PROJECT

POSITION PAPER – GROUNDWATER CONDITIONS AT THE PROPOSED SERVICE STATION SITE, PRECINCT 1 KINGS FOREST NEW SOUTH WALES

PREPARED FOR

A SECTION 34 CONCILIATION CONFERENCE IN THE PROCEEDINGS PROJECT 28 V MINISTER FOR PLANNING

PREPARED BY

NEIL SUTHERLAND & CHRIS ANDERSON

DATE

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GILBERT SUTHERLAND

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CLIENT Project 28 Pty Ltd
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CLIENT REFERENCE

SYNOPSIS This Position Paper presents the summary of results from the assessment of groundwater conditions at the proposed Service Station site within Precinct 1 of the Kings Forest site, Kings Forest, New South Wales.

REVISION HISTORY

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SUMMARY

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to identify the existing groundwater conditions at the proposed service station site. An understanding of these conditions informs the proposed design and any mitigation measures during both the construction and operational phases of the development to ensure no adverse effects to the receiving environment.

Accordingly, this report provides a review of:

- groundwater levels during the monitoring period,
- groundwater quality,
- likely impacts of the proposed development and associated infrastructure on groundwater quality and quantity, and
- management strategies to minimise any impacts.

To investigate this, five (5) additional groundwater bores were installed (in additional to the one existing). These bores were used to assess water quality and level. They were also used to facilitate preliminary hydraulic conductivity testing on the site soils.

The findings of the site investigations are summarised as:

- Fieldworks conducted between 1 September and 29 September 2016 measured groundwater levels in the monitoring bores between 0.50 and 1.82 metres below ground level (mBGL).
- The near-surface groundwaters on the site represent an unconfined sand aquifer.
- This aquifer has an indicative permeability (derived by falling head testing) ranging from 4.6 to 8.4 m/day.
- Groundwaters are influenced by two near-surface hydraulic boundaries – one to the north of the site within a constructed drain and the other being Cudgen Creek.
- Groundwater flows in the main to the east, towards Cudgen Creek.

- Calculations estimate that these groundwaters have an advective velocity ranging between 0.02 and 0.30 m/day.

Dewatering of the near-surface, unconfined sand aquifer will be required for a limited period of time during the installation of the underground petroleum storage system (UPSS). If no mitigation measures are employed, the dewatering cone of depression is estimated to extend between 260 and 350 m from the base of the excavation, depending upon the specific, localised aquifer characteristics and near-surface conditions.

However, the stratum in this landform readily enables the use of mitigation measures (e.g. recharge swale) to manage localised groundwater recharge and hence to minimise the drawdown extent. In simple terms, the water removed from the excavation is reinjected/ recharged at targeted locations through the use of the swale, resulting in no net loss and hence managing any drawdown. This is a well understood and commonly employed technique. Indeed, the process would be monitored throughout the construction phase to confirm the efficacy of the mitigation measure.

Dewatering activities, including the ongoing monitoring of the mitigation measures, will allow for sampling to appropriately monitor any changes to the physiochemical characteristics of the site groundwaters. This would include their variability over time in response to seasonal and other influences.

We note that the proposed recharge swale regime is consistent with (if not the same) as that which the Respondent has already approved in respect of groundwater management for the protection of Groundwater Dependent Ecosystems (GDE) during the construction and operational phases of development in the nearby Cudgen Paddock portion of the Kings Forest development site.

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GLOSSARY

TERM	MEANING
Australian Height Datum (AHD)	National reference for relative height measurement in Australia.
Average Recurrence Interval (ARI)	The average or expected length of time between which a given variable, such as rainfall, is exceeded.
Bund	An embankment constructed around an area to prevent the inflow or outflow of liquids. Also called Bunding.
Catchment	The area above a given point that contributes to the runoff.
Clay	Very fine-grained sediment or soil (often defined as having a particle size less than 0.002 mm, or 2 microns, in diameter).
Ephemeral stream	A stream that flows briefly only in direct response to precipitation in the immediate locality and the channel of which is at all times above the watertable.
Erosion	The process by which material (such as rock or soil) is worn away or removed (as by wind or water).
Groundwater	The water contained in interconnected pores located below the watertable in an unconfined aquifer or located in a confined aquifer.
Intermittent stream	A stream in which the flow is seasonal, usually in response to rainfall in the immediate area (see ephemeral).
Loam	Medium-textured soil composed of approximately 10% to 25% clay, 25% to 50% silt and less than 50% sand.
mBGL	Metres below ground surface level.
pH	The degree of acidity or alkalinity measured on a scale of 1 to 14 with 7 as neutral. From 0 to 7 is acidic; from 7 to 14 is alkaline.
Sand	Sediment composed of particles within the size range 63 microns to 2 millimetres.

TERM	MEANING
Scouring	The action of removing sediment from stream banks, particle by particle. This is a more destructive process than collapse when viewed over time due to incremental effects.
Sediment	Unconsolidated, fine-grained material (typically derived from the weathering of rocks), that is transported by water and settles on the floor of seas, rivers streams and other bodies of water.
Silt	Sediment having particles finer than sand and coarser than clay (i.e. 2 to 63 microns).
Sub-catchment	A smaller area within a catchment drained by one or more tributaries of the main water body.
Suspended Solids (SS)	The concentration of filterable particles in water (retained on a 1.2μm filter) and reported by volume (mg/L).
Total Nitrogen (TN)	Total nitrogen is the sum of the nitrogen present in all nitrogen-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Total Phosphorus (TP)	Total phosphorus is the sum of the phosphorus present in all phosphorus-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Turbidity	A measure of the cloudiness of water that is determined by the amount of light scattered by suspended particles.

1 Introduction

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to undertake additional specialist investigations of soil, surface water and groundwater conditions at the proposed service station development site within Precinct 1 of the Kings Forest development site, Kings Forest, New South Wales.

1.1 Objectives

The objectives of this assessment were to:

- examine and describe the groundwater conditions at the site
- identify potential impacts on the site groundwater characteristics as a result of the proposed development
- investigate the construction phase impact of the installation of an Underground Petroleum Storage System (UPSS)
- provide management strategies for the management of groundwater during the project's construction phase and
- identify measures to be undertaken during the operational phase of the proposed development to maintain the site's groundwater characteristics.

1.2 Scope of works

To meet the objectives of this investigation, the following scope of works was conducted:

- desktop assessment
- field investigations
- assessment of groundwater flow direction, velocity, drawdown calculations and
- report preparation.

1.3 Proposed development

The site is described as Lot 7 on DP875447. The proposed development consists of a multiuse service station, station shop, fast food tenancies, eating areas, car parks and a car wash bay and dog wash facility within a development area of 1.09 ha (as shown on Drawing No. 11728.102 in Appendix 1). The proposed development would also include the construction and/or installation of the following components:

- site earthworks
- roads
- water reticulation mains
- UPSS tanks and infrastructure/components
- underground electricity distribution cables, telecommunication cables and other ancillary services and
- landscaping.

2 Methods

2.1 Desktop assessment

A desktop assessment was undertaken to identify site inspection priorities and to define fieldwork requirements. This involved the study of aerial photography, contour maps, geological mapping and other available information describing:

- land-use
- climate
- geology
- vegetation
- topography and landform
- site drainage
- previous assessments.

2.2 Field investigations

2.2.1 Soils and groundwater

Soil sampling and data interpretation was conducted in accordance with the Australian Soil and Land Survey Field Handbook (McDonald et. al., 1990[1]) with the soils classified according to the Australian Soil Classification (Isbell, 2016[2]).

The site investigation was conducted on 19 May 2016. A total of five boreholes were constructed using a T110 track-mounted drill rig ('the G&S boreholes'). A single pre-existing groundwater borehole installed by HMC Consulting was also present ('the existing bore'). All borehole locations are shown on Drawing No. 11636.02.

The G&S boreholes were constructed to a maximum depth of 6.0 m below ground level (mBGL). Soil physical attributes recorded included depth, colour, texture, structure, moisture and consistence.

2.2.2 Groundwater bore installation

After logging, groundwater wells were installed in the G&S boreholes and completed with 50 mm PVC casing from above ground with a 3 m factory cut slotted screen at the base of the hole. Above the screen the hole was sealed with bentonite and cement to prevent surface water ingress. Stand pipes were left to a nominal 80 cm above ground and capped with a close fitting PVC cap.

All six boreholes (i.e. five G&S and one existing) were subject to a site survey to establish relative elevations (ground level and top of casing).

2.2.3 Permeability

Permeability testing of the soils surrounding each of the six groundwater bores was undertaken using the Falling Head Test method. The falling head tests were conducted in accordance with the methods outlined in Cedergren (1997).[3]

Soil permeability testing was undertaken in all six of the boreholes and the results of these tests are provided in Section 3.2.2.

2.2.4 Water levels monitoring

Water level monitoring was conducted in the five G&S boreholes by both manual methods (six monitoring occasions) and using automatic dataloggers recording at six minute intervals. A barometric pressure logger was also installed close to ground level to allow for variations in atmospheric pressure.

A nominal value of 100, representing the top of the monument (or casing) at BH1, was used as a common datum to record groundwater levels across the five G&S bores and the existing bore.

2.2.5 Water gradients and flow directions

Groundwater flow paths were assessed using a three dimensional digital model created using the

[1] McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. 1990 *Australian Soil and Land Survey Field Handbook (2nd Edition)*. Inkata Press, Melbourne.
[2] Isbell, R.F. (2016) The Australian Soil Classification (2nd Edition). CSIRO Publishing.

[3] Cedergren H.R. 1997 Seepage drainage and flownets, Wiley professional series London.

Vertical Mapper software package to show the spatial distribution of boreholes and groundwater levels in each.

2.2.6 Water quality assessment

Water samples were also recovered from the six groundwater bores. The groundwater sampling procedure for each bore involved the removal (via pumping) of a minimum of three times the well volume to ensure that the groundwater sampled was representative of the groundwater condition.

The groundwater sampling locations are shown on drawings numbered 11728 108 and 109 in Appendix 1. Field parameters were derived on site using field instrumentation. The parameters were pH, electrical conductivity (EC), dissolved oxygen, temperature and redox potential.

Samples were recovered in containers that were appropriate for the selected analytes and stored in chilled conditions in the field, before refrigeration and dispatch to a NATA-registered laboratory[4] for analysis for the following parameters.

- pH
- EC
- Oxygen Reduction Potential (Redox)
- Dissolved Oxygen (DO)
- Total dissolved solids (TDS)
- Alkalinity
- Dissolved major cations (Ca, Mg, Na, K)
- Dissolved major anions (Cl, SO_4, HCO_3)
- Dissolved Aluminium and Iron
- Total Aluminium and Iron
- Ammonia, Total N
- Total P, Reactive P
- Total Anions
- Total Cations

[4] ALS Laboratories conducted the analysis and is NATA accredited for the analytes considered in this investigation.

2.3 Estimation of groundwater flow velocity and seepage

The advective groundwater velocity was used to estimate the amount of seepage that would require removal (dewatering). The advective groundwater velocity was calculated using Darcy's Law and specifically the groundwater equation as shown below.

$$V = K.I/N$$

where

V = Advective groundwater velocity (m d^{-1})

K = Permeability (m d^{-1})

I = Hydraulic gradient (m/m)

N = Porosity

The seepage estimate is based on the continuity equation:

$$Q = K*I*A$$

Where

Q = volume (m^3 d^{-1})

K = saturated hydraulic conductivity

I = hydraulic gradient (m m^{-1})

A = area of seepage face (m^2)

The results of the calculations are included in Section 3.4.

2.4 Drawdown calculations

Groundwater drawdown associated with dry excavations for the installation of the UPSS was estimated using Hooghoudt's Equation.

Hooghoudt's Equation is a steady state drainage formula that estimates head losses due to horizontal and radial flow. While primarily used to estimate drain spacing, it also provides a useful

indicator of likely groundwater drawdown given theoretical inputs such as:

- inflow rates:
- hydraulic conductivities
- depth of drain (or in this case excavation) below surface
- allowable rise in water surface.

Hooghoudt's Steady State Formula is shown below:

$$L^2 = \frac{8K_2dh}{q} + \frac{5K_1h^2}{q}$$

where:

q = Inflow rate (mm/day)

K1 = Hydraulic conductivity - pipe to surface (m/day)

K2 = Hydraulic conductivity - below pipe (m/day)

d = Depth of drain (or in this case excavation) below surface (m)

h = Allowable rise in water surface between drains (m)

L = Estimated spacing between drains (m)

3 Results

3.1 Desktop assessment

3.1.1 Stratigraphy

The site is generally flat to gently sloping to the east and is comprised of Quaternary alluvial deposits associated with estuarine and riverine deposition. The site is bound to the east by Cudgen Creek, which lies some three metres below the general ground level of the site. A drain constructed to depth of approximately 2 m below the site's ground level is present on the northern site boundary. Beyond the drain lies further alluvial deposits and a remnant basalt plateau composed of Lamington Volcanics.

3.2 Field investigations

3.2.1 Soils

The site soils are generally fine silty sands with some coffee rock (partially indurated organic rich sand strata).

3.2.2 Permeability

The preliminary falling head permeability testing revealed a highly permeable soil at the site. The permeability results are summarised in Table 3.2.2.1.

Table 3.2.2.1 Permeability results

Borehole	Permeability (m/day)
BH1	6
BH2	4.6
BH3	6.5
BH4	8.4
BH5	4.8
Existing bore	6.8

Saturated hydraulic conductivities (permeability) was measured at between 4.6 and 8.4 m/day. The highest value was measured in BH4, in the centre of the site.

3.2.3 Groundwater levels

Groundwater levels were manually measured on six occasions and those results are depicted on the groundwater contour drawings in Appendix 2. Table 3.2.3.1 summarises those results.

Table 3.2.3.1 Groundwater levels from top of casing (TOC)

Borehole	Groundwater monitoring date and levels					
	01/09/16	09/09/16	12/09/16	16/09/16	23/09/16	29/09/16
BH1	1.17	1.27	1.19	1.24	1.34	1.42
BH2	1.52	1.60	1.52	1.58	1.66	1.72
BH3	2.13	2.20	2.21	2.23	2.26	2.30
BH4	1.47	1.55	1.45	1.53	1.63	1.70
BH5	1.42	1.48	1.41	1.47	1.55	1.63
Existing Bore	1.40	1.50	1.39	-	1.57	1.64

Groundwater loggers were installed in each of the five G&S boreholes on 16 September 2016. The dataloggers are recording groundwater levels on six-minute time-steps. These results are depicted on Figure 1 in Appendix 2. Water levels in the existing bore were manually recorded on five occasions but no datalogger was installed.

Data from those loggers identified that elevation varied across the site and over time, from 0.5 m below ground level (mBGL) and 1.82 mBGL. Most wells recorded levels approximating 1.1 mBGL, with the exception of BH3, which is located to the east of the site and adjacent to two abrupt changes in topography. The recorded levels at BH3 were between 1.75 mBGL and 1.82 mBGL. All wells exhibited gradual declines in groundwater levels during the study.

The groundwater level in well BH2 exhibited some atmospheric effect, i.e. the groundwater level in the well fluctuated with changes in air pressure.

Level monitoring is continuing and this will be the subject of further analysis following the acquisition of additional data.

3.2.4 Groundwater contours

The relative levels of the groundwaters in the observed boreholes changed over time, in a generally consistent manner between all wells – i.e. there were no apparent changes in gradient. Groundwater flow was generally to the east, towards Cudgen Creek. The groundwater contours are represented on drawings numbered 11728 110 to 115, included within Appendix 1.

3.2.5 Water quality results

The results for the one round of monitoring from the groundwater bores monitoring completed in September 2016 are discussed in this section. It should be noted that monitoring is continuing to ensure that a statistically valid database of baseline water quality is available prior to any site works commencing.

This includes in-situ and laboratory analysed results (where applicable). Appendix 3 of this report provides copies of the in-situ field results. Appendix 4 of this report provides copies of the laboratory certificates of analysis.

pH

In-situ results ranged between 3.4 (existing well) to 4.8 (BH1). Laboratory results ranged between 4.0 (Existing and BH5) and 5.5 (BH1).

EC (µS/cm)

In-situ results ranged between 75 µS/cm (BH2) to 464 µS/cm (BH5). Laboratory results ranged between 84 µS/cm (BH2) and 509 µS/cm (BH5).

Oxygen Reduction Potential (Redox)

In-situ results ranged between 153 (BH1) to 499 (Existing).

Dissolved Oxygen (DO) (mg/L)

In-situ results were less than 0.1 mg/L at all locations.

Total dissolved solids (TDS) (mg/L)

Laboratory results ranged between 55 mg/L (BH2) and 331 mg/L (BH5).

Dissolved major cations (Ca, Mg, Na, K) (mg/L)

Sodium was the prominent dissolved major cation with laboratory results ranging between 10 mg/L (Existing) and 83 mg/L (BH5). All other dissolved major cations had laboratory results of less than 4 mg/L (typically in the range of <1 to 2 mg/L).

Dissolved major anions (Cl, SO4, HCO3) (mg/L)

Laboratory results for chloride (Cl) ranged between 13 mg/L (BH2) and 129 mg/L (BH5). Laboratory results for Sulfate (SO_4) were below the laboratory's limit of reporting (LOR) of <10 mg/L for all sites. Laboratory results for bicarbonate alkalinity (as $CoCO_3$) were below the laboratory's limit of reporting (LOR) of <1 mg/L for all sites except BH1 and BH2, having measured results of 26 mg/L and 3 mg/L respectively.

Dissolved Aluminium and Iron (mg/L)

Laboratory results for dissolved aluminium ranged between 0.21 mg/L (BH1) and 0.83 mg/L (BH4). Laboratory results for dissolved iron ranged between 0.19 mg/L (BH1) and 0.74 mg/L (BH5).

Total Aluminium and Iron (mg/L)

Laboratory results for total aluminium ranged between 0.66 mg/L (Existing) and 16.8 mg/L (BH3). Laboratory results for total iron ranged between 0.34 mg/L (Existing) and 4.11 mg/L (BH1).

Ammonia, Total N (mg/L)

Laboratory results for ammonia as N ranged between 0.11 mg/L (Existing) and 0.83 mg/L (BH1). Laboratory results for total N ranged between 1.9 mg/L (Existing) and 14.5 mg/L (BH1).

Total P, Reactive P (mg/L)

Laboratory results for total P ranged between 0.11 mg/L (BH3) and 0.66 mg/L (BH1). Laboratory results for reactive P ranged between below the

laboratory's LOR of <0.05 mg/L (Existing) and 0.34 mg/L (BH4).

Total Anions (meq/L)
Laboratory results ranged between 0.39 meq/L (Existing) and 3.64 meq/L (BH5).

Total Cations (meq/L)
Laboratory results ranged between 0.46 meq/L (Existing) and 3.91 meq/L (BH5).

Piper and Durov plots
Piper and Durov plots have been created for the relevant laboratory data to further analyse the major cation and anion, pH and TDS results. These plots are contained within Appendix 5.

The Piper plot, displaying the cation and anion relationships, generally showed a consistent grouping for all six monitoring locations, therefore suggesting similar ion balances. The Piper plot generally characterised the monitoring results as chloride anion type dominant and sodium cation type dominant. The general location of the Piper plot is characteristic of brackish / sea water. These findings are expected, noting the proximity of the monitoring locations to Cudgen Creek.

Like the Piper plot, the Durov plot generally showed a similar cation anion grouping for all six monitoring locations, therefore suggesting similar ion balances. TDS, which provides an understanding of salinity, varied between the monitoring locations, but was generally in the range of 100 mg/L or less (excluding BH4 and BH5 being 189 mg/L and 331 mg/L respectively). pH levels were generally in the range of 4.0 to 4.5 (i.e. moving towards an acidic environment).

3.2.6 Estimation of groundwater flow velocity

Groundwater flow velocities were estimated using saturated hydraulic conductivity and matrix porosity. Representative gradients were employed of 0.12% to 1.08% (minimum and maximum gradients during manual monitoring).

Table 3.2.1 Advective groundwater velocity modelling assumptions

Permeability	4-6 – 8.4 (m d^{-1})
Hydraulic gradient	0.0012 – 0.0108 (m m^{-1})
Porosity	0.3 (30%)

The calculation showed that these groundwaters have an advective velocity ranging between 0.02 and 0.30 m/day, depending on the permeability and hydraulic gradient.

3.2.7 Construction phase seepage

The indicative flow rate to the sump associated with the dewatering for the UPSS was calculated using the following measurements and assumptions as detailed in Table 3.2.6.

Table 3.2.6 Construction phase seepage estimate assumptions*

Permeability	4-6 – 8.4 (m d^{-1})
Hydraulic gradient	0.4 (m m^{-1}) assuming the recharge trench is located approx. 10 m from the edge of the excavation
Porosity	0.3 (30%)

Note: *assumes no dewatering techniques, such as sheet piling, employed and dewatering occurring to approximately 2.0 m AHD (some 4.0 m below ground surface).

Using the assumptions from Table 3.2.6, the following minimum and maximum seepage rates were derived.

1. Q_{min}= 4.6 (m d^{-1}) x 0.4 (m m^{-1}) x 1.0 m^2
   i.e. Q_{min} = 1.84 m^3 d^{-1} (per square m)
2. Q_{max}= 8.4 (m d^{-1}) x 0.4 (m m^{-1}) x 1.0m^2
   i.e. Q_{max} = 3.36 m^3 d^{-1} (per square m)

3.3 Drawdown calculations

A Hooghoudt's Equation estimate was used to examine the extent of temporary drawdown associated with the installation of the UPSS. This approach is conservative given the hydraulic conductivities and inflow rates listed. The input

assumptions for these calculations are summarised in Table 3.3.1.

Table 3.3.1 Construction phase drawdown assumptions

Permeability	4-6 – 8.4 (m d^{-1})
Groundwater level	5.5 mAHD (0.5 mBGL)
Base of excavation	2 mAHD (4 mBGL)
Inflow rate	1.5 mm d^{-1} *

Note: *Approximately 30% of annual rainfall, distributed on an average daily basis.

If no mitigation measures are employed, the dewatering cone of depression is estimated to extend between 260 and 350 m from the base of the excavation, depending upon the specific, localised aquifer characteristics and near-surface conditions.

However, the stratum in this landform readily enables the use of mitigation measures (e.g. recharge swale) to manage localised groundwater recharge and hence to minimise the drawdown extent. In simple terms, the water removed from the excavation is reinjected/ recharged at targeted locations through the use of the swale, resulting in no net loss and hence managing any drawdown. The ongoing monitoring will help to inform the detailed design of the recharge system.

4 Conclusions

Fieldwork has been undertaken to better characterise the site's groundwater regime in order to estimate the potentials impacts of development, including the installation of UPSS and associated infrastructure. Our fieldwork on site indicates that:

- The near-surface groundwaters on the site represent an unconfined sand aquifer.
- This aquifer has an indicative permeability (derived by falling head testing) ranging from 4.6 to 8.4 m/day.
- Measurements taken during fieldworks conducted between 1 September and 29 September 2016 identified that groundwater lies between 0.50 and 1.82 metres below ground level (mBGL).
- Groundwaters are influenced by two near-surface hydraulic boundaries – one to the north of the site within a constructed drain and the other being Cudgen Creek.
- Groundwater flows in the main to the east towards Cudgen Creek.
- Calculations estimate that these groundwaters have an advective velocity ranging between 0.02 and 0.30 m/day.

Dewatering of the near-surface, unconfined sand aquifer will be required for a limited period of time during the installation of the underground petroleum storage system (UPSS). If no mitigation measures are employed, the dewatering cone of depression is estimated to extend between 260 and 350 m from the base of the excavation, depending upon the specific, localised aquifer characteristics and near-surface conditions.

However, the stratum in this landform readily enables the use of mitigation measures (e.g. recharge swale) to manage localised groundwater recharge and hence to minimise the drawdown extent. In simple terms, the water removed from the excavation is reinjected/ recharged at targeted locations through the use of the swale, resulting in no net loss and hence managing any drawdown. This is a well understood and commonly employed technique. Indeed, the process would be monitored throughout the construction phase to confirm the efficacy of the mitigation measure.

Dewatering activities, including the ongoing monitoring of the mitigation measures, will allow for sampling to appropriately monitor any changes to the physiochemical characteristics of the site groundwaters. This would include their variability over time in response to seasonal and other influences.

We note that the proposed recharge swale regime is consistent with (if not the same) as that which the Respondent has already approved in respect of groundwater management for the protection of Groundwater Dependent Ecosystems (GDE) during the construction and operational phases of development in the nearby Cudgen Paddock portion of the Kings Forest development site.

Groundwater monitoring is ongoing.

5 Appendix 1 – Drawings

ORIENTATION

SCALE 1:20,000

200 400 600 800 1000 metres

ROBINA

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Email robina@access.gs **www.access.gs**

LEGEND

Site Boundary

SOURCES

Satellite Image: Google Earth Pro, Accessed: 01/09/2016, Imagery Dated: 05/05/2016.
Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated: 09/2016

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

SITE LOCATION

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:20,000@A3	06/10/2016	BMW	CMA	11728	101	-

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ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

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BH# Groundwater Monitoring Location

Site Boundary

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

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PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

GROUNDWATER MONITORING WELL LOCATIONS ON EXISTING AERIAL

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	108	-

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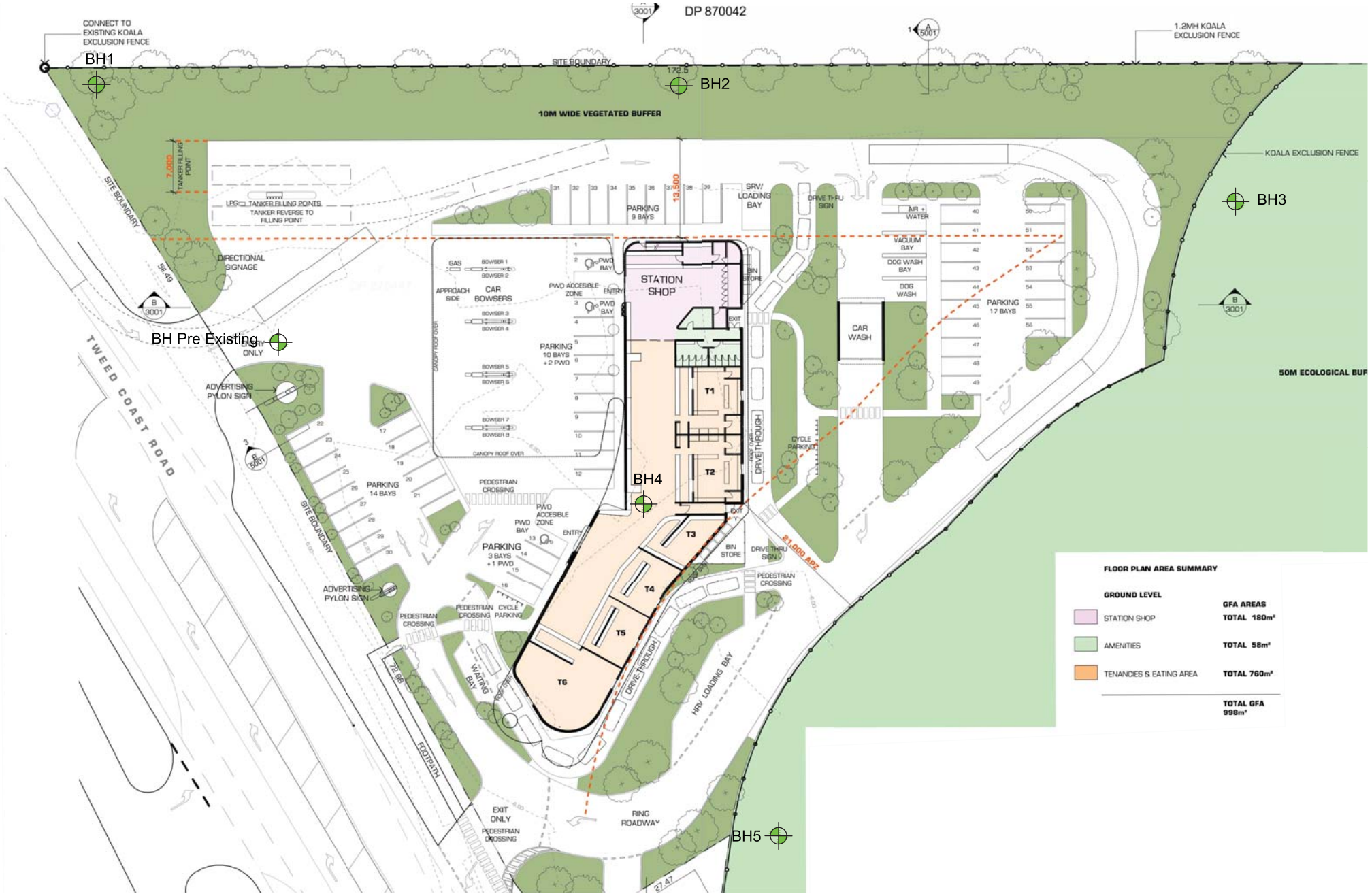

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

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LEGEND

BH# Groundwater Monitoring Location

For additional Legend entries see the drawing.

SOURCES

Proposed Development Layout: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

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PROJECT 28 PTY LTD

DRAWING

GROUNDWATER MONITORING WELL LOCATIONS ON PROPOSED DEVELOPMENT LAYOUT

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	109	-

GILBERT SUTHERLAND

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944

Email robina@access.gs **www.access.gs**

LEGEND

- BH# Groundwater Monitoring Location
- Site Boundary
- Major Contour (Interval 0.5m)
- Minor Contour (Interval 0.1m)
- Contour Slope Arrow

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

Notes

Datum base of RL 100m at top of BH1 casing has been adopted.

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

GROUNDWATER ELEVATION CONTOURS 01/09/2016

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	110	-

GILBERT SUTHERLAND

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

ROBINA

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Email robina@access.gs **www.access.gs**

LEGEND

- BH# Groundwater Monitoring Location
- Site Boundary
- Major Contour (Interval 0.5m)
- Minor Contour (Interval 0.1m)
- Contour Slope Arrow

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

Notes

Datum base of RL 100m at top of BH1 casing has been adopted.

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

GROUNDWATER ELEVATION CONTOURS 09/09/2016

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	111	-

GILBERT SUTHERLAND

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- BH# Groundwater Monitoring Location
- Site Boundary
- Major Contour (Interval 0.5m)
- Minor Contour (Interval 0.1m)
- Contour Slope Arrow

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

Notes

Datum base of RL 100m at top of BH1 casing has been adopted.

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

GROUNDWATER ELEVATION CONTOURS 12/09/2016

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	112	-

GILBERT SUTHERLAND

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- BH# Groundwater Monitoring Location
- Site Boundary
- Major Contour (Interval 0.5m)
- Minor Contour (Interval 0.1m)
- Contour Slope Arrow

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

Notes

Datum base of RL 100m at top of BH1 casing has been adopted.

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

GROUNDWATER ELEVATION CONTOURS 16/09/2016

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	113	-

GILBERT SUTHERLAND

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- BH# Groundwater Monitoring Location
- Site Boundary
- Major Contour (Interval 0.5m)
- Minor Contour (Interval 0.1m)
- Contour Slope Arrow

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

Notes

Datum base of RL 100m at top of BH1 casing has been adopted.

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

DRAWING

GROUNDWATER ELEVATION CONTOURS 23/09/2016

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	114	-

GILBERT SUTHERLAND

ORIENTATION

SCALE 1:500

5 10 15 20 25 metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs **www.access.gs**

LEGEND

- BH# Groundwater Monitoring Location
- Site Boundary
- Major Contour (Interval 0.5m)
- Minor Contour (Interval 0.1m)
- Contour Slope Arrow

SOURCES

Image: Google Earth Pro, *NSW Globe*, Accessed 06/10/2016, Imagery Dated 05/05/2012.

Site Boundary: Push Architecture, *Proposed Site Plan*, Drawing No. 1000 Issue O, Dated 08/2016

Notes

Datum base of RL 100m at top of BH1 casing has been adopted.

PROJECT

PROPOSED SERVICE STATION, TWEED COAST RD, KINGS FOREST, NSW

CLIENT

PROJECT 28 PTY LTD

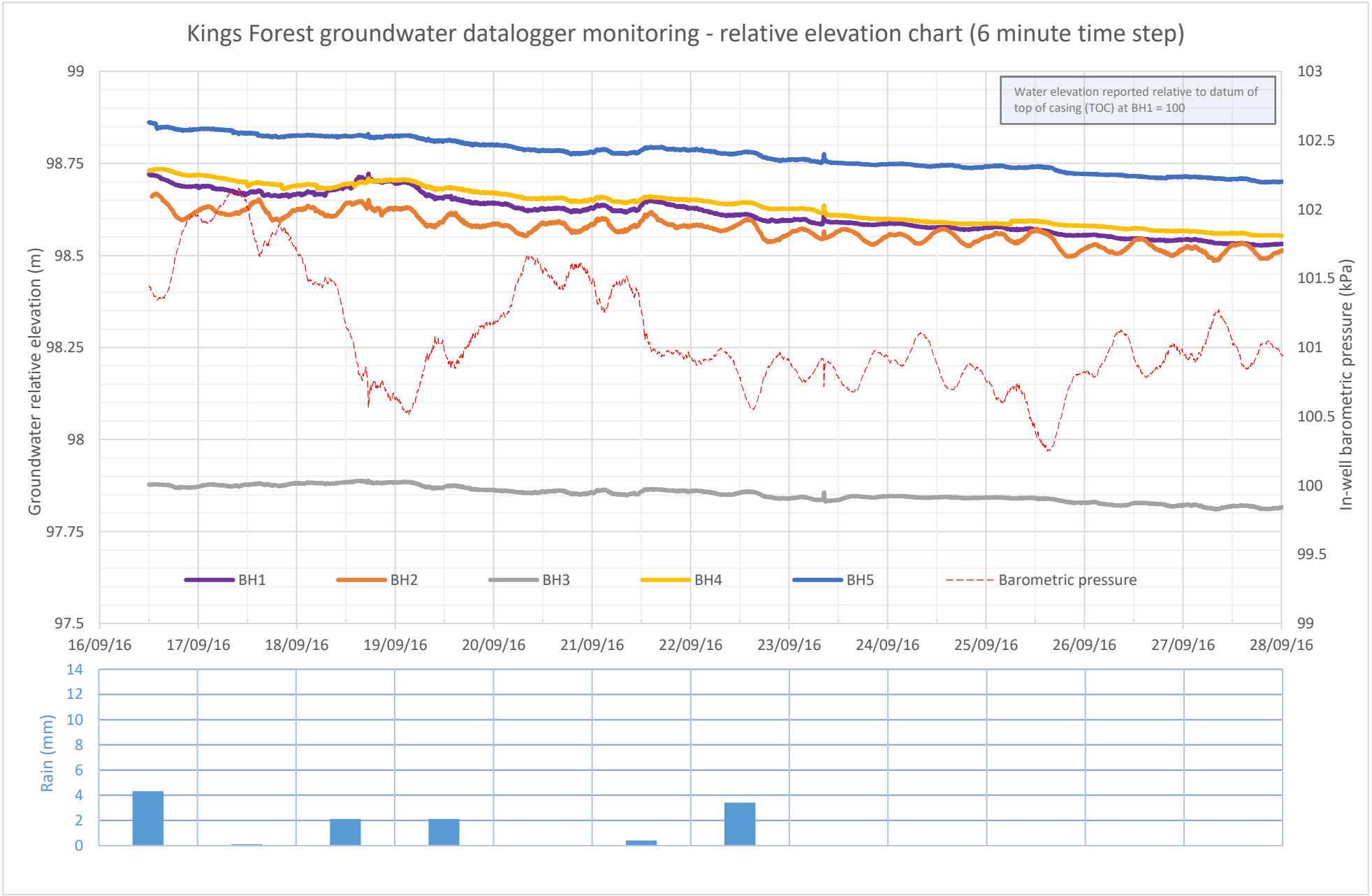
DRAWING

GROUNDWATER ELEVATION CONTOURS 29/09/2016

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:500@A3	06/10/2016	BMW	CMA	11728	115	-

GILBERT SUTHERLAND

6 Appendix 2 – Groundwater levels (relative elevations)


Kings Forest groundwater datalogger monitoring - relative elevation chart (6 minute time step)
Water elevation reported relative to datum of top of casing (TOC) at BH1 = 100
Groundwater relative elevation (m)
In-well barometric pressure (kPa)
99
98.75
98.5
98.25
98
97.75
97.5
103
102.5
102
101.5
101
100.5
100
99.5
99
BH1
BH2
BH3
BH4
BH5
Barometric pressure
16/09/16
17/09/16
18/09/16
19/09/16
20/09/16
21/09/16
22/09/16
23/09/16
24/09/16
25/09/16
26/09/16
27/09/16
28/09/16
Rain (mm)
14
12
10
8
6
4
2
0

7 Appendix 3 – In situ results

Kings Forest In-situ Measurements 12-Sep-16 - Conducted by GRC and CMA

Well	Volume removed (L)	pH	EC (uS)	Redox	DO (mg/L)	Temp (oC)	Time
Existing	30	3.41	98	579	0.15	20.44	11:18
	40	3.44	96	537	0.1	20.44	11:20
	50	3.44	96	522	0.1	20.43	11:21
	60	3.45	96	499	0.1	20.43	11:22
	80	3.45	96	461	0.09	20.42	11:24
	100	3.45	96	434	0.09	20.42	11:26
	120	3.44	96	411	0.09	20.43	11:28
BH1	30	4.78	130	212	0.1	20.38	11:58
	40	4.77	125	179	0.06	20.39	12:00
	50	4.77	125	163	0.06	20.39	12:01
	60	4.77	125	153	0.05	20.38	12:02
	80	4.75	127	140	0.04	20.37	12:04
	100	4.72	130	134	0.04	20.38	12:06
	120	4.68	132	130	0.03	20.39	12:09
BH2	30	4.38	75	333	0.08	20.64	10:33
	40	4.38	75	299	0.05	20.61	10:34
	50	4.38	75	276	0.04	20.62	10:36
	60	4.37	75	264	0.04	20.61	10:37
	80	4.35	76	242	0.04	20.61	10:39
	100	4.34	76	232	0.04	20.63	10:41
	120	4.33	76	216	0.03	20.62	10:44
BH3	30	3.83	84	480	--	20.88	9:41
	40	3.85	84	463	--	20.93	9:43
	50	3.86	83	441	--	20.94	9:46
	60	3.86	83	435	--	20.97	9:48
	70	3.87	83	432	--	20.98	9:50
	80	3.87	82	431	--	20.99	9:53
	90	3.88	82	435	--	21.01	9:56
	100	3.87	82	441	--	21.01	9:59
BH4	--	4.03	425	220	0.11	20.77	8:14
(11 buckets	--	4.01	248	204	0.09	20.78	8:15
taken out of this	--	4	254	193	0.07	20.8	8:16
well. In-situ	--	3.99	258	184	0.06	20.8	8:18
measurements	--	3.98	263	180	0.05	20.79	8:19
starting around	--	3.97	273	172	0.04	20.8	8:23
bucket 5)	--	3.96	283	177	0.02	20.77	8:21
BH5	40	3.57	431	248	0.19	20.26	8:51
	60	3.55	451	226	0.14	20.26	8:52
	70	3.53	459	218	0.13	20.26	8:53
	80	3.52	469	215	0.11	20.25	8:55
	90	3.51	477	212	0.1	20.26	8:57
	100	3.5	486	211	0.1	20.25	8:58

Medians

Well	pH	EC (uS)	Redox	DO (mg/L)	Temp (oC)
Existing	3.44	96	499	0.10	20.43
BH1	4.77	127	153	0.05	20.38
BH2	4.37	75	264	0.04	20.62
BH3	3.87	83	438	--	20.98
BH4	3.99	263	184	0.06	20.79
BH5	3.53	464	217	0.12	20.26

Notes: Pumping was via two 12v amazon pumps, may have affected the DO and temperature readings
20 L bucket used to approximate volume removed
In-situ measurements undertaken with Yeo-Kal YK615 (S/N 513)
BH3 DO - due to depth of SWL and hose length on pump, pump was intermittently sucking air so DO reading artificially increased.

8 Appendix 4 – Laboratory results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1622395**	Page	: 1 of 8
Client	: **GILBERT & SUTHERLAND PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR CHRIS ANDERSON	Contact	: Jenny Bevan
Address	: SUITE 20 115 WICKHAM ST FORTITUDE VALLEY QLD, AUSTRALIA 4006	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 38523999	Telephone	: 07 3552 8657
Project	: ----	Date Samples Received	: 13-Sep-2016 15:00
Order number	: 11728	Date Analysis Commenced	: 14-Sep-2016
C-O-C number	: ----	Issue Date	: 19-Sep-2016 18:12
Sampler	: GLYN COWIE		
Site	: ----		
Quote number	: ----		
No. of samples received	: 6		
No. of samples analysed	: 6		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020-F and EG020-T (Dissolved Metals and Total Metals by ICP-MS): Limit of reporting raised due to matrix interference.
- ED093F (Major Cations - Dissolved): Unable to calculate Sodium Adsorption Ratio result for some samples as required Calcium and Magnesium results are less than the limit of reporting.
- EG035T (Total Mercury): LOR raised for some samples due to matrix interference.
- ED041G (Sulfate as SO4 2-): Samples were diluted due to matrix interference. LOR adjusted accordingly.
- EK057G (Nitrite as N) / EK071G (Reactive Phosphorus as P): Samples were diluted due to matrix interference. LOR adjusted accordingly.
- Ionic Balance out of acceptable limits due to analytes not quantified in this report.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH1	BH2	BH3	BH4	BH5
				Client sampling date / time	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]
Compound	CAS Number	LOR	Unit		EB1622395-001	EB1622395-002	EB1622395-003	EB1622395-004	EB1622395-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		5.48	4.97	4.36	4.36	3.96
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		----	1.67	2.37	7.88	10.3
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		141	84	92	291	509
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	1	mg/L		92	55	60	189	331
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		<5	13	7	8	12
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		26	3	<1	<1	<1
Total Alkalinity as CaCO3	----	1	mg/L		26	3	<1	<1	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<10	<10	<10	<10	<10
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		26	13	20	72	129
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	2	1	<1	<1
Magnesium	7439-95-4	1	mg/L		<1	2	1	2	3
Sodium	7440-23-5	1	mg/L		30	14	14	52	83
Potassium	7440-09-7	1	mg/L		2	4	<1	2	2
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.21	0.47	0.47	0.83	0.47
Arsenic	7440-38-2	0.001	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Cadmium	7440-43-9	0.0001	mg/L		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	7440-47-3	0.001	mg/L		<0.005	<0.005	<0.005	0.005	<0.005
Copper	7440-50-8	0.001	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Nickel	7440-02-0	0.001	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Lead	7439-92-1	0.001	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Selenium	7782-49-2	0.01	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	7440-66-6	0.005	mg/L		<0.025	0.046	0.051	<0.025	<0.025
Iron	7439-89-6	0.05	mg/L		0.19	0.68	0.23	0.61	0.74

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH1	BH2	BH3	BH4	BH5
				Client sampling date / time	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]
Compound	CAS Number	LOR	Unit		EB1622395-001	EB1622395-002	EB1622395-003	EB1622395-004	EB1622395-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**12.9**	**2.20**	**16.8**	**8.90**	**6.45**
Arsenic	7440-38-2	0.001	mg/L		**0.009**	<0.005	<0.005	<0.005	<0.005
Cadmium	7440-43-9	0.0001	mg/L		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	7440-47-3	0.001	mg/L		**0.070**	**0.016**	**0.023**	**0.036**	**0.034**
Copper	7440-50-8	0.001	mg/L		**0.024**	<0.005	**0.007**	**0.010**	**0.012**
Nickel	7440-02-0	0.001	mg/L		**0.012**	**0.007**	**0.006**	<0.005	**0.006**
Lead	7439-92-1	0.001	mg/L		**0.009**	<0.005	<0.005	<0.005	**0.006**
Selenium	7782-49-2	0.01	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	7440-66-6	0.005	mg/L		**0.144**	**0.105**	**0.234**	**0.036**	<0.026
Iron	7439-89-6	0.05	mg/L		**4.11**	**1.24**	**1.02**	**1.92**	**1.83**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0005	<0.0001	<0.0005	<0.0005	<0.0005
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.66**	**0.41**	**0.11**	**0.40**	**0.26**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.10	<0.10	<0.10	<0.10	<0.10
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.10	<0.10	<0.10	<0.10	<0.10
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**14.5**	**2.4**	**7.0**	**7.5**	**8.9**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**14.5**	**2.4**	**7.0**	**7.5**	**8.9**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.83**	**0.45**	**0.48**	**0.59**	**0.49**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.18**	**0.21**	**0.07**	**0.34**	**0.18**
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BH1	BH2	BH3	BH4	BH5
				Client sampling date / time	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]	[12-Sep-2016]
Compound	CAS Number	LOR	Unit		EB1622395-001	EB1622395-002	EB1622395-003	EB1622395-004	EB1622395-005
					Result	Result	Result	Result	Result
EN055: Ionic Balance - Continued									
Total Anions	----	0.01	meq/L		**1.25**	**0.43**	**0.56**	**2.03**	**3.64**
Total Cations	----	0.01	meq/L		**1.36**	**0.98**	**0.74**	**2.48**	**3.91**
Ionic Balance	----	0.01	%		**----**	**----**	**----**	**----**	**3.55**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Existing	----	----	----	----
			Client sampling date / time	[12-Sep-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1622395-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**3.99**	----	----	----	----
EA006: Sodium Adsorption Ratio (SAR)								
Sodium Adsorption Ratio	----	0.01	-	**----**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**102**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**66**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	<5	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	<1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<10	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**14**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
Sodium	7440-23-5	1	mg/L	**10**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**1**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.27**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.005	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0005	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.005	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.005	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.005	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.005	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.05	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.072**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.27**	----	----	----	----

Analytical Results

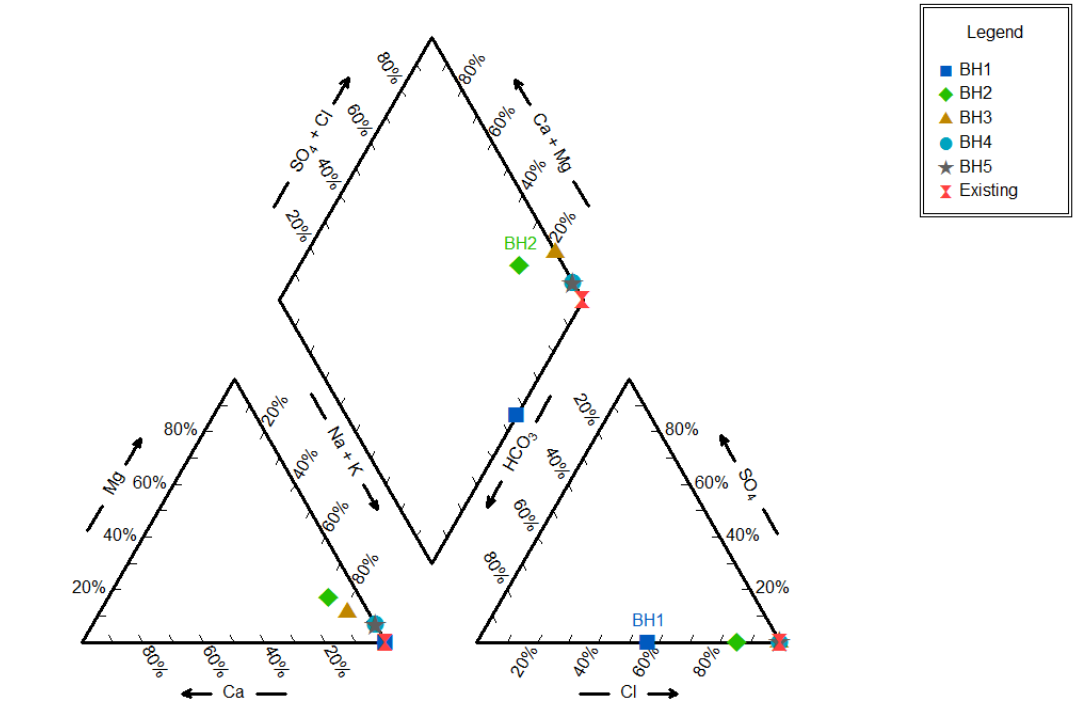
Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Existing	----	----	----	----
				Client sampling date / time	[12-Sep-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1622395-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.66**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.005	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0005	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.005	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.005	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.012**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.005	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.05	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.103**	----	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.34**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.31**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.10	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.14**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.14**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.8**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.9**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.11**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.05	----	----	----	----
EN055: Ionic Balance									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	**Existing**	**----**	**----**	**----**	**----**
				Client sampling date / time	[12-Sep-2016]	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB1622395-006**	**--------**	**--------**	**--------**	**--------**
					Result	----	----	----	----
EN055: Ionic Balance - Continued									
Total Anions	----	0.01	meq/L		**0.39**	**----**	**----**	**----**	**----**
Total Cations	----	0.01	meq/L		**0.46**	**----**	**----**	**----**	**----**
Ionic Balance	----	0.01	%		**----**	**----**	**----**	**----**	**----**

9 Appendix 5 – Piper and Durov data plots

Piper Diagram - GW Monitoring 12-Sep-16



Durov Diagram - GW Monitoring 12-Sep-16