

Monitoring Report

Dunmore Quarry

Prepared for Boral Resources (NSW) Pty Ltd
September 2019



Servicing projects throughout Australia and internationally

SYDNEY

Ground Floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE

Level 3, 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE

Level 1, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

ADELAIDE

Level 1, 70 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE

Ground Floor, 188 Normanby Road
Southbank VIC 3006
T 03 9993 1905

PERTH

Level 6, 191 St Georges Terrace
Perth WA 6000

CANBERRA

PO Box 9148
Deakin ACT 2600

2018 - 2019 Annual Groundwater Monitoring Report

Dunmore Quarry

Report Number

J17314 RP2

Client

Boral Resources (NSW) Pty Ltd

Date

24 September 2019

Version

v1 Final

Prepared by



Roger Middlemis
Environmental Engineer
24 September 2019

Approved by



James Duggleby
Associate Director | Water
24 September 2019

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM and Boral Limited provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM and Boral Limited's prior written permission.

Table of Contents

1	Introduction	1
1.1	Scope of works	1
2	Environmental setting	4
2.1	Site setting and topography	4
2.2	Climate	4
2.3	Surface water	7
2.4	Geology	7
2.5	Hydrogeology	8
2.6	Conceptual hydrogeological model	8
2.6.1	Groundwater flow	8
2.6.2	Recharge and discharge	9
2.6.3	Groundwater-surface water connectivity	9
3	Groundwater monitoring program	11
3.1	Monitoring network design	11
3.2	Groundwater quality	12
3.2.1	Sampling technique	12
3.2.2	Chemical analysis	12
3.2.3	Quality assurance and quality control (QA/QC)	13
3.3	Groundwater levels	13
4	Groundwater levels and spatial trends	14
4.1	Groundwater levels	14
4.1.1	Alluvium	14
4.1.2	Bumbo Latite	14
4.2	Spatial trends	15
5	Groundwater quality	16
5.1	Groundwater quality	16
5.1.1	Field parameters	16
5.1.2	Major ions	17
5.1.3	Dissolved metals	18
5.1.4	Nutrients	19

6	Conclusions and recommendations	22
7	References	23

Appendices

Appendix A	Groundwater hydrographs
Appendix B	Water quality summary tables
Appendix C	Laboratory reports
Appendix D	Water quality timeseries at Bumbo Latite sites

Tables

Table 2.1	Temperature and rainfall statistics	5
Table 3.1	Groundwater monitoring bore construction details	11
Table 3.2	Water quality monitoring program	12
Table 3.3	Water quality suite of analysis	12

Figures

Figure 1.1	Site location and monitoring bores	3
Figure 2.1	Cumulative deviation from long term monthly mean rainfall	6
Figure 2.2	Monthly rainfall for June 2018 to June 2019 compared to average	6
Figure 2.3	Surface geology	10
Figure 4.1	Groundwater levels in the alluvium	14
Figure 4.2	Groundwater levels in the Bumbo Latite	15
Figure 5.1	EC timeseries for all monitoring bores	16
Figure 5.2	pH timeseries for all monitoring bores	17
Figure 5.3	Piper plot for all monitoring bores (2018/2019 monitoring year)	18
Figure 5.4	Dissolved metal concentrations for all monitoring bores (2018/2019 monitoring year)	19
Figure 5.5	Nitrate timeseries for all monitoring bores	20
Figure 5.6	Total phosphorus timeseries for all monitoring bores	20
Figure 5.7	Ammonia timeseries for all monitoring bores	21

1 Introduction

Dunmore Hard Rock Quarry (the quarry) is located at the end of Tabbita Road, in the Shellharbour local government area (LGA). The quarry is owned and operated by Boral Resources (NSW) Pty Ltd (Boral).

The quarry supplies construction materials to markets in the Illawarra, Southern Highland and Sydney regions. A western expansion of the quarry is proposed to enable the continued delivery of aggregate until about 2034.

Boral received approvals for a pit modification to extend the quarry to the west with the additional area referred to as the proposed Croome West pit (Figure 1.1). Staged extraction was proposed according to the forecasted demand for hard rock, and began in the 2017-2018 monitoring year with the construction of acoustic and visual bunding. The final pit will be extended both laterally and vertically with a maximum proposed pit depth of 60 metres (m) Australian Height Datum (AHD).

During the 2018-2019 monitoring year, extraction has continued in the Croome West pit towards the north. Overburden placement has occurred in the northern section of the formerly mined Croome Pit. Production for the last financial year was approximately 2,028,544 tonnes with the majority of the produced material servicing the Sydney and Illawarra areas.

Hard rock extraction commenced at the quarry in the early twentieth century. The quarry comprises one elongated open cut pit with an approved disturbance area of about 100 hectares (ha) (Figure 1.1). Site infrastructure includes a crushing and screening plant, product stockpiles, workshop and site offices located east of the pit.

Water management at the quarry comprises routine groundwater monitoring and the capture of intercepted surface runoff. Captured runoff is directed into dedicated stormwater dams for storage. Stored water is utilised for site operations (dust suppression) and excess water is directed back to one of the storage dams, which has a holding capacity of 120 to 150 megalitres (ML) (Arcadis 2016).

EMM Consulting Pty Limited (EMM) was engaged by Boral to characterise the hydrogeological environment and conduct groundwater monitoring and interpretation in relation to the western expansion.

1.1 Scope of works

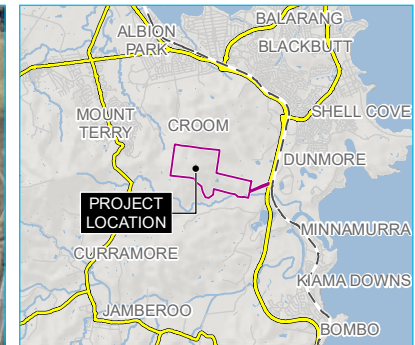
This annual groundwater monitoring report has been prepared as a requirement of the groundwater monitoring program (GMP) in compliance with condition 44 of the quarry's current approval (EMM 2016). It includes analysis and interpretation of groundwater quality and groundwater level data collected from the groundwater monitoring network consisting of three bores screened in the Bumbo Latite and three in the alluvium, with emphasis on the data obtained during the 12 months from 1 July 2018 to 30 June 2019 (the monitoring year).

The scope of works as defined in the GMP was to:

- conduct groundwater monitoring, including six-hourly groundwater level measurements and six-monthly groundwater sampling events at the Bumbo Latite monitoring bores located up hydraulic gradient from the quarry (Figure 1.1);
- analyse and interpret water level and water quality data obtained from the Bumbo Latite monitoring bores with reference to the conceptual model where relevant; and
- analyse and interpret water level and water quality data obtained from the Dunmore Sand & Soil (DSS) quarry monitoring bores located in the alluvium down hydraulic gradient from the quarry (Figure 1.1, data collected by Environmental Earth Sciences).

This report also includes a review of the current monitoring network design and provides recommendations for ongoing monitoring.

\\lemmsvr1\EMMU\Jobs\2017\17314 - Boral Quarry Dunmore groundwater monitoring\GIS\Maps\G010 MonitoringBores_20190920_03.mxd 20/09/2019

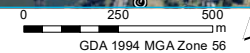


- KEY**
- Croome West monitoring bore
 - Dunmore Sand and Soil monitoring bores
 - Rail line
 - Watercourse
 - Approved extraction boundary
 - Mod 8 disturbance boundary
 - - - Acoustic / visual bund (Mod 8)
 - Proposed Croome West pit extension

Site location and monitoring bores

Boral Dunmore Quarry
Annual Groundwater Monitoring Report
Figure 1.1

Source: EMM (2018); NearMap (2018); DFSI (2017); DCW (2016)



2 Environmental setting

2.1 Site setting and topography

The regional topography rises from coastal flats in the east to a ridge which then descends to a shallow and broad valley at the foot of a larger rise to the Southern Highlands region of the Great Dividing Range in the west.

The quarry is set on a north south-west trending range. The peak is named Locking Hill, and is partially incised by the existing pit. The ridge extends along the current western quarry highwall and has an elevation of approximately 164 mAHD. The elevation of the south-east processing area is 10 mAHD.

The project area is surrounded by small agricultural plots, with cattle and horse grazing, and rural residential properties. Historically the area has been used for dairy farming. Remnant native vegetation lines the top of the prominent ridge line and exists in isolated pockets in the lower lying areas.

The DSS quarry and the Dunmore Concrete Batching Plant (CBP) are generally east of the quarry. Quaternary alluvium sediments associated with the Minnamurra River system are extracted and processed at the DSS quarry.

Approximately 1.5 kilometres (km) to the north is the Cleary Bros Bombo Pty Ltd (Cleary Bros) Albion Park Quarry. The quarry is approved to produce 900,000 tonnes per annum (tpa) and has extracted and processed hard rock from the Bumbo Latite since the 1950s (MMJ 2013). Holcim Australia Pty Ltd (Holcim) operates the Readymix Albion Park Quarry immediately west of the Cleary Bros Albion Park Quarry. This hard rock quarry also extracts a hard rock resource from the Bumbo Latite.

2.2 Climate

The project area is part of the Illawarra region, which is characterised by a mild/temperate climate described as warm and humid. Rainfall and climate data were obtained from the Bureau of Meteorology, Albion Park weather station (BoM 068241), which is approximately 10 km north of the quarry. Temperature and rainfall data have been collected at this monitoring station since 1999.

Temperature fluctuates throughout the year. January is the warmest month and July the coldest month. The mean, maximum, and minimum temperatures are shown in Table 2.1. The average annual rainfall is 914 millimetres (mm) (BoM 068241) with the most significant rainfall events generally experienced in late summer (February and March) and the lowest rainfall in late winter (July-September).

Table 2.1 Temperature and rainfall statistics

	Temperature (°C)			Rainfall (mm)		
	Min	Mean	Max	Min	Mean	Max
January	25.1	27.1	29.8	2.6	74.4	178.4
February	24.3	26.4	28.0	9.8	135.0	334.0
March	23.6	25.3	26.5	4.2	124.1	422.2
April	21.5	23.3	25.2	8.0	72.0	261.2
May	19.4	20.7	22.4	4.8	53.3	398.6
June	16.6	18.1	19.6	0.0	93.6	340.4
July	16.6	17.8	18.6	1.4	49.0	185.6
August	17.0	18.8	20.8	1.2	53.5	281.8
September	19.8	21.4	23.4	0.0	42.4	112.0
October	20.7	23.0	25.0	0.2	66.7	218.8
November	22.3	24.0	26.0	9.6	83.5	222.0
December	22.3	25.6	28.1	14.2	66.1	171.8

Source: Data from BoM station 068241

No evaporation data is available for the quarry. Mean monthly evaporation for the BoM Goulburn Tafe station (070263) is 105 mm and the BoM Sydney Observatory station (066062) is 89 mm. These regional evaporation results are comparable, and the average of these results suggests evaporation exceeds rainfall all year, except for May, June and July.

The cumulative deviation of monthly rainfall from the mean (from 1999 to mid-2019, Albion Park) is plotted in Figure 2.1. The long-term CDFM is generated by subtracting the long-term average monthly rainfall for the recorded period from the actual monthly rainfall and then accumulating these residuals over the assessment period. Periods of below average rainfall are represented as downward trending slopes while periods of above average rainfall are represented as upward trending slopes.

The cumulative deviation plot for Albion Park shows a period of predominantly below average or average rainfall from 1999 until late 2007, followed by some years with generally average rainfall. From 2010 until the start of 2017 rainfall was well above average, followed by average or below average rainfall since then.

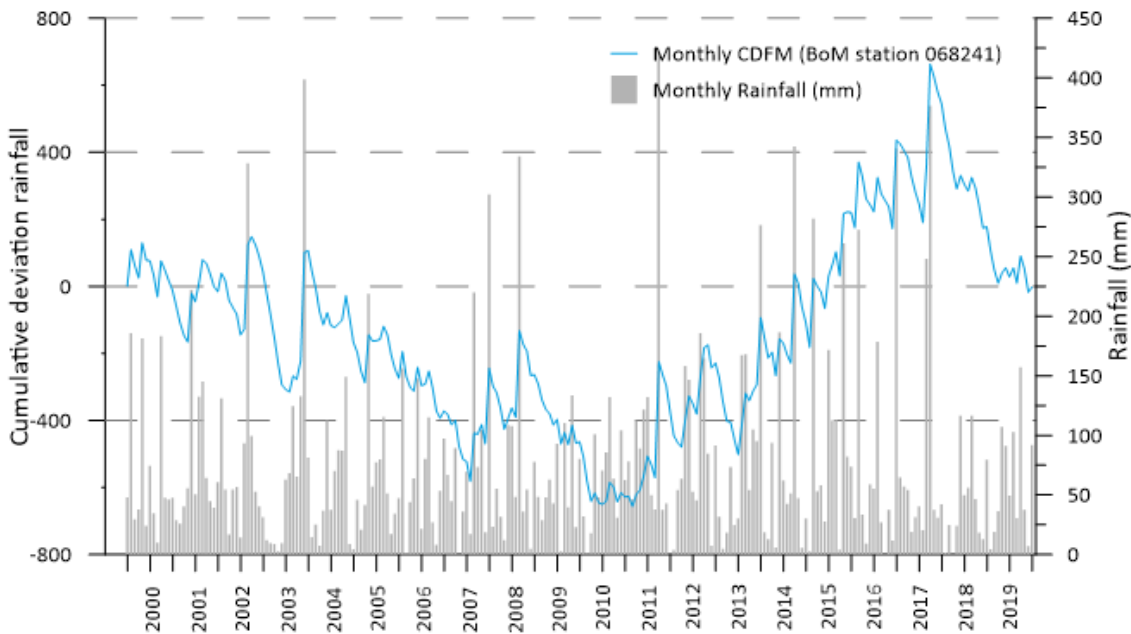


Figure 2.1 Cumulative deviation from long term monthly mean rainfall

Over the last 12 months, rainfall was below average compared to the monthly average rainfall from 1999 to 2019 (Figure 2.2). Only October, November, January and March had above average rainfall, and July, August, February and May had significantly below average rainfall. 734 mm of rain was recorded in the monitoring year compared to the average of 914 millimetres per year (mm/yr).

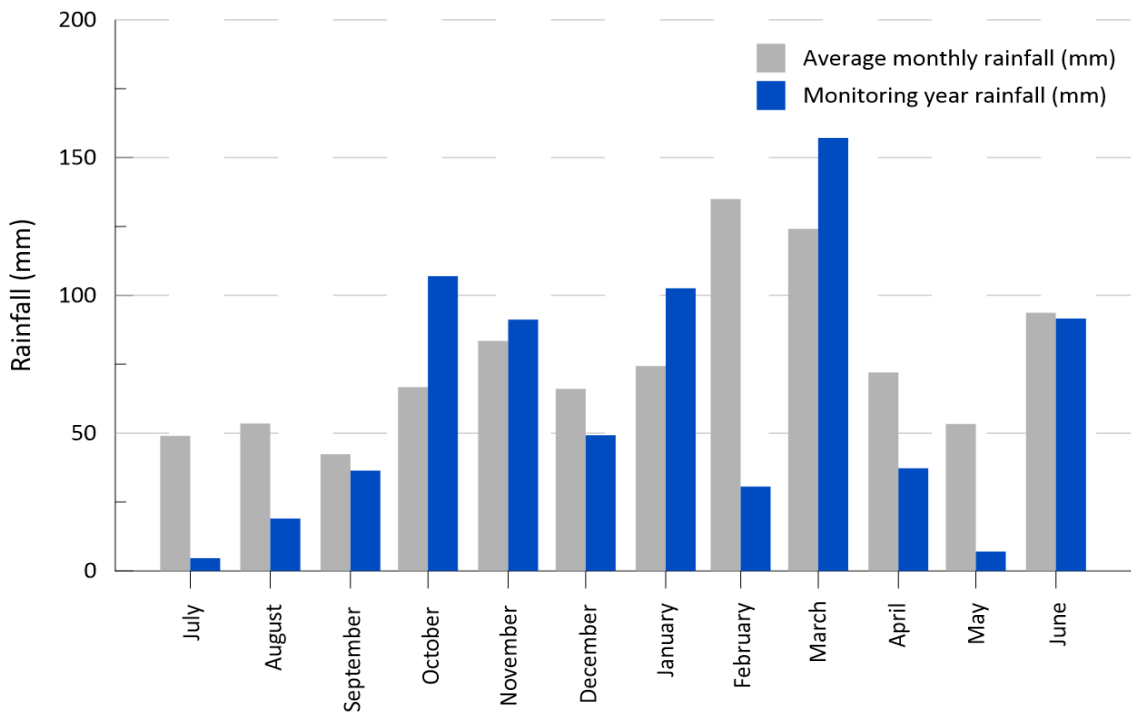


Figure 2.2 Monthly rainfall for June 2018 to June 2019 compared to average

2.3 Surface water

The quarry is in the Rocklow Creek catchment area, which forms part of the Minnamurra River Catchment. The Minnamurra River discharges into the Pacific Ocean approximately 8 km south-east of the project area.

Rocklow creek is south of the quarry, flowing to the east and draining to the Minnamurra River. The Rocklow Creek catchment (21 km²) originates in the Illawarra Range, 3 km west of the project area (Arcadis 2016). All clean water runoff from the project area flows into Rocklow Creek. Boral have a current surface water extraction licence (WAL 25152 under Section 12 of the Water Act) to extract 227 ML of surface water from Rocklow Creek.

To the north of the project area is the Frasers Creek catchment area which drains to Lake Illawarra. Frasers Creek is an ephemeral system and forms disconnected pools during dry periods.

2.4 Geology

The project area is situated in the south-eastern corner of the Permo-Triassic Sydney Basin. The Sydney Basin predominantly comprises Permian and Triassic aged sedimentary rocks. In the vicinity of the quarry the Triassic and Late Permian sedimentary rocks have been eroded and early Permian Gerringong Volcanics of the Shoalhaven Group dominate (*Geology of the Wollongong, Kiama and Robertson 1:50,000 Sheet*, Department of Mines 1974).

Volcanic activity in the area has produced a series of flat lying lava flows interspersed with volcanoclastic sandstone members and breccias. The thickness of each successive flow decreases with distance from the volcanic origin, assumed to be off the current coastline to the south (Cohen 2006). At the quarry all geological units exhibit a gentle dip in an easterly direction at approximately 2 to 3° (Evans and Peck 2006; MMJ 2013).

The Gerringong Volcanics facies comprise nine latite members, and three volcanic sandstones or tuff members. Latite is a term used to describe the type of basalts along the south coast of NSW, they are also referred to as trachybasalts (Cohen 2006). The Gerringong Volcanics were deposited in a shallow marine environment, which was then uplifted above sea level. The area has since been eroded via river action to form the present landscape (Cohen 2006). Geological outcrop for the project area is shown in Figure 2.3.

The Bumbo Latite is the areas greatest and most persistent lava flow, and is the predominant geological unit at the quarry. The latite has a maximum thickness of 150 m. The Bumbo Latite Member is divided into three flows: upper, middle and lower. The Bumbo Latite is a grey to dark grey, very hard dense rock with light coloured phenocrysts of feldspar (Cohen 2006). Weathered latite is generally softer with a brownish, yellow colour. The latite can be jointed and fractured, with the dominant jointing close to vertical, however jointing is not widespread (MMJ 2013).

A breccia layer was deposited between the middle and lower Bumbo Latite Member flows. This breccia layer, also comprising volcanic material, ranges in thickness between 5 to 22 m (Cohen 2006). It comprises a softer layer of fragmental, angular materials cemented in a fine grained matrix (Department of Mines 1974).

The Bumbo Latite Member overlies the Kiama Sandstone Member at the quarry, although to the west of the quarry the Kiama Sandstone outcrops. The Kiama Sandstone has a maximum thickness of 90 m (Evans and Peck 2006). The Kiama Sandstone Member comprises tuff, and interbedded volcanic and lithic sandstones and shales. The sandstones are typically moderately sorted and the lithic material comprises mainly andesitic to basaltic material (Department of Mines 1974). This sandstone is easily weathered and therefore not extracted for quarrying activities.

Further east is Quaternary Alluvium associated with the floodplain areas of the Minnamurra River and its tributaries. This alluvium comprises unconsolidated to loosely consolidated gravels, sands, silts and clays.

2.5 Hydrogeology

The regional groundwater system flows south-east, governed by the dip of the strata and topography (Cohen 2006). Recharge to the regional groundwater system (the Kiama Sandstone) is via infiltration from overlying sedimentary units to the west of the project area. Regional groundwater in the Kiama Sandstone discharges to the Pacific Ocean (Cohen 2006).

Local groundwater flow systems (horizontal scale of less than 5 km) are present within the Bumbo Latite along the elevated ridgeline (Walker *et al* 2003). These systems are isolated and have limited connection to the regional flow system. The Bumbo Latite is tight with a low primary and low secondary porosity (Cohen 2006) restricting groundwater flow.

Groundwater flow is minimal and predominantly occurs along fractures and contacts between volcanic rock and the underlying sandstone (MMJ 2013). Cleary Bros report that groundwater inflows are observed and collected in the pit sump when quarrying intersects the contact between the Bumbo Latite and Kiama Sandstone (2003).

Information from Boral suggests that the breccia layer is partially saturated and more permeable than the surrounding Bumbo Latite. Breccia generally exhibits a variable porosity with areas of higher permeability common however generally limited in their extent. There is no visual evidence of groundwater seepages to the pit with the rockface remaining dry throughout the year.

Cohen (2006) reports that there is no active mine dewatering at the two Albion Park quarries which also intersect the Bumbo Latite. Water use at these quarries constitutes only collected rainwater runoff.

The local groundwater systems are recharged by rainfall with infiltration higher in areas where the Bumbo Latite outcrops on the ridgelines and hilltops of the landscape (ie areas with limited soil profile). Cohen (2006) identified the Locking Hill peak, within the project area, as a recharge area for the Bumbo Latite. Discharge from the local groundwater system occurs in the valleys and includes ephemeral springs.

The Quaternary alluvial sediments associated with the surface water courses form unconfined groundwater systems of varying storage. These systems are recharge by leakage from surface water courses during wet periods. The alluvial systems are depleted during dry periods and are not recharged by underlying porous and fractured rocks (Cohen 2006).

Groundwater at the quarry is fresh to brackish with an average EC of 1,885 micro siemens per centimetre ($\mu\text{S}/\text{cm}$), and neutral to slightly alkaline with an average pH of 7.6. The groundwater is classified as calcium carbonate dominant and typical of groundwater found in igneous rocks.

2.6 Conceptual hydrogeological model

2.6.1 Groundwater flow

Groundwater within the Bumbo Latite flows from areas of high relief towards the valleys and low lying plains where it discharges to the alluvium and surface watercourses. The bulk rock mass has a low primary permeability with groundwater flow primarily through fractures and along the contacts between the latite flows and breccia.

In the vicinity of the quarry, groundwater flow is generally towards the south-east discharging to Rocklow Creek and the Minnamurra estuary system. To the north of the quarry the landscape gives way to steep valleys that shed surface water and provide limited potential for groundwater recharge.

The deep groundwater systems within the Kiama Sandstone and Berry formation typically flow sub-horizontally towards the east and are coincident with the dip of the strata.

2.6.2 Recharge and discharge

The regional groundwater system is recharged by rainfall and losses to surface watercourses. The steep relief increases runoff with a smaller percentage of rainfall infiltration in this steeper terrain.

Groundwater from the shallow latite is largely thought to discharge to the Minnamurra River and Rocklow Creek, which form the main drainage systems in the vicinity of the quarry.

2.6.3 Groundwater-surface water connectivity

The surface watercourses are hydraulically disconnected from the underlying fractured rock groundwater systems in the elevated parts of the landscape. Here, the surface water systems are ephemeral in nature with the upper reaches drying out during periods of low rainfall. This ephemeral nature indicates that the surface water courses are not connected to the groundwater systems.

The surface water systems to the east of the quarry in the lower parts of the landscape (Illawarra River, Minnamurra River and Rocklow Creek) are connected to shallow, marginal groundwater systems within surficial alluvial systems. Direct rainfall and surface runoff recharges these shallow systems during wet periods which rapidly deplete during the drier periods providing an important source of baseflow for the surface watercourses.

Although groundwater within the shallow latite flows through to the alluvium in the east, the volume of this flux is likely to be insignificant in comparison to the recharge from the overlying rivers.

\\lemmsvr1\EMMU\obs\2017\17314 - Boral Quarry Dunmore groundwater monitoring\GIS\Maps\G011 Geology_20190920_03.mxd 20/09/2019



- KEY**
- Croome West monitoring bore
 - Dunmore Sand and Soil monitoring bores
 - — Rail line
 - Watercourse
 - ⋯ Approved extraction boundary
 - ▭ Mod 8 disturbance boundary
 - ⋯ Acoustic / visual bund (Mod 8)
 - Proposed Croome West pit extension
- Lithology**
- Quaternary Alluvium (Qa)
 - Shoalhaven Group, Bumbo Latite (Psgb)
 - Shoalhaven Group, Kiamma Tuff (Psb)
 - Shoalhaven Group, undifferentiated siltstone (Psg)

Surface geology

Boral Dunmore Quarry
Annual Groundwater Monitoring Report
Figure 2.3

Source: EMM (2019); NearMap (2018); DFSI (2017); DPE (1996)



3 Groundwater monitoring program

3.1 Monitoring network design

The monitoring network designed to satisfy the GMP consists of a total of six monitoring bores (Figure 1.1 and Table 3.1). In summary:

- three deep monitoring bores (GW1, GW2 and GW3) were completed within the Bumbo Latite in July 2014. GW1 is screened across the latite and the top of the underlying sandstone, GW2 is screened across the latite, and GW3 is screened across the latite and the breccia. These bores are located up hydraulic gradient from current quarrying activities; and
- DSS installed and monitored several bores as part of their operations. Of these, three shallow monitoring bores (DG-17, DG-31 and DG-59), screened in the alluvium and located down hydraulic gradient from current quarrying activities were selected to be part of the monitoring network:
 - the shallow monitoring bore BH-F, which was part of the monitoring network in previous reports, was decommissioned in March 2018 due to an expansion of the nearby dredge pond;
 - DG-59 was demolished in July 2019 due to further expansion of the dredge pond, and will therefore not be a part of future reports; in this report, DG-17 has been added to the network; and
 - for the 2019-2020 monitoring year, it is recommended that another bore in the alluvium be analysed to maintain three shallow monitoring bores.

Table 3.1 provides an overview of the completion details for the monitoring network.

Table 3.1 Groundwater monitoring bore construction details

Monitoring bore	Total depth (mbgl)	Total depth (mAHD)	Screened interval (mbgl)	Screened interval (mAHD)	Lithology	Formation	Duration of monitoring
GW1	78.0	70.0	72.0–78.0	76.0–70.0	Latite / sandstone	Bumbo Latite and Kiama Sandstone	July 2014 - present
GW2	86.0	51.5	79.0–85.0	51.5–57.5	Latite	Bumbo Latite	July 2014 - present
GW3	80.0	51.5	68.0–80.0	51.5–63.5	Latite / breccia	Bumbo Latite and Breccia	July 2014 - present
BH-F (decommissioned)	5.2	3.0	2.1–5.2	0.1–3.0	Sand	Alluvium	July 2014 - May 2017
DG-17	tbc	tbc	tbc	tbc	Sand	Alluvium	November 2018 - present
DG-31	11.3	3.087	tbc	tbc	Sand	Alluvium	May 2016 - present
DG-59	8.69	1.763	tbc	tbc	Sand	Alluvium	February 2017 - August 2019

Notes: mbgl = metres below ground level
 mAHD = metre Australian Height Datum
 tbc = to be confirmed by Boral

3.2 Groundwater quality

In accordance with the GMP, groundwater quality sampling was undertaken as detailed in Table 3.2.

Table 3.2 Water quality monitoring program

Monitoring bores	Monitoring events (during the 2018/19 monitoring year)	Monitored by
GW1, GW2, GW3	December 2018 and June 2019	EMM
DG-17, DG-31, DG-59	July, October and November 2018, March and May 2019	Environmental Earth Sciences (EES)

3.2.1 Sampling technique

Due to the low permeability of the Bumbo Latite, a low-flow sampling technique (stainless steel double-check bailer) was used to obtain groundwater quality samples from the deep monitoring bores. A submersible pump or a bailer was used to obtain groundwater quality samples from the higher permeability shallow alluvial monitoring bores.

Physicochemical parameters (pH, electrical conductivity (EC), temperature, total dissolved solids (TDS), dissolved oxygen (DO) and oxidation reduction potential (ORP)) were measured during and following purging using a calibrated hand-held water quality meter.

3.2.2 Chemical analysis

Water quality samples collected from the Bumbo Latite monitoring network were analysed for a broad chemical suite designed specifically to assess the chemical characteristics of the different water bearing zones at the monitoring sites. Table 3.3 details the analytical suite.

Table 3.3 Water quality suite of analysis

Grouping	Parameters	
Physicochemical parameters (field)	EC	Temperature
	pH	TDS
	DO	ORP
Major ions	Calcium ¹	Chloride
	Magnesium	Total alkalinity
	Sodium	Sulphate
	Potassium	Silica ¹
Dissolved metals	Aluminium ¹	Iron
	Arsenic ¹	Manganese ¹
	Cadmium ¹	Nickel ¹
	Chromium ¹	Zinc ¹
	Copper ¹	
Nutrients	Ammonia	Total nitrogen
	Nitrate	Total phosphorus
	Nitrite	

Note: 1. Not analysed in the shallow monitoring bores (DG-17, DG-31 and DG-59).

The samples collected from the Bumbo Latite bores by EMM were analysed by Australian Laboratory Services (ALS) in Smithfield. The samples collected from the alluvial bores by Environmental Earth Sciences (EES) were analysed by Sydney Analytical Laboratories in Seven Hills. All laboratories used for analysis are NATA accredited.

Water samples for laboratory analysis were collected in sample bottles specified by the laboratory, with appropriate preservation where required. Samples undergoing dissolved metal analysis were filtered through 0.45 µm filters in the field prior to collection.

3.2.3 Quality assurance and quality control (QA/QC)

Field sampling procedures conformed to EMM's QA/QC protocols to prevent cross-contamination and preserve sample integrity. The following QA/QC procedures were applied:

- samples were collected in clearly labelled bottles with appropriate preservation solutions;
- samples were delivered to the laboratories within the specified holding times; and
- unstable parameters were analysed in the field (physiochemical parameters).

i Laboratory QA/QC

The laboratories conduct their own internal QA/QC program to assess the repeatability of the analytical procedures and instrument accuracy. These programs include analysis of laboratory sample duplicates, spike samples, certified reference standards, surrogate standards/spikes and laboratory blanks. In addition, a duplicate sample is collected in the field for every ten samples collected to assess sampling and laboratory analysis accuracy. A duplicate sample was collected during the June 2019 sampling round. The duplicate sample results were within acceptable range (within 20%).

3.3 Groundwater levels

Following completion of the deep monitoring bores in July 2014, Solinst™ pressure transducers (dataloggers) were installed in the water column and programmed to record a groundwater level every six hours. To verify the level recorded by the dataloggers, manual measurements were recorded during each six-monthly monitoring event (December 2018 and June 2019) using an electronic dip meter.

Dataloggers were installed by EES in monitoring bore DG-31 in May 2016, in DG-59 in February 2017 and in DG-17 in May 2019. These dataloggers were programmed to record a groundwater level every hour. Manual measurements have been recorded periodically since installation.

4 Groundwater levels and spatial trends

Hydrographs showing groundwater levels and rainfall from the start of monitoring until June 2018 are presented in Figure 4.1 and Figure 4.2 . Individual hydrographs for each monitoring bore are included in Appendix A.

4.1 Groundwater levels

4.1.1 Alluvium

Groundwater levels in the alluvium (DG-17, DG-31 and DG-59) are shallow (less than 3 metres below ground level - mbgl) and show a direct response to rainfall and minor tidal influx (EES 2017) (Figure 4.1).

During the monitoring year, alluvial bores continued to show direct responses to rainfall, which is expected. A decline in groundwater levels in the alluvial system between January and March 2019 reflects the below-average rainfall conditions observed in the majority of the monitoring year, with increases after the significant rainfalls events in early January and April.

Groundwater level data for the alluvial bores was supplied to EMM by Boral.

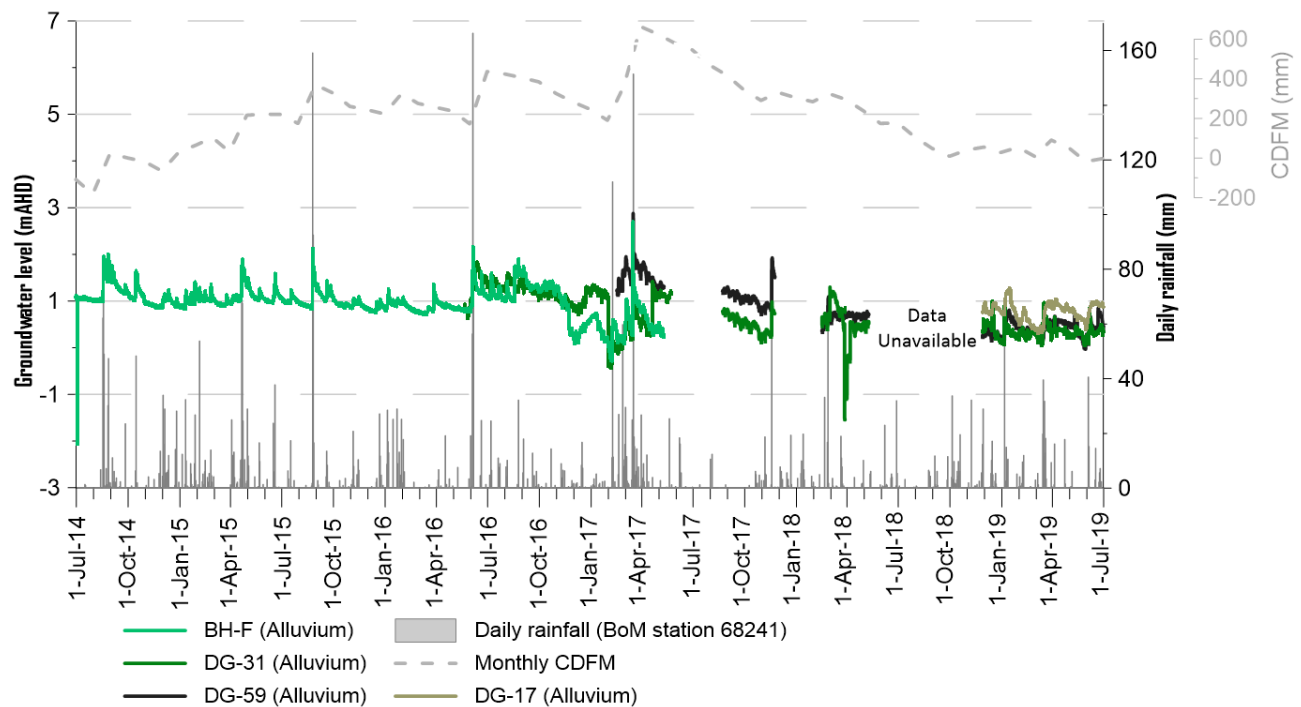


Figure 4.1 Groundwater levels in the alluvium

4.1.2 Bumbo Latite

Groundwater levels in the Bumbo Latite monitoring bores vary spatially between the three monitoring bores (Figure 4.2). The groundwater level elevation is highest at monitoring bore GW2 (128 m AHD) and lower at monitoring bores GW1 (generally between 100 m AHD and 110 m AHD) and GW3 (105 m AHD). This suggests that there is a potential downward hydraulic gradient from the Bumbo Latite to the underlying Kiama Sandstone and towards the Breccia.

The groundwater levels at GW1 (partially screened in the Bumbo Latite and the underlying Kiama Sandstone) and GW2 (screened entirely in the Bumbo Latite) show a slow recovery (longer than 1 year) after installation. This slow recovery is due to the very low permeability of the Bumbo Latite formation at these locations (between 1.93×10^{-8} metres per day (m/d) and 6.39×10^{-8} m/d (EMM 2014)).

The groundwater level at monitoring bore GW3 (partially screened in the Breccia) recovered immediately after installation. This is consistent with the hydraulic conductivity measured at this location (8.93×10^{-7} m/d (EMM 2014)) information from Boral which suggests that the Breccia is more permeable than the surrounding Bumbo Latite (Section 2.5).

GW1 has historically shown a clear response to rainfall during periods of above and below average rainfall. Comparatively, GW2 and GW3 show little to no response to rainfall. Although GW1 is deeper, it is screened within the Kiama Sandstone and responds to regional groundwater flows. Rainfall over the 2018/2019 twelve-month monitoring year was less than the long term average, but is at a similar level to the previous year. Overall groundwater levels in all three monitoring wells have remained stable in this monitoring year.

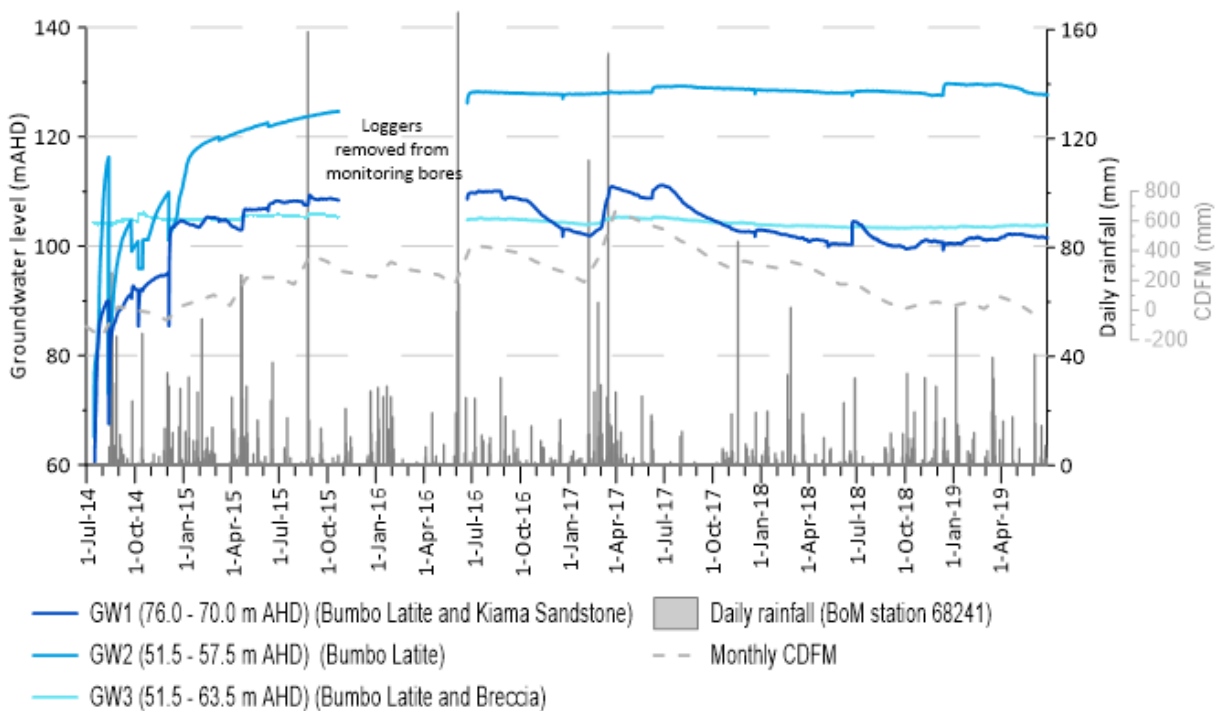


Figure 4.2 Groundwater levels in the Bumbo Latite

4.2 Spatial trends

The data collected to date suggest that the groundwater within the Bumbo Latite flows from areas of high relief towards the valleys and low lying plains where it discharges to the alluvium and surface watercourses in accordance with the conceptual model (Section 2.6).

Groundwater flow within the alluvium is in an easterly direction, locally towards BH-F and regionally towards the ocean.

Croome West pit operations (which began in January 2018) have had no observable effect on groundwater levels in the Bumbo Latite or Kiama Sandstone Formations.

5 Groundwater quality

Water quality results for the 2018/2019 monitoring year are summarised in this chapter and are compared to previous monitoring years. The 2018/2019 monitoring year full water quality results are presented in Appendix B and laboratory results in Appendix C.

5.1 Groundwater quality

5.1.1 Field parameters

Time series of field EC and pH are presented in Figure 5.1 and Figure 5.2. Groundwater sampled from the alluvium is brackish, with a neutral pH. DG-31 is showing an increasing EC trend over the last year, which may require investigation if it continues over the next monitoring year. The newly drilled DG-17 shows results which are very similar to DG-59, which is expected due to their proximity, and useful since DG-59 was decommissioned at the end of this monitoring year.

Groundwater sampled from the Bumbo Latite monitoring bores is similar to previous years: marginal (GW3) to brackish (GW1 and GW2) with neutral to alkaline pH.

Groundwater EC and pH were overall comparable to previous monitoring years.

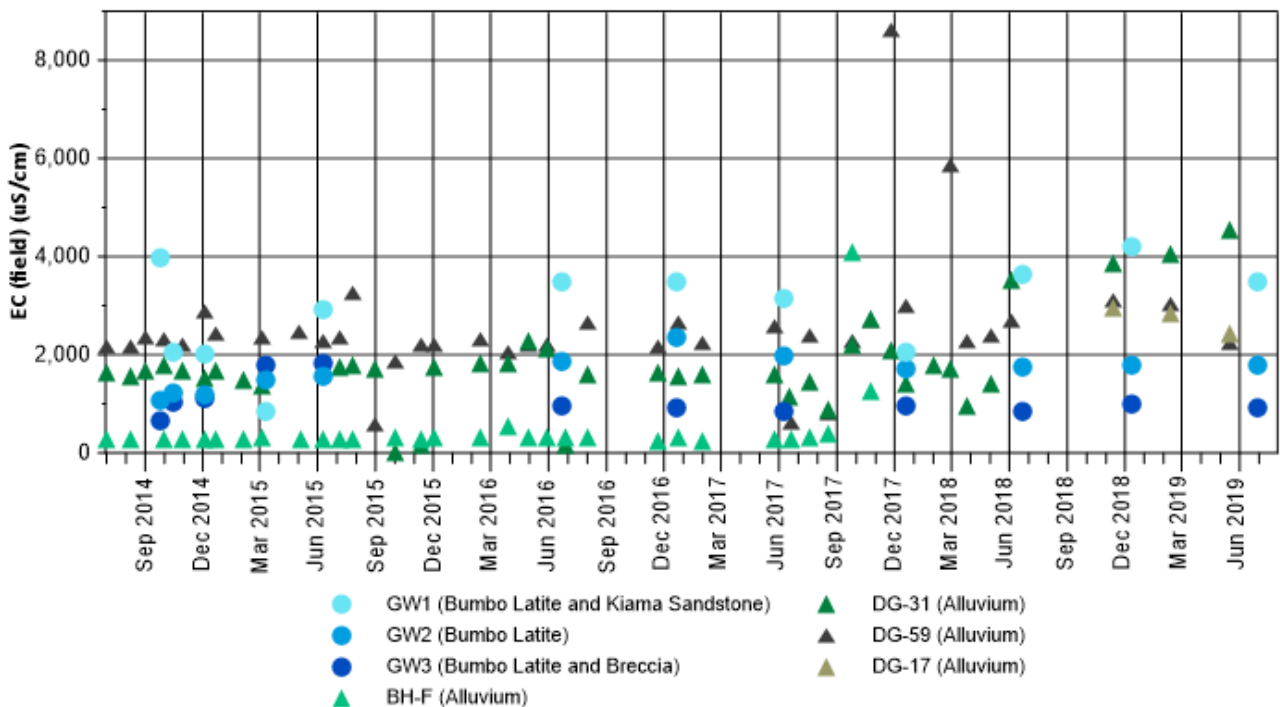


Figure 5.1 EC timeseries for all monitoring bores

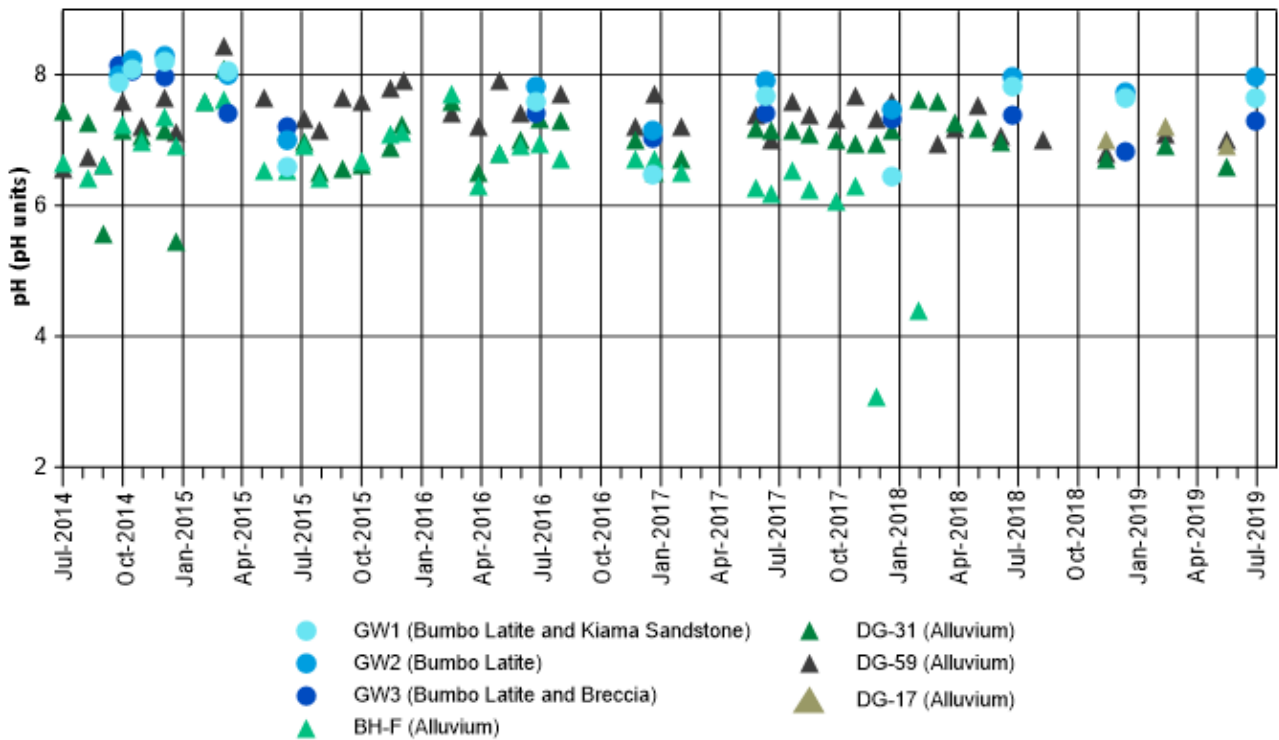


Figure 5.2 pH timeseries for all monitoring bores

5.1.2 Major ions

The major ion characteristics of groundwater samples for the Croome West and alluvial monitoring bores for this monitoring year are shown in a piper diagram (Figure 5.3 **Error! Reference source not found.**). A piper diagram is a graphical representation of the relative concentrations of major ions (Ca^{2+} , Mg^{2+} , Na^+ , K^+ , Cl^- , HCO_3^- , CO_3^{2-} and SO_4^{2-}).

Groundwater at the Bumbo Latite monitoring sites is typically dominated by sodium and bicarbonate, and is high in magnesium.

Groundwater at the alluvial sites is also sodium and bicarbonate dominant, which is consistent with the hydrogeological conceptual model. In this monitoring year, DG-31 has elevated chloride levels compared to previous years.

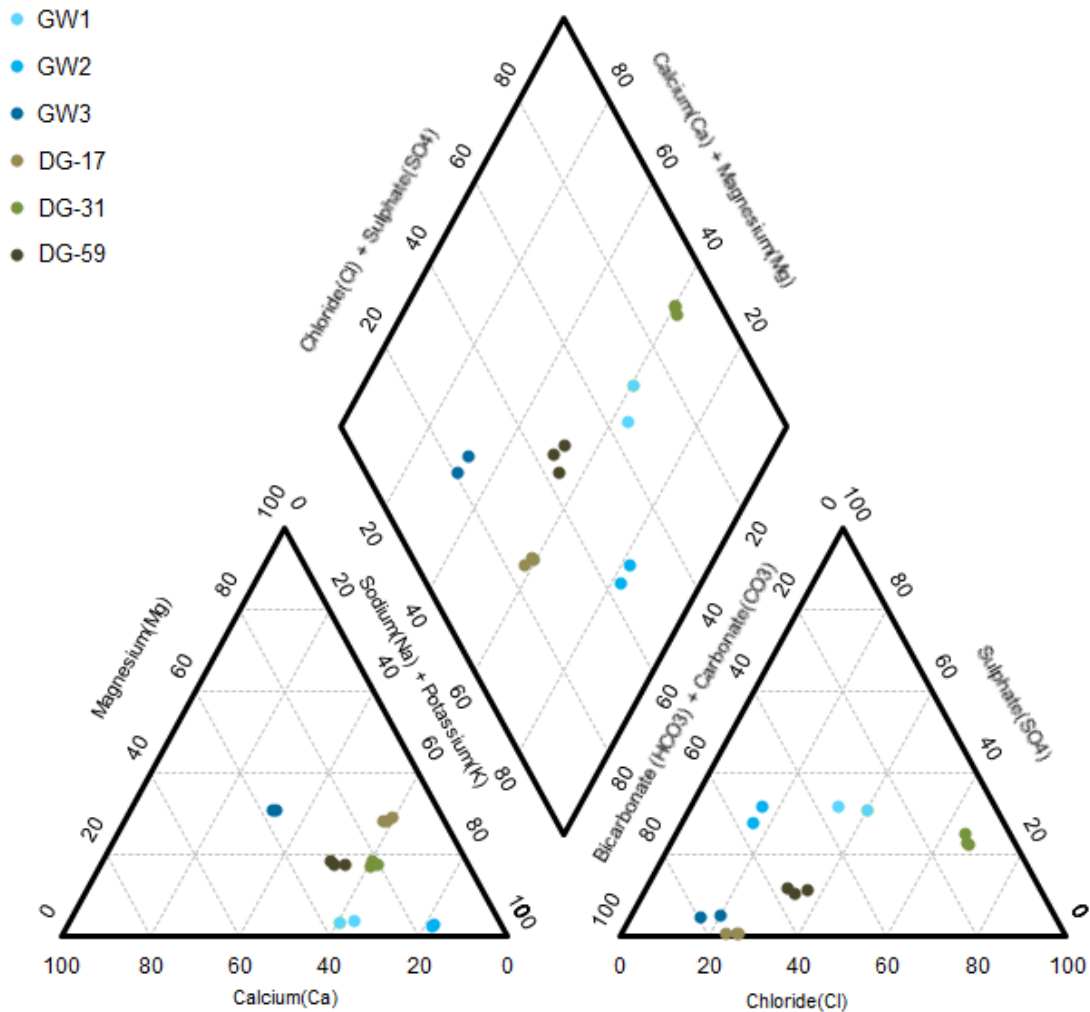


Figure 5.3 Piper plot for all monitoring bores (2018/2019 monitoring year)

5.1.3 Dissolved metals

Concentrations of dissolved metals in groundwater in the 2018/2019 monitoring year are presented in Figure 5.4. A full suite of metals was analysed for the Bumbo Latite and timeseries of dissolved metals at the Bumbo Latite sites is shown in Appendix D. In the Alluvium, only dissolved iron was analysed for two of the sampling events and aluminium, iron and manganese were analysed for the third sampling event.

The major findings for dissolved metals for this monitoring year are as follows:

- dissolved metal concentrations at the Bumbo Latite sites are overall comparable to previous monitoring years (Appendix D) and do not vary significantly between the sites; and
- dissolved metal concentrations in the alluvium are at similar concentrations to the Bumbo Latite sites and within an acceptable range.

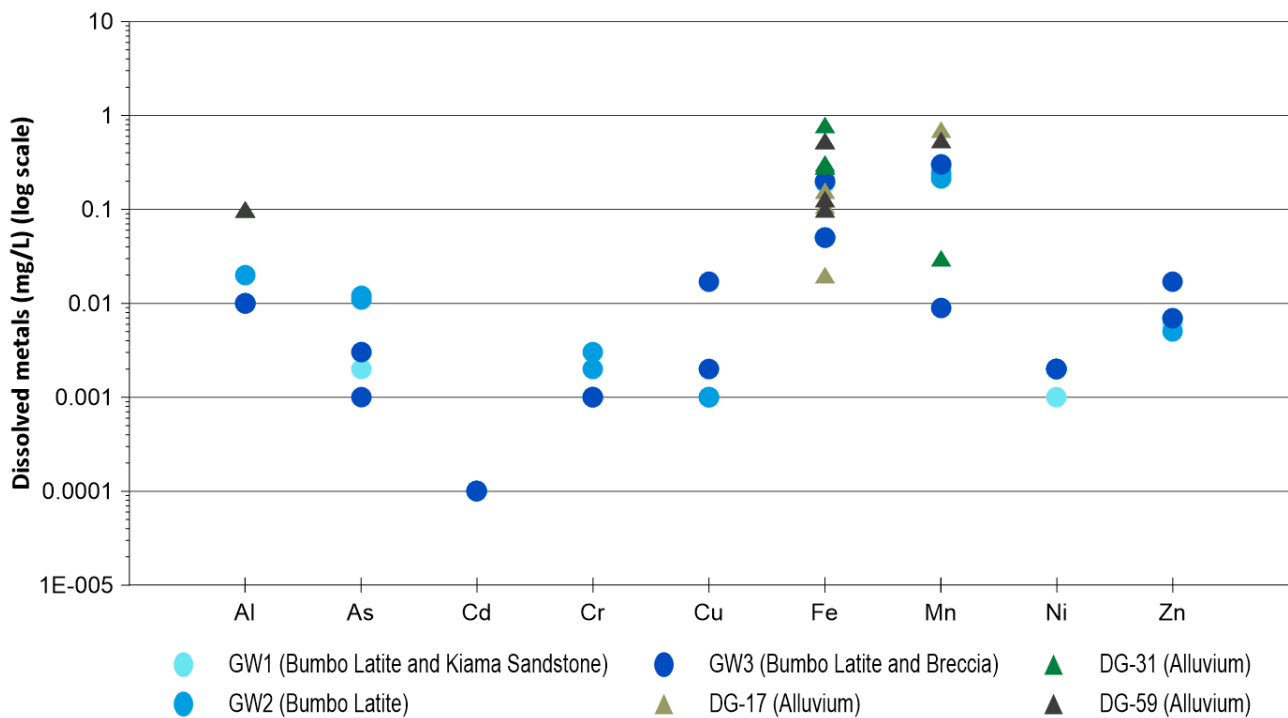


Figure 5.4 Dissolved metal concentrations for all monitoring bores (2018/2019 monitoring year)

5.1.4 Nutrients

Time series of nitrate, total phosphorus and ammonia concentrations are presented in Figure 5.5, Figure 5.6 and Figure 5.7 respectively.

The major findings for nutrients are as follows:

- nitrate concentrations at the Bumbo Latite monitoring bores were comparable to previous monitoring years, with the highest concentrations detected at GW3;
- total phosphorus concentrations were comparable to previous monitoring years at the Bumbo Latite sites. Phosphorus concentrations in the alluvial are generally within range of historic values, except for the newly constructed DG-17, which has more elevated phosphorus levels; and
- ammonia concentrations were mostly comparable to previous monitoring years, except for GW2, which continues to show a moderate increasing trend over the past 2 to 3 years. Ammonia concentration values at the alluvial sites were comparable to previous monitoring years.

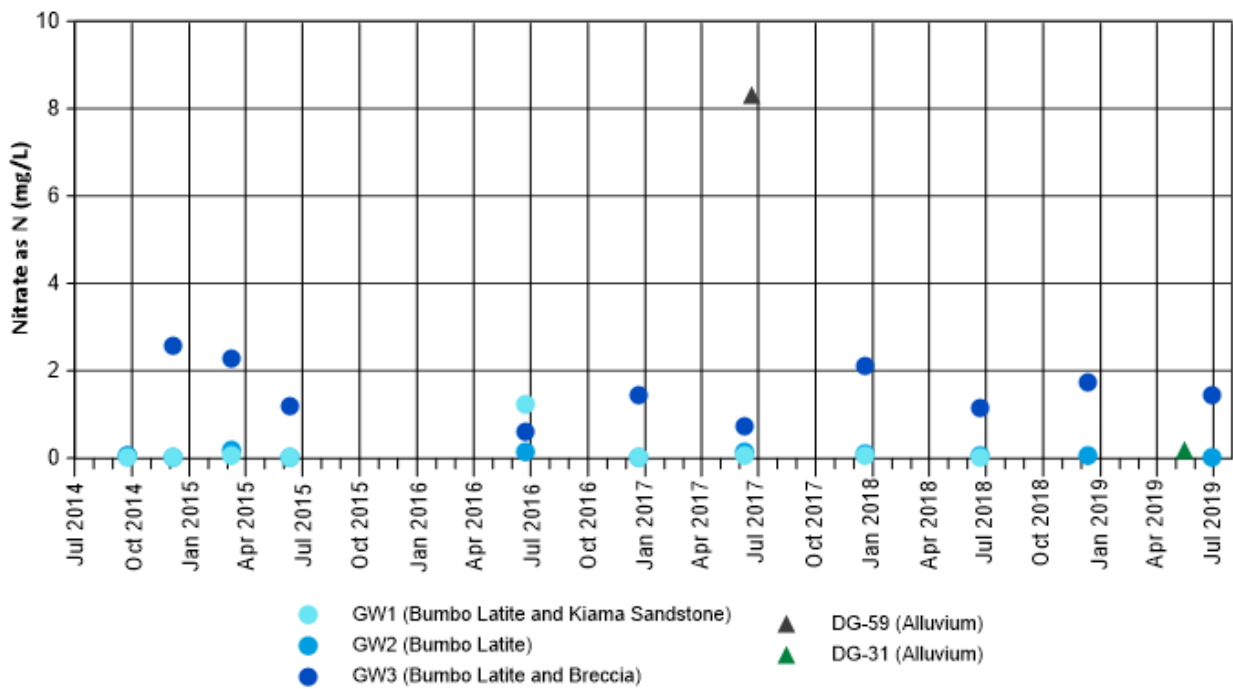


Figure 5.5 Nitrate timeseries for all monitoring bores

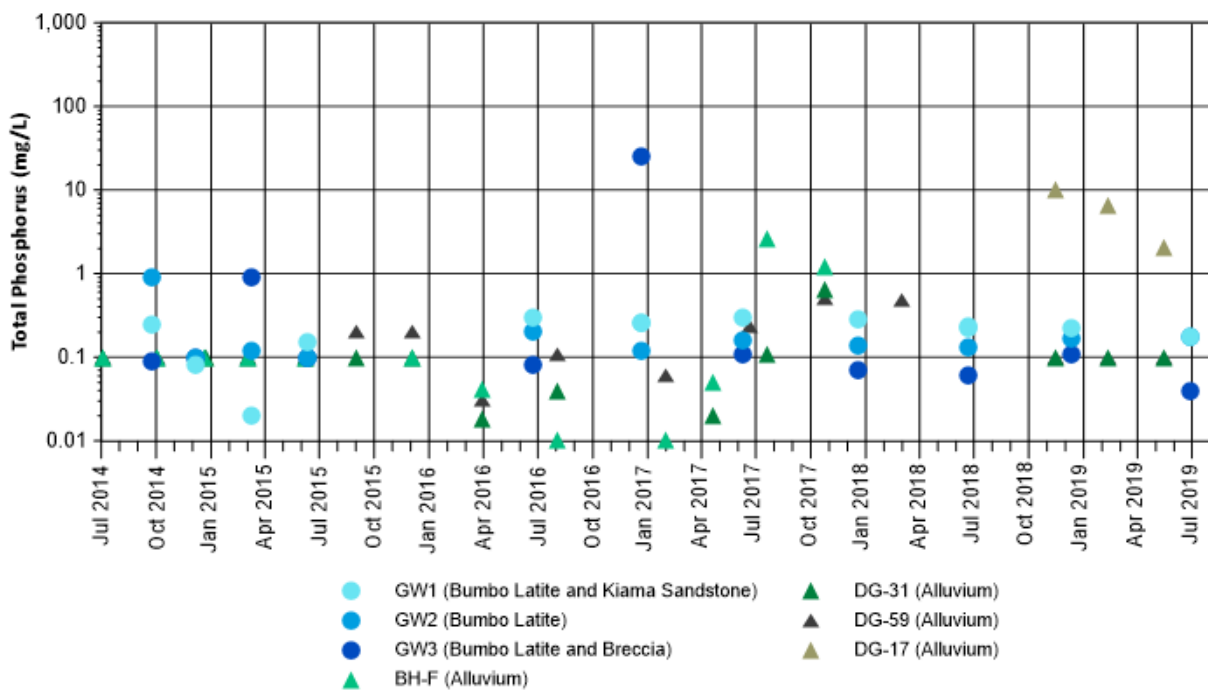


Figure 5.6 Total phosphorus timeseries for all monitoring bores

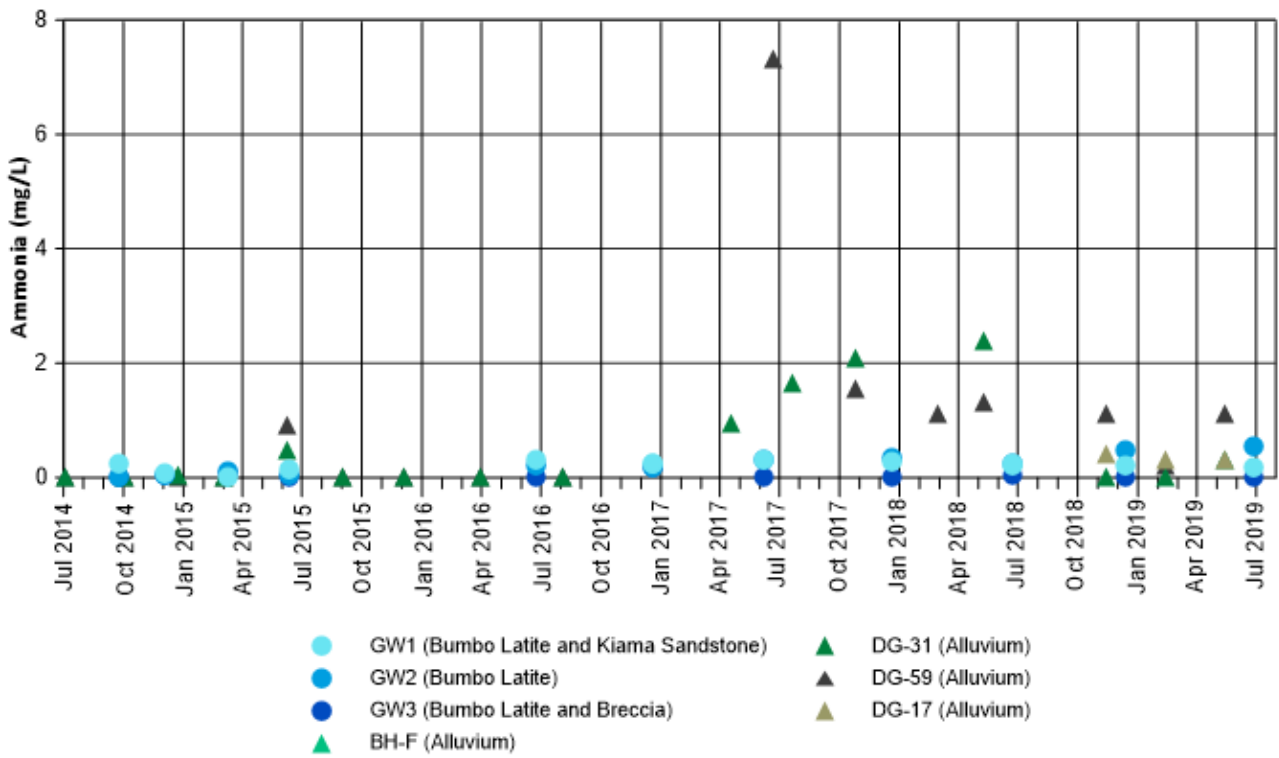


Figure 5.7 Ammonia timeseries for all monitoring bores

6 Conclusions and recommendations

Groundwater levels are recorded every six-hours allowing water level trends to be identified in the alluvium and the Bumbo Latite. Six monthly sampling of water quality at all sites also established useful trends.

The main findings for the 2018/2019 monitoring year regarding water levels are:

- groundwater levels in the alluvium at the DSS sites show a direct response to rainfall and minor tidal influences; and
- groundwater levels in the Bumbo Latite monitoring bores vary spatially between the three monitoring bores. Groundwater levels are the highest at monitoring bore GW2 (128 mAHD) and lower at monitoring bores GW1 (between 100 mAHD and 110 mAHD) and GW3 (105 m AHD). Groundwater levels are steady after a slight decline at GW1 and GW3 corresponding with continued below average rainfall. GW2 shows little response to rainfall.

The main findings for this monitoring year regarding water quality are:

- groundwater quality at the alluvial monitoring sites was consistent with historical data, except DG-31 showing chlorine anions dominant over bicarbonate in this monitoring year. The newly monitored DG-17 has elevated phosphorus in comparison to the rest of the alluvial sites; and
- groundwater quality in the Bumbo Latite is marginal to brackish, of near neutral to alkaline pH. Groundwater in the latite is dominated by sodium and bicarbonate and is elevated in silica reflecting the mineralogy of the host rock. Dissolved metals and nutrients are detected at overall low concentrations. Groundwater quality remains constant and was comparable to results from the previous monitoring years.

The results for the 2018/19 monitoring year are consistent with the conceptual model for the project.

It is recommended that groundwater level monitoring via dataloggers continues at six-hourly intervals and that groundwater quality monitoring continues at the six-monthly frequency at the Bumbo Latite monitoring bores, and at approximately quarterly intervals at the DSS sites in accordance with the GMP. For the 2019/2020 monitoring year, it is recommended that data from another bore in the alluvium be analysed to replace the decommissioned DG-59 maintain three shallow monitoring bores.

7 References

Arcadis 2016, *Dunmore Hard Rock Quarry Project, Water Management Plan*.

Cohen 2006, *Shellharbour/Kiama regional hard rock resource review groundwater assessment study*, NSW Government – Department of Planning.

Department of Mine 1974, *Geology of the Wollongong, Kiama and Robertson 1:50,000 Sheets*.

EES 2017, *Annual report on groundwater level monitoring at the Swamp Road Quarry, Dunmore NSW – May 2016 to May 2017*. Prepared for Boral Dunmore Sand and Soils Pty Ltd, dated 16 June 2017.

EMM 2016, *Groundwater Monitoring Program for Dunmore Hard Rock Quarry*, prepared for Boral Dunmore Quarry, dated 18 November 2016.

Evans and Peck 2006, *Statement of Environmental Effects, Section 4 Water Management, Dunmore Hardrock Quarry extension*.

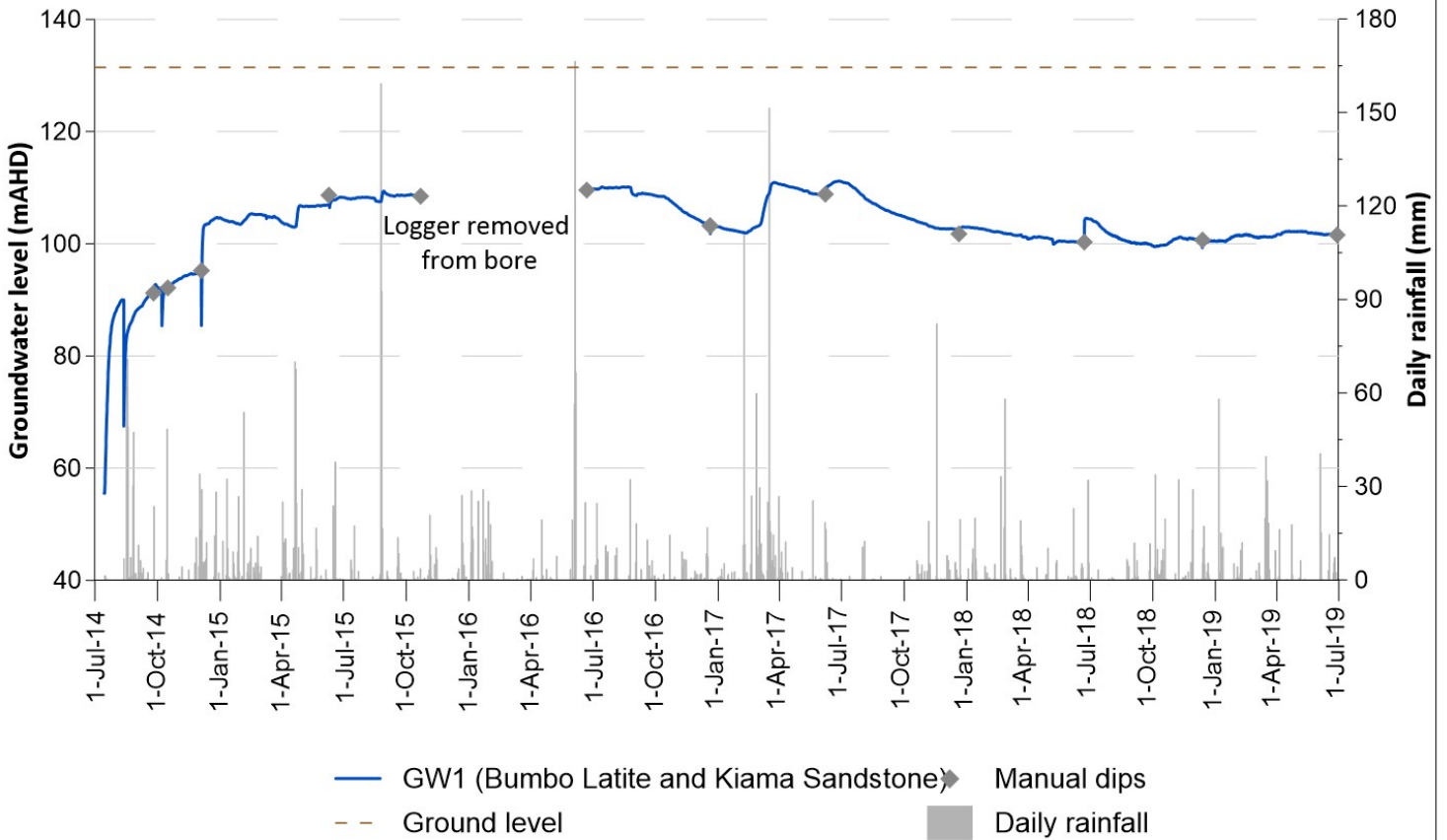
MMJ Wollongong (MMJ) 2013, *Environmental Assessment, Modification of Development Consent 10639 of 2005 Albion Park Quarry*.

Walker G., Gilfedder M., Evans R., Dyson P., Stauffacher M. 2003, *Groundwater Flow Systems Framework – Essential Tools for Planning Salinity Management*, Murray Darling Basin Commission and CSIRO Land and Water.

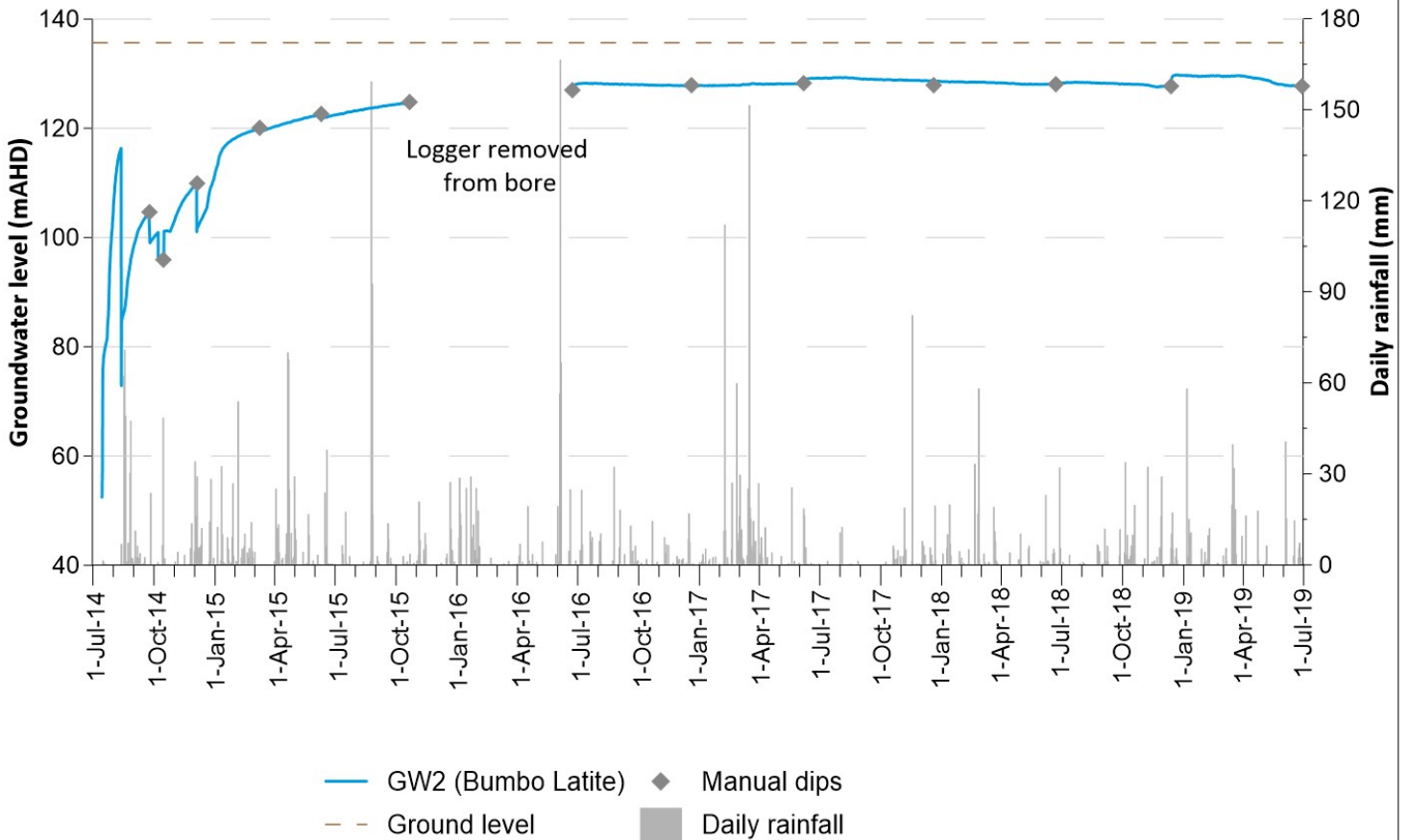
Appendix A

Groundwater hydrographs

GW1



GW2

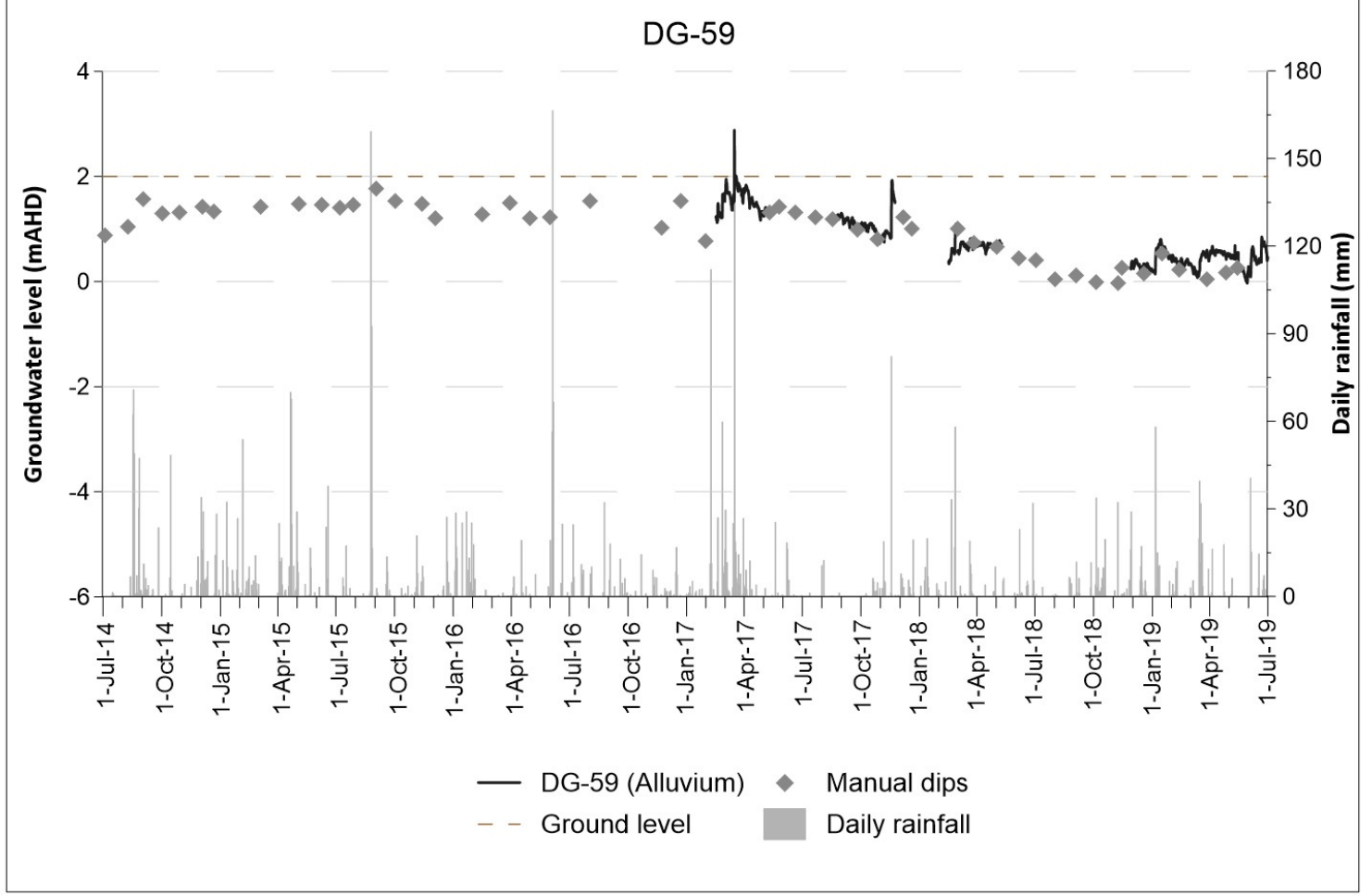
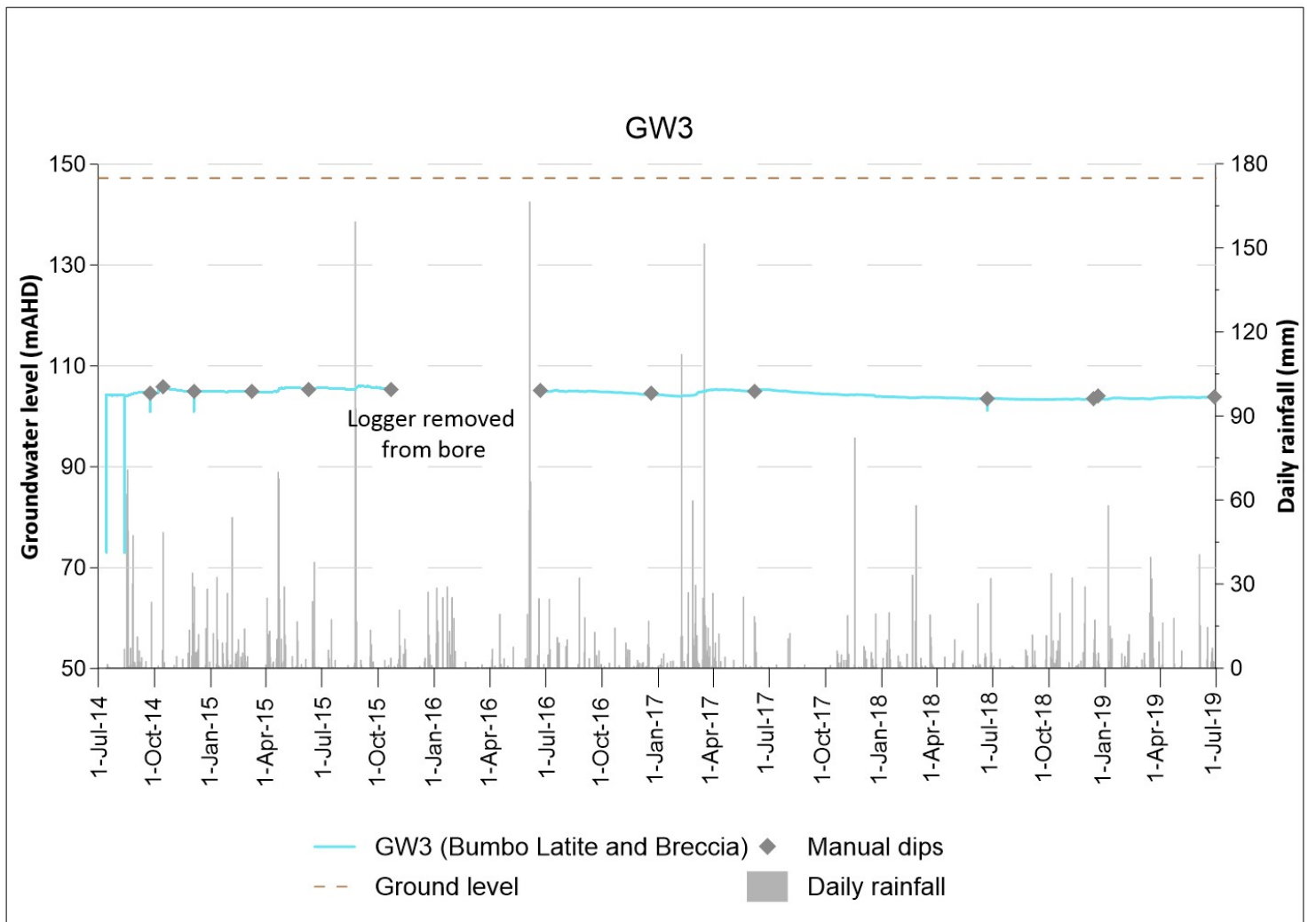


GW1 and GW2 hydrographs

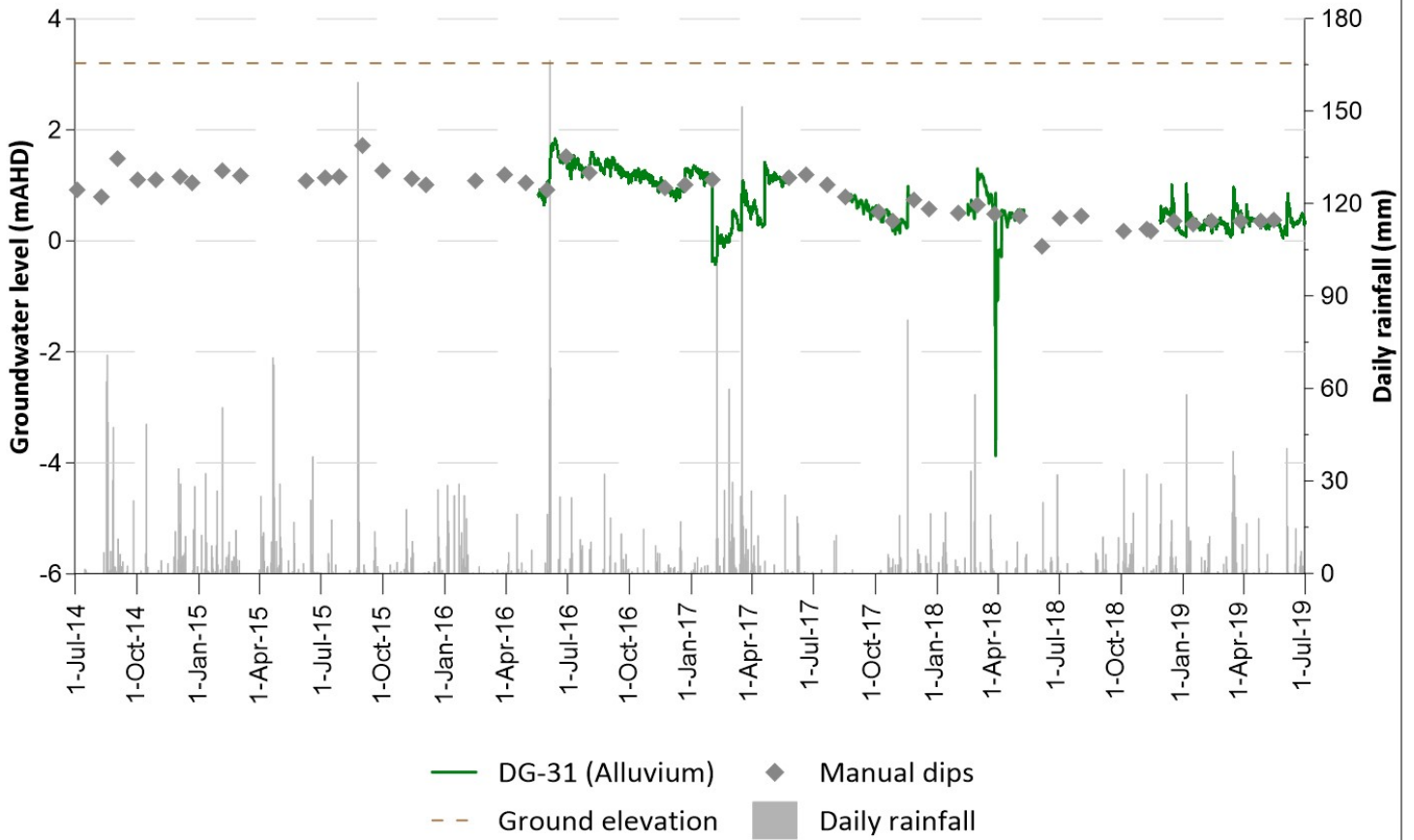
Boral Dunmore Quarry

2018-2019 Annual Groundwater Monitoring Report

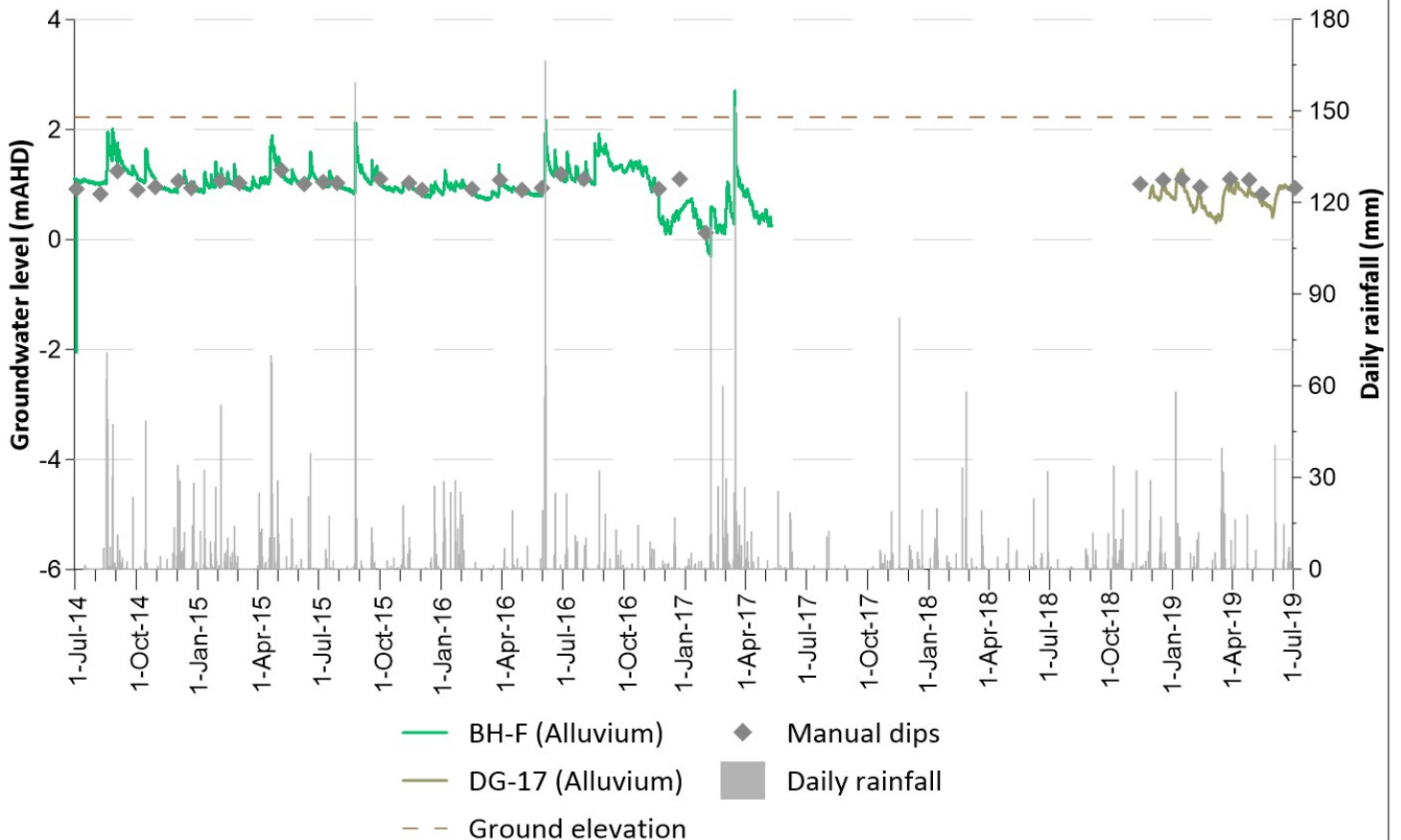
Figure A.1



DG-31



BH-F & DG-17



DG-31 and BH-F hydrographs

Appendix B

Water quality summary tables

Appendix B.1 - Water quality results for the Croome West monitoring bores

			Site ID	GW1	GW1	GW2	GW2	GW3	GW3
			Date	12/12/2018	28/06/2019	12/12/2018	28/06/2019	12/12/2018	28/06/2019
		Units	EQL						
Field	pH (field)	pH units		7.66	7.64	7.74	7.97	6.81	7.28
	Electrical conductivity (field)	uS/cm		4187	3496	1770	1797	981	914
	Temperature (field)	°C		18.1	17.9	19.1	19.1	19.0	19.1
	Dissolved oxygen (field)	%		51.2	28.5	48.5	34.3	52.7	42.9
	Dissolved oxygen	mg/L		4.68	2.66	4.43	3.16	4.86	3.92
	Total dissolved solids (field)	mg/L		-	2275	-	1170	-	591.5
	Redox (field)	mV		16	-92	73	-132	257	114
	Total dissolved solids (lab)	mg/L		-	2275	-	1170	-	592
Laboratory analytes	Alkalinity (Hydroxide) as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1
	Alkalinity (total) as CaCO3	mg/L	1	381	365	321	320	277	280
	Bicarbonate Alkalinity-mg CaCO3/L	mg/L	1	381	365	321	320	277	280
	Calcium	mg/L	1	307	252	52	57	64	73
	Carbonate Alkalinity-mg CaCO3/L	mg/L	1	<1	<1	<1	<1	<1	<1
	Chloride	mg/L	1	729	486	137	124	103	76
	Magnesium	mg/L	1	19	19	5	7	33	37
	Potassium	mg/L	1	2	2	2	3	<1	<1
	Silicon as SiO2	mg/L	0.1	-	21.5	-	24	-	38.7
	Sodium	mg/L	1	591	565	307	352	64	70
	Sulfate as SO4 - Turbidimetric	mg/L	1	772	636	378	307	37	34
Dissolved metals	Aluminium	mg/L	0.01	<0.01	<0.01	0.01	0.02	<0.01	<0.01
	Arsenic	mg/L	0.001	0.003	0.002	0.011	0.012	<0.001	<0.001
	Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	<0.001	0.001	0.002	0.003	<0.001	0.001
	Copper	mg/L	0.001	0.002	<0.001	<0.001	<0.001	0.017	0.01
	Iron	mg/L	0.05	0.2	0.19	<0.05	<0.05	<0.05	<0.05
	Manganese	mg/L	0.001	0.304	0.275	0.212	0.24	0.009	0.01
	Nickel	mg/L	0.001	0.002	0.001	0.002	0.002	0.002	0.002
	Zinc	mg/L	0.005	0.007	0.006	0.007	<0.005	0.017	0.024
Nutrients	Ammonia (as N)	mg/L	0.01	0.22	0.18	0.48	0.56	<0.01	<0.01
	Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Nitrate (as N)	mg/L	0.01	0.02	0.03	0.05	0.03	1.73	1.46
	Nitrite + Nitrate as N	mg/L	0.01	0.02	0.03	0.05	0.03	1.73	1.46
	Nitrogen (Total)	mg/L	0.1	0.7	0.5	1	1	1.9	1.8
	Kjeldahl Nitrogen Total	µg/L	100	700	500	900	1000	200	300
	Total phosphorus	mg/L	0.01	0.16	0.07	0.17	0.18	0.11	0.04
Additional analytes	Ionic Balance	%	0.01	1.85	6.19	5.03	7.2	2.89	6.42
	Anions Total	meq/L	0.01	44.2	34.2	18.1	16.3	9.21	8.56
	Cations Total	meq/L	0.01	42.6	38.8	16.4	18.8	8.69	9.73

Note: samples collected by EMM Consulting; EQL - laboratory estimated quantitation limit.

Appendix B.2 - Water quality results for the alluvial monitoring bores

				Site ID	DG-17	DG-31	DG-59	DG-17	DG-31	DG-59
				Date	14/11/2018	14/11/2018	14/11/2018	12/02/2019	12/02/2019	12/02/2019
		Units	EQL							
Field	pH (field)	pH units		7.0	6.7	6.8	7.2	6.9	7.1	
	Electrical conductivity (field)	uS/cm		2950	3870	3110	2830	2490	3050	
	Temperature (field)	°C				-				
	Dissolved oxygen (field)	%				-				
	Dissolved oxygen	mg/L				-				
	Total dissolved solids (field)	mg/L				-				
	Redox (field)	mV				-				
	Total dissolved solids (lab)	mg/L		1870	2420	1940	1740	4060	1860	
Laboratory analytes	Alkalinity (Hydroxide) as CaCO3	mg/L	1			-				
	Alkalinity (total) as CaCO3	mg/L	1			-				
	Bicarbonate Alkalinity-mg CaCO3/L	mg/L	1	1180	130	690	1090	130	720	
	Calcium	mg/L	1	77	170	200	83	170	200	
	Carbonate Alkalinity-mg CaCO3/L	mg/L	1			-				
	Chloride	mg/L	1	540	1050	610	495	1020	560	
	Magnesium	mg/L	1	120	93	72	110	91	75	
	Potassium	mg/L	1	35	34	21	40	39	26	
	Silicon as SiO2	mg/L	0.1			-				
	Sodium	mg/L	1	440	540	385	405	565	370	
	Sulfate as SO4 - Turbidimetric	mg/L	1	25	490	270	19	490	245	
Dissolved metals	Aluminium	mg/L	0.01			-				
	Arsenic	mg/L	0.001			-				
	Cadmium	mg/L	0.0001			-				
	Chromium	mg/L	0.001			-				
	Copper	mg/L	0.001			-				
	Iron	mg/L	0.05	0.02	0.29	0.53	0.16	0.31	0.13	
	Manganese	mg/L	0.001			-				
	Nickel	mg/L	0.001			-				
Zinc	mg/L	0.005			-					
Nutrients	Ammonia (as N)	mg/L	0.01	<0.1	<0.1	1.1	0.3	<0.1	0.2	
	Nitrite (as N)	mg/L	0.01			-				
	Nitrate (as N)	mg/L	0.01			-				
	Nitrite + Nitrate as N	mg/L	0.01			-				
	Nitrogen (Total)	mg/L	0.1	1.8	1.4	1.8	1.6	0.6	1.7	
	Kjeldahl Nitrogen Total	µg/L	100			-				
	Total phosphorus	mg/L	0.01			-				
Additional analytes	Ionic Balance	%	0.01			-				
	Anions Total	meq/L	0.01			-				
	Cations Total	meq/L	0.01			-				

Note: samples collected by EMM Consulting; EQL - laboratory estimated quantitation limit.

Appendix B.2 - Water quality results for the alluvial monitoring bores

				Site ID	DG-17	DG-31	DG-59
				Date	15/05/2019	15/05/2019	15/05/2019
		Units	EQL				
Field	pH (field)	pH units		6.9	6.6	7	
	Electrical conductivity (field)	uS/cm		-	-	-	
	Temperature (field)	°C		-	-	-	
	Dissolved oxygen (field)	%		-	-	-	
	Dissolved oxygen	mg/L		-	-	-	
	Total dissolved solids (field)	mg/L		-	-	-	
	Redox (field)	mV		-	-	-	
	Total dissolved solids (lab)	mg/L		1620	1040	1910	
Laboratory analytes	Alkalinity (Hydroxide) as CaCO ₃	mg/L	1	-	-	-	
	Alkalinity (total) as CaCO ₃	mg/L	1	-	-	-	
	Bicarbonate Alkalinity-mg CaCO ₃ /L	mg/L	1	1060	140	765	
	Calcium	mg/L	1	79	210	185	
	Carbonate Alkalinity-mg CaCO ₃ /L	mg/L	1	-	-	-	
	Chloride	mg/L	1	420	1150	545	
	Magnesium	mg/L	1	100	100	72	
	Potassium	mg/L	1	32	32	18	
	Silicon as SiO ₂	mg/L	0.1	-	-	-	
	Sodium	mg/L	1	365	630	405	
	Sulfate as SO ₄ - Turbidimetric	mg/L	1	22	610	280	
Dissolved metals	Aluminium	mg/L	0.01	<0.1	<0.1	<0.1	
	Arsenic	mg/L	0.001	-	-	-	
	Cadmium	mg/L	0.0001	-	-	-	
	Chromium	mg/L	0.001	-	-	-	
	Copper	mg/L	0.001	-	-	-	
	Iron	mg/L	0.05	0.11	0.79	0.1	
	Manganese	mg/L	0.001	0.7	0.03	0.55	
	Nickel	mg/L	0.001	-	-	-	
	Zinc	mg/L	0.005	-	-	-	
Nutrients	Ammonia (as N)	mg/L	0.01	-	-	-	
	Nitrite (as N)	mg/L	0.01	-	-	-	
	Nitrate (as N)	mg/L	0.01	<0.1	<0.1	<0.1	
	Nitrite + Nitrate as N	mg/L	0.01	-	-	-	
	Nitrogen (Total)	mg/L	0.1	-	-	-	
	Kjeldahl Nitrogen Total	µg/L	100	-	-	-	
	Total phosphorus	mg/L	0.01	-	-	-	
Additional analytes	Ionic Balance	%	0.01	-	-	-	
	Anions Total	meq/L	0.01	-	-	-	
	Cations Total	meq/L	0.01	-	-	-	

Note: samples collected by EMM Consulting; EQL - laboratory estimated quantitation limit.

Appendix C

Laboratory reports

CERTIFICATE OF ANALYSIS

Work Order : **ES1837704**
Client : **EMM CONSULTING PTY LTD**
Contact : IMOGEN FRAWLEY
Address : Ground Floor Suite 1 20 Chandos Street
 St Leonards NSW NSW 2065

Telephone : ----
Project : ----
Order number :
C-O-C number : ----
Sampler : ----
Site : ----
Quote number : EN/112/18
No. of samples received : 3
No. of samples analysed : 3

Page : 1 of 4
Laboratory : Environmental Division Sydney
Contact : Sepan Mahamad
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164

Telephone : +61 2 8784 8555
Date Samples Received : 13-Dec-2018 16:30
Date Analysis Commenced : 14-Dec-2018
Issue Date : 20-Dec-2018 16:01



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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



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.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW1	GW2	GW3	----	----
Client sampling date / time					12-Dec-2018 11:00	12-Dec-2018 10:15	12-Dec-2018 00:00	----	----
Compound	CAS Number	LOR	Unit	ES1837704-001	ES1837704-002	ES1837704-003	-----	-----	
				Result	Result	Result	----	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	381	321	277	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	381	321	277	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	772	378	37	----	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	729	137	103	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	307	52	64	----	----	
Magnesium	7439-95-4	1	mg/L	19	5	33	----	----	
Sodium	7440-23-5	1	mg/L	591	307	64	----	----	
Potassium	7440-09-7	1	mg/L	2	2	<1	----	----	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.01	<0.01	----	----	
Arsenic	7440-38-2	0.001	mg/L	0.003	0.011	<0.001	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----	
Chromium	7440-47-3	0.001	mg/L	<0.001	0.002	<0.001	----	----	
Copper	7440-50-8	0.001	mg/L	0.002	<0.001	0.017	----	----	
Manganese	7439-96-5	0.001	mg/L	0.304	0.212	0.009	----	----	
Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.002	----	----	
Zinc	7440-66-6	0.005	mg/L	0.007	0.007	0.017	----	----	
Iron	7439-89-6	0.05	mg/L	0.20	<0.05	<0.05	----	----	
EG052G: Silica by Discrete Analyser									
Reactive Silica	----	0.05	mg/L	20.9	23.5	39.1	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.22	0.48	<0.01	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.02	0.05	1.73	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.05	1.73	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW1	GW2	GW3	----	----
Client sampling date / time				12-Dec-2018 11:00	12-Dec-2018 10:15	12-Dec-2018 00:00	----	----	
Compound	CAS Number	LOR	Unit	ES1837704-001	ES1837704-002	ES1837704-003	-----	-----	
				Result	Result	Result	----	----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.9	0.2	----	----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	0.7	1.0	1.9	----	----	
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.16	0.17	0.11	----	----	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	44.2	18.1	9.21	----	----	
Total Cations	----	0.01	meq/L	42.6	16.4	8.69	----	----	
Ionic Balance	----	0.01	%	1.85	5.03	2.89	----	----	

CERTIFICATE OF ANALYSIS

Work Order : **ES1920339**
Client : **EMM CONSULTING PTY LTD**
Contact : IMOGEN FRAWLEY
Address : Ground Floor Suite 1 20 Chandos Street
 St Leonards NSW NSW 2065

Telephone : ----
Project : Dunmore
Order number : JF17314
C-O-C number : ----
Sampler : IF
Site : ----
Quote number : EN/112/18
No. of samples received : 4
No. of samples analysed : 4

Page : 1 of 4
Laboratory : Environmental Division Sydney
Contact : Sepan Mahamad
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164

Telephone : +61 2 8784 8555
Date Samples Received : 01-Jul-2019 15:30
Date Analysis Commenced : 01-Jul-2019
Issue Date : 05-Jul-2019 18:24



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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



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
∅ = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EN055: Ionic Balance out of acceptable limits for sample 3 due to analytes not quantified in this report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW1	GW2	GW3	QA	----
Client sampling date / time					28-Jun-2019 10:00	28-Jun-2019 11:30	28-Jun-2019 11:00	28-Jun-2019 00:00	----
Compound	CAS Number	LOR	Unit	ES1920339-001	ES1920339-002	ES1920339-003	ES1920339-004	-----	
				Result	Result	Result	Result	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	365	320	280	317	----	
Total Alkalinity as CaCO3	----	1	mg/L	365	320	280	317	----	
ED040F: Dissolved Major Anions									
Silicon as SiO2	14464-46-1	0.1	mg/L	21.5	24.0	38.7	24.5	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	636	307	34	385	----	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	486	124	76	119	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	252	57	73	58	----	
Magnesium	7439-95-4	1	mg/L	19	7	37	7	----	
Sodium	7440-23-5	1	mg/L	565	352	70	354	----	
Potassium	7440-09-7	1	mg/L	2	3	<1	3	----	
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.02	<0.01	0.02	----	
Arsenic	7440-38-2	0.001	mg/L	0.002	0.012	<0.001	0.011	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----	
Chromium	7440-47-3	0.001	mg/L	0.001	0.003	0.001	0.003	----	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.010	0.001	----	
Manganese	7439-96-5	0.001	mg/L	0.275	0.240	0.010	0.244	----	
Nickel	7440-02-0	0.001	mg/L	0.001	0.002	0.002	0.002	----	
Zinc	7440-66-6	0.005	mg/L	0.006	<0.005	0.024	0.007	----	
Iron	7439-89-6	0.05	mg/L	0.19	<0.05	<0.05	<0.05	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	0.18	0.56	<0.01	0.54	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.03	0.03	1.46	0.03	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.03	1.46	0.03	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW1	GW2	GW3	QA	----
Client sampling date / time				28-Jun-2019 10:00	28-Jun-2019 11:30	28-Jun-2019 11:00	28-Jun-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	ES1920339-001	ES1920339-002	ES1920339-003	ES1920339-004	-----	-----
				Result	Result	Result	Result	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.5	1.0	0.3	0.9	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L	0.5	1.0	1.8	0.9	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L	0.07	0.18	0.04	0.17	----	----
EN055: Ionic Balance									
∅ Total Anions	----	0.01	meq/L	----	----	8.56	----	----	----
∅ Total Anions	----	0.01	meq/L	34.2	16.3	----	17.7	----	----
∅ Total Cations	----	0.01	meq/L	38.8	18.8	9.73	18.9	----	----
∅ Ionic Balance	----	0.01	%	----	----	6.42	----	----	----
∅ Ionic Balance	----	0.01	%	6.19	7.20	----	3.38	----	----

**SYDNEY
ANALYTICAL
LABORATORIES**

Page 1 of 7

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: L.VISINTIN

JOB NO: SAL26772
CLIENT ORDER: 117053
DATE RECEIVED: 09/05/18
DATE COMPLETED: 25/05/18
TYPE OF SAMPLES: WATERS
NO OF SAMPLES: 8



.....
Issued on 25/05/18
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION 09/05/18 09/05/18
SAMPLES DG5-S DG5-D

pH		7.4	7.4
Total Dissolved Solids	mg/L	620	11600
Total Nitrogen	mg/L	2.7	4.0
Conductivity	uS/cm	980	18300
Iron (Dissolved)	mg/L	0.02	0.02

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	75	3.263	2950	128.325
Calcium Ca++	110	5.489	365	18.214
Potassium K+	11	0.282	240	6.144
Magnesium Mg++	17	1.399	610	50.203
Ammonia (Total)	0.4	0.029	3.9	0.278

TOTAL CATIONS		10.462		203.164
---------------	--	--------	--	---------

Chloride Cl-	145	4.089	6550	184.710
Fluoride F-	<0.1		<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	96	1.997	870	18.096
Bicarbonate HCO3-	280	4.592	295	4.838
Phosphate PO4---	<0.1		0.15	0.005

TOTAL ANIONS		10.678		207.649
--------------	--	--------	--	---------

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION	09/05/18	09/05/18
SAMPLES	DG6-S	DG6-D

pH		6.7	6.9
Total Dissolved Solids	mg/L	10300	16100
Total Nitrogen	mg/L	2.3	7.4
Conductivity	uS/cm	16800	25900
Iron (Dissolved)	mg/L	1.2	16

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	2500	108.750	3950	171.825
Calcium Ca++	290	14.471	495	24.701
Potassium K+	210	5.376	350	8.960
Magnesium Mg++	530	43.619	960	79.008
Ammonia (Total)	1.2	0.086	1.5	0.107

TOTAL CATIONS		172.302		284.601
---------------	--	---------	--	---------

Chloride Cl-	5550	156.510	9180	258.876
Fluoride F-	0.10	0.005	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	650	13.520	1320	27.456
Bicarbonate HCO3-	420	6.888	440	7.216
Phosphate PO4---	0.18	0.006	<0.1	

TOTAL ANIONS		176.929		293.548
--------------	--	---------	--	---------

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION	09/05/18	09/05/18
SAMPLES	BHA	DG55/BHD

pH		6.0	6.9
Total Dissolved Solids	mg/L	1220	8360
Total Nitrogen	mg/L	0.4	1.1
Conductivity	uS/cm	2060	13500
Iron (Dissolved)	mg/L	2.7	0.15

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	280	12.180	2050	89.175
Calcium Ca++	86	4.291	165	8.233
Potassium K+	17	0.435	220	5.632
Magnesium Mg++	47	3.868	435	35.801
Ammonia (Total)	0.2	0.014	0.4	0.029

TOTAL CATIONS		20.788		138.870
---------------	--	--------	--	---------

Chloride Cl-	590	16.638	4520	127.464
Fluoride F-	<0.1		0.13	0.007
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	150	3.120	710	14.768
Bicarbonate HCO3-	100	1.640	110	1.804
Phosphate PO4---	<0.1		0.18	0.006

TOTAL ANIONS		21.398		144.049
--------------	--	--------	--	---------

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION	09/05/18	09/05/18
SAMPLES	DG31-S	DG59

pH		6.9	7.2
Total Dissolved Solids	mg/L	1740	1920
Total Nitrogen	mg/L	4.0	2.9
Conductivity	uS/cm	2840	3000
Iron (Dissolved)	mg/L	2.1	0.04

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	330	14.355	425	18.488
Calcium Ca++	180	8.982	140	6.986
Potassium K+	24	0.614	35	0.896
Magnesium Mg++	78	6.419	80	6.584
Ammonia (Total)	2.4	0.171	1.3	0.093

TOTAL CATIONS		30.541		33.047
---------------	--	--------	--	--------

Chloride Cl-	620	17.484	585	16.497
Fluoride F-	<0.1		0.11	0.006
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	260	5.408	170	3.536
Bicarbonate HCO3-	430	7.052	825	13.530
Phosphate PO4---	<0.1		<0.1	

TOTAL ANIONS		29.944		33.569
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL26772
CLIENT ORDER: 117053

DATE OF COLLECTION 09/05/18
SAMPLES BLANK

pH		7.1
Total Dissolved Solids	mg/L	<1
Total Nitrogen	mg/L	<0.1
Conductivity	uS/cm	0.9
Iron (Dissolved)	mg/L	<0.01

	mg/L	meq/L
Sodium Na+	<0.1	
Calcium Ca++	<0.1	
Potassium K+	<0.1	
Magnesium Mg++	<0.1	
Ammonia (Total)	<0.1	

TOTAL CATIONS

Chloride Cl-	<1
Fluoride F-	<0.1
Nitrate NO3-	<0.1
Sulphate SO4--	<2
Bicarbonate HCO3-	<1
Phosphate PO4---	<0.1

TOTAL ANIONS

ANALYTICAL REPORT

JOB NO: SAL26772

CLIENT ORDER: 117053

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
4500B	Total Nitrogen
2510B	Conductivity
3111B	Iron (Dissolved)

SYDNEY ANALYTICAL LABORATORIES

Page 1 of 9

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: M.NARRACOTT

JOB NO: SAL26998
CLIENT ORDER: 118117
DATE RECEIVED: 15/11/18
DATE COMPLETED: 28/11/18
TYPE OF SAMPLES: WATERS
NO OF SAMPLES: 10



CS
.....
Issued on 28/11/18
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		14/11/18	14/11/18
SAMPLES		DG5-D	DG6-S
pH		7.2	6.5
Total Dissolved Solids	mg/L	11200	10900
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.9	2.1
Iron (Dissolved)	mg/L	0.05	1.3
Conductivity	uS/cm	17700	17500

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3380	147.030	3140	136.590
Calcium Ca++	200	9.980	210	10.479
Potassium K+	140	3.584	145	3.712
Magnesium Mg++	345	28.394	410	33.743
Ammonia (Total)	1.8	0.129	0.8	0.057

TOTAL CATIONS		189.117		184.581
---------------	--	---------	--	---------

Chloride Cl-	6120	172.584	5920	166.944
Fluoride F-	0.43	0.023	0.39	0.021
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	720	14.976	690	14.352
Bicarbonate HCO3-	250	4.100	365	5.986
Phosphate PO4---	0.12	0.004	<0.1	

TOTAL ANIONS		191.687		187.303
--------------	--	---------	--	---------

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION	14/11/18	14/11/18
SAMPLES	DG-35	DG-36

pH		6.6	6.9
Total Dissolved Solids	mg/L	565	630
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.8	0.3
Iron (Dissolved)	mg/L	20	0.44
Conductivity	uS/cm	925	1030

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	82	3.567	125	5.438
Calcium Ca++	66	3.293	56	2.794
Potassium K+	8.6	0.220	13	0.333
Magnesium Mg++	33	2.716	29	2.387
Ammonia (Total)	1.4	0.100	<0.1	

TOTAL CATIONS		9.896		10.952
---------------	--	-------	--	--------

Chloride Cl-	64	1.805	110	3.102
Fluoride F-	0.16	0.008	0.40	0.021
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	175	3.640	140	2.912
Bicarbonate HCO3-	260	4.264	295	4.838
Phosphate PO4---	<0.1		0.12	0.004

TOTAL ANIONS		9.717		10.877
--------------	--	-------	--	--------

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		14/11/18	14/11/18
SAMPLES		DG-59	DG-7
pH		6.8	6.8
Total Dissolved Solids	mg/L	1940	255
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.8	0.9
Iron (Dissolved)	mg/L	0.53	0.10
Conductivity	uS/cm	3110	415

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	385	16.748	40	1.740
Calcium Ca++	200	9.980	38	1.896
Potassium K+	21	0.538	6.5	0.166
Magnesium Mg++	72	5.926	13	1.070
Ammonia (Total)	1.1	0.079	0.5	0.036

TOTAL CATIONS		33.271		4.908
---------------	--	--------	--	-------

Chloride Cl-	610	17.202	62	1.748
Fluoride F-	0.39	0.021	0.26	0.014
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	270	5.616	36	0.749
Bicarbonate HCO3-	690	11.316	140	2.296
Phosphate PO4---	<0.1		0.12	0.004

TOTAL ANIONS		34.155		4.811
--------------	--	--------	--	-------

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION	14/11/18	15/11/18
SAMPLES	DG-17	DG-21

pH		7.0	6.3
Total Dissolved Solids	mg/L	1870	760
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.8	1.0
Iron (Dissolved)	mg/L	0.02	0.63
Conductivity	uS/cm	2950	1280

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	440	19.140	185	8.047
Calcium Ca++	77	3.842	39	1.946
Potassium K+	35	0.896	12	0.307
Magnesium Mg++	120	9.876	40	3.292
Ammonia (Total)	0.4	0.029	0.3	0.021

TOTAL CATIONS		33.783		13.613
---------------	--	--------	--	--------

Chloride Cl-	540	15.228	320	9.024
Fluoride F-	0.65	0.034	0.10	0.005
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	25	0.520	120	2.496
Bicarbonate HCO3-	1180	19.352	90	1.476
Phosphate PO4---	9.9	0.313	0.58	0.018

TOTAL ANIONS		35.447		13.019
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION		15/11/18	15/11/18
SAMPLES		DG-31	FD1
pH		6.7	6.3
Total Dissolved Solids	mg/L	2420	780
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.4	1.0
Iron (Dissolved)	mg/L	0.29	0.65
Conductivity	uS/cm	3870	1290

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	540	23.490	190	8.265
Calcium Ca++	170	8.483	40	1.996
Potassium K+	34	0.870	12	0.307
Magnesium Mg++	93	7.654	39	3.210
Ammonia (Total)	<0.1		0.3	0.021

TOTAL CATIONS		40.497		13.799
---------------	--	--------	--	--------

Chloride Cl-	1050	29.610	320	9.024
Fluoride F-	<0.1		<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	490	10.192	125	2.600
Bicarbonate HCO3-	130	2.132	91	1.492
Phosphate PO4---	<0.1		0.54	0.017

TOTAL ANIONS		41.934		13.133
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

DATE OF COLLECTION	15/11/18	15/11/18
SAMPLES	DG-7 DUP	BLANK
pH	6.8	7.2
Total Dissolved Solids	mg/L 250	<1
Ammonia NH3-N	mg/L <0.1	<0.1
Total Nitrogen	mg/L 1.1	<0.1
Iron (Dissolved)	mg/L 0.10	<0.01
Conductivity	uS/cm 420	1.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	38	1.653	<0.1	
Calcium Ca++	38	1.896	<0.1	
Potassium K+	6.2	0.159	<0.1	
Magnesium Mg++	13	1.070	<0.1	
Ammonia (Total)	0.5	0.036	<0.1	

TOTAL CATIONS 4.814

Chloride Cl-	62	1.748	<1
Fluoride F-	0.26	0.014	<0.1
Nitrate NO3-	<0.1		<0.1
Sulphate SO4--	37	0.770	<2
Bicarbonate HCO3-	135	2.214	<1
Phosphate PO4---	0.14	0.004	<0.1

TOTAL ANIONS 4.750

LABORATORY DUPLICATE REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-7	pH		0.1	6.8	6.8	0
DG-7	TDS	mg/L	1	255	250	2
DG-7	Sodium	mg/L	0.1	40	38	5
DG-7	Calcium	mg/L	0.1	38	38	0
DG-7	Potassium	mg/L	0.1	6.5	6.2	5
DG-7	Magnesium	mg/L	0.1	13	13	0
DG-7	Chloride	mg/L	1	62	62	0
DG-7	Fluoride	mg/L	0.1	0.26	0.26	0
DG-7	Nitrate	mg/L	0.1	<0.1	<0.1	0
DG-7	Sulphate	mg/L	2	36	37	3
DG-7	Bicarbonate	mg/L	1	140	135	4
DG-7	Phosphate	mg/L	0.1	0.12	0.14	15
DG-7	Ammonia	mg/L	0.1	0.5	0.5	0
DG-7	Ammonia	mg/L	0.1	<0.1	<0.1	0
DG-7	Total Nitrogen	mg/L	0.1	0.9	1.1	20
DG-7	Fe Dissolved	mg/L	0.01	0.10	0.10	0
DG-7	Conductivity	uS/cm	0.1	415	420	1

Acceptance criteria:

RPD <50% for low level (<10xMDL)
RPD <20% for medium level (10-50xMDL)
RPD <10% for high level (>50xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

ANALYTICAL REPORT

JOB NO: SAL26998
CLIENT ORDER: 118117

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
CALC.	Ammonia NH3-N
4500B	Total Nitrogen
3111B	Iron (Dissolved)
2510B	Conductivity

**SYDNEY
ANALYTICAL
LABORATORIES**

Page 1 of 9

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: E.GRIFFITHS

JOB NO: SAL27115
CLIENT ORDER: 118117
DATE RECEIVED: 14/02/19
DATE COMPLETED: 05/03/19
TYPE OF SAMPLES: WATERS
NO OF SAMPLES: 10



.....
Issued on 05/03/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION	12/02/19	12/02/19
SAMPLES	DG5-D	DG6-S

pH		6.9	6.7
Total Dissolved Solids	mg/L	10600	10100
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	2.1	2.0
Iron (Dissolved)	mg/L	0.02	0.58
Conductivity	uS/cm	17000	16200

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3210	139.635	3080	133.980
Calcium Ca++	195	9.730	200	9.980
Potassium K+	150	3.840	155	3.968
Magnesium Mg++	330	27.159	390	32.097
Ammonia (Total)	1.4	0.100	0.8	0.057

TOTAL CATIONS		180.464		180.082
---------------	--	---------	--	---------

Chloride Cl-	5610	158.202	5450	153.690
Fluoride F-	0.41	0.022	0.39	0.021
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	750	15.600	700	14.560
Bicarbonate HCO3-	255	4.182	365	5.986
Phosphate PO4---	0.11	0.003	0.10	0.003

TOTAL ANIONS		178.009		174.260
--------------	--	---------	--	---------

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION	12/02/19	12/02/19
SAMPLES	DG-35	DG-36

pH		6.9	7.0
Total Dissolved Solids	mg/L	550	660
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	4.0	0.2
Iron (Dissolved)	mg/L	0.23	0.17
Conductivity	uS/cm	895	1080

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	75	3.263	125	5.438
Calcium Ca++	62	3.094	61	3.044
Potassium K+	9.0	0.230	15	0.384
Magnesium Mg++	29	2.387	31	2.551
Ammonia (Total)	<0.1		<0.1	

TOTAL CATIONS		8.974		11.417
---------------	--	-------	--	--------

Chloride Cl-	58	1.636	110	3.102
Fluoride F-	0.19	0.010	0.40	0.021
Nitrate NO3-	1.8	0.029	<0.1	
Sulphate SO4--	185	3.848	150	3.120
Bicarbonate HCO3-	230	3.772	300	4.920
Phosphate PO4---	<0.1		0.12	0.004

TOTAL ANIONS		9.295		11.167
--------------	--	-------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION	12/02/19	12/02/19
SAMPLES	DG-59	DG-7

pH		7.1	7.3
Total Dissolved Solids	mg/L	1860	185
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	1.7	1.1
Iron (Dissolved)	mg/L	0.13	1.1
Conductivity	uS/cm	3050	315

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	370	16.095	24	1.044
Calcium Ca++	200	9.980	28	1.397
Potassium K+	26	0.666	3.3	0.084
Magnesium Mg++	75	6.172	10	0.823
Ammonia (Total)	0.2	0.014	<0.1	

TOTAL CATIONS		32.927		3.348
---------------	--	--------	--	-------

Chloride Cl-	560	15.792	29	0.818
Fluoride F-	0.45	0.024	0.33	0.017
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	245	5.096	22	0.458
Bicarbonate HCO3-	720	11.808	125	2.050
Phosphate PO4---	<0.1		0.21	0.007

TOTAL ANIONS		32.720		3.350
--------------	--	--------	--	-------

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION	12/02/19	12/02/19
SAMPLES	DG-17	DG-21
pH	7.2	7.2
Total Dissolved Solids	mg/L 1740	1130
Ammonia NH3-N	mg/L <0.1	<0.1
Total Nitrogen	mg/L 1.6	1.1
Iron (Dissolved)	mg/L 0.16	0.18
Conductivity	uS/cm 2830	1810

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	405	17.618	260	11.310
Calcium Ca++	83	4.142	62	3.094
Potassium K+	40	1.024	14	0.358
Magnesium Mg++	110	9.053	64	5.267
Ammonia (Total)	0.3	0.021	0.4	0.029

TOTAL CATIONS		31.858		20.058
---------------	--	--------	--	--------

Chloride Cl-	495	13.959	530	14.946
Fluoride F-	0.65	0.034	0.14	0.007
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	19	0.395	145	3.016
Bicarbonate HCO3-	1090	17.876	98	1.607
Phosphate PO4---	6.6	0.209	0.13	0.004

TOTAL ANIONS		32.473		19.580
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION	12/02/19	12/02/19
SAMPLES	DG-31	FD1

pH		6.9	7.3
Total Dissolved Solids	mg/L	2490	1730
Ammonia NH3-N	mg/L	<0.1	<0.1
Total Nitrogen	mg/L	0.6	1.8
Iron (Dissolved)	mg/L	0.31	0.14
Conductivity	uS/cm	4060	2820

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	565	24.578	400	17.400
Calcium Ca++	170	8.483	81	4.042
Potassium K+	39	0.998	42	1.075
Magnesium Mg++	91	7.489	115	9.464
Ammonia (Total)	<0.1		0.3	0.021

TOTAL CATIONS		41.548		32.002
---------------	--	--------	--	--------

Chloride Cl-	1020	28.764	490	13.818
Fluoride F-	<0.1		0.62	0.033
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	490	10.192	17	0.354
Bicarbonate HCO3-	130	2.132	1120	18.368
Phosphate PO4---	<0.1		7.0	0.221

TOTAL ANIONS		41.088		32.794
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

DATE OF COLLECTION	12/02/19	12/02/19
SAMPLES	DG-31 DUP	BLANK
pH	7.0	7.2
Total Dissolved Solids	mg/L 2460	<1
Ammonia NH3-N	mg/L <0.1	<0.1
Total Nitrogen	mg/L 0.5	<0.1
Iron (Dissolved)	mg/L 0.33	<0.01
Conductivity	uS/cm 4080	1.2

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	555	24.143	<0.1	
Calcium Ca++	175	8.733	<0.1	
Potassium K+	38	0.973	<0.1	
Magnesium Mg++	90	7.407	<0.1	
Ammonia (Total)	<0.1		<0.1	

TOTAL CATIONS 41.256

Chloride Cl-	1010	28.482	<1
Fluoride F-	<0.1		<0.1
Nitrate NO3-	<0.1		<0.1
Sulphate SO4--	500	10.400	<2
Bicarbonate HCO3-	125	2.050	<1
Phosphate PO4---	<0.1		<0.1

TOTAL ANIONS 40.932

LABORATORY DUPLICATE REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-31	pH		0.1	6.9	7.0	1
DG-31	TDS	mg/L	1	2490	2460	1
DG-31	Sodium	mg/L	0.1	565	555	2
DG-31	Calcium	mg/L	0.1	170	175	3
DG-31	Potassium	mg/L	0.1	39	38	3
DG-31	Magnesium	mg/L	0.1	91	90	1
DG-31	Chloride	mg/L	1	1020	1010	1
DG-31	Fluoride	mg/L	0.1	<0.1	<0.1	0
DG-31	Nitrate	mg/L	0.1	<0.1	<0.1	0
DG-31	Sulphate	mg/L	2	490	500	2
DG-31	Bicarbonate	mg/L	1	130	125	4
DG-31	Phosphate	mg/L	0.1	<0.1	<0.1	0
DG-31	Ammonia	mg/L	0.1	<0.1	<0.1	0
DG-31	Ammonia	mg/L	0.1	<0.1	<0.1	0
DG-31	Total Nitrogen	mg/L	0.1	0.6	0.5	17
DG-31	Fe Dissolved	mg/L	0.01	0.31	0.33	6
DG-31	Conductivity	uS/cm	0.1	4060	4080	0

Acceptance criteria:

RPD <50% for low level (<10xMDL)
RPD <20% for medium level (10-50xMDL)
RPD <10% for high level (>50xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

ANALYTICAL REPORT

JOB NO: SAL27115
CLIENT ORDER: 118117

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
4500F	Nitrate NO3-
4110B	Sulphate SO4--
2320B	Bicarbonate HCO3-
4500F	Phosphate PO4---
4500G	Ammonia (Total)
CALC.	Ammonia NH3-N
4500B	Total Nitrogen
3111B	Iron (Dissolved)
2510B	Conductivity

**SYDNEY
ANALYTICAL
LABORATORIES**

Page 1 of 14

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: E.GRIFFITHS

JOB NO: SAL27215
CLIENT ORDER: 119037
DATE RECEIVED: 17/05/19
DATE COMPLETED: 31/05/19
TYPE OF SAMPLES: WATERS
NO OF SAMPLES: 17



.....
Issued on 31/05/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION 15/05/19 15/05/19
SAMPLES DG5-S DG5-D

pH		7.2	7.2
Total Dissolved Solids	mg/L	710	13400
Total Nitrogen	mg/L	0.8	3.6
Iron	mg/L	0.10	0.12
Manganese	mg/L	0.18	0.32
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	120	5.220	3740	162.690
Calcium Ca++	115	5.739	280	13.972
Potassium K+	10	0.256	185	4.736
Magnesium Mg++	18	1.481	470	38.681
Ammonia (Total)	0.3	0.021	3.5	0.250

TOTAL CATIONS		12.717		220.329
---------------	--	--------	--	---------

Chloride Cl-	195	5.499	7240	204.168
Fluoride F-	0.28	0.015	0.41	0.022
Nitrate NO3-	0.22	0.004	<0.1	
Sulphate SO4--	92	1.914	880	18.304
Bicarbonate HCO3-	305	5.002	350	5.740
Phosphate PO4---	0.15	0.005	<0.1	

TOTAL ANIONS		12.439		228.234
--------------	--	--------	--	---------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION	15/05/19	15/05/19
SAMPLES	DG6-S	DG6-D

pH		6.5	6.8
Total Dissolved Solids	mg/L	10800	15400
Total Nitrogen	mg/L	2.5	1.2
Iron	mg/L	0.75	0.13
Manganese	mg/L	0.56	1.1
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3270	142.245	4610	200.535
Calcium Ca++	195	9.730	300	14.970
Potassium K+	155	3.968	220	5.632
Magnesium Mg++	390	32.097	550	45.265
Ammonia (Total)	1.0	0.071	0.4	0.029

TOTAL CATIONS		188.111		266.431
---------------	--	---------	--	---------

Chloride Cl-	5750	162.150	8280	233.496
Fluoride F-	0.44	0.023	0.34	0.018
Nitrate NO3-	<0.1		0.71	0.011
Sulphate SO4--	740	15.392	1130	23.504
Bicarbonate HCO3-	375	6.150	435	7.134
Phosphate PO4---	<0.1		<0.1	

TOTAL ANIONS		183.715		264.163
--------------	--	---------	--	---------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION	15/05/19	15/05/19
SAMPLES	DG-7	DG-17

pH		7.0	6.9
Total Dissolved Solids	mg/L	98	1620
Total Nitrogen	mg/L	1.3	1.5
Iron	mg/L	0.31	0.11
Manganese	mg/L	0.13	0.70
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	17	0.739	365	15.878
Calcium Ca++	12	0.599	79	3.942
Potassium K+	3.1	0.079	32	0.819
Magnesium Mg++	4.6	0.379	100	8.230
Ammonia (Total)	0.3	0.021	0.8	0.057

TOTAL CATIONS		1.817		28.926
---------------	--	-------	--	--------

Chloride Cl-	21	0.592	420	11.844
Fluoride F-	0.39	0.021	0.66	0.035
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	10	0.208	22	0.458
Bicarbonate HCO3-	63	1.033	1060	17.384
Phosphate PO4---	0.28	0.009	2.1	0.066

TOTAL ANIONS		1.863		29.787
--------------	--	-------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION	15/05/19	15/05/19
SAMPLES	DG-21	DG-31

pH		6.3	6.6
Total Dissolved Solids	mg/L	1040	2790
Total Nitrogen	mg/L	0.9	1.3
Iron	mg/L	0.67	0.79
Manganese	mg/L	1.4	0.03
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	250	10.875	630	27.405
Calcium Ca++	48	2.395	210	10.479
Potassium K+	13	0.333	32	0.819
Magnesium Mg++	42	3.457	100	8.230
Ammonia (Total)	0.3	0.021	0.3	0.021

TOTAL CATIONS		17.081		46.954
---------------	--	--------	--	--------

Chloride Cl-	460	12.972	1150	32.430
Fluoride F-	0.12	0.006	<0.1	
Nitrate NO3-	<0.1		0.18	0.003
Sulphate SO4--	135	2.808	610	12.688
Bicarbonate HCO3-	115	1.886	140	2.296
Phosphate PO4---	0.13	0.004	<0.1	

TOTAL ANIONS		17.676		47.417
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION	15/05/19	15/05/19
SAMPLES	DG-35	DG-36
pH	6.6	6.8
Total Dissolved Solids	mg/L 590	685
Total Nitrogen	mg/L 1.9	0.1
Iron	mg/L 13	0.37
Manganese	mg/L 1.4	0.55
Aluminium	mg/L <0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	91	3.959	130	5.655
Calcium Ca++	67	3.343	64	3.194
Potassium K+	8.2	0.210	13	0.333
Magnesium Mg++	33	2.716	35	2.881
Ammonia (Total)	1.8	0.129	0.1	0.007

TOTAL CATIONS		10.357		12.070
---------------	--	--------	--	--------

Chloride Cl-	61	1.720	130	3.666
Fluoride F-	0.16	0.008	0.41	0.022
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	190	3.952	165	3.432
Bicarbonate HCO3-	265	4.346	320	5.248
Phosphate PO4---	<0.1		<0.1	

TOTAL ANIONS		10.026		12.368
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		DG-36	DG-59
		DUP	
pH		6.8	7.0
Total Dissolved Solids	mg/L	700	1910
Total Nitrogen	mg/L	0.2	2.3
Iron	mg/L	0.35	0.10
Manganese	mg/L	0.52	0.55
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	135	5.873	405	17.618
Calcium Ca++	64	3.194	185	9.232
Potassium K+	12	0.307	18	0.461
Magnesium Mg++	34	2.798	72	5.926
Ammonia (Total)	0.1	0.007	1.1	0.079

TOTAL CATIONS		12.179		33.316
---------------	--	--------	--	--------

Chloride Cl-	135	3.807	545	15.369
Fluoride F-	0.41	0.022	0.51	0.027
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	160	3.328	280	5.824
Bicarbonate HCO3-	325	5.330	765	12.546
Phosphate PO4---	<0.1		<0.1	

TOTAL ANIONS		12.487		33.766
--------------	--	--------	--	--------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION 15/05/19 15/05/19
SAMPLES FD2 MW5A1

pH		6.5	6.2
Total Dissolved Solids	mg/L	11000	115
Total Nitrogen	mg/L	2.1	3.2
Iron	mg/L	0.78	0.24
Manganese	mg/L	0.54	<0.01
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3300	143.550	11	0.479
Calcium Ca++	200	9.980	20	0.998
Potassium K+	155	3.968	2.9	0.074
Magnesium Mg++	380	31.274	4.3	0.354
Ammonia (Total)	1.0	0.071	<0.1	

TOTAL CATIONS 188.843 1.905

Chloride Cl-	5840	164.688	29	0.818
Fluoride F-	0.44	0.023	<0.1	
Nitrate NO3-	<0.1		11	0.177
Sulphate SO4--	750	15.600	14	0.291
Bicarbonate HCO3-	375	6.150	36	0.590
Phosphate PO4---	<0.1		<0.1	

TOTAL ANIONS 186.461 1.876

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		MW5A3	MW5B2-S
pH		6.7	7.3
Total Dissolved Solids	mg/L	660	450
Total Nitrogen	mg/L	2.3	1.4
Iron	mg/L	6.0	0.65
Manganese	mg/L	0.17	0.10
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	130	5.655	52	2.262
Calcium Ca++	81	4.042	94	4.691
Potassium K+	4.8	0.123	3.3	0.084
Magnesium Mg++	17	1.399	12	0.988
Ammonia (Total)	1.1	0.079	0.4	0.029

TOTAL CATIONS		11.298		8.054
---------------	--	--------	--	-------

Chloride Cl-	295	8.319	50	1.410
Fluoride F-	0.18	0.009	0.18	0.009
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	16	0.333	42	0.874
Bicarbonate HCO3-	185	3.034	360	5.904
Phosphate PO4---	0.18	0.006	<0.1	

TOTAL ANIONS		11.701		8.197
--------------	--	--------	--	-------

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION SAMPLES		15/05/19 MW5B2-D		15/05/19 MW5B4	
pH		7.4		7.4	
Total Dissolved Solids	mg/L	360		460	
Total Nitrogen	mg/L	0.8		1.8	
Iron	mg/L	0.10		0.21	
Manganese	mg/L	0.09		0.06	
Aluminium	mg/L	<0.1		<0.1	
		mg/L	meq/L	mg/L	meq/L
Sodium Na+		38	1.653	45	1.958
Calcium Ca++		75	3.743	110	5.489
Potassium K+		3.6	0.092	2.7	0.069
Magnesium Mg++		13	1.070	10	0.823
Ammonia (Total)		0.6	0.043	0.1	0.007
TOTAL CATIONS			6.601		8.346
Chloride Cl-		52	1.466	36	1.015
Fluoride F-		0.17	0.009	0.23	0.012
Nitrate NO3-		<0.1		0.18	0.003
Sulphate SO4--		13	0.270	10	0.208
Bicarbonate HCO3-		300	4.920	450	7.380
Phosphate PO4---		<0.1		<0.1	
TOTAL ANIONS			6.665		8.618

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

DATE OF COLLECTION		15/05/19	15/05/19
SAMPLES		MW5B4 DUP	BLANK
pH		7.4	7.3
Total Dissolved Solids	mg/L	450	<1
Total Nitrogen	mg/L	1.8	<0.1
Iron	mg/L	0.20	<0.01
Manganese	mg/L	0.07	<0.01
Aluminium	mg/L	<0.1	<0.1

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	48	2.088	<0.1	
Calcium Ca++	105	5.240	<0.1	
Potassium K+	3.0	0.077	<0.1	
Magnesium Mg++	9.6	0.790	<0.1	
Ammonia (Total)	0.1	0.007	<0.1	

TOTAL CATIONS 8.202

Chloride Cl-	36	1.015	<1
Fluoride F-	0.22	0.012	<0.1
Nitrate NO3-	0.18	0.003	<0.1
Sulphate SO4--	9	0.187	<2
Bicarbonate HCO3-	445	7.298	<1
Phosphate PO4---	<0.1		<0.1

TOTAL ANIONS 8.515

LABORATORY DUPLICATE REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-36	pH		0.1	6.8	6.8	0
MW5B4	pH		0.1	7.4	7.4	0
DG-36	TDS	mg/L	1	685	700	2
MW5B4	TDS	mg/L	1	460	450	2
DG-36	Sodium	mg/L	0.1	130	135	4
MW5B4	Sodium	mg/L	0.1	45	48	6
DG-36	Calcium	mg/L	0.1	64	64	0
MW5B4	Calcium	mg/L	0.1	110	105	5
DG-36	Potassium	mg/L	0.1	13	12	8
MW5B4	Potassium	mg/L	0.1	2.7	3.0	10
DG-36	Magnesium	mg/L	0.1	35	34	3
MW5B4	Magnesium	mg/L	0.1	10	9.6	4
DG-36	Chloride	mg/L	1	130	135	4
MW5B4	Chloride	mg/L	1	36	36	0
DG-36	Fluoride	mg/L	0.1	0.41	0.41	0
MW5B4	Fluoride	mg/L	0.1	0.23	0.22	4
DG-36	Nitrate	mg/L	0.1	<0.1	<0.1	0
MW5B4	Nitrate	mg/L	0.1	0.18	0.18	0
DG-36	Sulphate	mg/L	2	165	160	3
MW5B4	Sulphate	mg/L	2	10	9	10
DG-36	Bicarbonate	mg/L	1	320	325	2
MW5B4	Bicarbonate	mg/L	1	450	445	1
DG-36	Phosphate	mg/L	0.1	<0.1	<0.1	0
MW5B4	Phosphate	mg/L	0.1	<0.1	<0.1	0
DG-36	Ammonia	mg/L	0.1	0.1	0.1	0
MW5B4	Ammonia	mg/L	0.1	0.1	0.1	0
DG-36	Total Nitrogen	mg/L	0.1	0.1	0.2	50
MW5B4	Total Nitrogen	mg/L	0.1	1.8	1.8	0
DG-36	Iron	mg/L	0.01	0.37	0.35	6
MW5B4	Iron	mg/L	0.01	0.21	0.20	5

LABORATORY DUPLICATE REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
DG-36	Manganese	mg/L	0.01	0.55	0.52	6
MW5B4	Manganese	mg/L	0.01	0.06	0.07	14
DG-36	Aluminium	mg/L	0.1	<0.1	<0.1	0
MW5B4	Aluminium	mg/L	0.1	<0.1	<0.1	0

Acceptance criteria:

RPD <50% for low level (<10xMDL)
RPD <20% for medium level (10-50xMDL)
RPD <10% for high level (>50xMDL)
No limit applies at <2xMDL

MDL = Method Detection Limit

All results are within the acceptance criteria

ANALYTICAL REPORT

JOB NO: SAL27215
CLIENT ORDER: 119037

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 22nd Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na ⁺
3111B	Calcium Ca ⁺⁺
3500B	Potassium K ⁺
3111B	Magnesium Mg ⁺⁺
4500D	Chloride Cl ⁻
4500C	Fluoride F ⁻
4500F	Nitrate NO ₃ ⁻
4110B	Sulphate SO ₄ ⁻⁻
2320B	Bicarbonate HCO ₃ ⁻
4500F	Phosphate PO ₄ ⁻⁻⁻
4500G	Ammonia (Total)
4500B	Total Nitrogen
3111B	Iron
3111B	Manganese
3111D	Aluminium

Appendix D

Water quality timeseries at Bumbo Latite sites

