including surface water features, groundwater users and groundwater dependent ecosystems within the vicinity of the site; and

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- An assessment of the potential impacts of the existing and proposed cumulative abstractions from 477 and 483 Urliup Road on the water environment.

2 Methodology

2.1 Desktop Review

ELA undertook a review of the information provided by the Karlos Family Trust which was supplemented by the following sources, this included:

- The groundwater explorer accessed November 2016 (www.bom.gov.au/water/groundwater/explorer/)
- The NSW Government portal for groundwater data accessed November 2016 (www.waterinfo.nsw.gov.au/gw/)
- Groundwater Dependent Ecosystem (GDE) Atlas accessed 2016 (www.bom.gov.au/water/groundwater/gde/)
- Bore logs, well completion details, drilling summaries;
- Current and historical pumping regimes;
- Current water access licenses;
- Monitoring data;
- Geological and hydrogeological mapping (where available);
- National and state publically available datasets

2.2 Field Reconnaissance

A field reconnaissance visit and site inspection was undertaken by members of the ELA groundwater team on 10th November 2016. The purpose of the site visit was to gather additional anecdotal information and local references to inform the hydrogeological conceptual model and supplement this report. Standing or dynamic water levels in all available bores were measured.

2.3 Hydraulic Testing

Subsequent to the field reconnaissance, the following tests were undertaken on the site by the Karlos Family Trust, with data provided to ELA:

- Water quality sampling of Bilambil Creek;
- Measuring of the water levels (river stage) within Bilambil Creek; and
- Basic aquifer testing of the main abstraction bores (B2, B5 and R2) pumping for approximately 10 hours accompanied by monitoring of groundwater levels during both pumping and recovery phases in each borehole.

2.4 Impact Assessment

An impact assessment was undertaken to assess the potential impacts from the groundwater abstraction on other water users and groundwater dependent ecosystems.

The assessment was undertaken in accordance with the requirements of the:

- NSW Aquifer Interference Policy (2012); and
- The relevant Water Sharing Plan.

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3 Legislation & Planning

3.1 Water Management Act 2000

The object of the *Water Management Act 2000* (NSW) is the sustainable and integrated management of the State's water for the benefit of both present and future generations.

The main tool the Act provides for managing the state's water resources are water sharing plans (WSPs). These are used to set out the rules for the sharing of water in a particular water source between water users and the environment as well as for the trading of water.

The following water sharing plan is relevant for the site:

- Water Sharing Plan (WSP) for the North Coast Fractured and Porous Rock Groundwater Sources (commenced on 1st July 2016) – New England Fold Belt Coast – groundwater source.

This WSP covers 13 fractured and porous rock groundwater sources and came into effect on the 1st July 2016. These groundwater sources extend from Hawkesbury River northwards to the NSW/Queensland border and inland to the Murray-Darling Basin. Although they extend over a large geographic area they are relatively undeveloped in terms of groundwater usage (DPI Water, 2016).

New groundwater abstractions occurring after commencement of the plan are required to follow rules for new water supply works approvals:

Table 3-1: Rules to minimise the interference between bores in fractured rock groundwater sources

Rule	Distance (m)
Rules to minimise interference between bores	
New bores cannot be located within the following distance (m) of an existing bore that is not used for basic rights	200 (for bores <20 ML/year) 400 (for bores > 20 ML/year)
New bores cannot be located within the following distance (m) of an existing bore that is used for basic rights	200
New bores cannot be located within the following distance (m) from the boundary of the property (unless consent gained from neighbour)	100
New bores cannot be located within the following distance (m) from a local or major water utility bore	500
New bores cannot be located within the following distance (m) from a bore used by the Department for monitoring purposes	400
Rules for bores located near high priority groundwater dependent ecosystems	
New bores that are used for basic rights cannot be located within the following distance (metres) of a high-priority GDE	100
New bores that are not used for basic rights cannot be located within the following distance (metres) of a high-priority GDE or the outside perimeter of a National Park estate.	200
New bores that are not used for basic rights cannot be located within the following distance (metres) of a high-priority karst environment GDE	500

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Rule	Distance (m)
New bores that are not used for basic rights cannot be located within the following distance (metres) of a river or stream (1st, 2nd or 3rd order) (Note: Bilambil Creek is a 3rd order stream)	40
New bores that are not used for basic rights cannot be located within the following distance (metres) of an escarpment	100

(Source: DPI Water 2016)

The distance restrictions specified above do not apply if the Minister is satisfied that the location of the water supply work at a lesser distance would result in no more than minimal impact on existing extractions within these groundwater sources. To satisfy the minister, the applicant may be required to submit a hydrogeological study (this report) to demonstrate to the Minister's satisfaction that the location of the water supply work at a lesser distance will result in no more than minimal impact on existing extractions within these groundwater sources.

To assist in implementing and defining the provisions of the *Water Management Act 2000* (NSW) the *Aquifer Interference Policy* (NOW, 2012) was introduced.

3.2 Aquifer Interference Policy 2012;

The *NSW Aquifer Interference Policy* (NOW 2012) explains the water licensing and assessment processes for aquifer interference activities under the *Water Management Act 2000* (NSW).

The volume of water taken from any water source needs to be predicted prior to approval and then measured and reported in annual returns or environmental management reports. An assessment is made of the predicted impact of the Proposal on groundwater receptors following the method set out by NOW in the document *Assessing a proposal against the NSW Aquifer Interference Policy – step by step guide* (NOW, 2013), as presented in Appendix A, Figure 3-1 and Figure 3-2 .

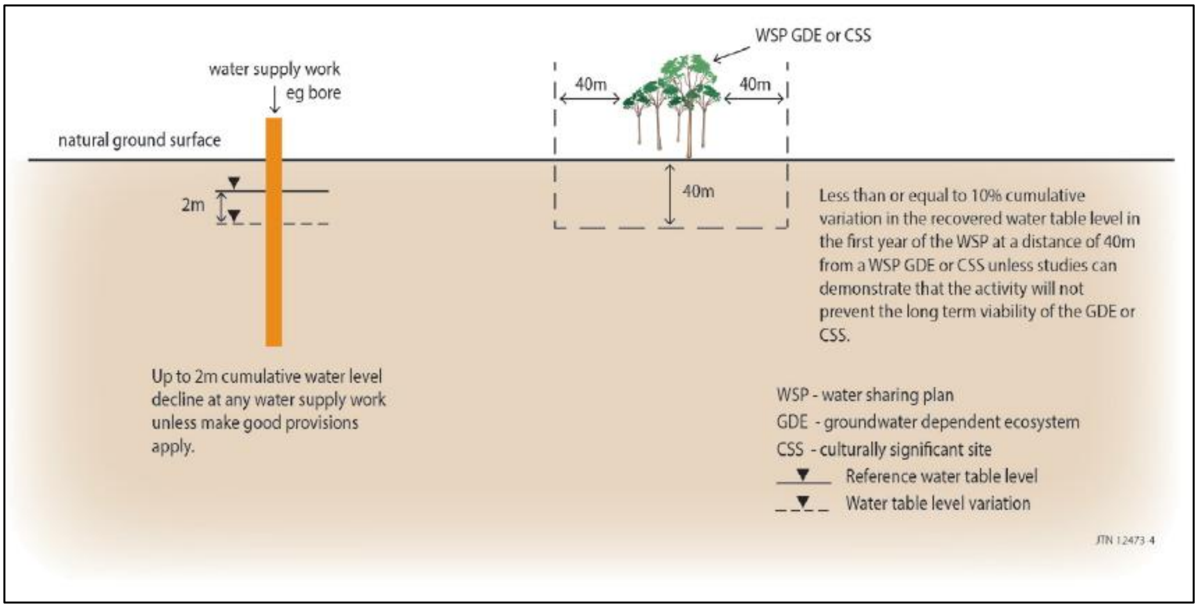

Figure 3-1 Porous and Fractured Rock Groundwater Sources (general) – maximum impacts considered acceptable on the water table Source: NSW Aquifer Interference Policy – Assessing the Impacts, 2013

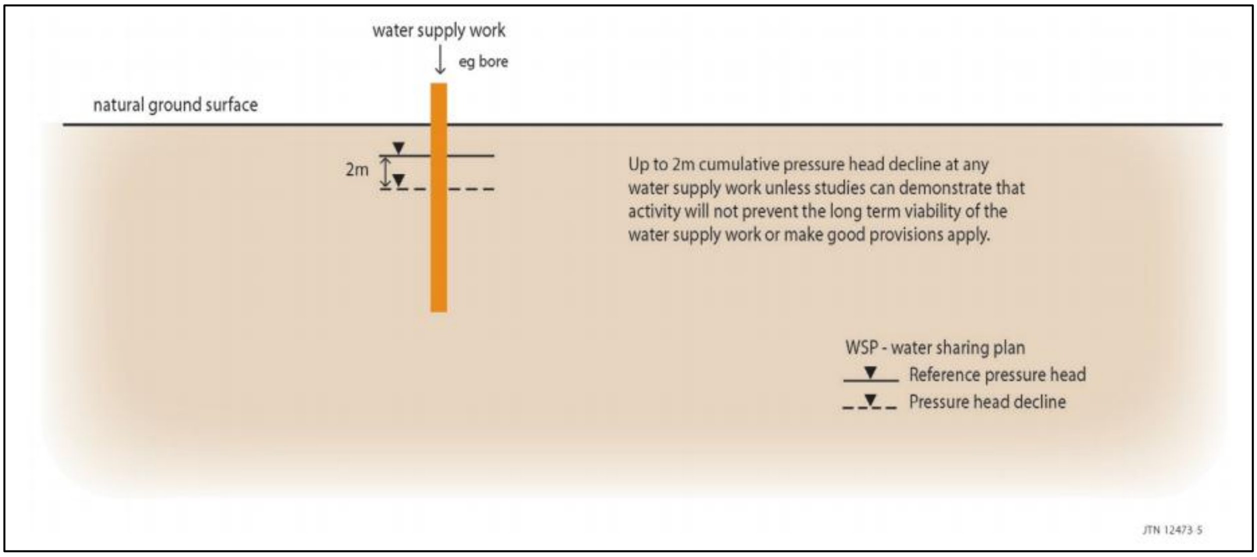

Figure 3-2 Porous and Fractured Rock Groundwater Sources (general) - maximum impacts considered acceptable on water pressure

Source: NSW Aquifer Interference Policy – Assessing the Impacts, 2013

4 Current Operations

4.1 Groundwater bores

4.1.1 477 Urliup Road

There are six bores on 477 Urliup Road (Table 4-1).

Three bores at 477 Urliup Road are licensed for commercial purposes with a fourth abstraction bore licensed for stock and domestic use, one monitoring bore and a sixth bore no longer in commission.

The locations of these bores are shown in Figure 4-1.

Table 4-1: 477 Urliup Road groundwater bores

Bore Number	Purpose	Year drilled	Depth (m bgl)	Slotted section (m bgl)	Description
B1	Commercial	2002	30	20 to 30	Basalt/broken rock/basalt
B2	Commercial	2007	90.8	18 to 90.8	Greywacke quartz
B3	Monitoring	2014	42	9 to 41	Greywacke
B4	Stock & Domestic	Unknown	25	12 to 25	Unknown
B5	Commercial	2016	40	16 to 22 and 34 to 38	Greywacke, fracture/grey wacky
No ref	Monitoring bore	Unknown	Unknown	Unknown	Unknown

Note: Descriptions are taken directly from drilling logs, greywacke is often confused with basalt as they look very similar. It is considered that B1 is also abstracting from greywacke and not basalt.

4.1.2 483 Urliup Road

There are two bores present on the adjacent 483 Urliup Road site (Table 4-2). R1 is used for stock and domestic use with R2 proposed to be used for commercial water production.

Table 4-2: 483 Urliup Road groundwater bores

Bore Number	Purpose	Year drilled	Depth (m bgl)	Slotted section (m bgl)	Description
R2	Commercial	2007	30.5	20.5 to 30.5	Basalt/Quartz, grey, white clay
R1	Stock & Domestic	2001	24	18 to 24	Broken rock/basalt

Note: Descriptions are taken directly from drilling logs, greywacke is often confused with basalt as they look very similar. It is considered that the rock in R1 and R1 is greywacke and not basalt.

4.2 Abstraction Licensing

4.2.1 477 Urliup Road

Three bores are currently licensed for commercial abstraction on the site with a total allowable abstraction volume of 60 ML/year. Bore license details are presented in Table 4-3. The majority of the supply is allowed from B2 and B5 with a combined licensed volume allowance of 55 ML/year.

Table 4-3: 477 Urliup Road groundwater licence details

Licence Number	Bore Number	Purpose	Licensed volume/year (ML)	Issue Date	Expiry Date
30BL184761	B1	Commercial	5	4-Jun-08	3-Jun-18
30BL183219	B2	Commercial	30	24-Jan-16	23-Jan-21
30BL207402	B3	Monitoring	n/a	14-Sep-16	No expiry
30WA308262	B4	Stock & Domestic	n/a	12-Mar-15	No expiry
30BL207356	B5	Commercial	25	14-Sep-16	13-Sep-21

4.2.2 483 Urliup Road

There are currently 2 operating abstraction bores only one is licensed for commercial purposes. However the site has recently acquired a commercial groundwater abstraction licence that covers two bores to allow for the drilling of an additional commercial abstraction bore. The total amount permitted to be extracted from these bores is 38 ML/year, with no one individual bore exceeding 19 ML/year. This is detailed in Table 4-4.

Table 4-4: 483 Urliup Road groundwater licence details

Licence Number	Bore Number	Purpose	Licensed volume/year (ML)	Issue Date	Expiry Date
30BL207367	R2	Proposed commercial	19	02-Nov-2016	01-Nov-2021
30BL179463	R1	Stock & Domestic	n/a	28-Jun-2001	No expiry
30BL207369	TBC	Proposed for commercial	19	02-Nov-2016	01-Nov-2021

4.3 Commercial Abstraction Operations

4.3.1 477 Urliup Road

There are three operational commercial abstraction bores on the site, although only B5 and B2 are routinely used:

- B5 delivers between 6,000 to 7,000 litres/hour (1.7 to 1.9 litres/second)

- B2 delivers 2,500 litres/hour (0.69 litres/second).

B1 is occasionally used for abstraction and can deliver up to 2,500 litres/hour. These bores are generally operational for up to 10 hours per day. Abstracted groundwater is delivered to a set of five interconnected tanks where the water is stored until collected by water trucks on behalf of bottling companies.

The local council Development Application (DA) currently limits export of groundwater from the site to 28 ML/year.

4.3.2 483 Urliup Road

Commercially licensed bore R2 at 483 Urliup Road is currently not in operation but is understood to be capable of delivering up to 10,000 litres/hour (2.8 litres/second).

4.4 Site Sewerage

Due to the rural location of the sites, each has a private sewerage system. In accordance with the planning requirements pertaining at the time of installation. These systems retain sewage sludge and treated decant water is discharged to the environment. The locations of the sewerage system outlets for both sites are as follows:

- 477 Urliup Road – the sewerage tank outlet is located approximately 160 m to the north-east of B1 and approximately 50 m to the north-north-east of B4.
- 483 Urliup Road – the sewerage outlet is located approximately 80 m to the west-north-west of R2.

4.5 Measuring and Monitoring Volumetric Take

Groundwater volumetric take at 477 Urliup Road, is currently measured using a water meter located at the tanker filling station to monitor the cumulative volume of water being transported from the site. This is a temporary arrangement.

Precision meters will be installed to each commercial bore, as per DPI's recommendations, prior to the approval of the DA associated with the proposal to increase the allocation amount to the full licensed quantity (60 ML/year).

4.6 Proposed Changes to Operation

Currently the commercial operation is restricted by current council restrictions to a maximum allowable amount of 28 ML/year. The cumulative annual licensed water abstraction volume for both 477 and 483 Urliup Road sites is 98 ML/year (60 ML/year at 477 Urliup Road and 38 ML/year at 483 Urliup Road).

A Development Application to increase the maximum allowable volume of water from the site to fall in line with the licensed abstraction volume from 477 Urliup Road of 60 ML/year, is currently with the council and a decision is expected in February 2017.

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Figure 4-1: Bore location plan

5 Existing Environment

5.1 Topography and drainage

The site is located in the Eastern Uplands of the New England-Moreton Uplands Province within a narrow valley with a valley floor elevation of approximately 30 m Australian Height Datum (m AHD).

Ground elevation increases sharply to the north of Urliup Road to a height of approximately 300 m AHD. The site itself sits on the relatively flat valley floor, which rises again to the south to a height of approximately 200 m AHD.

Bilambil Creek a third order stream flows eastwards, eventually joining Terranora Creek and discharging into the Tweed Estuary. To the north of Bilambil Creek runs Urliup Road which connects the site to Bilambil.

5.2 Geology

The site sits in the New South Wales portion of the New England Fold Belt. The 1:250,000 geological map (Brown *et al,* 2014) suggests that the site sits on the Neranleigh-Fernvale Beds. These beds are generally described as quartz-rich lithic wackes, lithic sandstone, phyllite and andesitic and mafic volcanics (Brown *et al,* 2014). Beneath the site, they generally consist of greywackes which are a argillaceous sandstones which contain a significant amount of silt or clay which originated from volcanic rocks such as basalt. These have been identified in drillers logs for the site. Basalt has also been described as being present beneath the site, however greywacke can easily be misidentified as basalt.

The surrounding hillsides to the north and south consist of the Lamington Volcanics Group. This sits upon the Neranleigh-Fernvale Beds but is separated by a layer of clay formed from the weathering and decomposition of the top of the Neranleigh-Fernvale Beds. The Lamington Volcanics to the north of the site are referred to as the Lismore Basalt, the hills to the south are referred to as the Beechmont Basalt. Generally these basalts are described as a sub-alkali and olivine basalt with minor tuff, agglomerate, sandstone, siltstone and mudstone (Brown *et al,* 2014 and Brown *et al,* 2001).

Within the valley bottom the Neranleigh-Beds are locally sporadically overlain by alluvial (river) deposits associated with Bilambil Creek. There is also likely to be colluviual clay deposits interfingering with the alluvium, which together drape over the basalt and Neranleigh-Fernvale Beds interface.

Table 5-1 gives a general overview of the site stratigraphy.

Table 5-1: Site Stratigraphy

Age	Group	Formation
Quaternary		Alluvial plain
Tertiary	Lamington Volcanics	Lismore Basalt
		Beechmont Basalt
Early to Late Carboniferous		Neranleigh-Fernvale Beds

5.3 Regional Hydrogeology

There are three principal groundwater systems, or hydrostratigraphic units, present in and around the site:

- The alluvium associated with Bilambil Creek and interconnected colluvial deposits;
- Basalt of the Lamington Volcanics; and
- The Neranleigh-Fernvale Group.

These are discussed in more detail below:

5.3.1 Neranleigh-Fernvale Group

The Neranleigh-Fernvale Beds forms part of the New England Fold Belt Coast Groundwater Source. It is the southern coastal section of a folded and fractured aquifer known as the New England Fold Belt, which extends from Port Stephens in the south to the NSW–QLD border in the north, and east of Moree. The New England Fold Belt Coast Groundwater Source is a fractured rock aquifer with groundwater contained within, and moving through, fractures in the rock that are present due to tectonic stress. Yields are typically low, being around 1 L/s, however yields up to 10 L/s may be obtained from highly fractured fault systems. Groundwater is typically recharged by direct rainfall infiltration. This combined with the degree of mineral leaching that has occurred over time, results in typically good quality water (DPI Water, 2016).

The upper extraction limit, based on estimated recharge rates, is 375,000 ML/year for the New England Fold Belt Coast (DPI Water, 2016). The current water requirements are only 35,468 ML/year with the majority of abstractions required for town water supply.

It is considered highly likely that the bores assessed in this study abstract from this groundwater source.

5.3.2 Lamington Volcanics Group Basalt

The Lamington Volcanics basalt is a fractured rock aquifer consisting of the Lamington Volcanics associated with the Mount Warning Igneous Complex. It overlies the rocks of the New England Fold Belt.

Yields are moderate being up to 5 L/s however some bores may obtain yields of up to 10 l/s when associated with highly fractured areas (DPI Water, 2016). Groundwater is typically recharged by infiltration of incident rainfall resulting in water with low concentrations of dissolved constituents. Due to the free draining nature of the basalt and recharge of hard rock, stream and spring flow is reliant on groundwater discharge during dry periods (DPI Water, 2016).

This aquifer forms the hillsides to the north and south of the site. It is considered likely that water draining from this aquifer from numerous springs and seepages at or around the bases of the steep basaltic slopes of the valley provides baseflow to the Bilambil Creek system in this area.

5.3.3 Alluvium

The alluvium in this area is shallow and discontinuous and will not be discussed in further detail.

5.4 Site Specific Hydrogeology

This section focuses on the hydrogeology of this aquifer, and summarises observations including water levels before, during and after pumping and what these observations suggest in terms of connectivity of the bores and the sustainable nature of the abstractions.

5.4.1 Conceptual Site Model

The conceptual model of the site is shown in Figure 5-1 below. In summary:

- Groundwater abstractions:
  - Abstractions from the fractured grey wackes of the Neranleigh-Fernvale Beds; and
  - Abstractions from the fractured basalts of the Lamington Volcanics;
- Groundwater connections:
  - There is no connection between the Lamington Volcanics and the Neranleigh-Fernvale Beds due to the presence of the weathered upper section of the Neranleigh-Fernvale Beds which mainly consists of clay and acts as a barrier to any flow;
  - The same weathered layer acts as a barrier to flow between groundwater in the alluvium and groundwater in the Neranleigh-Fernvale Beds.
- Surface water connections:
  - The weathered layer (as mentioned above) acts as a barrier between Bilambil Creek and the Neranleigh-Fernvale Beds, preventing water in the Neranleigh-Fernvale Beds to enter the creek and vice versa;
  - There are inputs into Bilambil Creek from seeps from the side of the Lamington Volcanics as observed on the site visit.

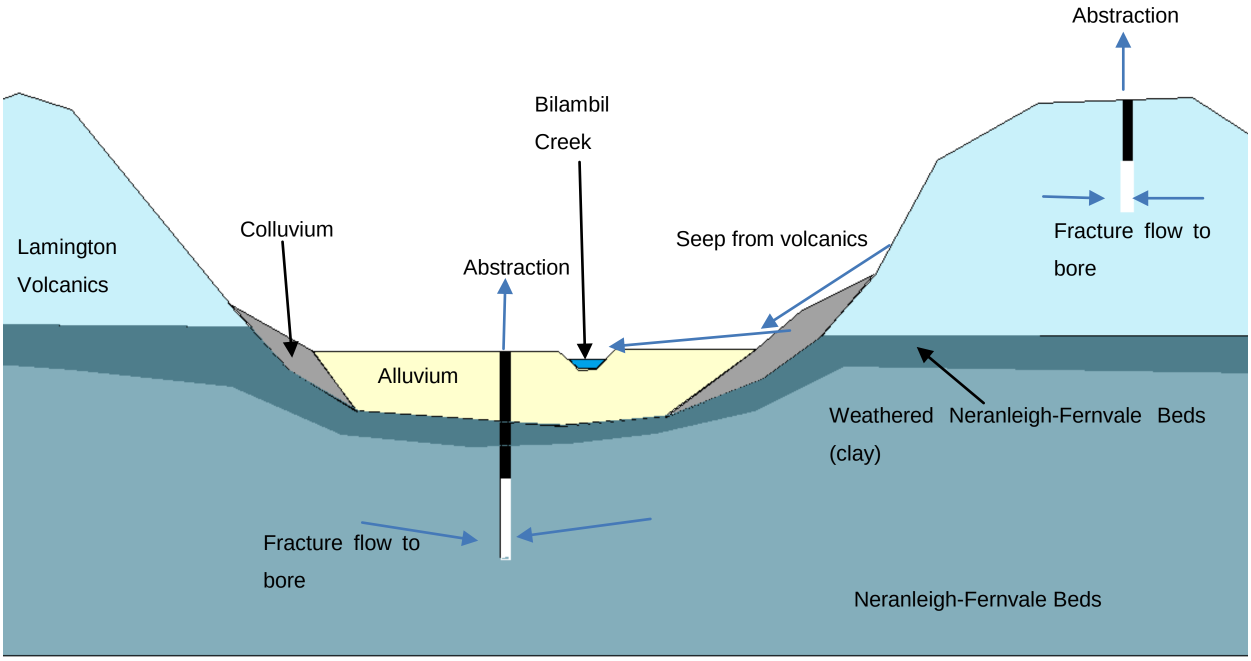

Figure 5-1 Conceptual Model of the Site

5.4.2 General Observations

The following general observations are made following interrogation of site data:

- B5, the newest bore at 477 Urliup Road is the most productive bore. It has a highly productive zone between 17 and 19 m.
- The cumulative abstraction from bores B1, B2, B5 and R2 is not considered to be exceeding the maximum sustainable yield of the Neranleigh-Fernvale aquifer and the

individual abstraction rates are currently restricted by the installed pump capacities. This is particularly evident in Bore 5 which has minimal drawdown at the full pumping rate.

- Drilling logs show very similar depths to water bearing zones (the difference in ground elevation of the bores is within approximately 5 m), these zones are generally described as broken rock interpreted as fractured greywacke.
- The yield (l/s) estimated immediately following drilling is similar in each bore varying from 0.9 (B2) to 3.3 l/s (R2).

Table 5-2: Estimated yield (l/s) and water bearing zones following initial drilling and testing

Bore	Water bearing zones (m bgl)	Yield (l/s)
B1	23 to 25	0.94
B2	19.5 to 20 65 to 78	0.5 0.9 (cumulative)
B5	17 to 19 34 to 37	1.9 1.93 (cumulative)
R1	19 to 21	1.181
R2	21.5 to 24.5	3.3

5.4.3 Results of pumping tests

Groundwater level measurements were recorded during and immediately following a number of occasions when combinations of the commercially-licensed abstraction bores were being used. Recorded data include:

- Spot measurements of groundwater depth from 28/08/2016 to 17/11/2016 (see Appendix B);
- Measurements of dynamic water level recovery in B5 on the 8th, 11th, 12th and 15th of November;
- Monitoring of recovery of B2 on the 11th, 12th, 14th and 16th of November;
- Monitoring of pumping and recovery on R2 (while monitoring levels in R1).

The maximum drawdown from each of the pumped bores, and the standing water levels are plotted on Figure 5-2 and summarised in Table 5-3. Analysis indicates a general consistency in the standing water levels and the maximum pumped levels (pumped at consistent rates), regardless of the number of bores pumping at the time and the cumulative abstraction rate. An increase in the cumulative pumping rate does not appear to have a persistent effect on the groundwater levels which return to resting (non-pumped) water levels quickly.

Table 5-3: Typical resting water levels (no pumping) and maximum pumped levels/drawdown

Bore	Typical resting water Level (no pumping) (meters below datum)	Maximum pumped level (meters below datum)
B1	5.0	19.8
B2	6.7	65.4
B3	5.2	N/A
B5	3.75	11.3

D1	6.85	N/A
D2	6.44	19.42

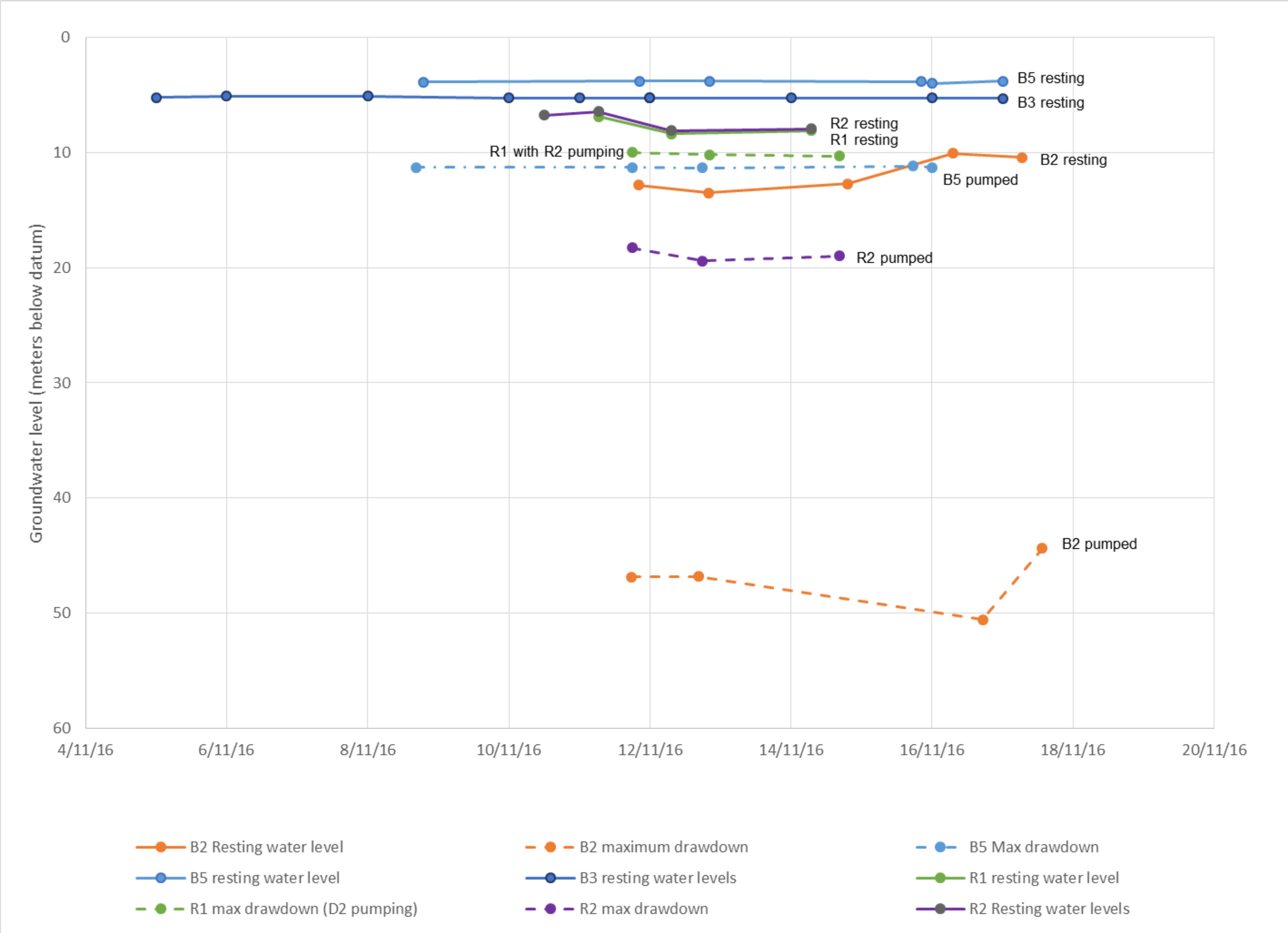

Figure 5-2: Pumped and resting water levels for all bores

5.4.4 Bore Connections

The Neranleigh-Fernvale Beds is a fractured aquifer which is likely to consist of local fracture networks. The presence of these local fracture networks means that it is unlikely that all the bores on the site are connected to one another. This means that pumping from one bore may not affect another bore. Observations on site during pumping provide evidence to this theory:

- B1 and B2: due to their close proximity (approximately 20 m apart), abstraction from either B1 or B2 results in a significant decline in the water levels in the other bore.
- R1 and R2: due to their close proximity (approximately 5 m), pumping from commercial bore R2 results in a drawdown of the water level in R1.
- B3 is a dedicated monitoring bore and is situated between the bores on 477 and 483 Urliup Road. No significant changes in groundwater levels were observed during monitoring of the pumping of the commercial bores in B3. This suggests that there is a poor connection between B3 and the pumped bores most likely due to the fractured nature of the aquifer (Figure 5-2).

5.4.5 Sustainability of increased abstraction rates

The monitoring of water levels during the pumping of one or all three of the abstraction bores B2, B5 and R2 suggests that there is no persisting change in the behavior of the aquifer with the increased abstraction rate:

- Figure 5-3, below, shows periods of water level recovery following 10 hours of abstraction from B5 on four separate occasions. On two of these occasions, B2 and R2 were also being pumped (dark blue lines), however recovery following each of the four tests is similar. Water levels in all bores recover quickly and in the same manner (i.e. at similar rates and following a similar recovery curve).
- The maximum pumped depth of groundwater, or drawdown, on these four occasions was also very similar. The maximum pumped depth of groundwater being 11.33 m BD when all three bores were pumping versus 11.27 m BD when only B5 was pumping.

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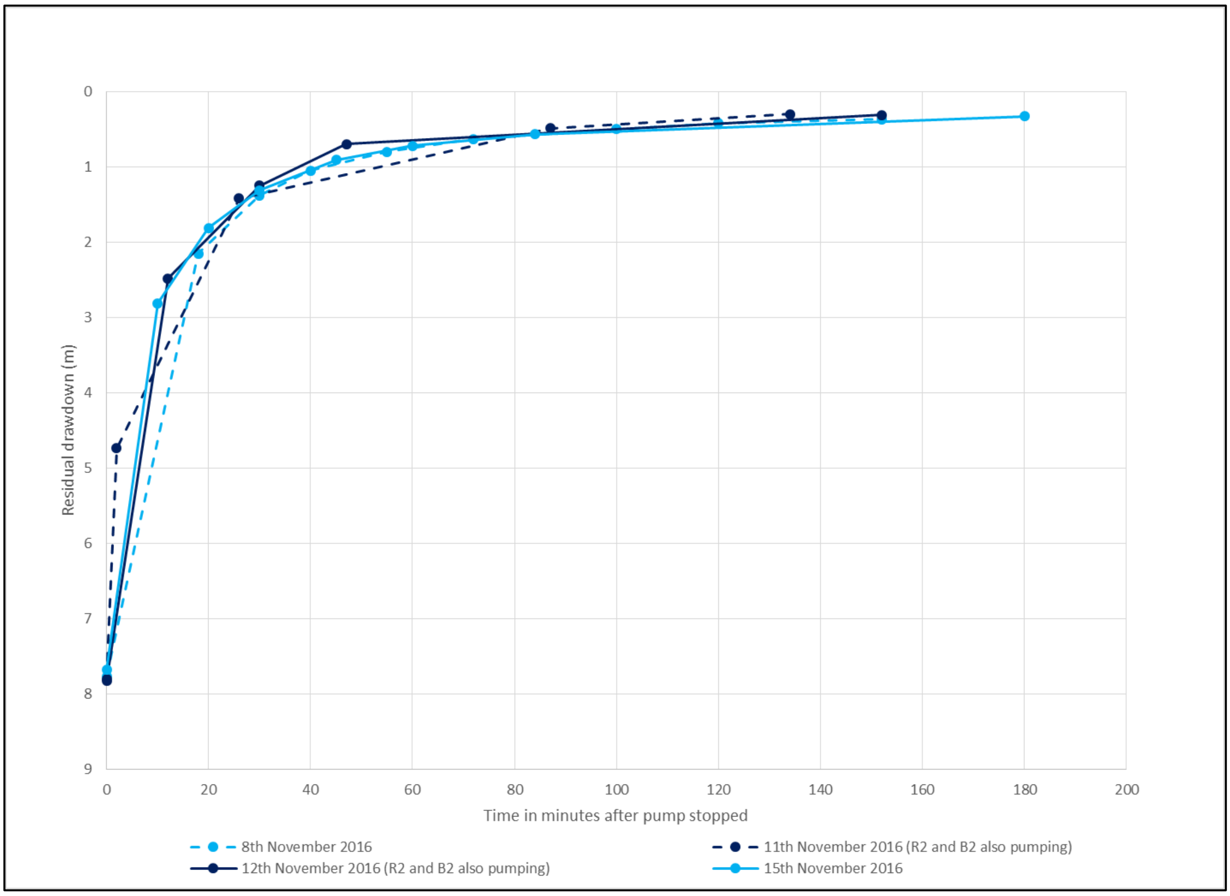

Figure 5-3: Recovery of B5 on 4 separate days of pumping

5.4.6 Groundwater quality

Groundwater samples have been taken previously for 6 of the abstraction bores. The results are summarised in Table 5-4 below. In general, the water quality of the bores is good and extracted water is clear. R1 which is located on the adjacent property at 483 Urliup Road has slightly elevated iron and manganese levels when compared to the other bores. It is recognised by the site owners that water from this bore is of slightly poorer quality than water abstracted from R2.

Table 5-4 Groundwater quality analyses

Analyte	Date of collection:	Drinking water standards	23/06/2014	10/04/2014	3/11/2015	04/10/2016	15/05/2006	02/02/2012
	Units		B1	B2	B4	B5	R1	R2
pH (lab)		6.5 – 8.5 (aesthetic)	5.25	6.15	5.65	6.1	6.5	6.6
Alkalinity as $CaCO_3$	mg/l	-	<20	30	54	56		54
Conductivity (lab)	µs/cm	-	155	135	180	170	198	164
Hardness total $CaCO_3$	mg/l	200 (aesthetic)	18.8	27.5	35.8	42		32
TDS by calculation	mg/l	-	100	85.6	115	110	-	100
Residual Alkalinity	mEq/L	-	<0.01	<0.1	0.4	<0.1		
Silica	mg/l	80 (aesthetic)	59	45	44	41.6		

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Analyte	Date of collection:	Drinking water standards	23/06/2014	10/04/2014	3/11/2015	04/10/2016	15/05/2006	02/02/2012
	Units		B1	B2	B4	B5	R1	R2
Sodium adsorption ratio		-	3	2.2	1.8	2.1		
Aluminium (dissolved)	mg/l	-	<0.01	<0.01	0.015	<0.01		
Aluminium (total)	mg/l	0.2 (aesthetic)	0.01	0.018	0.16	<0.01	<0.01	
Calcium (dissolved)	mg/l	-	4.38	6.65	9.16	11.8		9.8
Iron (dissolved)	mg/l	-	0.011	<0.01	0.039	<0.1		
Iron (total)	mg/l	0.3 (aesthetic)	0.034	0.013	0.092	<0.1	0.19	0.05
Magnesium (dissolved)	mg/l	-	1.91	2.65	3.14	2.9		1.9
Manganese (dissolved)	mg/l	-	<0.02	<0.02	<0.02	<0.001		
Manganese (total)	mg/l	0.1 (aesthetic) 0.5 (health)	<0.02	<0.02	<0.02	<0.001	0.07	<0.01
Potassium (dissolved)	mg/l		1.21	1.32	0.95	1		<5.0
Sodium (dissolved)	mg/l	180 (aesthetic)	20.1	17.2	15.3	16.9	21.5	16
Chloride	mg/l	250 (aesthetic)	15	39	15	16	20	10
Bicarbonate (HCO_3)	mg/l	-	13	37	67	69		33
Carbonate (CO_3)	mg/l	-	<10	<10	<10	<10		NP
Fluoride	mg/l	1.5 (health)	0.14	0.16	0.14	0.13		
Phosphate (PO_{4-})	mg/l	-	0.24	<0.1	<0.1	0.3		
Sulphate SO_4^{2-}	mg/l	250	7.2	7.7	5.5	4		7.4

A piper plot has been prepared to allow comparison and grouping of water quality in the bores (Figure 5-4).

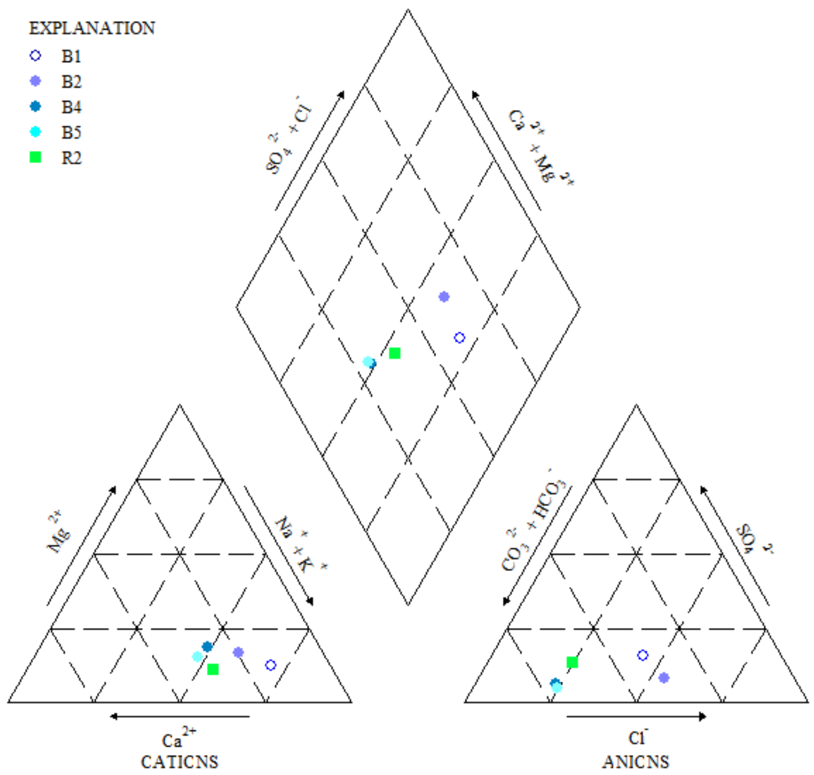

Figure 5-4: Piper plot of the water quality at 477 and 483 Urliup Road

Water quality is generally consistent across the 6 bores as expected. However, there seems to be two groups evident:

- Bores B4, B5 and R2 are of very similar water quality; and
- Bores B1 and B2.

This considered to be due to the location of the bores. B1 and B2 are very close together and of slightly higher elevation than the other bores, consequently they may be sourcing water from the shallower section of the aquifer where more weathered greywacke is present which results in a slightly poorer water quality.

5.5 Groundwater Users

Other groundwater bores within 2 km of the site have been identified using the NSW DPI Water web tool (www.allwaterdata.water.nsw.gov.au/water.stm). These are listed in Table 5-5 below and shown on Figure 5-5. There are no other water bores located within the valley of Bilambil Creek, the nearest water bore is located 900 m to the south east of the site.

The other water bores are located on, and understood to be abstracting from, the Lamington Group basalts (as confirmed by their drilling logs) to the north and south of the site.

Table 5-5 Groundwater bores within 2 km of the site

Bore ID	Bore Depth (m)	Drilled Date	Purpose	Latitude	Longitude	Aquifer
GW061114	40	1/06/1985	Water Supply	-28.2292	153.4261	Basalt
GW050336	22.8	1/04/1980	Water Supply	-28.2273	153.4333	Basalt
GW063704	60	1/10/1986	Water Supply	-28.242	153.4408	Basalt
GW062899	38	1/06/1986	Water Supply	-28.2412	153.4413	Basalt
GW304041	44	31/08/2000	Water Supply	-28.2513	153.4243	Unknown
GW306394	67	25/07/1997	Commercial and Industrial	-28.2289	153.4347	Basalt
GW057717	21	1/12/1980	Irrigation	-28.2287	153.4319	Unknown
GW057716	24	1/11/1980	Irrigation	-28.2281	153.4336	Unknown
GW070410	60	15/12/1992	Water Supply	-28.2312	153.4172	Basalt
GW065676	74	23/06/1986	Water Supply	-28.229	153.4297	Basalt
GW306648	48	2/02/2010	Water Supply	-28.2457	153.4361	Basalt
GW301750	30	22/02/1999	Water Supply	-28.244	153.445	Basalt
GW032498	17.7	1/07/1970	Water Supply	-28.2284	153.4336	Unknown
GW307397	36	12/12/2012	Water supply	-	-	Basalt
GW064007	49	1/02/1987	Water Supply	-	-	Basalt

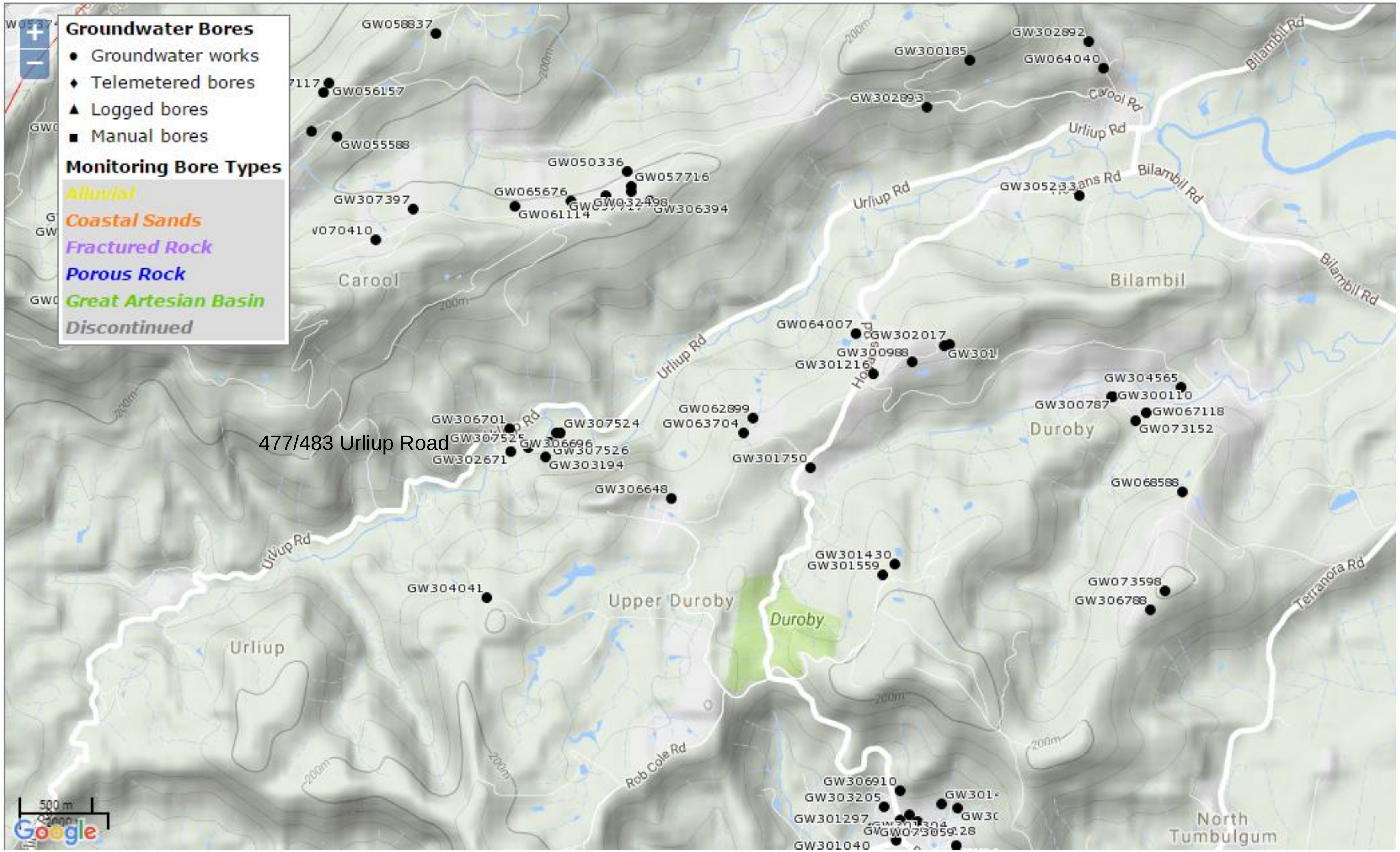

Figure 5-5: Other groundwater bores

5.6 Surface Water Systems

The site is located in a valley formed by Bilambil Creek, part of the Tweed River Basin. The creek flows eastwards towards Bilambil eventually joining Terranora Creek which drains into the Tweed Estuary.

Bilambil Creek is considered to be perennial, flowing year-round at the site. However, during the dryer months the creek has been observed to have ceased flow upstream and downstream of the site and to downstream suggesting it is intermittent in some sections. Water is always present in the section of the creek which flows through the site.

A number of springs/seeps have been observed from the Lamington basalt hills to the south into Bilambil Creek. These features are reported to flow for the majority of the year but may dry up during part of the dry season. It is likely that the seeps and spring features emerging from the basalt provide base flow to Bilambil Creek throughout much of the year.

5.6.1 Surface Water Levels

The water levels in Bilambil Creek have been recorded from two reference points, one upstream and one downstream of the abstraction bores. A common reference point was established at each of these points.

Water levels in the creek were measured from the 10th to the 17th of November 2016; intermittent pumping continued throughout the period. Figure 5-6 shows the hydrograph for this period. The hydrograph shows no correlation with periods of pumping from B2, B5 and R2, however it does show that the water levels in the creek respond very quickly to rainfall events. This is most likely due to the flashy nature of the catchment due to the presence of steep sided slopes within the catchment and the presence of generally low permeability rocks.

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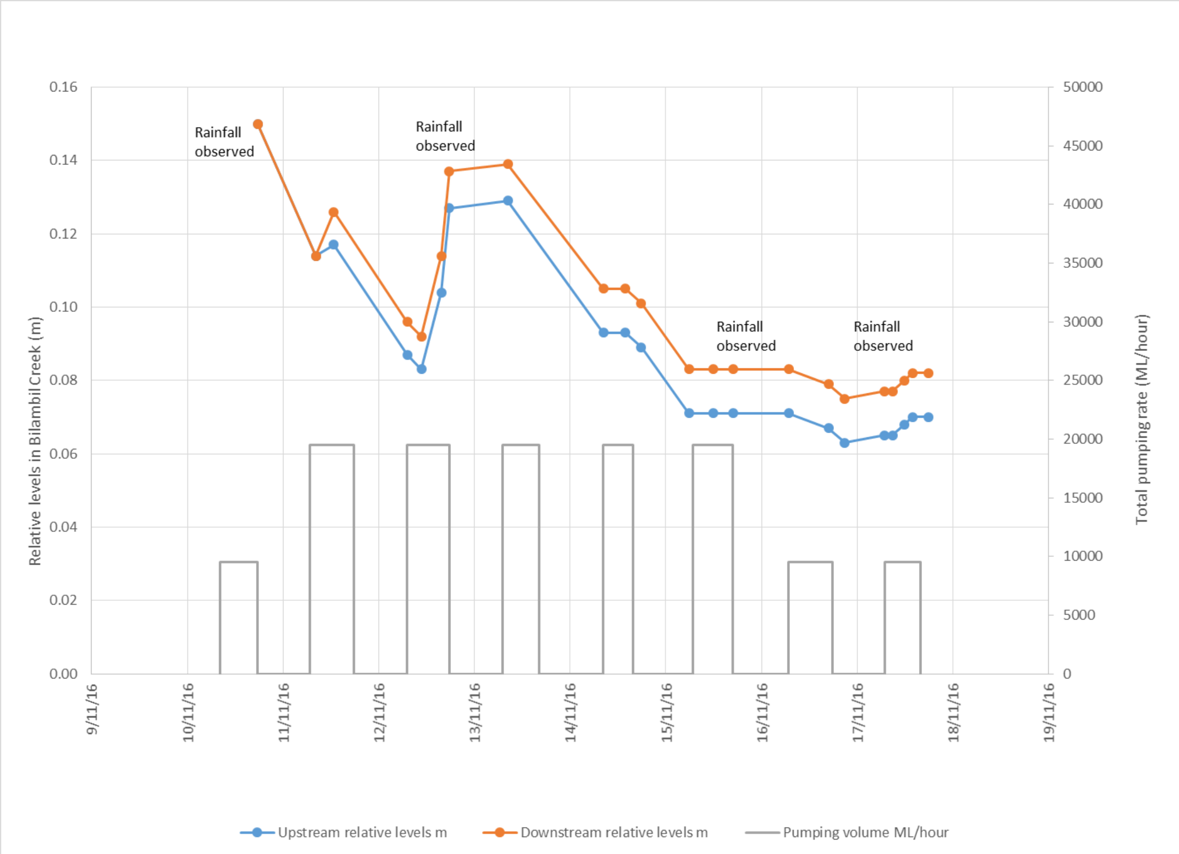

Figure 5-6: Water levels recorded in Bilambil Creek from the 10th to 17th November

5.6.2 Surface Water Quality

A water sample was taken from Bilambil Creek at the downstream stage monitoring location on the 15th November 2016. A water sample was also taken from B5 at the same time for a direct comparison of water quality. The samples were collected following a period of no rainfall in the vicinity of the site and recession of creek water levels to reflect the water quality of the creek with minimal interference from rainfall-induced overland flow.

The results of the mineral water quality analysis of the creek water sample are summarised in Table 5-6 and illustrated on Figure 5-7. In general, the mineral water quality of the creek is similar to that of the groundwater. It has a lower electrical conductivity and lower concentrations of total dissolved solids, silica, sodium, chloride, fluoride and sulphate; and higher concentrations of iron, magnesium and potassium. This similarity in quality reflects the inferred contribution to surface water baseflow from the Lamington Volcanics, with a high proportion of water in the system being provided from springs emerging from the Volcanics (discussed further in Section 5.6.3 below). Large discrepancies between surface and groundwater qualities are seen in the microbiological results (Table 5-7).

Table 5-6 Water quality results of Bilambil Creek

Analyte	Units	Drinking water standards	Bilambil Creek results
pH (lab)		6.5 – 8.5 (aesthetic)	6.8
Alkalinity as $CaCO_3$	mg/l	-	37
Conductivity (lab)	µs/cm	-	130
Hardness total $CaCO_3$	mg/l	200 (aesthetic)	30
TDS by calculation	mg/l	-	82

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Analyte	Units	Drinking water standards	Bilambil Creek results
Residual Alkalinity	mEq/L	-	<0.1
Silica	mg/l	80 (aesthetic)	20.3
Sodium adsorption ratio		0.2 (aesthetic)	1.6
Aluminium (dissolved)	mg/l	-	0.04
Aluminium (total)	mg/l	-	0.14
Calcium (dissolved)	mg/l	-	6
Iron (dissolved)	mg/l	0.3 (aesthetic)	0.8
Iron (total)	mg/l	-	1.3
Magnesium (dissolved)	mg/l	-	3.6
Manganese (dissolved)	mg/l	0.2 (aesthetic) 0.5 (health)	0.001
Manganese (total)	mg/l		0.099
Potassium (dissolved)	mg/l	180 (aesthetic)	1.8
Sodium (dissolved)	mg/l	250 (aesthetic)	13.8
Chloride	mg/l	-	16
Bicarbonate (HCO_3)	mg/l	-	45
Carbonate (CO_3)	mg/l	1.5 (health)	<10
Fluoride	mg/l	-	0.07
Phosphate (PO_{4-})	mg/l	250	<0.1
Sulphate SO_4^{2-}	mg/l		3

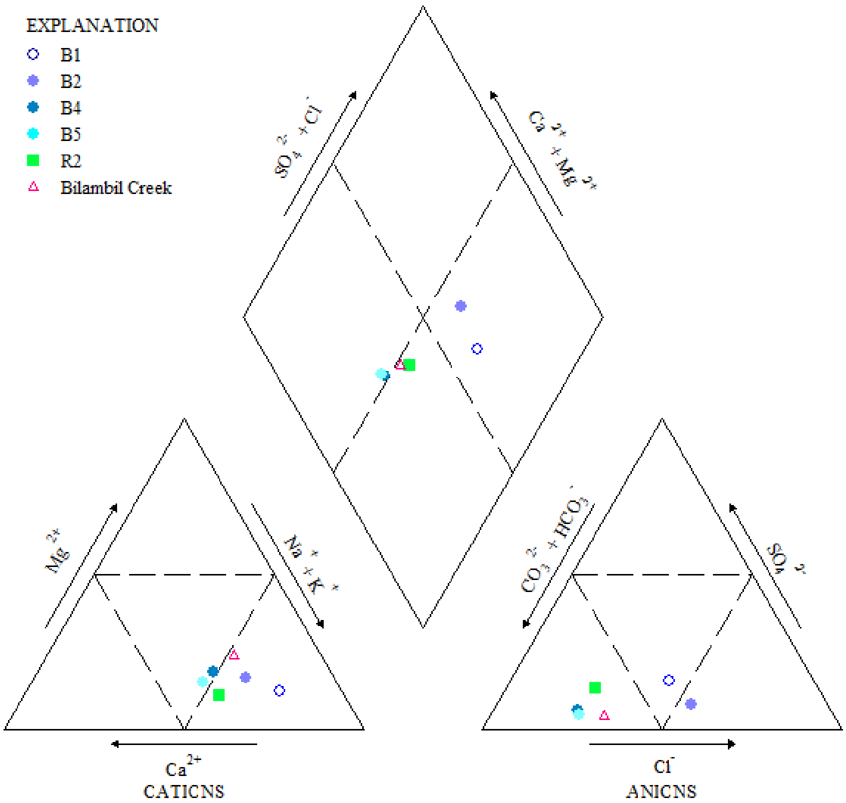

Figure 5-7 Piper plot of Creek Water Quality

5.6.3 Groundwater – Surface Water Connections

The potential for connectivity between fractured and porous rock aquifers, and surface water is perceived to be low to moderate in the Water Sharing Plan (DPI Water, 2016). The potential for impact on stream value and ecosystem function as a result of abstractions from this source is considered to be low as groundwater is not seen as a major contributor (DPI Water, 2016). The travel time between groundwater and surface water is considered to be years to decades (DPI Water, 2016).

The following observations have been made on site which provide evidence to support the DPI Water conclusions, further suggesting that there is no hydraulic connection between Bilambil Creek water and the Neranleigh-Fernvale aquifer:

- Groundwater levels are reported to be relatively consistent throughout the year and are not influenced by season;
- Groundwater is consistently pumped across the year. During the dry season when flows decline in the ephemeral or intermittent sections of Bilambil Creek upstream of the site, water remains in the section of the creek running through the site whilst groundwater abstractions from the Neranleigh-Fernvale Beds continue. Water levels recorded in November 2016 during the pumping test shows that pumping has no impact on Bilambil Creek. The presence of a significant connection between the creek and the underlying aquifer would be expected to result in changes to the water level in the creek with the creek potentially drying up completely;

- Microbiological water quality of water sampled from Bilambil Creek and from bores illustrates very significant faecal contamination (as evidenced by E. coli in the sample) of the surface waters whilst Neranleigh-Fernvale groundwater abstracted from B5 reveals no E. coli. (see Table 5-7); and
- Despite sewage tank outlets on the site being located within 50 m of the some of the bores, no *E. coli* have been detected.

Table 5-7: Comparison of microbiological water quality of samples taken on the 15th November 2016

Analyte	Units	Sample Location	
		B5	Bilambil Creek
Heterotrophic Plate Count-Sim	Cfu/mL	<1	1,553
E. coli colilert	Cfu/100 mL	<1	740

It is considered highly likely that a groundwater connection exists between the overlying Lamington Volcanics and the surface water system due to its free draining nature (DPI Water, 2016). It is likely that Bilambil Creek and spring/seep flows from the surrounding hills are reliant on groundwater discharge from the Lamington Volcanics during dry periods and this may account for the persistent nature of Bilambil Creek throughout the year, in the vicinity of the site. This is evidenced by the presence of seeps from the hillside to the south of the site which were observed during the November site visit.

5.7 Water Dependent Ecosystems

5.7.1 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems which have their species composition and natural ecological processes determined to some extent by the availability of groundwater.

The Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources details high priority GDEs which must be considered during a licenced abstraction application. The water sharing plan does not identify high priority GDEs within 2 km of the site and the nearest appears to be more than 5 km away (DPI Water, 2016).

The GDE atlas, an online tool for the preliminary identification of ecosystems which potentially rely on groundwater, has been referenced and yielded the following:

- There are no GDEs reliant on the surface expression of groundwater (Type 3 GDE) present within 2 km of the site;
- There is moderate potential for an ecosystem reliant on the subsurface expression of groundwater (Type 2 GDE) approximately 1 km to the northeast of the bores referred to as FT221 Introduced scrub.

5.7.2 Surface Water Dependent Ecosystems

The GDE atlas also indicates landscapes which show the inflow dependence, they are dependent on an additional water source (other than rainfall) which may be soil or surface water, or groundwater. Inflow dependence mapping from the GDE atlas showed areas of riparian vegetation around Bilambil Creek which are dependent on the inflow of water. The riparian vegetation is likely to be dependent on the presence of surface water associated with the creek which will surcharge the associated alluvial deposits.

5.8 Contaminated Land

The previous use of the land on the site has been for grazing cattle, primarily dairy cattle and there is no history/evidence of land-contamination. Potential sources of contamination were not observed during the site visit.

The NSW contaminated land register (NSW EPA online www.epa.nsw.gov.au) has been consulted and no notices have been identified for the site or for nearby.

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6 Impact Assessment

6.1 Potential Receptors and their sensitivity

Potential receptors (groundwater users, GDEs and the surface water system) are identified in the Section 5. A summary of the potential receptors and their sensitivity is presented in Table 6-1 below.

Table 6-1: Potential receptors and their sensitivity

Potential receptor	Comment	Sensitivity
Other groundwater users	There **are no other groundwater users** taking from the same water source (Neranleigh-Fernvale Beds) within 2 km of the site.	N/A
Groundwater dependent ecosystems	There are **no high priority groundwater dependent ecosystems** within 2 km of the site. There is one potential GDE located 1 km to the east which has not been confirmed but its presence is considered to be unlikely. If its presence is confirmed it is more likely to be supported by the alluvium or Lamington Volcanics.	N/A
Surface water system (Bilambil Creek)	Evidence suggests that the **surface water system and the underlying Neranleigh-Fernvale Beds are not connected**.	N/A

The study has not identified potential receptors which could be affected by the abstraction of water from the fractured Neranleigh-Fernvale Beds.

6.2 Impact Assessment

An impact assessment has been undertaken based on the abstraction of water from the Neranleigh-Fernvale Beds. Due to a lack of potential receptors, as described above, the resulting impact is very low to negligible (Table 6-2).

Table 6-2 Groundwater impact assessment summary

Potential Receptor	Potential Impact	Comment
Other groundwater users	Very low to negligible	There are currently no other groundwater users taking water from the same aquifer within 2 km of the site, therefore impact to other groundwater users is very low to negligible.
Groundwater dependent ecosystems	Very low to negligible	There are no GDEs within 1 km of the site, and the evidence which suggests there is no connection between the surface water system and abstracted groundwater system results in a very low to negligible impact.
Surface water system (Bilambil Creek)	Very low to negligible	There is no evidence to suggest a connection between the surface water system and groundwater

Potential Receptor	Potential Impact	Comment
		system from which the site is abstracting therefore potential impact is defined as very low to negligible.

6.3 Assessment under the Aquifer Interference Policy (AIP)

An assessment has been undertaken in accordance with the NSW AIP (Appendix A and Table 6-3). The water source to be affected by the Proposal is the high productive fractured rock aquifer identified as the New England Fold Belt Coast Groundwater Source.

The aquifer interference policy assesses potential impacts to other groundwater 'works' and groundwater dependent ecosystems. The assessment concludes that under the terms of the Aquifer Interference Policy the abstraction does not cause a potential material impact to other groundwater works or groundwater dependent ecosystems.

Table 6-3 Assessment against the aquifer interference policy

Aquifer	Fractured Rock
Category	Highly Productive
Level 1 Minimal Impact Consideration	Assessment

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Aquifer	Fractured Rock
Category	Highly Productive
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem; or • high priority culturally significant site; listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	The Neranleigh-Fernvale Beds are confined at the location (not a water table aquifer). The assessment has not identified GDEs within 1 km of the site. It is considered that connections between the surface water and groundwater within the Neranleigh-Fernvale Beds are unlikely thus the existing and proposed abstractions are unlikely to have an impact on nearby GDEs.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	There are no nearby water supplies taking water from the same formation which could be impacted by the abstraction. The nearest groundwater bore is 900 m to the SE of the site, this is abstracting from the overlying Lamington Volcanics. There are no other groundwater works taking from the Neranleigh-Fernvale Group within 2 km of the site.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	The abstraction of water from the bores is unlikely to result in a change of groundwater quality at the site, or beyond 40 m from the activity. There are no known historic or current contaminative industries on the site. There is no evidence to suggest that the surface and groundwater systems are connected. Historical water quality analyses indicate continuity of water quality during the period of operation of commercial water abstraction from the 477 Urliup Road site.

6.4 Assessment under the Water Sharing Plan Requirements

The Proposal is assessed under the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources. The abstraction takes from the New England Fold Belt Coast Groundwater source which is a fractured rock aquifer. The upper extraction limit, based on estimated recharge rates, is 375,000 ML/year for the New England Fold Belt Coast (DPI Water, 2016). The current water requirements are only 35,468 ML/year with the majority of abstractions required for town water supply.

Current licenses for the abstraction bores on site have been granted under the Water Sharing Plan rules, details of these licenses are provided in Section 4.2.

The rules to minimise the interference between bores under the Water Sharing Plan are summarised in Table 3-1 in Section 3. The rule pertaining to a minimum distance of 40 m from a river or stream is not considered appropriate given the evidence provided which suggests that there is no hydraulic connection between the creek and the source aquifer (Section 5.6). It is considered that future bores on the site, abstracting from the Neranleigh-Fernvale Beds, may be drilled within 40 m of Bilambil Creek without producing a negative impact on surface water quantities or qualities.

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7 Conclusions

A hydrogeological assessment has been undertaken for the site at 477 Urliup Road, Bilambil, and including the adjoining 483 Urliup Road site. The assessment has been conducted to investigate potential groundwater and surface water impacts from a combined commercial groundwater abstraction of up to 98 ML/year.

The following conclusions have been drawn:

- The site is assessable under the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources (commenced 1st July 2016) within the New England Fold Belt Coast Groundwater Source;
- The site currently abstracts groundwater from the Neranleigh-Fernvale Beds which is a fractured rock aquifer consisting of fractured greywacke to a proven depth of 90 m;
- There are no other bores abstracting water from the Neranleigh-Fernvale Beds within 2 km of the site. The nearest groundwater bore is 900 m to the south west and abstracts from the overlying Lamington Volcanics fractured rock aquifer which is covered by the same Water Sharing Plan as the Neranleigh-Fernvale Beds but is classed as the North Coast Volcanics groundwater source. It is considered that the potential for impact on other groundwater bores from the abstraction is very low;
- Interpretation of the water quality and water level data gathered as part of this assessment indicates that there is unlikely to be a hydraulic connection between groundwater within the Neranleigh-Fernvale Beds and Bilambil Creek. Abstraction of groundwater from the Neranleigh-Fernvale Beds is not considered likely to have an impact on this surface water system;
- There are no groundwater dependent ecosystems within 1 km of the site, and none beyond 1 km which would be likely to be impacted by the abstraction due to the inferred absence of a hydraulic connection between the surface water and groundwater system; and
- It is considered that additional abstraction bores, completed within the Neranleigh-Fernvale Beds and in accordance with the guidance from the relevant Water Sharing Plan (DPI Water, 2016) may be installed within 40 m radial distance of Bilambil Creek with negligible risk of detrimental impact to the creek.

The cumulative impact from a total abstraction of up to 98 ML/year has been assessed and is concluded to have very low to negligible risk to the surface water and groundwater systems.

The conditions of the abstraction licence allow DPI Water to vary the water allocation volumes at any time and it is envisaged that an increase of the total cumulative annual abstraction rate may be sought in the future. On the basis of the current hydrogeological conceptual model and recent data it is considered likely that a cumulative annual abstraction rate of up to 120 ML/year from the combined 477 and 483 Urliup Road sites will not have more than a very low to negligible risk to the surface water and groundwater systems. The risk to the environment of a cumulative annual abstraction rate above 120 ML/year may need further assessment involving the analysis of long-term groundwater level monitoring data from periods where the composite site is abstracting at the current maximum licensed rate of 98 ML/year.

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Appendix A Aquifer Interference Policy

Table 1. Does the activity require detailed assessment under the AIP?

	Consideration	Response
1	Is the activity defined as an aquifer interference activity?	If **NO,** then no assessment is required under the AIP. If **YES,** continue to Question 2.
2	Is the activity a defined minimal impact aquifer interference activity according to section 3.3 of the AIP?	If **YES**, then no further assessment against this policy is required. Volumetric licensing still required for any water taken, unless exempt. If **NO**, then continue on for a full assessment of the activity.

1. Accounting for, or preventing the take of water

Table 2. Has the proponent:

	AIP requirement	Proponent response
1	Described the water source(s) the activity will take water from?	Section 4.1 and Section 5
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Section 4.3 – as per licence conditions
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	No water will be taken.
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (refer to Table 3, below)	Yes
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	100% groundwater take
6	Described how any licence exemptions might apply?	N/A
7	Described the characteristics of the water requirements?	N/A

	AIP requirement	Proponent response
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	Section 5.3.1
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Section 3.1 and Section 6.3
10	Determined how it will obtain the required water?	Abstraction bores. Section 4.
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	N/A
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	N/A
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	N/A
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	N/A
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	N/A
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Section 4

Table 3. Determining water predictions in accordance with Section 3.2.3

	AIP requirement	Proponent response
3	In all other processes, estimate based on a desk-top analysis that is: • Developed using the available baseline data that has been collected at an appropriate frequency and scale; and • Fit-for-purpose?	Desk-top analysis has been completed using all available bore, water level, water quality, and other data. It is deemed to be fit-for-purpose due to the small volume of water proposed for abstraction.

Other requirements to be reported on under Section 3.2.3

Table 4. Has the proponent provided details on:

	AIP requirement	Proponent response
1	Establishment of baseline groundwater conditions?	Section 5.4
2	A strategy for complying with any water access rules?	N/A
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Section 0
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	Section 0
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	Section 0
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	N/A
7	Potential to cause or enhance hydraulic connection between aquifers?	N/A
8	Potential for river bank instability, or high wall instability or failure to occur?	N/A
9	Details of the method for disposing of extracted activities (for coal seam gas activities)?	N/A

2. Addressing the minimal impact considerations

Note for proponents

Section 3.2.1 of the AIP describes how aquifer impact assessment should be undertaken.

1. Identify all water sources that will be impacted, referring to the water sources defined in the relevant water sharing plan(s). Assessment against the minimal impact considerations of the AIP should be undertaken for each ground water source.
2. Determine if each water source is defined as ‘highly productive’ or ‘less productive’. If the water source is named in the Water Sharing Plan then it is defined as highly productive, all other water sources are defined as less productive.
3. With reference to pages 13-14 of the Aquifer Interference Policy, determine the sub-grouping of each water source (e.g. alluvial, porous rock, fractured rock, coastal sands).
4. Determine whether the predicted impacts fall within Level 1 or Level 2 of the minimal impact considerations defined in Table 1 of the AIP, for each water source, for each of water table, water pressure, and water quality attributes. The tables below may assist with the assessment. There is a separate table for each sub-grouping of water source – only use the tables that apply to the water source(s) you are assessing, and delete the others.
5. If unable to determine any of these impacts, identify what further information will be required to make this assessment.
6. Where the assessment determines that the impacts fall within the Level 1 impacts, the assessment should be ‘Level 1 – Acceptable’
7. Where the assessment falls outside the Level 1 impacts, the assessment should be ‘Level 2’. The assessment should further note the reasons the assessment is Level 2, and any additional requirements that are triggered by falling into Level 2.
8. If water table or water pressure assessment is not applicable due to the nature of the water source, the assessment should be recorded as ‘N/A – reason for N/A’.

Table 5. Minimal impact considerations

Aquifer	**Fractured Rock**
Category	**Highly Productive**
Level 1 Minimal Impact Consideration	**Assessment**
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem; or • high priority culturally significant site; listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	See section 6
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	See section 6
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	See section 6

3. Proposed remedial actions where impacts are greater than predicted.

THIS SECTION IS NOT APPLICABLE.

Table 6. Has the proponent:

	AIP requirement	Proponent response
1	Considered types, scale, and likelihood of unforeseen impacts *during operation*?	N/A
2	Considered types, scale, and likelihood of unforeseen impacts *post closure*?	N/A
3	Proposed mitigation, prevention or avoidance strategies for each of these potential impacts?	N/A
4	Proposed remedial actions should the risk minimization strategies fail?	N/A
5	Considered what further mitigation, prevention, avoidance or remedial actions might be required?	N/A
6	Considered what conditions might be appropriate?	N/A

4. Other considerations

Note for proponents

These considerations are not included in the assessment framework outlined within the AIP, however are discussed elsewhere in the document and are useful considerations when assessing a proposal.

Table 7: Has the proponent:

	AIP requirement	Proponent response
1	Addressed how it will measure and monitor volumetric take? (page 4 of the AIP)	Section 4
2	Outlined a reporting framework for volumetric take? (page 4 of the AIP)	Section 4

Appendix B Water level Data

Groundwater Level Records (meters below datum)

	B1		B2		B3		B5	
Date	Standing	Pumped	Standing	Pumped	Standing	Pumped	Standing	Pumped
25/08/2016	5.1		6.7					
27/08/2016	5.1		6.7					
28/08/2016	4.7		6.7					
29/08/2016		19.8		55.9				
1/09/2016		14.5		15.2				
11/09/2016				65.4				
17/09/2016				58				
18/09/2016			11.5					
19/09/2016				47				
20/09/2016				54				
8/10/2016		15.1		53.2	5			
9/10/2016							3.75	
23/10/2016		13.4		25.1	4.9			
5/11/2016		7.4	8.5		5.2		3.5	
6/11/2016		6.5	7.5		5.1			
8/11/2016						5.1	4.88	11.27
10/11/2016	13.46			35.87		5.27		11.02
11/11/2016	14.58		15.27	46.85	5.27	5.27	4.92	11.28
12/11/2016						5.27		
12/11/2016	14.82		16.04	46.84	5.27	5.27	4.75	11.33
14/11/2016	8.3		13.19	34.97	5.27	5.27	3.98	11.26
15/11/2016							4.22	11.18
16/11/2016	13.92		16.68	50.59	5.27		4	11.29
17/11/2016	9.34		16.5	48.2	5.28		3.8	

Bilambil Creek Level Records

Time	Date	Upstream	Relative level upstream	Downstream	Relative level downstream	Bores pumping? y/n	Estimate pump volume L/hour	Length of time pumping	Time since bores were off	Rainfall?
1740	10/11/2016	1.852	0.15	0.241	0.15	Y - B2 and B5	9500	9.5	-	Heavy but brief rainfall earlier in the day
815	11/11/2016	1.888	0.114	0.277	0.114	Y- B2, B5 and R2	19500	1.5	-	Nil rainfall observed
1245	11/11/2016	1.885	0.117	0.265	0.126	Y- B2, B5 and R2	19500	6	-	Nil rainfall observed
710	12/11/2016	1.915	0.087	0.295	0.096	No		-	14.75	Nil rainfall observed
1040	12/11/2016	1.919	0.083	0.299	0.092	Y- B2, B5 and R2	19500	3.5	-	Nil rainfall observed
1540	12/11/2016	1.898	0.104	0.277	0.114	Y- B2, B5 and R2	19500	8.5	-	Heavy but brief downpour from storm cell passing through about 0.5 hour earlier.
1740	12/11/2016	1.875	0.127	0.254	0.137	Y- B2, B5 and R2	19500	10.5	-	Nil rainfall observed
820	13/11/2016	1.873	0.129	0.252	0.139	Y- B2, B5 and R2	19500	1.15		A couple of periods of rain were observed last night.
820	14/11/2016	1.909	0.093	0.286	0.105	No		-	16	Nil rainfall observed
1350	14/11/2016	1.909	0.093	0.286	0.105	Y- B2, B5 and R2	19500	5.5	-	Nil rainfall observed
1750	14/11/2016	1.913	0.089	0.29	0.101	N		-	2	Nil rainfall observed
550	15/11/2016	1.931	0.071	0.308	0.083	N		-	14	Nil rainfall observed
1150	15/11/2016	1.931	0.071	0.308	0.083	Y- B2, B5 and R2	19500	5	-	Nil rainfall observed
1650	15/11/2016	1.931	0.071	0.308	0.083	Y- B2, B5 and R2	19500	10	-	A very brief light shower occurred at time 1308, amount of rainfall appeared negligible.
650	16/11/2016	1.931	0.071	0.308	0.083	N		-	14	Nil rainfall overnight
1650	16/11/2016	1.935	0.067	0.312	0.079	Y-B2 and B5	9500	10	-	Nil rainfall observed
2050	16/11/2016	1.939	0.063	0.316	0.075	N		-	3	Nil rainfall observed
650	17/11/2016	1.937	0.065	0.314	0.077	N		-	10	Rainfall observed overnight
850	17/11/2016	1.937	0.065	0.314	0.077	Y - B2 and	9500	2	-	Nil rainfall observed

						B5				
1150	17/11/2016	1.934	0.068	0.311	0.08	Y - B2 and B5	9500	5	-	Reasonable showers of rain have been observed on and off in this period, particularly upstream towards Murwillumbah. Weather radar shows rain out that way also.
1350	17/11/2016	1.932	0.07	0.309	0.082	Y - B2 and B5	9500	7	-	Brief, but reasonably heavy rain was observed in the area during this period.
1750	17/11/2016	1.932	0.07	0.309	0.082	Y - B2 and B5	9500	(first 2 of the last 4 hours)	2	none

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