ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

ANNUAL REPORT 2019 - ENVIRONMENTAL MONITORING AT THE DUNMORE RECYCLING AND WASTE DEPOT, DUNMORE, NEW SOUTH WALES

REPORT TO SHELLHARBOUR CITY COUNCIL

23 OCTOBER 2019
118109
VERSION 1

EXECUTIVE SUMMARY

Environmental Earth Sciences NSW have undertaken quarterly environmental monitoring of groundwater, surface water and leachate at the Dunmore Recycling and Waste Disposal Depot, Dunmore, New South Wales (the site) since 1992.

Surface water, groundwater, leachate, landfill gas and dust were collected/monitored on a quarterly basis between November 2018 and August 2019. The locations monitored include BHA, BH1c, BH2, BH3, BH4, BH5, BH12R, BH13, BH14, BH15, BH16,BH17R, BH19, BH20, BH20s, a leachate tank (LP1), four surface water ponds (SWP1, SWP2, SWP4 and SWP5) and four samples in Rocklow Creek; SWC_Up, SWC_Down, SWC_Down_2 and SWC2. This location is directly below current landfilling activities and the leachate ponds.

Inferred groundwater contours for the past four quarterly monitoring rounds, show a general groundwater direction to the south south-east towards Rocklow Creek. Groundwater velocity throughout the site varies between 1-16 m/yr with the lower rates found towards the southern areas (Rocklow Creek) due to the lower hydraulic gradients.

Over the 2018-2019 monitoring period, groundwater at boreholes BH1c, BH2, BH3, BH20 and BH20s exhibited strong signs of leachate influence, whereas bores BH4, BH13, BH14, BH16 and BH19 showed minor to no influence of leachate. This influence can be attributed to historical or current landfill leachate, and effluent leachate.

Annual organic, inorganic and microbial analysis of the water in the leachate tanks (LP1) continued to indicate that concentrations of leachate and contaminants poses a risk to human health and any contact with this water should be avoided.

Results from surface water monitoring indicate possible site impacts are affecting locations SWP1, SWP2 and SWP4. It was noted that SWP5 had been dry since November 2018, therefore no samples were obtained. The connectivity between the surface water bodies and groundwater has not been specifically assessed however past chemical results indicate a potential interaction between the two.

There was no evidence of leachate impact detected at the down gradient Rocklow Creek site SWC2, SWC_Up, SWC_Down and SWC_Down_2. These locations had ammonium and nitrate levels over the last four sampling events between 0.1 and 2.1 mg/L. All constituents were below the adopted site criteria values for marine waters (1.88 mg/L and 10.6 mg/L, respectively).

Ammonium in the groundwater generally exceeded the threshold values. Historically there has been an apparent decreasing trend in concentration in nitrogen species in the groundwater towards the south. However, between 2015-2017, elevated levels of ammonium were detected at BH20 which were higher than the upgradient bores. Results and previous review (Environmental Earth Sciences, 2017) suggest that the ammonia plume at BH20 was relatively stable and did not apparently impact Rocklow Creek.

No landfill cap deficiencies were noted during the 2018-2019 monitoring period. The current level of capping on the landfill is deemed sufficient. Furthermore, no gas was detected at site sheds, buildings, weighbridge, or offices. Ongoing monitoring should continue to occur

on a quarterly basis to ensure no landfill gas related human health hazards are present at these locations.

The dust deposition gauge positioned at the north western site boundary contained slight levels of insoluble solids, ash and combustible matter. Calculated quarterly dust levels, were below the guideline value and are not considered a concern based on the appropriate Australian/New Zealand Standard AS/NZ 3580.10.1: (2003).

Results collected over the monitoring period for 2018-2019, suggest that the landfilling activities untaken at Dunmore Recycling and Waste Disposal Depot, are not likely to be impacting offsite receptors.

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1 INTRODUCTION

Environmental Earth Sciences NSW have undertaken quarterly environmental monitoring of groundwater, surface water and leachate at the Dunmore Recycling and Waste Disposal Depot, Dunmore, New South Wales (the 'site') since 1992. This report discusses the monitoring results from groundwater monitoring locations in and around the Depot, as well as surface water samples collected from Rocklow Creek, surface water ponds and the site leachate collection pond.

In addition, landfill gas monitoring was carried out across the cap and within buildings located on the property, while dust monitoring was performed adjacent to the north-western boundary.

Results for the past 12-month monitoring period between November 2018 and August 2019 has been discussed within the report in conjunction with trends established by comparing monitoring data collected since November 1992.

Monitoring has been undertaken in accordance with Dunmore Recycling and Waste Depot's Environmental Protection License No.5984.

The data interpretation relies on professional judgement used to extrapolate between assessed areas. Actual conditions may vary from those inferred to exist. The actual interface between materials and variation of ground or surface water quality may be more abrupt or gradual than the report indicates.

This report should be read in conjunction with the limitations presented in Section 13.

2 OBJECTIVES

The objective of this investigation is to assess the impacts of landfilling activities on surrounding land, adjacent watercourses and groundwater. All works have been undertaken in accordance with NSW EPA license No. 5984. It is noted that Council has commissioned works above and beyond the scope of the EPL to ensure that any potential environmental concerns are assessed, and a solution established as early as possible.

3 SCOPE OF WORK

The following scope of works was undertaken to achieve this objective:

- collect field measurements and sample water from selected boreholes, the leachate pond, the four surface water ponds and Rocklow Creek on a quarterly and biannual basis;
- analyse water from the boreholes for pH, total dissolved solids (TDS), total organic carbon (TOC), oxidation-reduction potential (ORP), temperature, soluble iron and manganese, total iron, biological oxygen demand (BOD) and an ionic balance for each quarterly sampling event;
- analyse water from the leachate pond for turbidity, faecal coliforms and all borehole parameters on a quarterly basis;
- analyse water from the leachate pond for phenolic compounds, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), benzene, toluene, ethyl-benzene and xylene (BTEX) and halogenated volatile compounds (HVC) annually;
- analyse water from Rocklow Creek (adjacent to the landfill) for nitrogen species, soluble iron, bicarbonate and turbidity quarterly;
- collect and analyse sample from a dust gauge bottle to the north of the site (DDG);
- undertake a gas walkover of all site buildings and the landfill cap with a flame ionisation detector (FID) or an Inspectra Laser Unit (ILU) and a Landfill Gas Analyser (GA2000 or GA5000);
- report on the physical and chemical characteristics of the groundwater and how the leachate produced from the Dunmore Waste Disposal Depot chemically and physically affects ground and surface water quality; and
- report on leachate plume movements (if any) and if necessary, recommend action that may be required to prevent contamination of groundwater.

4 REGIONAL SETTING

The Dunmore Recycling and Waste Disposal Depot is located at Buckleys Road, Dunmore, New South Wales (**Figure 1**).

4.1 Regional Geology

The local geology has been described in the Kiama 1:50 000 *Geological series sheet* 9028-1 (Bowman, 1974) as being Quaternary aged (up to three million years old) alluvium, gravel, beach and dune sand. This sequence is underlain by early to late Permian aged (225-275 million years old) aphanitic (fine grained) to porphyritic (some large crystals) latite (the

Bumbo Latite Member) which also forms the surrounding hills and is found outcropping to the north of the site. Swamp deposits consisting of sands, silts and clays are located in and around the area of Shellharbour.

4.2 Soil

A review of the Soil Landscapes of the Kiama 1:100 000 Sheet (Hazelton, 1992) indicates that the site falls within the Killalea (swamp) soil landscape. Soils are formed on coastal alluvial plains and swamps. Soil is described (Hazelton, 1992) as organic, black, massive sandy loam topsoil overlying loose bleached light grey sand with iron staining in the subsoil. The structure is generally apedal massive, with abundant roots and limited coarse material. Soils may also be sodic and strongly acid and have been characterised as Oxyaquic Hydrosols.

The Department of Land and Water Conservation (1997) Albion Park acid sulfate soil risk map indicates the site lies within the “Ap2” category, indicating a high probability of acid sulfate soils occurring within the soil profile. The potential acid sulfate soil material is within 1 metre of the ground surface, and severe environmental risk is considered likely if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.

4.3 Topography and drainage

Steep hills (<15%) surround the site to the west, with Rocklow Creek located on the periphery of the site to the south and southwest.

Elevation across the site is between approximately 3 and 5 m AHD, with the area of greatest elevation in the catchment being the artificial rise of the landfill to the east. The upper limit of the catchment alluvial soils is positioned at close to 10 m AHD. The catchment drains to Rocklow Creek, which flows south east into the estuary of Minnamurra River, approximately 1,100 m south-east of the site. The lower catchment is subject to floods and has water-logging issues due to the permanently high-water tables (Hazelton, 1992).

Surface water runoff from the old and the active landfill cell eventually drains into pond SWP4 (**Figure 2**). Given the shallow water table and sandy soil profile there is potential for surface runoff to infiltrate rapidly and contribute to groundwater flow in a general southward direction towards SWP4.

4.4 Vegetation

The existing vegetation communities within the site include the following:

- exotic grass cover (pasture species);
- planted buffer zone: native Casuarina sp. trees with pasture grass understorey – 0.44 hectare; and
- native Swamp Oak Floodplain Forest (NSW Endangered Ecological Community) – 0.18 hectare.

The planted buffer zone of *Acacia* and *Casuarinaceae* species have the potential to affect the levels of nitrogen in the groundwater through atmospheric nitrogen fixation mechanisms occurring in and around the root zone.

4.5 Rainfall

Long term rainfall data has been sourced from the Bureau of Meteorology (2019) (*www.bom.gov.au*, verified 1 October 2019) Albion Park (Wollongong Airport) weather station, approximately 10 km from site. As this weather station has now been closed, monthly rainfall data from the Albion Park weather station has been compared to long term rainfall data in **Chart 1**. The long-term data consists of average rainfall data from 1897 to 2011. Total annual rainfall for the 2018 – 2019 period was 767 mm, with a monthly rainfall average of 64 mm, which is slightly lower than the long-term average of 75 mm. The largest rainfall events occurred in winter in March 2019, with 157 mm and a total of 15 days of rainfall. Large rainfall events were also recorded in October 2018, with a total of 107 mm falling over 18 days.

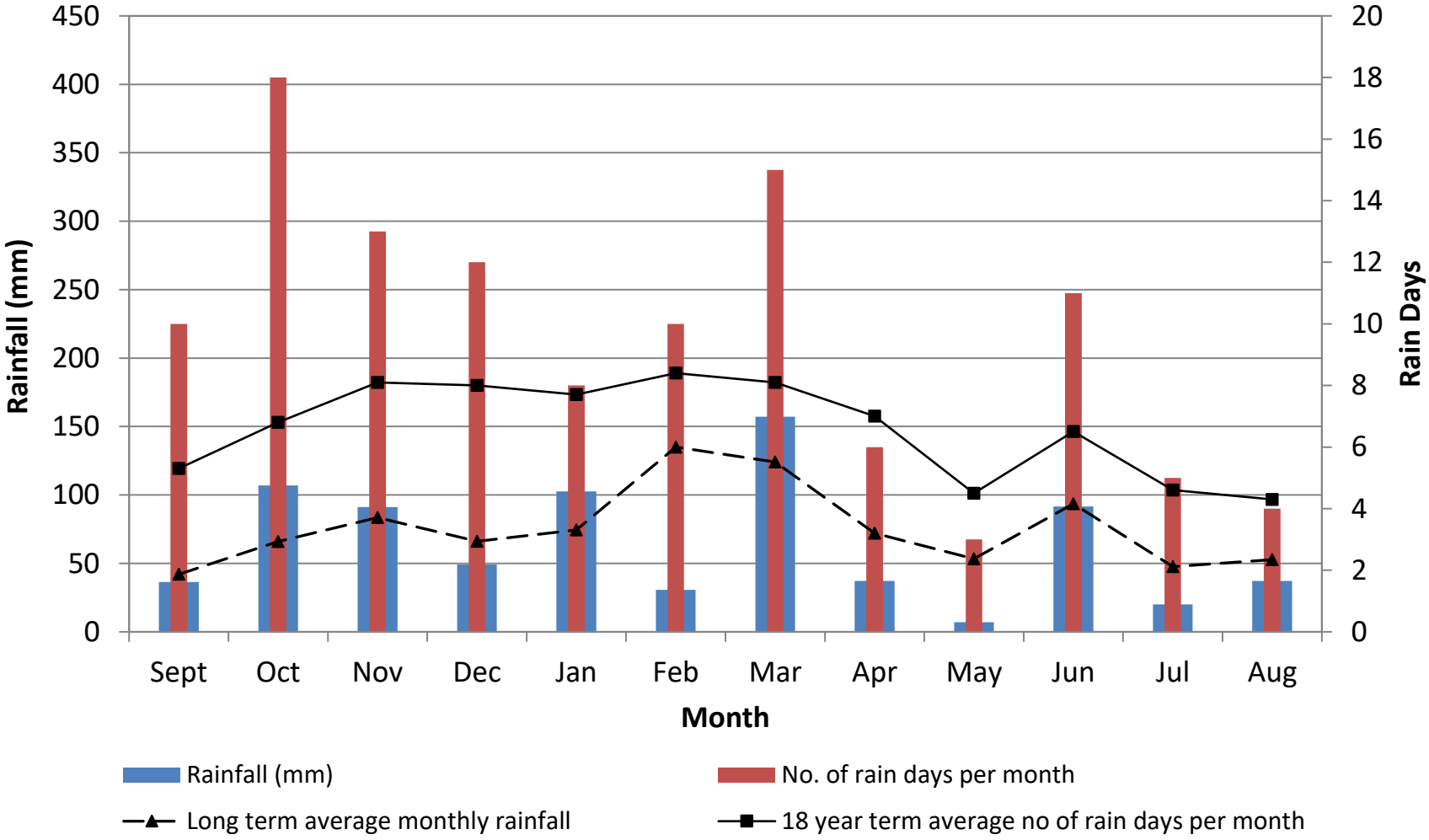

Chart 1. Rainfall and the number of rain days for the 2018/2019 monitoring period, Albion Park (Wollongong Airport) weather station.

5 SITE HISTORY AND LAND USE

Pertinent information relating to the site history and land use is described below:

- the Dunmore Recycling and Waste Disposal Depot is reported to have been established in 1945;
- Shellharbour City Council has managed the site since 1983;
- putrescible and non-putrescible waste generated in the Municipality of Shellharbour is deposited at the Dunmore Recycling and Waste Disposal Depot;
- before the mid-1980s there was no control on the disposal locations, or the types of waste disposed of at the landfill. In the mid-1980s the landfill operations became more controlled and present filling is confined to the area depicted on Figure 1, adjacent to Buckleys Road;
- since Shellharbour City Council took over the operation of the Dunmore Recycling and Waste Disposal Depot, filling areas have been designated and regular night cover applied. A weighbridge and checkpoint station have been installed to inspect the type and amount of waste being disposed of, and a recycling collection area has been established;
- night soil and grease trap wastes were deposited in the vicinity of the former borehole BH1 and BH6 (Figure 1), until around 1985 where night soil disposal decreased;
- no night soil/effluent was disposed of in this area after 1989;
- it has been reported that ash material has been dumped at the landfill, supposedly spent dolomite from the Wollongong steel mill. The possibility that other industrial wastes may be present in the older parts of the landfill has not been discounted, due to the uncontrolled nature of dumping at the landfill up until the mid-1980s;
- current landfill disposal operations work on the principle of filling a cell with concrete, brick, tile and rock-fill wastes until the surface level is approximately one and a half metres above the groundwater table. A clay or geo-textile liner is then applied before putrescible wastes are disposed of in the cell. A clay/silt cap covers the cell at its final design surface. The cap was then top-soiled and re-vegetated with grass and shrubs;
- in 1983 an environmental impact statement (EIS) was prepared by Council for commencement of a sand dredging operation. This operation was put into effect in the latter half of 1993 and was located between boreholes BH1 and BH6 (Figure 1). Current sand mining operations are undertaken in the west of the site near SWP4;
- a landfill gas flare was installed to the north east section of the landfill. The landfill gas flare monitors the levels of gas within the landfill and safely vents the landfill gasses;

- the surface water pond SWP3 was filled with crushed rock and concrete during 2014, this is now an active landfill cell; and
- a surface water pond was constructed in the southern portion of the site near BH13. This surface water pond has been labelled as SWP5 and incorporated into the monitoring plan.
- two leachate ponds were present on the eastern side of the site before 2016. These former leachate ponds overflowed during 2003 with impacts notable on the surrounding groundwater chemistry;
- these two former leachate ponds were replaced in 2016 with four leachate tanks. Any water migrating through the landfill cells is intercepted by the leachate interception trenches. The leachate from the landfill cells is then directed towards the leachate tanks on site where it is stored and removed;
- During 2016-2017 a new waste management facility was constructed in the eastern section of the site (the area around former BH5, BH6, BH12, and BH17). This construction caused the necessity of decommissioning of the boreholes located in this area.

6 SITE CHARACTERISTICS

6.1 Location of monitoring points

The location of monitoring points is illustrated in **Figure 2.**

Table 1: Borehole locations

Bore	Date of installation	Location description	Former bores	Currently monitored
BH1a	May 2004 – May 2010	Immediately south and topographically down-gradient of the previous disposal area, and to the west of the currently operating fill area	BH1 - moved in 1995 due to the extension of the outer wall of the active landfill; destroyed during waste depot operations in February 2004	Decommissioned in 2010
BH1b	August 2010	As above	BH1a – required replacement due to damage.	-
BH1c	August 2013	As above	BH1a and BH1b	Yes
BH2	August 1991	South of the access road, down-gradient of land filling activities	-	Yes
BH3	August 1991	Down-gradient of landfilling activities, between the landfill and Rocklow Creek	-	Yes
BH4	August 1991	Down-gradient of land filling activities, between the landfill and Rocklow Creek	-	Yes
BH5	August 1991	In a low-lying area on the verge of swamplands adjacent to Restoration Fill Services	-	Decommissioned in 2017
BH6b	February 2007	Down-hydraulic gradient of the HDPE lined leachate ponds	BH6 (August 1991) – situated east of the current landfill disposal site, inaccessible due the shallow sand mining; BH6a (August 2000) - south of the former leachate pond, damaged due to dredging related activities	Decommissioned in 2016 during construction works undertaken for new waste management facility.
BH7	August 1991	-	-	Destroyed by dredging activities

Bore	Date of installation	Location description	Former bores	Currently monitored
BH8	August 1991	Up-gradient of old landfill cell and land filling activities	-	Could not be located
BH9	August 1991	On edge of old landfill cell and up-gradient of current activities	-	Yes
BH10	December 1992	North of site and up-gradient of the landfill, in a paddock adjacent to and down gradient of residential dwellings	-	Yes
BH11	June 2002	Immediately east of the active landfill and south-east of the old capped landfill	Replaced by BH18	Decommissioned
BH12	July 2019	Down-hydraulic gradient of the HDPE lined leachate ponds and land filling operations	Previous BH12 moved south ~4 m to allow expansion of adjacent landfill cell. Decommissioned in 2017 during construction works for waste management facility	Reinstalled July 2019
BH13	June 2002	Down-hydraulic gradient of land filling operations on the southern side of the site - should detect impacts on groundwater from the controlled waste disposal areas	-	Yes
BH14	June 2002	Down-hydraulic gradient of land filling operations on the southern side of the site - should detect impacts on groundwater from the controlled waste disposal areas	-	Yes

Bore	Date of installation	Location description	Former bores	Currently monitored
BH15	June 2010	South of former borehole BH5 located within Killalea State park	-	- (inaccessible as located at bottom of bank which became overgrown after November 2018 monitoring round)
BH16	June 2010	East of former borehole BH5 located on adjacent property	-	Yes
BH17	July 2019	North east corner of leachate pond	Decommissioned in 2016 during construction works undertaken for new waste management facility.	Reinstalled July 2019
BH18	June 2010	North of former borehole BH11	Decommissioned in 2016 during construction works undertaken for new waste --management facility.	-
BHA	July 2019	North-western corner of DRR depot building	Installed to provide coverage previously provided by BH18	Yes
BH19	July 2019	On the south west boundary of the site in close proximity to Rocklow creek	Decommissioned as monument damaged in August 2018 and reinstalled 3.0 to the west.	Reinstalled July 2019
BH20	July 2013	On the south boundary of the site in close proximity to Rocklow creek	-	Yes
BH20s	September 2017	Nested well near BH20 (screened at 1.5-4.5 mBGL)	-	Yes
SWC2	-	Rocklow creek south of the landfill	-	Yes
SWC_UP	August 2013	Upper Rocklow creek south of the landfill	-	Yes

Bore	Date of installation	Location description	Former bores	Currently monitored
SWC_Down	August 2013	South Rocklow creek south of the landfill	-	Yes
SWC_Down_2	November 2017	South east of SWC_Down within Rocklow Creek	-	Yes
LP1	-	Leachate tanks to the east of current active cell	-	Yes
SWP1	-	West of the current active landfill and adjacent to the access road running around the site	-	Yes

6.2 Stratigraphy

The interpreted stratigraphy based on geological logs (presented in **Appendix A)** is typically comprised fill material underlain by granular natural soils.

Grey, fine to medium grained sand matrix with metal, rock and household rubbish (Fill material) was encountered to 1.5 m below ground level at borehole BH1a/b. Road base and a brown sandy loam with blue metal aggregate were encountered to 1 m below ground level (mbgl) at BH1, BH11 and BH18. Household waste was found at BH2 and BH3 to 1.5 m below ground level. BH6a had 0.9 m of clay fill while fill material was noted in BH8 down to 0.5 mbgl.

Borehole BH18 could not be reinstalled at the weighbridge location in July 2019. Road base material and large fragments of concrete were encountered from surface, with refusal encountered at depths of between 0.2 and 1.0 m below ground level.

Natural material on site consisted of fine to medium grained sands (occasionally silty within the top 1 mbgl), yellow/orange/brown in colour sometimes grading to grey at 6 to 8 mbgl. Shell and gravel lenses were common throughout. A grey to green clay overlayed the latite bedrock encountered at 11 mbgl in borehole BH11 and 10 mbgl in borehole BH13. A sandy clay/clay horizon was encountered at boreholes BH7, BH8 and BH9 between 5 and 8 mbgl.

The stratigraphy at BH10 was different to the rest of the site. Brown sandy silts were intercepted to a depth of 2.0 mbgl. Underlying these sediments were brown silty clays and clayey silts, which overlies a weathered latite bedrock intercepted at 4.3 mbgl. It is understood that borehole BH10 has been constructed within a different aquifer to the bores located on the landfill site. As a result, sampling BH10 was excluded from the monitoring program.

Shallow water bearing zones were encountered between 0.39 and 0.98 mbgl at boreholes BH2, BH5, BH7, BH8 and BH9. For the remaining boreholes, groundwater was encountered between 2.43 and 6.00 mbgl during drilling.

Boreholes BH15 and BH16 were installed on the eastern boundary of the site into swampland environments where groundwater was encountered at or near surface level. Natural material encountered was light grey/ brown sand with grain size increasing with depth.

BH19 and BH20 were installed close to the Rocklow Creek to monitor the potential leachate movement towards the creek. No fill material was encountered at BH19 and all the layers were composed of sand (silty sand was observed in the first ~30 cm). Water strike was noted at 3.5 m at this location. Approximately 1 m of fill material was observed at BH20 containing plastic bags and other types of artificial material, before encountering natural sand. Groundwater was encountered at around 2.5 m at BH20.

6.3 Groundwater physics

Inferred groundwater flow has been established in a south to south easterly direction (Environmental Earth Sciences, 2011, 2012a, 2013 and 2017) however influences on gradient include historical local sandmining, the deep excavation of the landfill and subsequent overburden placement. There may also be minor tidal influences from Rocklow Creek (located to the south of the site). Changes in soil and bedrock stratigraphy across the site can also influence flow rates and pathways.

Groundwater recharge points include the upper catchment to the north and west, the site itself due to the high permeability of the soil and the large ponds created by sand mining/dredging. Recharge to the groundwater is expected to be rapid on the lower alluvial plains due to the high hydraulic conductivity of the alluvial based sandy soil. The expected discharge point for the local shallow groundwater is Rocklow Creek.

The groundwater monitoring wells are designed to collect water from the upper sand layers situated above the deep clay layer and latite bedrock (5-10 mbgl). Screens are positioned so that water from the unconfined Quaternary alluvium aquifer can be obtained. All boreholes except borehole BH10 are receiving water within the same groundwater flow path and aquifer. Borehole BH10 is located within a separate water bearing zone at the top of the local catchment (to the north of the site).

Groundwater velocity throughout the site varies between 1-16 m/yr (Environmental Earth Sciences NSW 2013). Groundwater levels are affected by the landfilling activities and calculated groundwater velocity and chemical groundwater results indicate (Environmental Earth Sciences NSW, 2013 and 2017) that movement of leachate is likely to be slower downgradient of the landfill near Rocklow Creek due to decreasing hydraulic gradients.

6.4 Tidal effects on groundwater

Environmental Earth Sciences NSW hydrogeological investigations on nearby sites in the same unconfined sand aquifer discharging to Rocklow Creek have determined that tidal influence from the creek results in a maximum observed tidal amplitude in the aquifer of 0.2 m (Environmental Earth Sciences, 2001). It was concluded that the tidal effect could extend as far west as between the landfill site and the Princes Highway (Environmental Earth Sciences, 2001).

Further work in 2005 (Environmental Earth Sciences, 2005) generally limited the tidal influence on between five and 50 m from the tidal creek, depending on soil permeability. Most of the groundwater monitoring wells (excluding BH3, 4, 19, 20 and 20s) are therefore unlikely to be significantly affected by tidal movements.

6.5 Groundwater inorganic chemistry interpretation

Groundwater chemical behaviour is controlled by its constituents that are determined by the initial source of water, the medium through which it travels and the quality and quantity of any infiltrating water (including leachate).

The identification of processes influencing groundwater is difficult when limited to comparing total ionic concentrations of different sources. This difficulty is enhanced by the variations in

ionic concentrations resulting from localised dilution, dispersion, attenuation and infiltration. These influences include rainfall, open water bodies and tidal effects.

As an example, if potassium (K^+) concentrations in a water sample were originally 50 mg/L and are found to have reduced to 30 mg/L when the water is sampled three months later, we would generally draw the conclusion that the K^+ concentration is decreasing in the bore. However, it is also possible that the groundwater has been diluted by an external water source such as rainwater. This means that the relative K^+ concentrations compared to the other ions in the groundwater have not changed, instead they have been diluted for a short while by the influence of an external water source. The long-term data collected from this site has confirmed these effects.

The use of ratios between ionic concentrations simplifies the identification of changes in water quality and can highlight the dominant influences on groundwater chemistry. This method is useful when undertaking contamination investigations of groundwater, in order to identify the major controls on chemical behaviour. A particularly useful ratio is the leachate to non-leachate ratio (L/N ratio), which analyses the sum of leachate ions (potassium, ammonium and nitrate) over non leachate ions (sodium, calcium and magnesium), multiplied by 100, where ratios greater than 10 may indicate leachate influence.

Other influences on water quality and chemical behaviour and that can be used in the interpretation of chemical results include field measurements and observations such as oxidation/reduction potential, temperature, odour, colour, dissolved oxygen and pH. These are used in conjunction with ionic ratios and changes in ionic concentrations to determine the chemical behaviour of surface water and groundwater.

6.6 Groundwater relationships at the site

The nitrogen (N) content in the groundwater (existing as either ammonium (NH_4^+), nitrate (NO_3^-) or nitrite (NO_2^-)) at most bore locations is elevated and can be generally associated with landfill leachate. However, given the natural setting of swamps and the presence of nitrogen fixing vegetation such as *Acacia* and *Casuarinaceae* species, contributions from naturally derived sources cannot be ignored.

Uncontrolled dumping was carried out on site before the mid-1980s and night soil and grease trap wastes were known to be located in the eastern portion of the site (near BH5). Household rubbish was noted in the logs of boreholes BH2 and BH3, but only to 1.5 mbgl. Furthermore, there might be several areas of land filling and night soil deposits, which were not identified in previous investigations and were possible sources of nutrients. These known and unknown sources may influence the nutrient detections at the groundwater monitoring points.

Many plant species such as *Leguminaceae*, *Casuarinaceae*, *Coriariaceae*, *Eleagnaceae* and *Mynacaceae* possess root nodules, which are capable of fixing N. Some of these species have been identified in the landfill and surrounding area. As many of these host plants are perennial growing, exact estimates of the amount of N fixed is difficult to ascertain.

Inputs of some nitrogen, usually as NH_4^+, into the catchment can therefore be attributed to local vegetation. The inclusion of K^+ cannot be associated with these species and alternative contributions such as leachate and the night soil should be assessed.

Although K^+ is usually a useful parameter for identifying night soil and landfill leachate, the differing water chemistry and stratigraphy over the site makes it difficult to establish whether the K^+ levels are actually elevated or natural. Ca^{2+}/K^+ ratios are a useful indicator for the presence of influence from night soil or landfill leachate. Ratios less than three are an indication of these sources on this site.

In the absence of a carbonate source and under uniform pH conditions, bicarbonate (HCO_3^-) values on this site can be used as a proportional measure of microbial activity between bores. The record of shells in the logs indicates the presence of a carbonate (CO_3^{2-}) source; however, unlike microbial activity shells do not cause a rapid change in CO_3^{2-} concentration unless dissolved by acid. Hence, on the site, elevated HCO_3^- levels indicate elevated microbial activity which can assist in attenuating any leachate contamination.

7 FIELD INVESTIGATIONS

7.1 Sampling and field analyses

Monitoring has been on-going on a quarterly basis since November 1992. During this annual monitoring round surface and groundwater sampling was undertaken by Environmental Earth Sciences NSW on 15 November 2018, 13 February 2019, 14 May 2019 and 20-21 August 2019.

Surface and groundwater samples were collected using submersible pumps or designated wattera tubing withdrawing the water straight from surface water bodies or boreholes into clean sampling containers. The sample is only taken after the wells have been purged of at least three standing volumes or water and redox potential (pe), EC (electrolytic conductance) and pH have stabilised. Sample containers are securely capped, stored in ice-filled coolers and transported to the laboratory for analysis. Cleaning and decontamination protocols have been provided in the QA/QC section in **Appendix C.**

Standing water level (SWL), temperature, pH, EC and ORP (oxidation-reduction potential in mV), colour, odour and flow characteristic measurements were collected in the field at each location.

During July 2019, bores BHA, BH12-r, BH17-r and BH19-r were installed to replace bores BH12, BH17, BH19 and BH18, destroyed during the redevelopment of buildings at Dunmore Resource and Recycling (DRR). It was intended to reinstall BH18 near its original location, however due to refusal on buried obstructions and concrete, the bore was relocated to the north-western corner of the offices at DRR (BHA).

Locations of the monitoring network is illustrated in **Figure 2**.

Table 2 presents the water levels measured over the last year. Field measurements for the previous twelve months of sampling are reproduced in **Table 7** (back of report).

7.2 Groundwater flow

Table 2: Groundwater levels

Sample location	SWL (mAHD)	SWL (mAHD)	SWL (mAHD)	SWL (mAHD)
	Nov-18	Feb-19	May-19	Aug-19
BHA	-	-	-	0.91
BH1c	0.614	0.554	0.624	0.84
BH2	0.832	0.717	0.767	0.95
BH3	-1.416	0.634	0.614	0.49
BH4	0.619	0.529	0.649	-
BH5	-	-	-	-
BH6b	-	-	-	-
BH8	-	-	-	-
BH9	0.945	-	0.975	
BH10	3.901	1.4161	-	3.91
BH12	-	-	-	
BH12-r	-	-	-	0.73
BH13	0.915	0.835	0.885	0.83
BH14	0.875	0.805	0.855	0.81
BH15[1]*	0.76	-	-	-
BH16	0.68	0.54	0.56	0.47
BH17	-	-	-	-
BH17R	-	-	-	0.89
BH18	-	-	-	-
BH19	-	-	-	-
BH19R	-	-	-	0.45
BH20s	0.365	0.4	0.46	0.4

[1] BH15 is located at the bottom of a slope which became very overgrown and difficult to access following the November 2018 monitoring round.

Sample location	SWL (mAHD)	SWL (mAHD)	SWL (mAHD)	SWL (mAHD)
BH20	0.35	0.44	0.44	0.4

8 ADOPTED SITE CRITERIA

Adopted site derived criteria are taken from the guidelines for the protection of ecosystems as per ANZECC (2000) — *Australian water quality guidelines* (ANZECC, 2000). The guidelines take into account trigger values for fresh and marine waters and provide level of protection percentages for specific analytes.

The ANZG (2018) – *Australian and New Zealand guidelines for fresh and marine water quality* provide revised set of guideline values for certain values for the protection of both fresh and marine waters. Both sets of guidelines take into account trigger values for fresh and marine waters and provide level of protection percentages for specific analytes. For the purpose of this assessment, site derived criteria are based on ANZECC (2000) values and long-term monitoring of data over the past 20 years.

Groundwater flows vary over the site, but in general the pressure gradient is towards Rocklow Creek to the south of the site. The ANZECC (2000) guidelines are therefore appropriate as the groundwater beneath the landfill will ultimately discharge into a marine environment. Values for a level of protection for 95% of species in a marine environment are considered relevant to this site and have been adopted as site criteria **(Table 3).**

It should also be recognised that these trigger values are conservative when used to assess groundwater at the point of discharge into a surface water body. Attenuation effects (e.g. dilution, dispersion and biological activity) could reduce contaminant levels substantially by the time the waters migrate and discharge to the river.

A guideline value of 0.3 mg/L is used for soluble iron. This value is derived from interim indicative working level presented in *section 8.3.7* of ANZECC 2000 and is based on Canadian guidelines. Presently there are no Australian derived guidelines for dissolved iron in a marine environment.

Guidelines for the annual organic analysis of the leachate are presented in **Table 4**.

Table 3: Ecological investigation threshold levels

Analyte	Adopted criteria for groundwater (mg/L)	Adopted criteria for surface water (mg/L)
Ammonia[D]	2.09^	1.88^
Nitrate[J*]	10.6	10.6
pH	6.5-8.5	6.5-8.5
Dissolved iron[#]	300	300

Notes:

1. C = Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species) – check Section 8.3.7 for spread of data and its significance. Where grey shading and 'C' coincide, refer to text in Section 8.3.7.
2. D = Ammonia as TOTAL ammonia as [NH3-N] at pH 7.1. For changes in trigger value with pH refer to Section 8.3.7.2 of ANZECC 2000
3. J = Figures protect against toxicity and don't relate to eutrophication. Refer to Section 3.3 if eutrophication is the issue.
4. * = Nitrate trigger value of 10600 µg/l used from Hickey (2013).
5. # = interim indicative working level presented in section 8.3.7 of ANZECC 2000, (Based on Canadian derived guidelines).
6. ^ = Ammonia-N value for 95% species protection for freshwater ecosystems adopted for groundwater.
7. Grey shading = adopted site criteria.

Table 4: Guidelines for organic analysis

Analyte	Adopted site criteria (µg/L)
Total petroleum hydrocarbons	10,000*
Phenol	320[a]
Benzene	950[a]
Toluene	300[a]
Ethyl benzene	140[b]
Naphthalene	16[a]

Notes:

1. [a] – guideline levels from ANZECC (2000) Guidelines for protection of freshwater aquatic ecosystems; and
2. [b] – guideline levels from NSW EPA (1994) Contaminated sites: Guidelines for assessing service station sites for protection of freshwater aquatic ecosystems
3. * - Refer to Table 12.

9 LABORATORY ANALYSIS

NATA accredited laboratories were used for required analyses including:

- Sydney Analytical Laboratories (SAL) for inorganic analyses on water samples and ambient dusts concentrations;
- the National Measurement Institute (NMI) for organic analysis on the leachate sample (LP1) in November 2018; and
- Sonic Health for faecal coliforms and Escherichia coli on the leachate sample (LP1).

The following analyses were undertaken for site groundwater and surface water during the 2018 - 2019 monitoring events:

- groundwater – ionic balance (total dissolved salts (TDS), sodium, calcium, potassium, magnesium, fluoride, chloride, ammonium, sulfate, bicarbonate, phosphate and nitrate),

total organic carbon (TOC), biological oxygen demand (BOD), total and soluble iron, and soluble manganese.

- surface water (SWC2, SWC_UP, SWC_DOWN and SWC_DOWN_2) – total and soluble iron, turbidity, nitrate, nitrite, ammonium and bicarbonate;
- SWP 1,2, 4 and 5, SWC_UP and SWC_DOWN – ionic balance, total and soluble iron and turbidity;
- additional analyses for SWP4, include TOC and BOD; and
- leachate tanks – ionic balance, TOC, BOD, total and soluble iron, soluble manganese, turbidity, faecal coliforms and E. Coli. Additional sampling for total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, m/p xylene, o-xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs) and halogenated aliphatic compounds (HACs) was undertaken on sample LP1 during the November 2017 monitoring round.

Over the 2018/2019 monitoring period surface water bodies continued to be monitored for most of the above constituents to assist in interpretation. Annual organic analysis was undertaken on a water sample collected from the leachate tanks in November 2018 round.

A discussion on quality assurance and quality control (QA/QC) sampling procedures is presented in **Appendix B** of this report, with results of field blind and laboratory duplicate analysis given as part of the laboratory transcripts in **Appendix D**.

10 RESULTS

All laboratory results are tabulated in **Table 8** and **Table 10**. Biological results are presented in **Table 11** and organic lab results are presented in **Table 12**. Original laboratory transcripts or all analyses undertaken are presented in **Appendix D.**

11 DISCUSSION

11.1 Groundwater levels

Groundwater was determined to be flowing in a south by south easterly direction over the monitoring period (**Figure 3**), which was similar to previous years.
Standing water levels across the site have decreased slightly to an average of 0.78 m AHD but have remained predominantly stable throughout the monitoring period from November 2018 – August 2019. Groundwater levels across the site are highly correlated and historically show rapid recharge following months of average to above average rainfall (see **Chart 2**), with the site's sandy soils promoting percolation through the soil profile to groundwater.

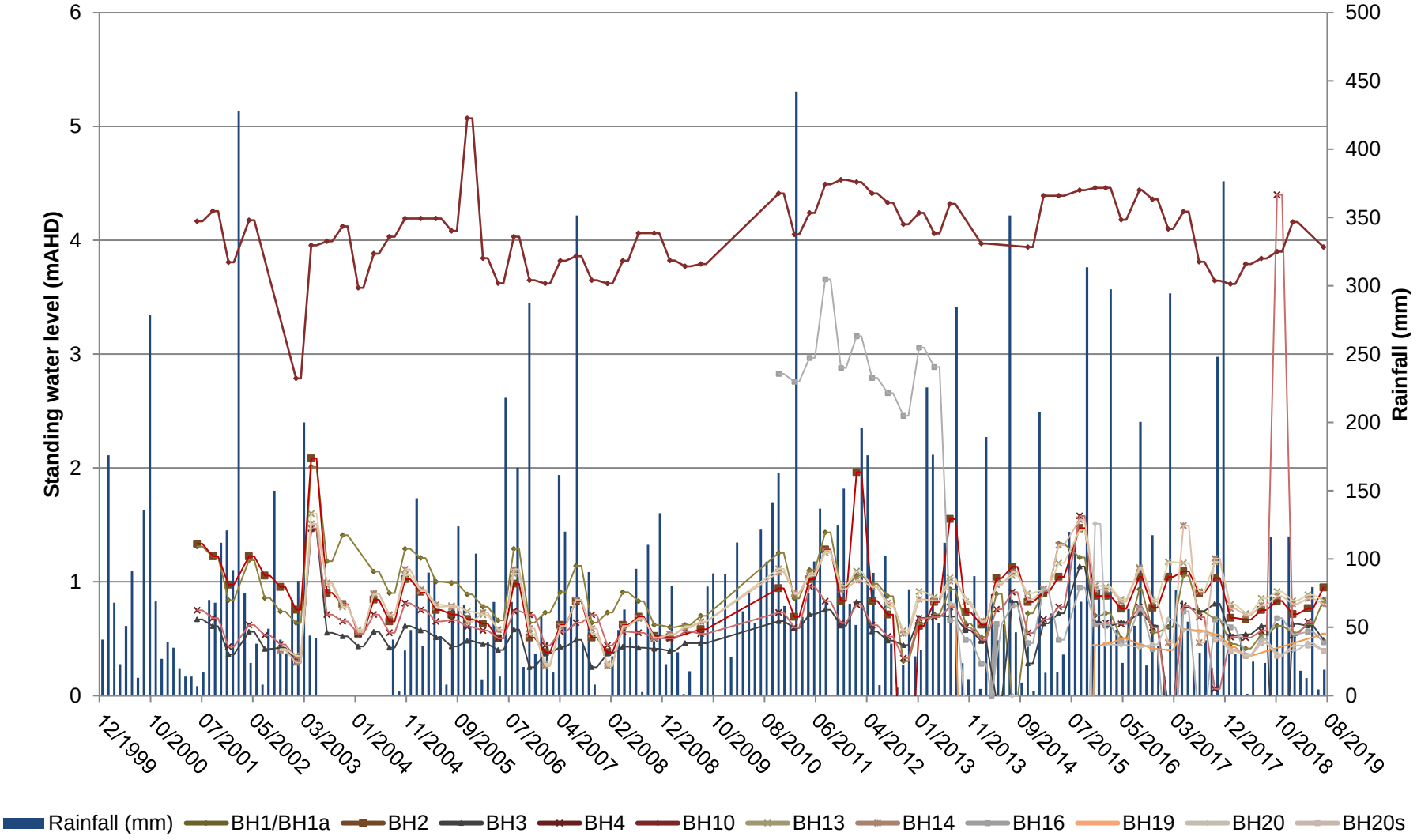

Chart 2 – Groundwater levels and rainfall since 2001

11.2 Groundwater chemistry

Groundwater chemistry across the site varies between those locations impacted by leachate and those not impacted. At locations of limited to no leachate impact, groundwater was characterised by K^+/TDS ratio of <3 and Ca^{2+}-Cl^- species dominance. Impacted groundwater locations generally displayed a high Cl^-/SO_4^{2-} ratio with K^+/TDS >3. Elevated HCO_3^- and TOC is also observed at leachate impacted groundwater locations. Groundwater ionic ratios are presented in **Table 13** (Tables section).

The comparison of ratios for groundwater between November 1992 and the last monitoring year generally indicates ongoing leachate plume movement across the site. A comparison of natural groundwater ion concentrations to those of the leachate pond shows that leachate water is chemically different to natural groundwater beneath the site. A detailed assessment on chemical status of groundwater at the site is included in the following sections. Individual borehole chemistry is discussed in **Appendix E** with accompanying Schoeller plots (**Appendix F**) to aid in interpretation.

11.2.1 Sample locations impacted by leachate

Over the past monitoring year, groundwater monitoring locations BH1c, BH2, BH3, BH15, BH20 and BH20s, as well as BH17 and BH12 from the August 2019 monitoring round displayed chemistry indicative of groundwater dominated by non-native cations in one or more monitoring rounds (**Appendix F – Schoeller Plots**). Chemical results are summarised in **Table 8 and Table 13.** Full laboratory transcripts are in **Appendix D.** This indicated that an external influence, such as leachate, is altering the groundwater chemistry.

The sources of these non-native cations can potentially be from multiple sources including:

- landfill leachate associated with current land filling activities;
- residual landfill leachate associated with the shallow old landfill;
- residual impact from an overflow of the former leachate pond which occurred in 2003;
- stockpiles of organic waste;
- residual night soil deposits (referred to as aged or effluent contamination); and
- possibly nitrogen fixing vegetation and decomposition of organic matter under the forested area to the south (only minor influence).

The relative contribution of non-native ions is exhibited by elevated concentrations of potassium (K^+), ammonium (NH_4^+) and/or nitrate (NO_3^-) relative to sodium (Na^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}). The elevated non-native ion concentrations are expressed in a high (>10) or significantly high (>20) L/N ratio (**Chart 3**). Field measurements indicated possible leachate influence with elevated EC, leachate or H_2S odour, negative redox and a yellow and/or brown colour (**Table 7**).

<u>BH1c</u>

Borehole BH1c is situated within the landfill cell and leachate was expected to be encountered at this location. The chemical signature of groundwater from this location was

consistent with that of the sample collected from the leachate tank (e.g. elevated L/N and K/TDS ratios, reducing state).

BH2

Borehole BH2 showed slight leachate influence, which can be attributed to being in close proximity to current landfilling activities and also being located in the shallow old landfill cells. No significant changes to chemical characteristics were notable at BH2 with the L/N ratio fluctuating between 13 and 15. NH_4-N levels were elevated at concentrations between 39 and 44 mg/L.

BH3

Groundwater from borehole BH3 has consistently shown leachate impact. During the last year, the L/N ratios at this location were recorded between 30 and 60%. The dominating nitrogen species at this location was NO_3^-. This indicated the occurance of nitrification in this area. Field observations at this location noted a clear color and no odour during 2018-2019 annual round. In previous monitoring reports, it was suggested that elevated nitrogen species concentrations and an increase of the L/N ratio was associated with relatively high rainfall recorded in October and November 2018 and subsequent leaching of nitrogen species from the overlying unconfined waste in the vicinity of BH3 through the soil profile and into groundwater. Elevated L/N ratios after significant rainfall has been observed over the historical data range. The best example of this trend was observed during the August 2013 monitoring round, which was undertaken following a cumulative rainfall of 390.2 mm for May, June and July comparative to the 198.5 mm mean rainfall for 1999-2018 for that period. BH3's historic peak L/N ratio (208.90%) was recorded that monitoring round.

BH12-r

Bore BH12_r was reinstalled in July 2019 to the southwest of the leachate tanks and south of the compost/green waste stockpiles. This bore was installed to replace BH12 (monitoring point 9 of EPA license number 5984) following the development of the new facilities at Dunmore Resource and Recycling. Field observations recorded a negative redox (-4 mV). Groundwater was observed to be clear with no discernible odour recorded, however a strong odour associated with the adjacent green waste and compost stockpiles made it difficult to pick up any slight odours in groundwater. The chemical signature of the groundwater at this location is indicative of leachate impact (elevated TDS (1580mg/L), K^+(62 mg/L), which is in keeping with the migration of leachate from the main landfill to the southeast. When compared with historic data for BH12, concentrations of other landfill indicators such as Ca/K ratio had increased (9.28 in August 2019 compared to 1.07 in November 2016) and NH_4^+-N had decreased (1.50 mg/L in August 2019 compared to 12 mg/L in November 2016), indicative of degradation of the leachate plume. This is further supported by elevated concentrations of Fe (2.4 mg/L) and very low levels of dissolved oxygen (as low as -0.23 ppm) indicate an anaerobic environment and biochemical demand in response to microbial degradation.

BH15

Borehole BH15 displayed elevated L/N ratio, which was 54% in the August 2018 monitoring round and 39% in the November 2018 round. The location BH15 is at the bottom of a bank. Following the November 2018 round, this area became overgrown with vegetation and inaccessible due to the expansion of the green waste area. Elevated L/N ratios is associated with high K^+ and NH_4^+-N levels and a high K/TDS ratio >15. Petroleum hydrocarbon analysis

of groundwater at BH15 in the November 2017 monitoring round resulted in non-detections for all analytes. BH15 is located down-hydraulic gradient of the old unlined landfill cell and former leachate ponds and is also close to a drainage line with the groundwater bearing zones <0.5 m from the ground surface. A data review report issued in August 2017 (Environmental Earth Sciences, 2017) provided visual plots of a leachate plume, which was moving towards the south-south-east through bore BH15. The plume first appeared around 2006 to the north-west of bore BH5 (Environmental Earth Sciences, 2017). This plume may be associated with the leachate pond overflow incident that was recorded on 2003 or a potential leachate migration from the landfill. Over the course of the monitoring period (August 2018 and November 2018) the trend of decreasing L/N ratio continued from 109.33% recorded in November 2017 which occurred parallel to below average rainfall on site to 39% in November 2018. It is important to note that bore BH15's location near the drainage line presents the potential for groundwater to be influenced by surface water flow and local onsite and offsite works. It is likely that high L/N values occur at BH15 from nutrient rich runoff that is transported through the drainage channel during times of rainfall.

BH17_r

BH17_R was installed in July 2019 to replace BH17b, following the development of the new facilities at Dunmore Resource & Recycling. Bore 17R is located to the east of the leachate tanks, which provides coverage to the eastern bounds of the site (**Figure 1**). Results compared with historical data from BH17 (**Schoeller plot BH17, Appendix F)** indicates that the chemical signature has reduced slightly since 2016 but remains broadly stable. The L/N ratio (14.64 %) is higher than the last recorded value of nearby bore BH17 (7.06%) but is consistent with values recorded in 2012. Negative ORP (-114 mV) and very low dissolved oxygen in addition to elevated concentrations of Fe (3.2 mg/L) and Mn (0.23 mg/L) are indicative of an anaerobic environment and high microbial activity. Further evidence of microbial activity and respiration of nitrogen species in groundwater is elevated HCO_3^- (545 mg/L) resulting in a low Cl/HCO_3^- ratio of 1.2. This indicates degradation of the leachate plume, and the organic nitrogen species therein.

BH20

BH20 is located directly down gradient of the landfill, leachate ponds and shallow old landfill. This borehole was positioned to assess the chemical characteristics on the boundary of the landfill site. The field observations of BH20 were found to have a negative redox with sulphuric odour and a colour fluctuating between light brown and clear between monitoring rounds. The L/N ratio was observed to be decreasing from November 2018 to May 2009, from 29.9% to 17.54%, however had increased again to 26.2% in the August 2019 monitoring round. Whilst recorded concentrations of K^+ and NH_4^+ were elevated, other landfill indicators were low or absent. In addition, TDS at this location was low (<1000 mg/L), making the L/N susceptible to natural variations in chemistry

BH20s

Bore BH20s is located directly adjacent to BH20 but at a shallower depth. Screened intervals of BH20 and BH20s are 6.0-9.0 mBGL and 1.5-4.5 mBGL respectively. This bore was positioned to compare the chemical characteristics on the boundary of the landfill site in order to locate potential transport pathways to Rocklow Creek. In comparison to August 2018, the monitoring round in August 2019 recorded a positive redox (32 mV), indicative of an oxidative atmosphere. Increasingly elevated NO_3^-led to elevated L/N ratios (69.8% in August 2019), however due to the low TDS value, it is considered that this may be due

natural chemical fluctuations. As observed within BH3, relatively high rainfall from March to June 2019 may have impacted the nitrogen species within BH20s, causing leaching of nitrogen species from the soil into the groundwater, resulting in elevated NO_3^- concentrations. Ammonium levels has increased during the August round (1.2 mg/L) but remain lower than those seen at the deeper BH20 bore. It was previously thought that high nitrate levels in this shallower bore location was indicative of nitrification throughout the soil profile, however, continued monitoring at this location will be necessary to determine potential leachate transport pathways to Rocklow Creek. A detailed description of leachate impact at these locations is presented in **Appendix E**.

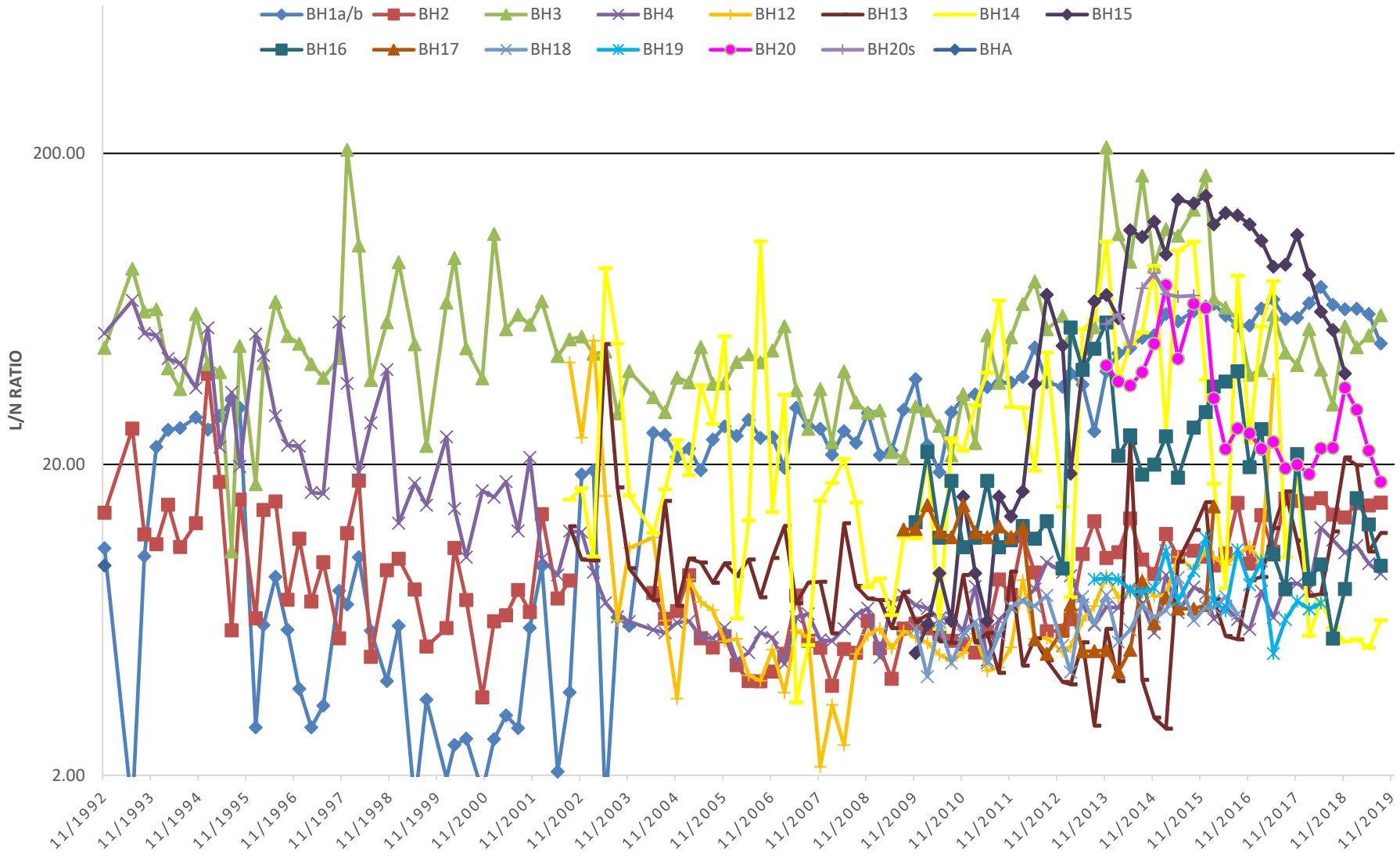

Chart 3. L/N ratio for all active groundwater boreholes from the beginning of monitoring in 1992.

11.2.2 Remaining bore locations

Boreholes BHA, BH4, BH13, BH14, BH16 and BH19 showed minimal leachate impact through the measurement of native ion dominance within groundwater.

BHA

BHA is located to the east of the landfill and to the south of the former BH18 and positioned to be hydraulically upgradient of the leachate plume migrating to the southeast. During the August 2019 monitoring round, the L/N ratio was 9.45%, suggesting mild impact by leachate. A redox potential of 6 ppm and dissolved oxygen content of -0.27 ppm is suggestive of a slight oxidative to reducing environment. TDS is relatively low (790 mg/L) making the L/N susceptible to natural variation in groundwater chemistry. Both ammonium and nitrate levels were relatively low to moderate (0.4 mg/L and 9.8 mg/L respectively). In addition, groundwater was also low in Na^+ (76 mg/L) with an elevated Ca/K ratio (20.20) and moderate K/TDS ratio (1.77%) (**Table 13**). Bore BHA is strategically placed up gradient of landfilling activities and should be continually monitored to determine the background water quality.

BH13

In addition to BH12R, Bore BH13 is in close proximity to a former night soil area (**Figure 1**). A slight residual leachate influence has been apparent at this location in the past. Analysis of chemical data from the 2018- 2019 monitoring round shows an increase of L/N ratio of 15.59 % from 12.03 % in August 2019. Concentrations of NO_3^- continue to fluctuate; at 2.30 mg/L are comparable with the February 2019 monitoring round (3.10 mg/L), but still significantly lower than the November 2018 round (31.0 mg/L). Large fluctuations in NO_3^- have previously been observed in the historic data, however, chemical composition of the groundwater has generally remained consistent since monitoring began in 2002 (**Schoeller plot BH13**, **Attachment F**). Similar to the previous year, nitrogen species were dominated by nitrate, which suggested redox conditions are slightly favouring oxygenated conditions. Ammonia concentrations have been elevated at this location since August 2017 (2.8 mg/L) where levels reached an historical peak. This location is strategically down gradient of the landfill and the ionic balance within borehole BH13 and chemical indicators measured across 2017-2018 may indicate a leachate plume has passed through the location over this time. This location will continue to be closely monitored as any future leachate front should be noticeable here.

BH14

The L/N ratio at Borehole BH14 recorded a 69% decrease during the 2018 monitoring round and remianed relatively stable throughout 2019, with a slight increase to 6.3% in the August 2019 monitorng round (Table 13). Concentrations of K^+ have stabilised and reduced steadily from historical high levels recorded from 2017. NO_3^- was below typical concentrations at this location during the November, February and May 2019 monitoring rounds, but had increased to 3.6 mg/L in the August 2019 round (**Table 8**). It has previously been discussed that BH14 may be in hydraulic connectivity with the former SWP3 which most likely collected run off from the former unlined landfill cell. The historical presence of nitrate as the dominant species within groundwater at BH14 is reflected by the typically positive historical ORP values. The oxygenation of the groundwater at BH14 was a relict effect of the former position of SWP3. The decrease in NO_3^- concentration and negative ORP values for the November, February and May 2019 monitoring rounds is evidence of the closure of the infiltration pathway for oxygenated water from SWP3 into BH14 following SWP3's infilling.

Historically, fluctuation of NO_3^- has occurred at this location with very elevated levels occurring, peaking at 250 mg/L in May 2015. These fluctuations could be linked to rainfall events and the subsequent increase in groundwater flow, transporting nitrate from the shallow old landfill near this location and the main landfill mass up-gradient of this location (see Figure 1).

BH16

Borehole BH16 is located on the neighboring site to the east and on the opposite side of the drainage line in a swampy area (Figure 2) with groundwater field observations recording a brown colour and a minor leachate / sulfuric odour. The sampled redox potential indicates a reducing environment, which may have an influence on the historical dominance of NH4+-N over NO_3^-. Groundwater sampling over the 2018-2019 monitoring period showed limited to impact at BH16, with peak L/N ratios of 15.56% and 12.81% recorded in the February and May 2019 monitoring rounds respectively. Bores BH15 and BH16 are located close to a drainage channel where offsite impacts can readily influence the chemical characteristics of the shallow groundwater and should continue to be monitored for fluctuations.

BH4

The L/N ratio at bore BH4 continued to decrease in the 2018- 2019 monitoring rounds, reducing from 10.94% in the November 2018 round. The L/N ratio at this location had not previously exceeded 10% since May 2003. NH_4^+-N levels decreased from 8.9 mg/L to 6.70 mg/L however concentrations in nitrite (NO_2^-) decreased further from the low concentrations recorded in May (0.1mg/L in the August 2019 round from 0.23mg/L in May 2019), indicative of a decrease in the nitrification process and transformation of NH_4^+-N to NO_2^-. BH4 is placed on the border of the historic shallow landfill site and down gradient of landfilling activities. This area should be continually monitored to determine water quality in this area.

BH19

Historically, chemical characteristics of BH19 suggested limited to no leachate influence such as an L/N ratio < 10 and a relatively higher Ca/K ratio (> 20). A blockage in BH19 was recorded in the August 2018 monitoring round, meaning that it was not possible to obtain a representative sample. The well was reinstalled in July 2019 and the first round of monitoring was in August 2019. BH19 is in place to determine any potential leachate migration to the south west of site and will continue to be monitored. The August 2019 monitoring round recorded no leachate influence, with a L/N ration of 7.16% (**Table 13)** and an elevated Ca/K ratio of 13.74 (**Table 13**). As for BH4, NH_4^+-N (5.5mg/L) was dominant over NO_3^- and was closely comparable to historical readings.

11.3 Leachate chemistry

The chemistry of leachate water at this site is different to that of the groundwater and surface water. This is best illustrated through observation of leachate indicators for boreholes and the leachate tank presented in **Table 8, 10, Chart 2** and **Appendix F** (Schoeller plot).

Impacted bores generally displayed elevated total dissolved solids (TDS), biochemical oxygen demand (BOD), ammonium (NH_4^+) and potassium (K^+) concentrations compared to unaffected bores (**Table 8 and Appendix F**). Additionally, very low Ca^{2+}/K^+, and high Na^+/Ca^{2+}, Cl^-/SO_4^{2-}, total organic carbon (TOC) and L/N ratios are chemical signatures of landfill leachate (**Schoeller Plot Appendix F**).

During the annual monitoring period, laboratory analysis for faecal coliforms and Escherichia coli sampled at LP1 (**Table 11**) were low in comparison to historical values in all round, with the highest recorded in February 2019, 170 cfu/100mL and 140 cfu/mL respectively, which were still three orders of magnitude lower than those recorded in November 2017. Although low concentrations may indicate a reduced health risk, fluctuations occur regularly at LP1 and as such leachate waters must be treated as potential health risk and dermal contact should be kept to a minimum.

11.4 Surface water monitoring

Results of surface water analysis (**Table 9 and 10**) for samples collected from Rocklow Creek (SWC2, SWC_Up, SWC_Down and SWC_Down_2) and four surface water ponds (SWP1, SWP2 and SWP4) confirm that concentrations of ions in the waters continue to be similar to previous monitoring rounds (**Schoeller Plots, Appendix F**).

Ponds SWP1, SWP2, SWP4 and SWP5 are intended to retain any surface water migrating towards Rocklow Creek. The results of the samples collected from these locations provide information about the potential leachate impact in the runoff water. The ionic balance results of the samples collected from these ponds were consistent with historical levels.

In the surface water ponds, in general, nitrate was the dominant nitrogen species indicating oxygenised conditions. However, ammonium has dominated the nitrogen species at SWC-UP, and at SWP1 and SWP4 on two occasions over the past monitoring year.

SWP1 is located on the northern boundary (**Figure 2**) of the site and water at this site has very little impact from landfill activities. Surface water chemistry showed elevated ammonia concentrations in November 2018 (3.5 mg/L) which exceeded the adopted site criteria for surface water (1.88 mg/L) (**Table 10**). Ammonia presence at SWP1 is unlikely to be caused by leachate due to its up-gradient position from the landfill. This location generally has significant levels of organic matter floating on the surface and the presence of ammonia is likely as a result of the natural ammonification process of organic nitrogen to ammonia.

Surface water sampling location SWP2 did not record elevated nitrate in the 2018 -2019 monitoring round. This surface water pond collects runoff from around the site and potential impacts from nutrient-transporting runoff are often observed. Chemical characteristics at SWP2 over the year were within historical levels.

Surface water samples from SWP4 may indicate leachate influence from the adjacent active cell and former unlined landfill cell with exceedances of the adopted site criteria for ammonia in May 2019 (3.2 mg/L) and August 2019 (2.1 mg/L). The retention ponds are able to buffer changes associated with leachate influence through biological activity. In the 2018-2019 annual round, the L/N ratio followed a decreasing trend (**Table 14)**, which may be correlated to the below average rainfall and the subsequent below average volume of surface runoff collected within surface water ponds on site.

Surface water pond SWP5 was found to be dry in all quarterly monitoring rounds. Historical low TDS measurements (<1000 mg/L) at this location is evidence that water within this pond originates from surface water runoff and rainfall.

Four surface water sites are sampled from Rocklow Creek (SWC_Up, SWC_Down, SWC_Down_2 and SWC2). SWC_Up, SWC_Down are positioned up and down gradient of the SWC2 site and aid in assessing leachate impacts within Rocklow Creek. SWC_Down_2 is located further downstream of SWC_Down (Figure 1). Rocklow Creek is an estuarine environment, represented by very high levels of EC and TDS, which fluctuate with the tide, and Na-Cl dominance with low calcium and low L/N ratio (<10%). These chemical characteristics are distinctly different to that of the onsite surface water ponds which is visually represented in **Chart 4**.

Low nutrient and L/N ratios at these locations indicated no leachate impact within Rocklow Creek. SWC2, SWC_Up, SWC_Down and SWC_Down_2 generally had low concentrations of ammonia and nitrate (<0.6 mg/L). Elevated concentrations exceeding the site criteria were recorded at SWC2 in May 2019 (3 mg/L) (**Table 10**). Dissolved iron was within historical values at all locations within Rocklow Creek and below adopted site criteria (0.3 mg/L).

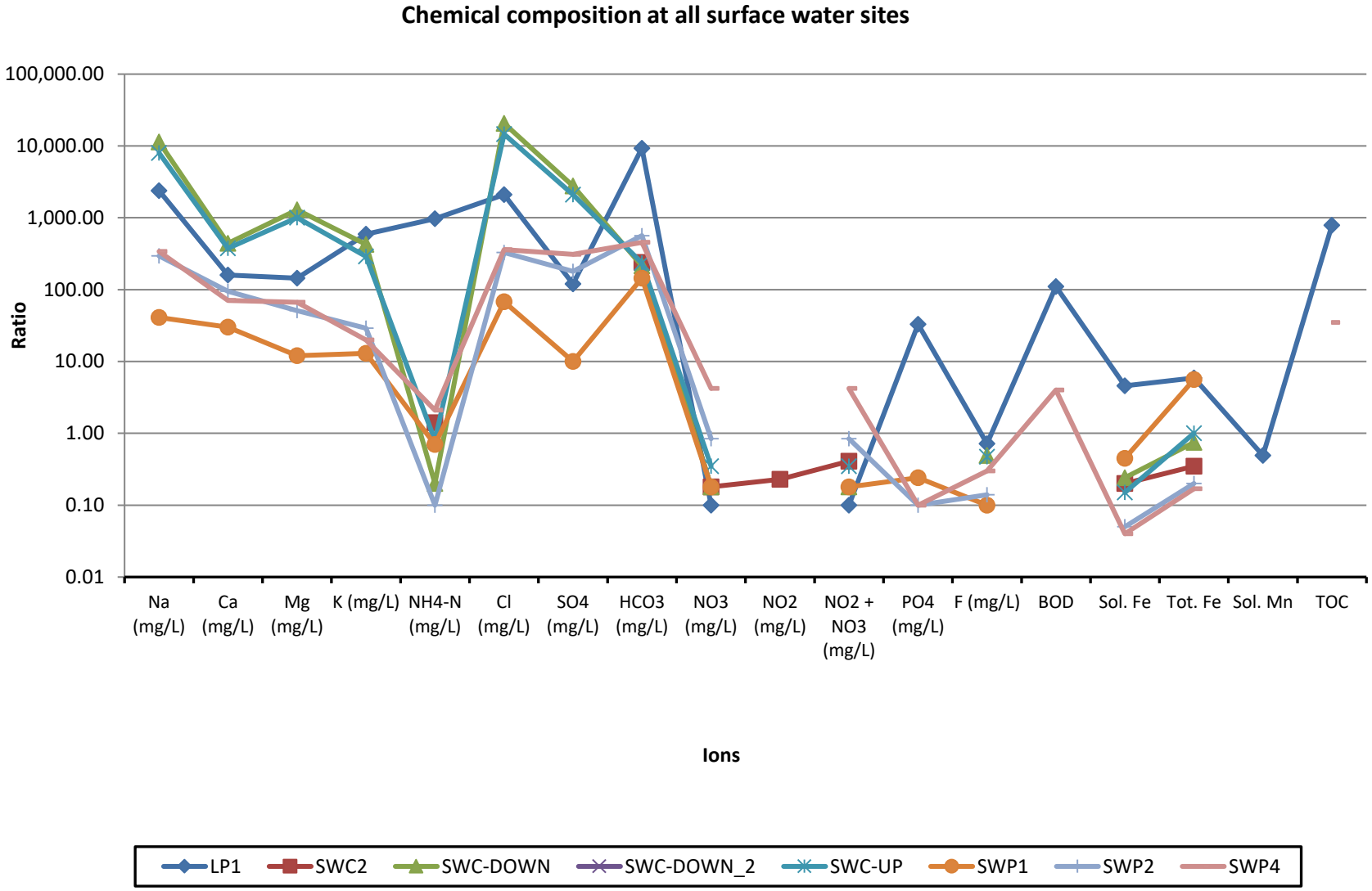

Chart 4. Chemical composition of surface water sites for the August 2019 sampling period.

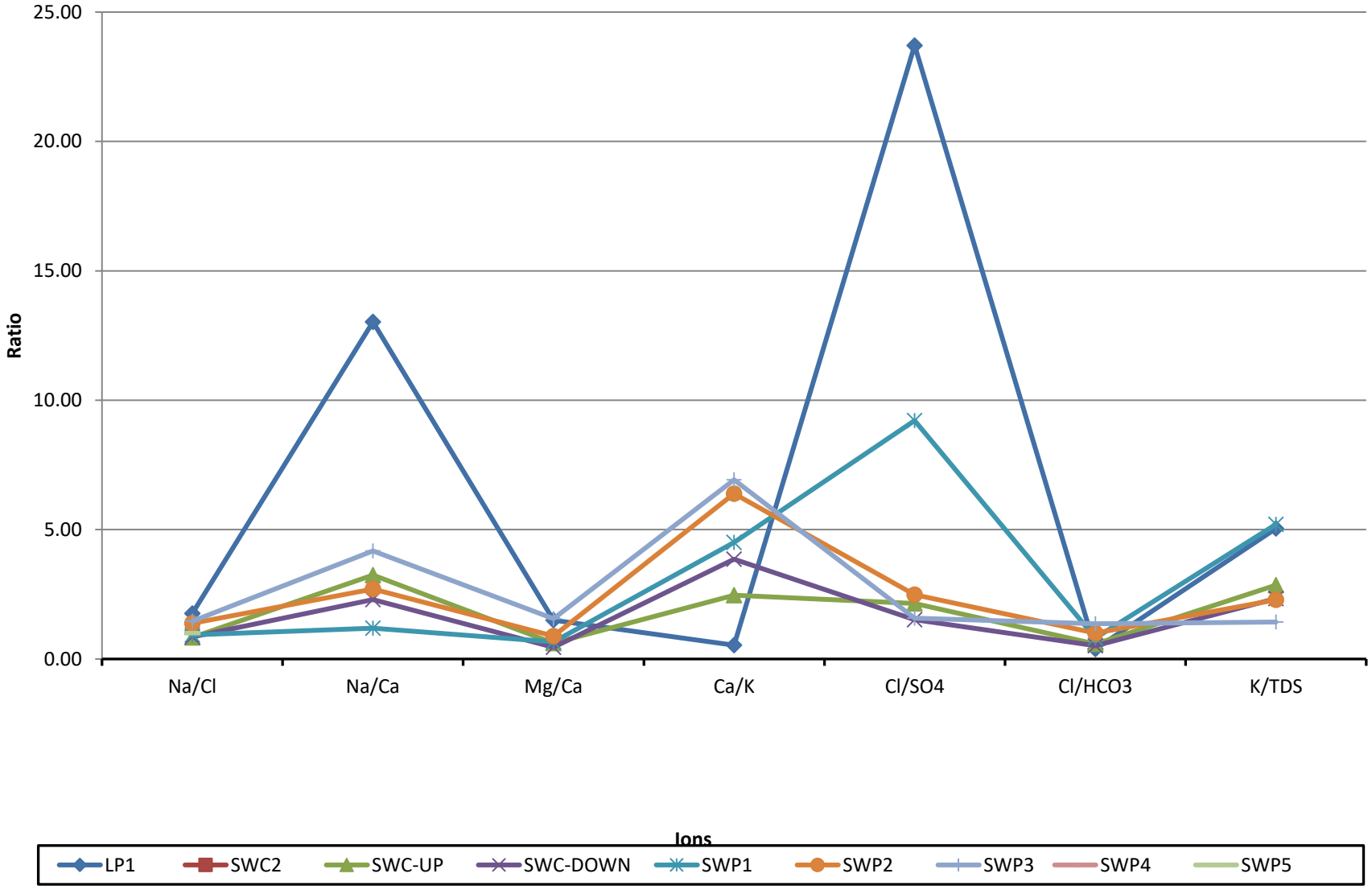

Chart 4. Surface water ratios for the August 2019 sampling period.

11.5 Gas monitoring

Landfill gas was measured in the field using a Flame Ionisation Detector (FID)/ Intra spectre Laser Unit (ILU) and a GA5000 Landfill Gas Analyser (a GFM430 was used during the August 2018 monitoring round). Measurements were taken within and around all buildings in a 250 m radius from the current landfill cell as well as across the landfill cap and active landfilling face for the four monitoring periods. A summary of these results is presented in Table 5. Sampling across the relevant locations consisted of walking a grid pattern and taking readings every minute (see **Figure 4** for the gas walkover grids).

A deficiency in the landfill cap is indicated by the presence of methane at levels greater than 500 ppm (NSW EPA, 2016). No landfill deficiencies were noted over the period from November 2018 to August 2019. Ongoing monitoring will occur on a quarterly basis to ensure any future deficiencies are detected.

Table 5: Summary of gas analysis for 2018 -2019

Location	Nov-18		Feb-19		May-19		Aug-19	
	GA 5000 V/V%	ILU V/V%	GA 5000 V/V%	ILU V/V%	GA 5000 V/V%	ILU V/V%	GA 5000 V/V%	ILU V/V%
Landfill cap	**0**	0.00027	0.5	0.48	0	0.0206	0	0.00014
Main weigh bridge, weigh bridge office and landfill office sheds	0	0.00021	0	0.00025	0	0.00033	0	0.00014
Dunmore Resource & Recycling Services	0	0.00023	0	0.00026	0	0.00098	0	0.0001
GUIDELINES	1.00% v/v and 0.05% v/v							

Notes:

1. results and guidelines are expressed in V/V %.
2. Guidelines are as per the NSW EPA (2016):
3. reporting threshold of 1.00 % v/v CH_4 within onsite buildings;
4. the threshold level for further investigation and corrective action is 500 parts per million (volume/volume) of methane at any point on the landfill surface for intermediate and finally capped areas.
5. CH_4 = methane; VOCs = volatile organic compounds (total);
6. - not analysed; and
7. values above the guidelines are **bolded**.

11.6 Dust monitoring

Dust monitoring and analysis is carried out to comply with the requirements of Australian Standards AS 3580.10.1. The annual average limit for fallout of dust (derived for coal mining areas of NSW) is 4 g/m^2/month annual average of total solids. The location of the dust deposition gauge is placed at the northern boundary of the site, adjacent to the closest residences, along Shellharbour Road (**Figure 1**).

The average total solids for dust deposition measured from November 2018 to August 2019 was 1 g/m^2/month (annual average), slightly higher than 0.7g/m^2/month recorded the previous year but below the average limit of 4 g/m^2/month for fallout of dust. Hence, dust

generation from the landfill towards the nearest residences does not appear to be significant and as such is not a concern. Results of dust analysis are presented as part of **Table 15** and **Appendix D**.

11.7 Comparison to adopted site criteria

Groundwater and surface water samples were compared to the adopted site criteria listed in Section 8 to assess the impact of leachate on and offsite.

Exceedances of the adopted site criteria are summarised below and in **Table 6**:

- Two slight exceedances of pH (field criteria) below the minimum value of 6.5
- 28 exceedances of the ammonium adopted site criteria at eight groundwater locations and two surface water ponds. One exceedance recorded in Rocklow Creek in May 2019.
- 10 exceedances of the nitrate adopted site criteria at four groundwater locations. No exceedances in surface water ponds or Rocklow Creek.
- 20 exceedances of the dissolved iron adopted site criteria at eight groundwater locations and one surface water pond. No exceedances within Rocklow Creek.

Groundwater locations with high ammonium levels were generally in close proximity to or directly beneath known areas of waste such as at BHA, BH1c, BH2, BH3 and BH4. BH20 is located down-hydraulic gradient of the landfill mass and has a screened interval of 6 to 9 mBGL which intercepts the ammonium plume that is transported through the deeper aquifer.

Relatively high exceedances for nitrate in groundwater (>20 mg/L) were observed at BH3, BH12_r BH13 and BH20s. BH3 accounted for four of the ten exceedances at groundwater locations and down-hydraulic gradient BH20s accounted for four exceedances. Levels of nitrate measured at BH3 were typically higher than at BH20s indicating dispersion and dilution of the nitrate plume towards Rocklow Creek, although elevated concentrations at BH20s recorded in November 2018 and August 2019is associated with the breakdown of ammonium in the deeper aquifer.

Table 6: Sample locations exceeding adopted site criteria

Analyte	Number of exceedances	Exceedance location	Exceedance date	Value (mg/L)
pH (6.5 – 8.5)	**2**	BHA	August 2019	**6.45**
		BH15	November 2018	**6.44**
Ammonium (NH_4^+-**N**) (1.88 mg/L for surface water and 2.09 mg/l for groundwater)	**28**	BH1c	November 2018	**350**
			February 2019	**355**
			May 2019	**325**
			August 2019	**330**
		BH2	November 2018	**44**
			February 2019	**39**
			May 2019	**41**
			August 2019	**42**
		BH3	November 2018	**29**
			February 2019	**19**
			May 2019	**27**
			August 2019	**41**
		BH4	November 2018	**16**
			February 2019	**6.7**
			May 2019	**8.9**
			August 2019	**6.7**
		BH13	May 2019	**2.8**
			August 2019	**3**
		BH17_R	August 2019	**9.6**
		BH19-R	August 2019	**5.5**
		BH20	November 2018	**39**
			February 2019	**21**

Analyte	Number of exceedances	Exceedance location	Exceedance date	Value (mg/L)
			May 2019	**14**
			August 2019	**24**
		SWC2	May 2019	3
		SWP1	November 2018	**3.5**
		SWP4	May 2019	**3.2**
			August 2019	**2.1**
Nitrate (NO_3^-) (10.6 mg/L)	**10**	BH3	November 2018	**64**
			February 2019	**56**
			May 2019	**105**
			August 2019	**26**
		BH12_r	August 2019	**130**
		BH13	November 2018	**31**
		BH20s	November 2018	**105**
			February 2019	**33**
			May 2019	**54**
			August 2019	**55**
Soluble Iron (Fe) (0.3 mg/L)	**20**	BHA	August 2019	**0.89**
		BH1c	November 2018	**1.4**
			February 2019	**2.9**
			May 2019	**3.5**
			August 2019	**2.1**
		BH2	November 2018	**1**
			February 2019	**3.2**
			May 2019	**2.5**

Analyte	Number of exceedances	Exceedance location	Exceedance date	Value (mg/L)
			August 2019	**1.2**
		BH3	August 2019	**0.35**
		BH12_r	August 2019	**2.4**
		BH14	November 2018	**1.5**
			February 2019	**0.32**
			August 2019	**1.4**
		BH16	November 2018	**0.65**
		BH17_r	August 2019	**3.2**
		SWP1	November 2018	**3.1**
			February 2019	**2.3**
			May 2019	**0.64**
			August 2019	**0.45**

Notes: SWP = surface water pond, BH = borehole.

12 RECOMMENDATIONS AND CONCLUSION

Inferred groundwater contours for the past four quarterly monitoring rounds, show a general groundwater direction to the south south-east towards Rocklow Creek. Groundwater velocity throughout the site varies between 1-16 m/yr with the lower rates found towards the southern areas due to the lower hydraulic gradients.

Over the 2018-2019 monitoring period, groundwater at boreholes BH1c, BH2, BH3, BH15, BH20 and BH20s as well as BH17-R and BH12-R exhibited strong signs of leachate influence, whereas bores BHA, BH4, BH13, BH14, BH16 and BH19-R showed minor to no influence of leachate. This influence can be attributed to historical or current landfill leachate, and effluent leachate. Groundwater from the remaining sampling locations did not appear influenced by leachate.

Annual organic, inorganic and microbial analysis of the water in the leachate tanks (LP1) continued to indicate that concentrations of leachate and contaminants in this water poses a risk to human health and any contact with this water should be avoided.

Results from surface water monitoring indicate possible site impacts are affecting locations SWP1, SWP2 and SWP4. The connectivity between the surface water bodies and groundwater has not been specifically assessed however past chemical results indicate a potential interaction between the two.

There was limited evidence of leachate impact detected at the down gradient Rocklow Creek site SWC2, SWC_Up, SWC_Down and SWC_Down_2. These locations typically had low ammonium and nitrate levels over the last four sampling events between November 2018 and August 2019 (between 0.1 and 1.4 mg/L). With the exception of an exceedance on ammonium at SWC2 in May 2019, all constituents were below the ANZECC (2000) trigger values for marine waters (1.88 mg/L and 10.6 mg/L, respectively).

Ammonium in the groundwater generally exceeded the threshold values. Historically there has been an apparent decreasing trend in concentration in nitrogen species in the groundwater towards the south. Results and previous review (Environmental Earth Sciences, 2017) indicate elevated ammonium and nitrate is recorded in groundwater across the site but is not impacting Rocklow Creek.

No landfill cap deficiencies were noted during the 2018-2019 monitoring period. The current level of capping on the landfill is deemed sufficient. Furthermore, no gas was detected at site sheds, buildings, weighbridge, or offices. Ongoing monitoring should continue to occur on a quarterly basis to ensure no landfill gas related human health hazards are present at these locations.

The dust deposition gauge positioned at the north western site boundary contained slight levels of insoluble solids, ash and combustible matter. Calculated quarterly dust levels, were below the guideline value and are not considered a concern based on the appropriate Australian/New Zealand Standard AS/NZ 3580.10.1: (2003).

All results collected over the monitoring period for 2018-2019, suggest that the landfilling activities untaken at Dunmore Recycling and Waste Disposal Depot, are not significantly impacting offsite receptors.

The following recommendations can be considered by Shellharbour City Council:

- continue the current monitoring program to meet EPL requirements and to ensure leachate plume, landfill gas migration and surface water conditions are monitored;
- BH15 has not been able to be monitored during the recent annual monitoring rounds due to very overgrown vegetation. It is recommended to clear access to BH15 to enable monitoring in future rounds.

13 LIMITATIONS

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from Shellharbour City Council;
2. The specific scope of works set out in PO112168 issued by Environmental Earth Sciences NSW for and on behalf of Shellharbour City Council;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at Dunmore Recycling and Waste Depot, Buckleys Road, Dunmore, NSW (“the site”);
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill, excavated natural material (ENM) or virgin excavated natural material (VENM) if deposited off site;
9. This report is not a geotechnical or planning report suitable for planning or zoning purposes; and
10. Our General Limitations set out at the back of the body of this report.

14 REFERENCES

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15 GLOSSARY OF TERMS

The following descriptions are of terms used in the text of this report.

Acid Sulfate Soil (ASS). A soil containing iron sulfides deposited during either the Pleistocene or Holocene geological epochs (Quaternary aged) as sea levels rose and fell.

Alluvial. Describes material deposited by, or in transit in, flowing water.

Anaerobic. Reducing or without oxygen.

Aquifer. A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, confined. An aquifer that is overlain by a confining bed with significantly lower hydraulic conductivity than the aquifer.

Aquifer, perched. A region in the unsaturated zone where the soil is locally saturated because it overlies soil or rock of low permeability.

Background. The natural level of a property.

Baseline. An initial value of a measure.

Biodegradation. A biochemical process of microbial oxidation of complex organic compounds, to simpler chemical products. Micro-organisms derive the energy and cell carbon for growth from oxidation of organic compounds.

Bore. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface.

Borehole. An uncased well drill hole.

Cation Exchange Capacity (CEC). The maximum positive charge required to balance the negative charge on colloids (clays and other charged particles). The units are milli-equivalents per 100 grams of material or centimoles of charge per kilogram of exchanger.

Clay. A soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Colluvial. Unconsolidated soil and rock material moved down-slope by gravity.

Confined Aquifer. An aquifer that is confined between two low-permeability aquitards. The groundwater in these aquifers is usually under hydraulic pressure, i.e. its hydraulic head is above the top of the aquifer.

Confining layer. A layer with low vertical hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. A confining layer is an aquitard. It may lie above or below the aquifer.

Contaminant. Generally, any chemical species introduced into the soil or water. More particularly relates to those species that render soil or water unfit for beneficial use.

Contamination. Is considered to have occurred when the concentration of a specific element or compound is established as being greater than the normally expected (or actually quantified) background concentration.

Diffusion. A process by which species in solution move, driven by concentration gradients (from high to low).

Dilution. The mixing of a small volume of contaminated leachate with a large volume of uncontaminated water. The concentration of contaminants is reduced by the volume of the lower concentrated water. However, the physical process of dilution often causes chemical disequilibria resulting in the destruction of ligand bonds, the alteration of solubility products and the alteration of water pH. This usually causes precipitation by different chemical means of various species.

Discrete sample. Samples collected from different locations and depths that will not be composited but analysed individually.

Dispersion. A process by which species in solution mix with a second solution, thus reducing in concentration. In particular, relates to the reduction in concentration resulting from the movement of flowing groundwater.

Dissolved Oxygen (DO). Oxygen in the gaseous phase dissolved in water. Measured either as a concentration in mg/L or as a percentage of the theoretical saturation point, which is inversely related to temperature. At 19, 20 and 21 degrees Celsius, the oxygen concentrations in mg/L corresponding to 100% saturation are 9.4, 9.2 and 9.0 respectively.

Electrical Conductivity (EC). The EC of water is a measure of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration. An estimate of TDS in fresh water can be obtained by multiplying EC by 0.65.

Flow path. The direction in which groundwater is moving.

Fluvial. A material deposited by, or in transit, in streams or watercourses.

Fracture. A break in the geological formation, e.g. a shear or a fault.

Gradational. The lower boundary between soil layers (horizons) has a gradual transition to the next layer. The solum (soil horizon) becomes gradually more clayey with depth.

Gradient. The rate of inclination of a slope. The degree of deviation from the horizontal; also refers to pressure.

Groundwater. The water held in the pores in the ground below the water table.

Groundwater Elevation. The elevation of the groundwater surface measured relative to a specified datum such as the Australian Height Datum (mAHD) or an arbitrary survey datum onsite, or “reduced level” (mRL).

Head space. The air space at the top of a soil or water sample.

Heavy Metals. All metallic elements whose atomic mass exceeds that of calcium (20) and includes lead (Pb), copper (Cu), Zinc (Zn), cadmium (Cd), and tin (Sn).

Heterogeneous. A condition of having different characteristics in proximate locations. Non-uniform. (Opposite of homogeneous).

Horizon. An individual soil layer, based on texture and colour, which differs from those above and below.

Hydraulic Conductivity (K). A coefficient describing the rate at which water can move through a permeable medium. It has units of length per time. The units for hydraulic conductivity are typically m3/day/m2 or m/day.

Hydraulic Gradient (i). The rate of change in total head per unit of distance of flow in a given direction – the direction is that which yields a maximum rate of decrease in head. Hydraulic Gradient is unit less.

Hydraulic Head (h). The sum of the elevation head and the pressure head at a point in an aquifer. This is typically reported as an elevation above a fixed datum, such as sea level.

Hydrocarbon. A molecule consisting of carbon and hydrogen atoms only, such as found in petroleum.

Hydrocarbon, volatile. A hydrocarbon with a low boiling point (high vapour pressure). Normally taken to mean those with ten (or less) carbon atoms per molecule.

Infiltration. The passage of water, under the influence of gravity, from the land surface into the subsurface.

Ionic Exchange. Adsorption occurs when a particle with a charge imbalance, neutralises this charge by the attraction (and subsequent adherence of) ions of opposite charge from solution. There are two types of such a charge: pH dependent; and pH independent or crystalline charge. Metal hydroxides and oxyhydroxides represent examples of the former type, whilst clay minerals are representative of the latter and are normally associated with cation exchange.

Ions. An ion is a charged element or compound as a result of an excess or deficit of electrons. Positively charged ions are called cations, whilst negatively charged ions are called anions. Cations are written with superscript +, whilst anions use - as the superscript. The major aqueous ions are those that dominate total dissolved solids (TDS). These ions include Cl-, SO42-, HCO3-, Na+, Ca2+, Mg2+, K+, NH4+, NO3-, NO2-, F-, PO43- and the heavy metals.

Lithic. Containing large amounts of fragments derived from previously formed rocks.

Mottled. Masses, blobs or blotches of sub-dominant, varying colours in the soil matrix.

Nodulation. Are hard, usually small, accumulation of precipitated iron and/or manganese in the soil profile, usually a result of past alternating periods of oxidation/reduction.

Nodule. A small, concretionary (hard) deposit, usually of iron and/or manganese.

Organics. Chemical compounds comprising atoms of carbon, hydrogen and others (commonly oxygen, nitrogen, phosphorous, sulfur). Opposite is inorganic, referring to chemical species not containing carbon.

Oxidation. Was originally referred only to the addition of oxygen to elements. However, oxidation now encompasses the broader concept of the loss of electrons by electron transfer to other ions.

Perched Groundwater. Unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone. Perched groundwater typically occurs in discontinuous, often ephemeral, lenses, with unsaturated conditions both above and below.

Permeability (k). Property of porous medium relating to its ability to transmit or conduct liquid (usually water) under the influence of a driving force. Where water is the fluid, this is effectively the hydraulic conductivity. A function of the connectivity of pore spaces.

Piezometric or Potentiometric Surface. A surface that represents the level to which water will rise in cased bores. The water table is the potentiometric surface in an unconfined aquifer.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Polycyclic aromatic Hydrocarbons (PAHs). Complex organic molecules which originate typically in the combustion of organic compounds.

Potential Acid Sulfate Soil (PASS). A soil that has the potential to become acidic if it is exposed to the atmosphere.

Porosity (n). The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment. Typically given as a percentage.

Porosity, effective (ne). The volume of the void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment.

Precipitation (chemical). There are two types of precipitation, pH dependent precipitation and solubility-controlled precipitation. As the pH is raised beyond a threshold level the precipitation of metal cations such as oxy-hydroxides and hydroxides occur. As the pH is raised further precipitation continues until there are very few metal cations remaining in solution. This reaction is entirely reversible. Solubility controlled precipitation occurs between two ions when, at a given temperature and pressure, the concentration of one of the ions exceeds a certain level.

Profile. The solum. This includes the soil A and B horizons and is basically the depth of soil to weathered rock.

Purge (wells). The pumping out of well water to remove drilling debris or impurities; also conducted to bring fresh groundwater into the casing for sample collection. The later ensures that a more representative sample of an aquifer is taken.

QA/QC. Quality Assurance / Quality Control.

Recharge Area. Location of the replenishment of an aquifer by a natural process such as addition of water at the ground surface, or by an artificial system such as addition through a well

Recovery. The rate at which a water level in a well rises after pumping ceases.

Redox. REDuction-OXidation state of a chemical or solution.

Redox potential (Eh). The oxidation/reduction potential of the soil or water measured as milli-volt.

Reducing Conditions. Can be simply expressed as the absence of oxygen, though chemically the meaning is more complex. For more details refer to OXIDATION.

Remediation. The restoration of land or groundwater contaminated by pollutants, to a state suitable for other, beneficial uses.

Representative Sample. Assumed not to be significantly different than the population of samples available. In many investigations' samples are often collected to represent the worst-case situation.

Saturated Zone. A zone in which the rock or soil pores are filled (saturated) with water.

Shale. Fine-grained sedimentary rock formed by the compaction of silt, clay, or sand that accumulates in deltas and on lake and ocean bottoms. It is the most abundant of all sedimentary rocks.

Standing Water Level (SWL). The depth to the groundwater surface in a well or bore measured below a specific reference point – usually recorded as metres below the top of the well casing or below the ground surface.

Stratigraphy. A vertical sequence of geological units.

Subsoil. Subsurface material comprising the B and C horizons of soils with distinct profiles. They often have brighter colours and higher clay content than topsoils.

Texture. The size of particles in the soil. Texture is divided into six groups, depending on the amount of coarse sand, fine sand, silt and clay in the soil.

Topsoil. Part of the soil profile, typically the A1 horizon, containing material, which is usually darker, more fertile and better structured than the underlying layers.

Total Dissolved Salts (TDS). The total dissolved salts comprise dissociated compounds and undissociated compounds, but not suspended material, colloids or dissolved gases.

Toxicity. The inherent potential or capacity of a material to cause adverse effects in a living organism.

Unsaturated Zone. The zone between the land surface and the water table, in which the rock or soil pores contain both air and water (water in the unsaturated zone is present at less than atmospheric pressure). It includes the root zone, intermediate zone and capillary fringe. Saturated bodies such as perched groundwater may exist in the unsaturated zone. Also referred to as the Vadose Zone.

Volatile. Having a low boiling or subliming pressure (a high vapour pressure).

Water table. Interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

Well. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a Bore.

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light, we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

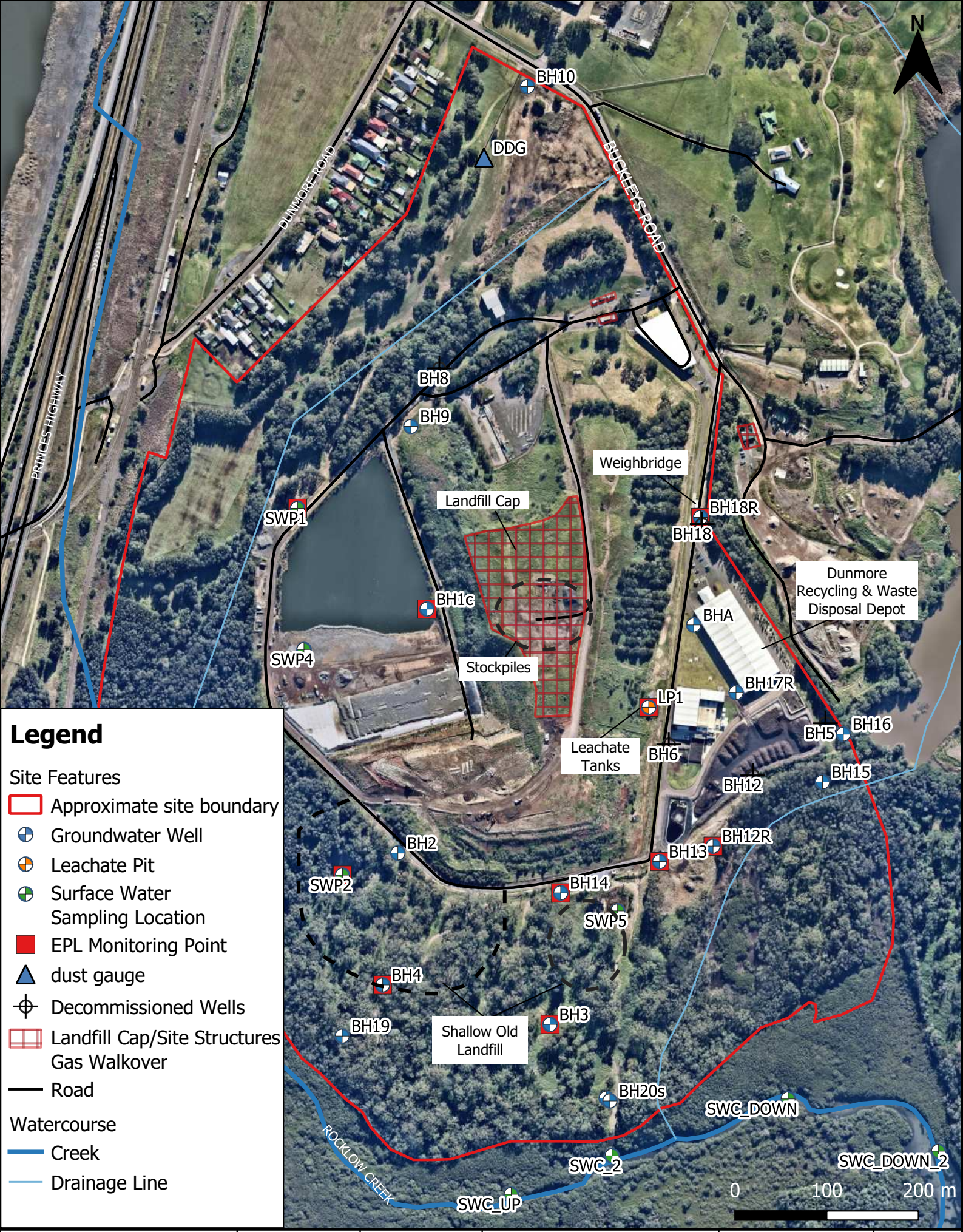
To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES

Legend

SITE BOUNDARY

ENVIRONMENTAL EARTH SCIENCES CONTAMINATION RESOLVED	Drawn by: EG	Date: Oct 2019	**Dunmore Resource and Recycling**	Site Locality	Figure No. 1
	Proj. Manager: EG	Scale: As shown	Shellharbour, NSW		
	Job No: 118109	Source: Google			



Legend

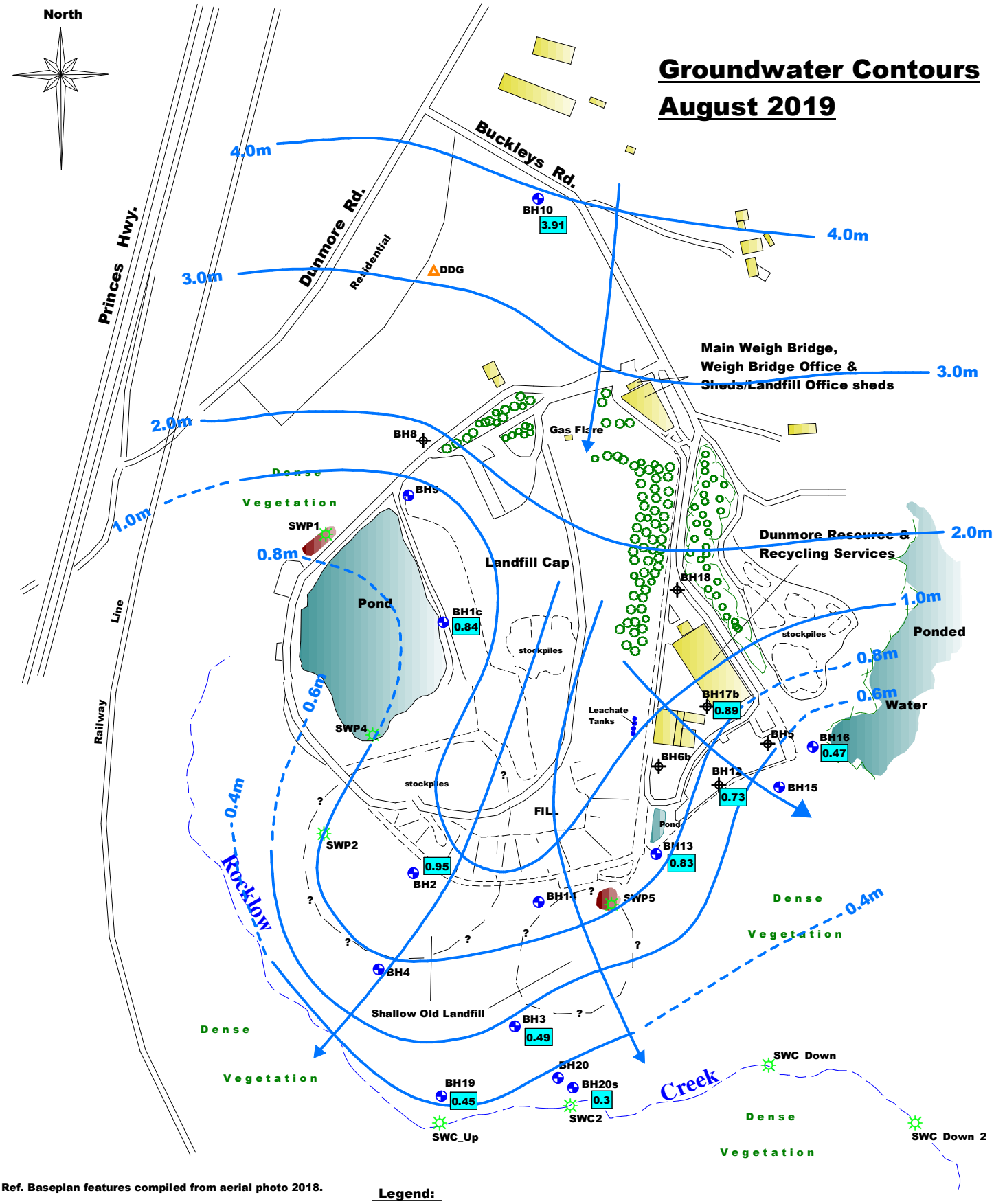
Site Features

- Approximate site boundary
- Groundwater Well
- Leachate Pit
- Surface Water Sampling Location
- EPL Monitoring Point
- dust gauge
- Decommissioned Wells
- Landfill Cap/Site Structures
- Gas Walkover
- Road

Watercourse

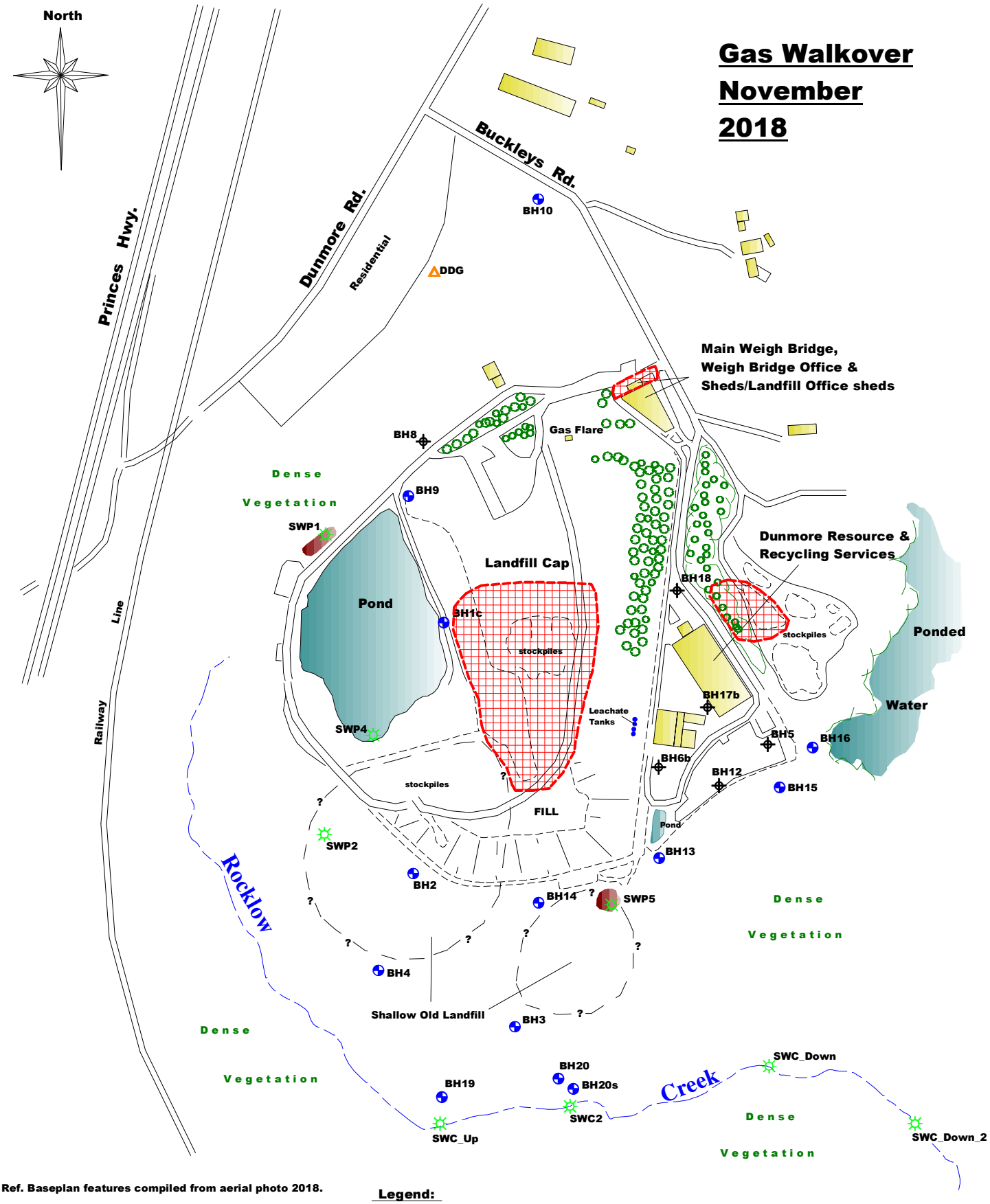
- Creek
- Drainage Line

ENVIRONMENTAL EARTH SCIENCES CONTAMINATION RESOLVED	Drawn by: MN	Date: Sept. 2019	**Shellharbour City Council**	Figure No.
	Proj. Manager: EG	Scale: As shown	Dunmore, NSW	Site Layout 1
	Job No: 118109	Source: Nearmaps		



ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	Groundwater Contours - August 2019
Location:	Buckleys Road, Dunmore, Shellharbour, NSW
Client:	Shellharbour City Council
Job No. 118109	Date: 19 Sept. 2019
Drawn by: TRJ	Proj. Man. MN
Scale: As shown	Figure 2



Ref. Baseplan features compiled from aerial photo 2018.

0 100 200

Scale (metres)

Legend:

- Bore locations
- Dust gauge locations
- Surface water locations
- Decommissioned bores
- Gas walkover

ENVIRONMENTAL EARTH SCIENCES CONTAMINATION RESOLVED	Title:	Gas Walkover	
	Location:	Buckleys Road, Dunmore, Shellharbour, NSW	
Client: Shellharbour City Council	Job No. 118077	Date: May 2019	Figure 3
	Drawn by: TRJ	Proj. Man. EG	Scale: As shown

TABLES

Table 7: Groundwater field measurements 2018 - 2019

Location	Date	SWL (m)	pH	EC (mS/cm)	Temp. ℃ C)	DO (ppm)	ORP (mV)	Colour	Odour	TDS (mg/l)	Comments
BHA	20/08/2019	3.29	6.45	1.2	17.9	-0.27	6	light cloudy brown	none		
BH1c	13/02/2019	3.40	7.01	7.3	26	0.17	-175	Light brown	sweet (Leachate)		
BH1c	14/05/2019	3.33	6.73	7.33	25.9	0.2	-96	Yellow brown	Strong ammonia		
BH1c	13/11/2018	3.34	6.8	7.39	25.8	0.19	-179.5	Brown tinge	sweet (Leachate)		
BH1c	21/08/2019	3.44	6.87	6.98	23.7	0.03	-137	light amber	Slight eggy (H2S)		
BH2	13/02/2019	4.075	7.01	3.15	23.5	0.26	-167	Light brown / yellow	Leachate		
BH2	14/05/2019	4.025	6.89	3.096	23	0.09	-74.8	Yellow	Slight sweet		
BH2	13/11/2018	3.96	6.77	3.45	22.8	0.08	-161	Light brown / yellow	sweet (Leachate)		
BH2	20/08/2019	4.03	6.74	3	20.6	-0.22	-1380	dark grey green	mild sweet leachate		no cap
BH3	13/02/2019	3.13	7.38	1.37	19.3	2.84	-108	Clear	None		
BH3	14/05/2019	3.15	7.19	1.546	19.2	1.08	1.1	None	Clear		
BH3	13/11/2018	5.18	7.17	1.71	18.7	2.22	-96.7	Clear	None		
BH3	20/08/2019	3.25	7.27	2.12	17.1	2.13	-128				small amount of organic matter
BH4	13/02/2019	4.49	7.15	1.7	19.8	0.13	-157	Clear	Mild sweet / leachate odour		
BH4	14/05/2019	4.37	7.3	1.73	19.6	0.04	-70	Clear	Eggy odour		
BH4	20/08/2019	4.43	6.92	1.9	17.1	-0.27	-122	clear	mildH2Stostart		
BH4	13/11/2018	4.4	7.04	1.98	19.1	0.12	-162	Clear	None		
BH13	13/02/2019	4.46	7.05	1.57	21.2	0.29	-51	Clear	sweet (Leachate)		
BH13	14/05/2019	4.41	6.8	1.55	21.5	1.3	-29	None	Clear		
BH13	13/11/2018	4.38	6.84	1.73	20.7	0.19	-19.2	Clear	None		
BH13	20/08/2019	4.46	6.82	1.68	19.3	1.45	-8	clear	none		
BH14	13/02/2019	4.91	6.84	2.15	21	0.3	-74	Clear	None		
BH14	14/05/2019	4.86	6.8	2.04	22.1	1.2	14	Slight light brown	Slight sweet		
BH14	13/11/2018	4.84	6.67	2.42	21.7	0.3	-117.9	Clear	None		
BH14	20/08/2019	4.91	6.54	1.85	19.9	0.03	12	clear	sweet (Leachate)		
BH15	13/11/2018	0.65	6.44	10.83	16.1	6.47	-150	Light brown	sweet (Leachate)		
BH16	13/02/2019	0.84	7.11	0.39	20.7	0.69	-225	Light brown	sweet (Leachate)		
BH16	14/05/2019	0.82	7.29	0.36	18.8	0.28	-161	Murky	Egg odour		
BH16	13/11/2018	0.7	7.45	0.27	17.4	2.83	-200.2	Light brown	sweet (Leachate)		

Location	Date	SWL (m)	pH	EC (mS/cm)	Temp. ℃ C)	DO (ppm)	ORP (mV)	Colour	Odour	TDS (mg/l)	Comments
BH16	21/08/2019	0.91	6.77	0.5	13.2	1.73	-128	clear	none		
BH19-r	20/08/2019	4.65	6.99	1.79	17	-0.15	-107	lightcloudybrown	none		
BH20	20/08/2019	2.375	7.29	1.53	17.1	2.13	-157	very light brown	verymildH2S		
BH20	13/02/2019	2.37	7.31	1.23	20.3	0.14	-112	Clear	None		
BH20	14/05/2019	2.31	7.28	1.3	19.2	0.74	-89	None	Clear		
BH20	13/11/2018	2.405	7.2	1.59	18.4	2.98	-188.6	Clear	None		
BH20s	20/08/2019	2.375	7.24	1.2	15.5	-0.34	32	very light brown	verymildH2S		
BH20s	13/02/2019	2.33	7.38	1.36	18.8	0.15	-210	Clear	None		
BH20s	14/05/2019	2.33	7.27	1.14	20.1	0.07	1.14	None	Clear		
BH20s	13/11/2018	2.42	7.09	1.29	18.3	1.29	22.6	Clear	None		
BH12-r	20/08/2019	4.47	6.53	2.4	20.6	-0.23	-4	clear	none		
BH17-r	20/08/2019	3.56	6.61	2.25	17.4	-0.27	-114	lightcloudybrown	none		

Notes:

1. DO = dissolved oxygen;
2. ORP = Oxygen/reduction potential recorded in mV; and
3. * = Uncertainty in field results associated with instrument malfunction.

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Table 8: Groundwater inorganic laboratory results

Sample	Date	pH	TDS	Na	Ca	Mg	K	NH4-N	Cl	SO4	HCO3	NO3	NO2	PO4	F	BOD	Sol. Fe	Tot. Fe	Sol. Mn	TOC
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
BHA	20-Aug-19	6.9	790	76	145	35	14	0.4	76	235	385	9.8	0	0.1	0.12	2	**0.89**	2.9	0.12	21
BH1c	13-Nov-18	7.3	3850	670	130	105	220	**350**	780	15	3270	0.1	0	0.55	0.31	8	**1.4**	15	0.12	170
	13-Feb-19	7.4	4020	695	140	105	240	**355**	820	13	3250	0.1	0	0.15	0.25	25	**2.9**	15	0.16	175
	14-May-19	7.1	4010	650	130	115	220	**325**	850	15	3070	0.1		0.1	0.18	12	**3.5**	19	0.14	175
	20-Aug-19	**8.1**	4010	930	145	110	250	**330**	850	35	4030	0.1		0.16	0.51	9	**2.1**	15	0.12	195
BH2	13-Nov-18	7.2	1940	325	220	71	39	**44**	460	79	1300	0.1	0	0.1	0.31	2	**1**	15	0.52	32
	13-Feb-19	7.2	1790	340	195	73	52	**39**	450	130	1150	0.1	0	0.1	0.26	2	**3.2**	13	0.47	64
	14-May-19	7.1	1820	335	175	74	45	**41**	400	120	1220	0.1	0	0.1	0.23	2	**2.5**	12	0.5	65
	20-Aug-19	**8.1**	1821	345	180	74	48	**42**	400	130	1180	0.1	0	0.1	0.28	3	**1.2**	10	0.41	60
BH3	13-Nov-18	7.1	875	67	160	23	26	**29**	195	73	445	**64**	0	0.24	0.12	2	0.06	2.2	0.11	14
	13-Feb-19	6.8	730	61	125	20	32	**19**	185	75	290	**56**	0	0.12	0.11	5	0.11	3	0.18	13
	14-May-19	7.2	775	70	180	27	35	**27**	200	77	490	**105**	0	0.1	0.1	2	0.1	1.6	0.12	13
	20.08.19	7.4	1120	135	165	**31**	33	**41**	290	87	640	**26**	0	0.1	0.2	7	**0.35**	13	0.22	15
BH4	13-Nov-18	7.1	1100	125	190	**34**	22	**16**	205	130	650	0.18	0.13	0.1	0.1	2	0.17	5.2	0.19	19
	13-Feb-19	7.1	1060	135	170	**37**	26	**6.7**	210	140	575	0.1	9.6	0.1	0.1	2	0.17	5.1	0.22	19
	14-May-19	7.1	1100	145	190	**36**	24	**8.9**	215	155	675	0.1	0.23	0.1	0.1	3	0.19	5.6	0.21	20
	20-Aug-19	7.3	1101	155	205	**40**	26	**6.7**	220	150	720	0.1	0.1	0.1	0.15	2	0.2	4.5	0.19	21
BH12-r	20-Aug-19	6.9	1580	155	295	**65**	62	1.5	280	300	705	**130**		0.1	0.13	2	**2.4**	3.5	**0.76**	16
BH13	13-Nov-18	7.2	1050	91	190	42	32	1.2	92	270	605	**31**	0	0.1	0.25	2	0.13	2.4	0.24	21
	13-Feb-19	7.3	975	100	185	40	30	1	105	195	625	3.1	0	0.1	0.22	3	0.29	1.2	0.26	23
	14-May-19	7.1	955	100	175	42	35	**2.8**	99	220	645	0.35	0	0.1	0.21	2	0.22	1.9	0.26	23
	20-Aug-19	7.2	1050	105	180	44	46	**3**	88	255	675	2.3	0	0.1	0.23	<2	0.18	1.6	0.23	26
BH14	13-Nov-18	7	1360	215	220	48	25	0.9	265	90	990	0.1	0.1	0.1	0.46	2	**1.5**	5.6	0.37	29
	13-Feb-19	7.2	1360	215	210	57	24	1.7	245	78	1000	0.66	0	0.1	0.44	2	**0.32**	5.4	0.36	27
	14-May-19	6.9	1290	205	195	57	20	1.8	235	85	920	1.7	0	0.1	0.39	2	0.16	4.5	0.4	29
	21-Aug-19	6.9	1200	185	200	48	21	2.7	200	97	880	3.6	0	0.1	0.41	2	**1.4**	3.8	0.32	30
BH15	13-Nov-18	6.9	6620	1350	320	145	605	105	3170	420	985	0.8	0.23	0.12	0.18	3	**15**	38	0.92	160
BH16	13-Nov-18	7.4	195	47	9.3	4.1	4.5	0.2	27	38	98	0.1	0	0.37	0.64	2	**0.65**	6.1	0.02	18
	14-Feb-19	7.5	245	29	22	21	11	0.1	48	35	135	0.1	0	0.1	0.34	9	0.25	2.6	0.09	10
	14-May-19	7.2	215	33	16	15	7.9	0.2	44	43	88	0.1		0.1	0.32	4	0.26	6	0.07	16
	21-Aug-19	7.1	385	64	24	33	11	0.2	120	52	170	0.22	0	0.1	0.26	2	0.22	4.9	0.09	19
BH17-r	20-Aug-19	6.9	1340	200	180	45	51	**9.6**	380	175	545	1.6	0	<0.1	0.11	<2	**3.2**	17	0.23	26
BH19-r	20-Aug-19	7.3	1060	190	155	39	22	**5.5**	230	185	590	0.01	0	0.1	0.11	2	0.19	2.5	0.14	24
BH20	13-Nov-18	7.5	1000	42	175	34	36	**39**	94	400	365	0.1	0	0.24	0.14	2	0.05	2	0.09	19
	13-Feb-19	7.1	815	43	150	38	30	**21**	150	220	355	0.1	0	0.34	0.13	2	0.06	1.7	0.1	19
	14-May-19	7.4	855	49	180	34	32	**14**	120	240	440	0.13	0	0.21	0.12	2	0.12	1.9	0.08	20

Sample	Date	pH	TDS	Na	Ca	Mg	K	NH4-N	Cl	SO4	HCO3	NO3	NO2	PO4	F	BOD	Sol. Fe	Tot. Fe	Sol. Mn	TOC
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	20-Aug-19	7.6	970	59	175	34	46	**24**	160	225	465	0.1	0	0.18	0.16	2	0.15	1.6	0.08	20
BH20s	13-Nov-18	7.7	820	30	150	33	70	0.2	52	140	435	**105**	0	0.1	0.11	2	0.14	1.8	0.06	15
	13-Feb-19	7.6	800	45	110	41	105	0.1	67	200	445	**33**	0	0.1	0.12	2	0.05	0.11	0.1	17
	14-May-19	7.4	810	46	120	39	87	1.1	54	190	425	**54**	0	0.1	0.1	2	0.07	0.12	0.07	16
	20-Aug-19	7.7	810	37	120	41	82	1.2	52	200	410	**55**	0	0.1	0.15	2	0.07	0.09	0.06	18
ANZECC 2000	-	**6.5-8.0**	-	-	-	-	-	**2.09**	-	-	-	**10.6#**	-	-	-	-	**0.3**	-	-	-

Notes:

1. results are in mg/L;
2. – not tested;
3. # guideline from trigger values for slightly disturbed ecosystems in lakes and reservoirs – Hickey (2013);
4. * guideline from freshwater trigger values as total NH4-N at different pH values - Table 8.3.7 of ANZECC (2000) - based on average laboratory measured pH of 7.1 from pH values from all quarters;
5. ** interim indicative working level presented in section 8.3.7 of ANZECC 2000 (based on Canadian derived guidelines);
6. # - based on the recalculated trigger value for freshwater, Hickey 2013; and
7. values above or below the guidelines are bolded.

Table 9: Surface water field measurements 2018 -2019

Sample	Date	pH	EC (mS/cm)	Temp. (°C)	DO (ppm)	ORP (mV)	Colour	Odour	TDS (mg/l)	Comments
LP1	13/11/2018	7.55	16.43	27.3	1.64	-16.3	Black	Leachate	-	-
LP1	13/02/2019	8.07	14.79	26.3	0.58	-110	Black	Leachate	-	-
LP1	14/05/2019	8.11	-32.4	18.3	4.06	13.53	Black	Strong leachate	-	-
LP1	21.08.19	-	-	-	-	-	-	-	-	-
SWC2	13/11/2018	7.15	46.3	21.2	1.69	-101.8	Clear	None	-	High tide
SWC2	13/02/2019	7.24	46.25	21	0.96	-148	Clear	None	-	Mid tide
SWC2	14/05/2019	7.26	43.6	16.1	3.05	39.66	None	Clear	-	-
SWC2	21.08.19	-	-	-	-	-	-	-	-	-
SWC-Up	13/11/2018	7.01	39.52	20.9	1.42	-116	Clear	None	-	High tide
SWC-Up	13/02/2019	7.14	44.34	21.5	0.46	-253	Clear	None	-	Mid tide / YSI resting in sediment
SWC-Up	14/05/2019	7.11	-180	16.3	0.37	38.16	Hydrogen Sulphide	Clear	-	Shallow sample. Black sediments present in water sample.
SWC-Up	21.08.19	7.22	3.6	11.9	3.92	62	clear	none	-	-
SWC-Down	13/11/2018	6.78	44.73	18.9	2.41	-219	Clear	None	-	High tide
SWC-Down	13/02/2019	7.25	42.85	21.2	1.77	-50	Clear	None	-	Mid tide
SWC-Down	14/05/2019	6.8	0.93	16.5	2.05	41.63	None	Clear	-	-
SWC-Down	21.08.19	7	42.6	11.1	3.37	107	clear	none	-	-
SWC_Down_2	13/11/2018	7.38	46.4	21.5	4.9	-91.5	Clear	None	-	High tide
SWC_Down_2	13/02/2019	7.37	46.25	21.3	1.94	-29	Clear	None	-	Mid tide
SWC_Down_2	14/05/2019	7.12	-39	16.1	3.34	39.83	None	Clear	-	Slight surface film
SWC_Down_2	21.08.19	7.44	42.7	10.9	7.1	92	clear	none	-	-
SWP1	13/11/2018	6.5	0.64	18.1	0.15	-119	Brown tinge	None	-	Algae covered pond. Sample obtained 21/11/2018
SWP1	13/02/2019	8.2	-	25	-	-	Brown tinge	None	-	Algae covered pond. Grab sample attained via bucket as no access to sampling point
SWP1	14/05/2019	7.88	-20.1	13.3	0.16	0.351	-	Pond green	-	-
SWP1	21.08.19	7.75	45.2	11.5	9.47	100	clear	none	-	-
SWP2	13/11/2018	7.73	2.11	22.3	5.09	-72.3	Very light brown	Swampy	-	-
SWP2	13/02/2019	8.39	2.15	25.7	6.13	-151	Very light brown	Slight sulfuric	-	-
SWP2	14/05/2019	7.74	-68	13.4	1.47	1.7	None	Clear	-	Green pond scum.
SWP2	21.08.19	6.63	0.48	10.7	1.9	-74	none	none	-	Bulrushes, duckweed
SWP4	13/11/2018	8.14	2.3	24.6	8.36	1.8	Very light brown	None	-	-
SWP4	13/02/2019	9.1	2.34	26.7	9.87	-64	Very light brown	None	-	-

Sample	Date	pH	EC (mS/cm)	Temp. (°C)	DO (ppm)	ORP (mV)	Colour	Odour	TDS (mg/l)	Comments
SWP4	14/05/2019	7.89	73	18	3.95	2.07	-	Murky green brown	-	-
SWP4	21.08.19	7.8	2.28	8.8	7.09	23	faint brown	mild H2S	-	organic matter at surface
SWP5	13/11/2018	-	-	-	-	-	-	-	-	DRY
SWP5	13/02/2019	-	-	-	-	-	-	-	-	DRY
SWP5	14/05/2019	-	-	-	-	-	-	-	-	DRY
SWP5	21.08.19	7.8	2.34	11.8	8	7	dark grey green	none	-	

Table 10: Surface water laboratory results

Sample	Date	pH	TDS	Na	Ca	Mg	K	NH4-N	Cl	SO4	HCO3	NO3	NO2	PO4	F	BOD	Sol. Fe	Tot. Fe	Sol. Mn	TOC
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	13-Nov-18	7.8	9840	1530	105	81	750	**1180**	1830	120	8270	0.71	0	24	0.44	110	**2.4**	2.5	**0.52**	740
	13-Feb-19	**8.1**	8870	1490	120	100	590	**1070**	1840	110	7170	0.1	0	29	0.77	130	**3**	48	**0.42**	695
	14-May-19	**8.5**	7270	1300	110	93	360	**895**	1600	105	5750	0.1		15	0.44	28	**3.7**	7.9	**0.49**	560
LP1	21-Aug-19	7.9	11700	2390	160	145	590	**970**	2100	120	9310	0.1	0	33	0.72	110	**4.6**	5.9	**0.49**	790
	13-Nov-18			-	-	-	-	0.6	-	-	235	0.22	0.1	-	-	-	0.11	0.55	-	-
	13-Feb-19			-	-	-	-	0.6	-	-	185	0.1	0.33	-	-	-	0.13	0.38	-	-
	14-May-19			-	-	-	-	**3**	-	-	210	0.22	0.36	-	-	-	0.13	1.5	-	-
SWC2	21-Aug-19		3600	-	-	-	-	1.4	-	-	240	0.18	0.23	-	-	-	0.2	0.35	-	-
	13-Nov-18	7.5	30300	9060	400	985	405	0.1	16600	2120	175	0.1	0	0.1	0.47	0	0.09	0.31	-	-
	13-Feb-19	7.3	36500	11400	430	1220	475	0.1	20600	2510	230	0.1	0	0.1	0.46	0	0.11	0.25	-	-
	14-May-19	7.2	22500	6670	300	820	250	0.4	12300	1670	195	0.35	0	0.1	0.39	0	0.09	0.24	-	-
SWC-DOWN	21-Aug-19	7.7	37400	11400	440	1290	425	0.2	20600	2780	215	0.18	0	<0.1	0.49	0	0.24	0.75	-	-
	13-Nov-18	7.38	31400	9570	385	1070	400	0.1	17700	2230	155	0.1	0	0.1	0.5	0	0.11	0.25	-	-
	13-Feb-19	7.37	36800	11600	440	1240	480	0.1	20600	2520	210	0.1	0	0.1	0.47	0	0.1	0.23	-	-
	14-May-19	7.12	23600	6670	300	820	250	0.4	12300	1670	195	0.1	0	0.1	0.39	0	0.09	0.24	-	-
SWC-DOWN-2	21-Aug-19	7.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13-Nov-18	7.3	25400	7490	345	880	360	0.6	13900	1830	215	0.1	0	0.1	0.45	0	0.1	0.57	-	-
	13-Feb-19	7.3	35200	10700	445	1250	500	0.2	19100	2490	235	0.1	0	0.1	0.45	0	0.15	0.28	-	-
	14-May-19	7.2	14900	4520	235	560	150	0.1	8070	1180	165	0.1	0	0.1	0.38	0	0.16	16	-	-
SWC-UP	21-Aug-19	7.4	26700	7980	375	1000	290	0.8	14600	2100	235	0.35	0	<0.1	0.47	0	0.15	1	-	-
	13-Nov-18	6.5	-	53	45	19	25	**3.5**	76	5	280	1.6	0	1.3	0.19	0	**3.1**	24	-	-
	13-Feb-19	**8.2**	325	47	42	16	11	0.1	66	12	230	0.1	0	0.1	0.15	0	**2.3**	47	-	-
	14-May-19	7.88	270	44	31	12	8.2	0.3	60	11	175	0.49	0	0.12	0.1	0	**0.64**	1	-	-
SWP1	21-Aug-19	6.63	250	41	30	12	13	0.7	68	10	145	0.18	0	0.24	0.1	0	**0.45**	5.6	-	-
	13-Nov-18	**7.73**	1260	265	88	46	29	0.3	320	175	520	0.22	0	0.12	0.15	0	0.16	0.19	-	-
	13-Feb-19	**8.39**	1290	290	79	58	36	0.2	360	185	510	0.1	0	0.1	0.15	0	0.05	0.15	-	-
	14-May-19	7.74	1260	280	81	50	27	0.1	330	170	545	0.49	0	0.12	0.1	0	0.07	0.09	-	-
SWP2	21-Aug-19	7.8	1270	295	95	51	29	0.1	330	180	565	0.84	0	0.1	0.14	0	0.05	0.2	-	-

Sample	Date	pH	TDS	Na	Ca	Mg	K	NH4-N	Cl	SO4	HCO3	NO3	NO2	PO4	F	BOD	Sol. Fe	Tot. Fe	Sol. Mn	TOC
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	13-Nov-18	**8.4**	1310	305	58	56	25	1	345	270	395	8	0	0.1	0.3	2	0.1	0.25	0	30
	13-Feb-19	**9**	1270	325	44	61	25	0.1	390	320	210	0.1	0	0.1	0.3	4	0.11	0.46	0	38
	14-May-19	7.7	1350	350	62	62	23	**3.2**	375	305	435	0.8	0	0.1	0.28	3	0.09	0.35	0	33
SWP4	21-Aug-19	**8.4**	1400	340	71	67	20	**2.1**	360	310	455	4.2	0	0.1	0.3	4	0.04	0.17	0	35
ANZECC 2000		**6.5-8.0**	**-**	**-**	**-**	**-**	**-**	**1.88***	**-**	**-**	**-**	**10.6#**	**-**	**-**	**-**		**0.3**	**-**	**-**	**-**

Notes:

1. results are in mg/L;
2. – not tested;
3. # guideline from trigger values for slightly disturbed ecosystems in lakes and reservoirs – Hickey (2013);
4. * guideline from marine trigger values as total NH_4-N at different pH values - Table 8.3.7 of ANZECC (2000) - based on average laboratory field measured pH of 7.5 from pH values from all quarters;
5. ** interim indicative working level presented in section 8.3.7 of ANZECC 2000 (based on Canadian derived guidelines); and
6. values above or below the guidelines are **bolded**.

Table 11: Leachate pit - biological laboratory results

Date	E. coli	Faecal Coliforms
	cfu/100 mL	cfu/100 mL
26/11/2008	1300	1300
26/02/2009	80	80
27/05/2009	5400	>16000
27/08/2009	330	330
26/11/2009	>160000	>160000
24/02/2010	>12000	>16000
25/05/2010	1700*	1700*
31/08/2010	>16000	>16000
25/11/2010	1700	1700
24/02/2011	>16000	>16000
23/05/2011	>16000	>16000
23/05/2011	>16000	>16000
21/11/2011	1700	1700
22/02/2012	1300	1300
22/05/2012	790	790
23/08/2012	230	330
5/12/2013	790	790
26/02/2013	34000	17000
28/05/2013	9200	9200
28/08/2013	2400*	2400*
13/11/2013	9200	>16000
26/02/2013	>16000	>16000
28/05/2013	4000	4000

Date	E. coli	Faecal Coliforms
	cfu/100 mL	cfu/100 mL
26/08/2014	1,600,000	1,600,000
21/11/2014	16,000	16,000
24/02/2015	160,000	160,000
27/05/2015	10,000	8,000
4/09/2015	92,000	5,400
3/12/2015	54,000	54,000
9/02/2016	490	490
19/05/2016	260	260
17/08/2016	<10	<10
10/11/2016	< 20	< 20
16/02/2017	1700	1300
9/05/2017	330	330
21/08/2017	400	400
22/11/2017	18000	18000
13/02/2018	<20	<20
10/05/2018	50	80
14/08/2018	<20	20
14/11/2018	20	<20
13/02/2019	170	140
14/05/2019	ND	ND
21/08/2019	20	20

Table 12: Organic laboratory analysis at LP/LP1 – 2008 - 2018

Analyte	Leachate Pond Waters										Nov-18	Guideline
	Nov-08	Nov-09	Nov-10	Nov-11	Nov-12	Nov-13	Nov-14	Nov-15	Feb-17	Nov-17		
Phenol	8.1[#]	7[#]	**352.3[#]**	ND	**180[#]**	ND	**84[#]**	ND	20.1[#]	**1,200**	3.5	**320[a]**
BTEXN												
Benzene	<40	<1	<1	<1	<1	<1	<1	<1	<1	2.9	4.3	**950[a]**
Toluene	<40	1.5	<1	<1	<1	<1	<1	<1	<1	36	5.9	**300[a]**
Ethylbenzene	<40	1.3	<1	<1	<1	<1	<1	<1	<1	7.8	4.1	**140[b]**
Naphthalene	<16[^]	1.7[^]	1.7[^]	ND	ND	ND	1[^]	ND	ND	1.4	4.6	**16[a]**
Petroleum hydrocarbons												
C_6-C_9	<250	<25	<25	<25	<25	<25	<25	<25	160	2,700	150	**-**
C_{10}-C_{14}	900	1,900	1,300	1100	750	<25	1,900	420	1,500	1,400	2100	**-**
C_{15}-C_{28}	3,400	5,500	6,000	4,800	2,800	<100	8,500	1,700	4,900	720	7400	**-**
C_{29}-C_{36}	560	630	1,200	450	390	<100	3,000	180	<100	<100	1200	**-**
Total petroleum hydrocarbons	4,860	8,030	8,500	5,350	3,940	<100	**13,400**	2,300	6,560	4,820	**10,850**	**10,000***

Notes:

1. results are expressed in μg/L;
2. [a] - guideline levels from ANZECC (2000) Guidelines for protection of freshwater ecosystems;
3. [b] - guideline levels from NSW EPA (1994) Contaminated sites: Guidelines for assessing service station sites for protection of freshwater aquatic ecosystems;
4. * - Information needed to select threshold concentrations is incomplete. The NSW Clean Waters Act 1970 and Clean Waters Regulations 1972 prohibit the pollution of waters by unlicensed contaminated discharges and require licensed discharges to be visually free of oil and grease. Experience has demonstrated that the latter criterion is equivalent to an oil and grease concentration of approximately 10mg/L;
5. [#] - Values given are for *Total Phenols* which were previously used as per ANZECC 1992;
6. ^ - Values given are for *Total PAHs* which were previously used as per ANZECC 1992.
7. PAH – polycyclic aromatic hydrocarbons; HACs – halogenated aliphatic compounds; PHs –petroleum hydrocarbons.

Table 13: Groundwater ionic ratios for 2018-2019

BHID	Sample Date	Na/Cl	Na/Ca	Mg/Ca	Ca/K	Cl/SO4	Cl/HCO3	K/TDS	L/N
BHA	Aug-19	1.54	0.46	0.40	20.20	0.44	0.34	1.77	9.45
BH1c	Nov-18	1.32	4.49	1.33	1.15	70.46	0.41	5.71	**62.99**
BH1c	Feb-19	1.31	4.33	1.24	1.14	85.47	0.43	5.97	**63.31**
BH1c	May-19	1.18	4.36	1.46	1.15	76.78	0.48	5.49	**60.91**
BH1c	Aug-19	1.69	5.59	1.25	1.13	32.91	0.36	6.23	**48.95**
BH2	Nov-18	1.09	1.29	0.53	11.00	7.89	0.61	2.01	13.49
BH2	Feb-19	1.17	1.52	0.62	7.32	4.69	0.67	2.91	14.98
BH2	May-19	1.29	1.67	0.70	7.59	4.52	0.56	2.47	14.74
BH2	Aug-19	1.33	1.67	0.68	7.32	4.17	0.58	2.64	15.04
BH3	Nov-18	0.53	0.37	0.24	12.00	3.62	0.75	2.97	**47.60**
BH3	Feb-19	0.51	0.43	0.26	7.62	3.34	1.10	4.38	**51.94**
BH3	May-19	0.54	0.34	0.25	10.03	3.52	0.70	4.52	**60.29**
BH3	Aug-19	0.72	0.71	0.31	9.75	4.52	0.78	2.95	**30.21**
BH4	Nov-18	0.94	0.57	0.30	16.85	2.14	0.54	2.00	10.94
BH4	Feb-19	0.99	0.69	0.36	12.75	2.03	0.63	2.45	9.59
BH4	May-19	1.04	0.67	0.31	15.44	1.88	0.55	2.18	8.89
BH4	Aug-19	1.09	0.66	0.32	15.38	1.99	0.53	2.36	8.20
BH12-r	Aug-19	0.85	0.46	0.36	9.28	1.26	0.68	3.92	**37.57**
BH13	Nov-18	1.5	0.42	0.36	11.58	0.46	0.26	3.05	**19.88**
BH13	Feb-19	1.47	0.47	0.36	12.03	0.73	0.29	3.08	10.49
BH13	May-19	1.56	0.50	0.40	9.75	0.61	0.26	3.66	12.03
BH13	Aug-19	1.84	0.51	0.40	7.63	0.47	0.22	4.38	15.59
BH14	Nov-18	1.25	0.85	0.36	17.17	3.99	0.46	1.84	5.38
BH14	Feb-19	1.35	0.89	0.45	17.07	4.26	0.42	1.76	5.47
BH14	May-19	1.35	0.92	0.48	19.02	3.75	0.44	1.55	5.14

BHID	Sample Date	Na/Cl	Na/Ca	Mg/Ca	Ca/K	Cl/SO4	Cl/HCO3	K/TDS	L/N
BH14	Aug-19	1.43	0.81	0.40	18.58	2.79	0.39	1.75	6.30
BH15	Nov-18	0.66	3.68	0.75	1.03	10.23	5.54	9.14	**39.16**
BH16	Nov-18	2.68	4.41	0.73	4.03	0.96	0.47	2.31	7.95
BH16	Feb-19	0.93	1.15	1.57	3.90	1.86	0.61	4.49	15.56
BH16	May-19	1.16	1.80	1.55	3.95	1.39	0.86	3.67	12.81
BH16	Aug-19	0.82	2.32	2.27	4.26	3.13	1.21	2.86	9.44
BH17-r	Aug-19	0.81	0.97	0.41	6.88	2.94	1.20	3.81	14.64
BH19-r	Aug-19	1.27	1.07	0.41	13.74	1.68	0.67	2.08	7.16
BH20	Nov-18	0.69	0.21	0.32	9.48	0.32	0.44	3.60	**29.92**
BH20	Feb-19	0.44	0.25	0.42	9.75	0.92	0.73	3.68	**22.12**
BH20	May-19	0.63	0.24	0.31	10.97	0.68	0.47	3.74	17.54
BH20	Aug-19	0.57	0.29	0.32	7.42	0.96	0.59	4.74	**26.16**
BH20s	Nov-18	0.89	0.17	0.36	4.18	0.50	0.21	8.54	**82.25**
BH20s	Feb-19	1.04	0.36	0.61	2.04	0.45	0.26	13.13	**70.46**
BH20s	May-19	1.31	0.33	0.54	2.69	0.39	0.22	10.74	**69.32**
BH20s	Aug-19	1.10	0.27	0.56	2.85	0.35	0.22	10.12	**69.80**

Notes:
1. Bolded values indicate L/N ratio above the threshold level of 20.

Table 14: Surface water ionic ratios for 2018-2019

Location	Sample Date	Na/Cl	Na/Ca	Mg/Ca	Ca/K	Cl/SO_4	Cl/HCO_3	K/TDS	L/N
LP1	13/11/2018	1.29	12.70	1.27	0.27	20.66	0.38	7.62	**112.51**
	13/02/2019	1.25	10.82	1.37	0.40	22.66	0.44	6.65	**97.08**
	14/05/2019	1.25	10.30	1.39	0.60	20.65	0.48	4.95	**83.51**
	21/08/2019	1.75	13.02	1.49	0.53	23.71	0.39	5.04	**57.89**
SWC-Up	13/11/2018	0.83	18.93	4.21	1.87	10.29	111.28	1.42	4.14
	13/02/2019	0.86	20.96	4.63	1.74	10.39	139.89	1.42	4.04
	14/05/2019	0.86	16.77	3.93	3.06	9.27	84.18	1.01	2.83
	21/08/2019	0.84	18.55	4.40	2.52	9.42	106.93	1.09	3.11
SWC-Down	13/11/2018	0.84	19.74	4.06	1.93	10.61	163.27	1.34	3.88
	13/02/2019	0.85	23.11	4.68	1.77	11.12	154.16	1.30	3.64
	14/05/2019	0.84	19.38	4.51	2.34	9.98	108.57	1.11	3.22
	21/08/2019	0.85	22.59	4.83	2.02	10.04	164.91	1.14	3.24
SWC-Down-2	13/11/2018	0.83	21.67	4.58	1.88	10.75	196.55	1.27	3.63
	13/02/2019	0.87	22.98	4.65	1.79	11.08	168.84	1.30	3.62
	14/05/2019	0.84	19.38	4.51	2.34	9.98	108.57	1.06	3.22
	21/08/2019	0.84	21.89	5.06	2.09	9.81	178.14	1.12	3.20
SWP1	13/11/2018	1.08	1.03	0.70	3.51	20.60	0.47	6.76	**24.44**
	13/02/2019	1.10	0.98	0.63	7.45	7.45	0.49	3.38	10.67
	14/05/2019	1.13	1.24	0.64	7.37	7.39	0.59	3.04	10.33
	21/08/2019	0.93	1.19	0.66	4.50	9.21	0.81	5.20	16.72
SWP2	13/11/2018	1.28	2.63	0.86	5.92	2.48	1.06	2.30	7.40
	13/02/2019	1.24	3.20	1.21	4.28	2.64	1.21	2.79	8.50
	14/05/2019	1.31	3.01	1.02	5.85	2.63	1.04	2.14	6.71
	21/08/2019	1.38	2.71	0.89	6.39	2.48	1.01	2.28	6.79
SWP4	13/11/2018	1.36	4.58	1.59	4.53	1.73	1.50	1.91	8.11
	13/02/2019	1.29	6.44	2.29	3.43	1.65	3.20	1.97	5.86
	14/05/2019	1.44	4.92	1.65	5.26	1.67	1.48	1.70	5.70
	21/08/2019	1.46	4.17	1.56	6.93	1.57	1.36	1.43	5.50

Notes:
1. **Bolded** values indicate L/N ratio above the threshold level of 20.

Table 15: Dust gauge results for 2018 - 2019

Analyte	Dust Gauge Analysis				Annual Average	Guidelines g/m²/month
	15-Nov-18	14-Feb-19	15-May-19	22-Aug-19		
Ash	0.3	1.1	0.6	0.3	0.6	-
Combustibles	0.2	0.4	0.3	0.2	0.3	-
Insolubles	0.5	1.5	0.9	0.5	0.9	-
Solubles	0.1	0.2	0.2	0.1	0.2	-
Total Solids	0.6	1.7	1.1	0.6	1.0	**4**
Particulates	<0.1	<0.1	<0.1	<0.1	<0.1	-
Total Exposure (days)	104	92	89	100	96.3	-

Notes:

1. Australian Standards AS 3580.10.1. The annual average limit for fallout of dust (derived for coal mining areas of NSW) is 4 g/m^2/month annual average of total solids;
2. Values in Bold indicate exceedances; and
3. Not calculated.

APPENDIX A: GEOLOGICAL BORELOGS

Type of Boring: Rotary wash boring | Bore Hole No: 1

Surface Elevation: | Location: DUNHORE TIP NSW South of solid waste disposal

Date: 6/8/91 | Checked By: | Surface Conditions: sand dunes

Logged By: CH

Description of Strata

Depth (m) | WATER LEVEL (Loge)(Cw)

BORE HOLE CONSTRUCTION DETAILS

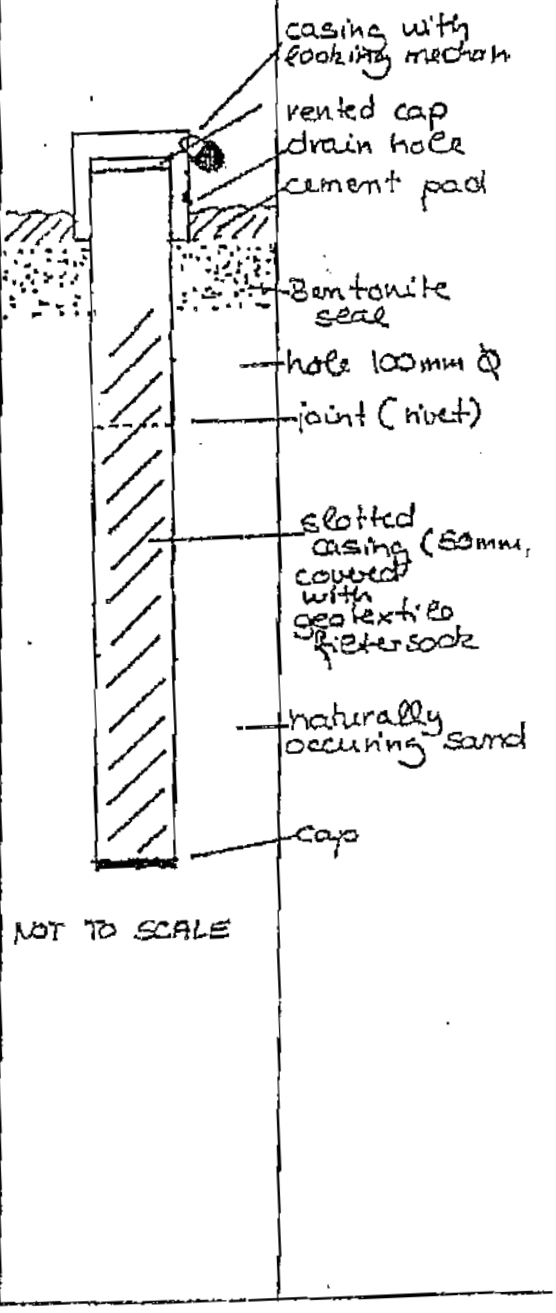
Fill from road base

fine sand, yellow brown

minor shell content

2.93

Hole terminated at 9.15 m



Driller: Hemrick & Del Santo

Commenced: 6/8/91 Drilling P/L

Completed: 6/8/91

TEST BORE LOG

AGC Woodward-Clyde Pty Limited | Date: 12/2/91 | Figure No: | Job No: 3152

LOCATION see sampling plan			Borehole Log: BH1a	Proj.manager TK	Logged by JL
SURFACE ELEVATION	JOB NUMBER	104010			
GROUNDWATER As shown	DATUM		PROJECT: Shellharbour Landfill		Approved
DRILL METHOD HFA	DATE	15/04/2004			

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth(metres)	SAMPLES: TYPE	SAMPLES: Undisturbed	SAMPLES: Disturbed	SAMPLES: Lost	Moisture content(%)	PID Background	PID Reading	CHEMICAL DATA: pH - soil	CHEMICAL DATA: pH - H2O	CHEMICAL DATA: pe - H2O	CHEMICAL DATA: EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH1a Fill	Grey sand, fine to medium grained, with metal, rock, concrete and household rubbish		1					M							concrete bentonite
Natural	Orange sand, fine to medium grained, with minor silt and clay		2					M							
			3												WL @ 2.91m
			4												Backfilled sand from augered hole
			5												
	grading to grey sand		6												
			7												slotted piezo
			8					W							
	Grey sand, medium grained, with 5% silt and clay, and 5% shell fragments		9												
			10												
			11												
			12												
			13												
			14												
			15												
	End of hole @ 15 metres - target depth Stick up = 0.78 metres SWL @ 2.91 metres		16												

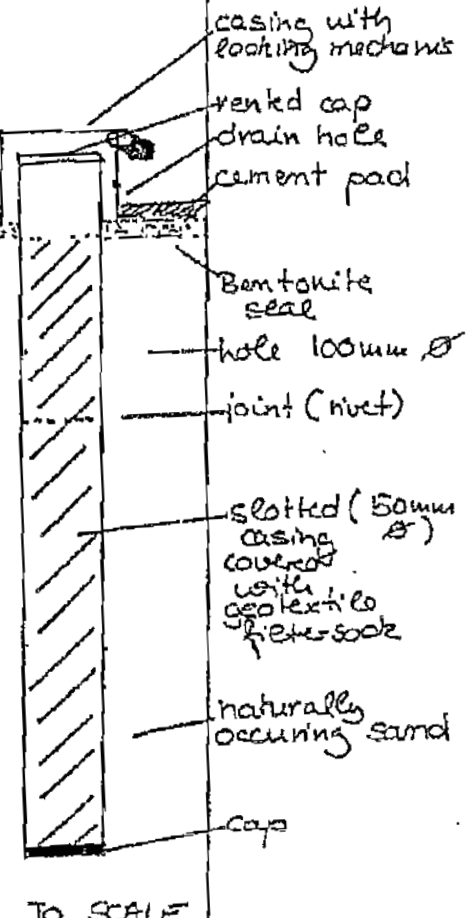
Type of Boring: Rotary wash boring | Bore Hole No: 2

Surface Elevation: | Location: DUNMORE TIP, NSW old disposal area

Date: 6/8/91 | Surface Conditions: grass on fill

Logged By: CH | Checked By:

Description of Strata	Depth (m)	WATER LEVEL (mbgl)(∇)	BORE HOLE CONSTRUCTION DETAILS
Fill (household waste)	0 – 1	▼ 0.98	
sand - fine grained yellow brown minor shell content	2 – 8		
hole terminated at 9.0 m	9		



Dr: Herrick & Del Santo
Commenced: 6/8/91 Drilling P/L
Completed: 6/8/91

TEST BORE LOG

AGO Woodward-Clyde Pty Limited | Date: 12/2/91 | Figure No: | Job No: 3150

Type of Boring: Rotary wash boring

Bore Hole No: 3

Surface Elevation:

Location: DUNMORE TIP, NSW

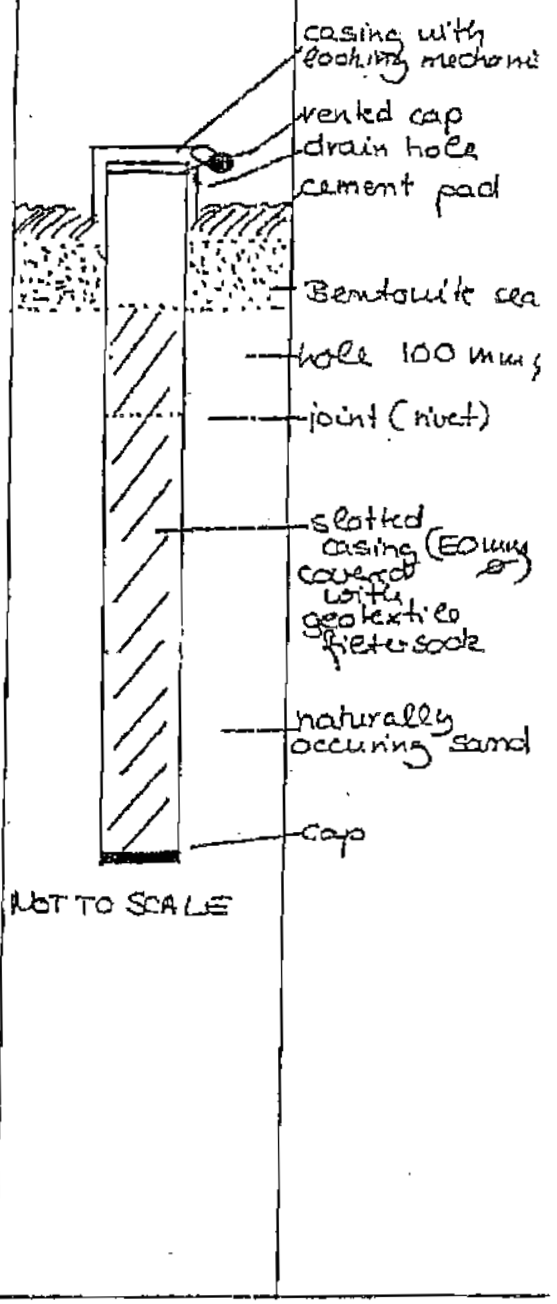
Date: 7/8/91

Logged By: CH Checked By:

Surface Conditions: Fill and Sand

Description of Strata	Depth (m)	WATER LEVEL (bgl)(m)
fill (household waste)	0 – 1	
sand - fine grained with minor shell content, yellow-brown	1 – 3	▼2.53
gravel and shell horizon	4 – 5	
sand - fine grained with minor shell content yellow-brown	5 – 8	
hole terminated at 9.0m	9	

BORE HOLE CONSTRUCTION DETAILS



Driller: Herrick & Del Santo

Commenced: 7/8/91 Drilling P/L

Completed: 7/8/91

TEST BORE LOG

Type of Boring: Rotary wash boring

Bore Hole No: 4

Surface Elevation:

Location: DUNHORE TIP NSW near dog disposal trenches

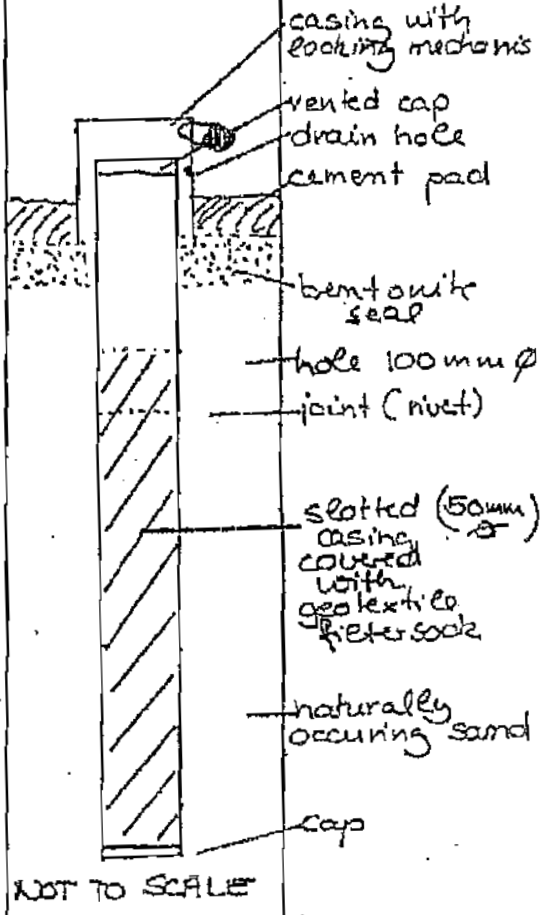
Date: 7/8/91

Logged By: CH

Checked By:

Surface Conditions: Sand

Description of Strata	Depth (m)	WATER LEVEL (bgl) m	BORE HOLE CONSTRUCTION DETAILS
	0		
sand - fine to medium grained yellow-brown	1		
	2		
	3	▼3.66	
	4		
	5		
	6		
	7		
	8		
hole terminated at 9.0 m	9		
	10		



Driller: Herrick & Del Santo

Commenced: 7/8/91 Drilling P/L

Completed: 7/8/91

TEST BORE LOG

AGO Woodward-Clyde Pty Limited

Date: 12/8/91 Figure No: Job No: 315

Type of Boring: Rotary wash boring

Bore Hole No: 5

Surface Elevation:

Location: DUNMORE, TIP, NSW near Sanitary depot

Date: 7/8/91

Logged By: CH Checked By:

Surface Conditions: Sand

Description of Strata

Depth (m)

WATER LEVEL (bge) m

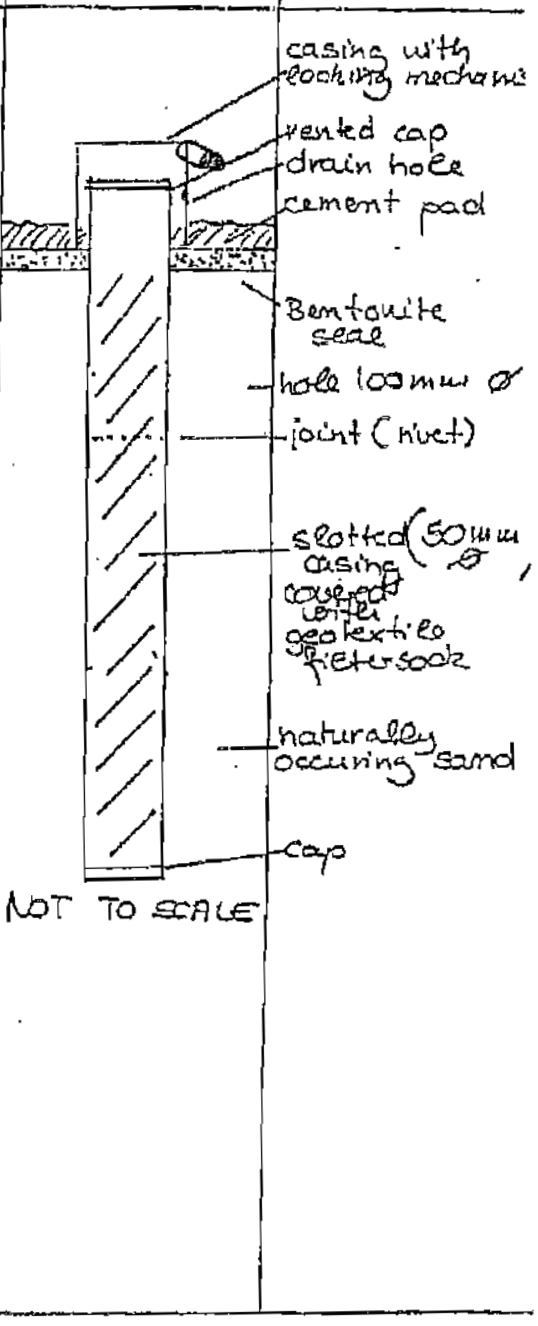
BORE HOLE CONSTRUCTION DETAILS

sand - fine grained white-grey

sand - silty and fine grained sand

hole terminated at 9m

0.23



Driller: Herrick & Del Santo

Commenced: 7/8/91 Drilling P/L

Completed: 7/8/91

TEST BORE LOG

AGO Woodward-Clyde Pty Limited

Date: 12/8/91 Figure No: Job No: 3152

LOCATION See Figure 2	Borehole No. BH6	LOGGED BY MS/MC	Project Manager
SURFACE ELEVATION (RL)	JOB No. 199175		
GROUNDWATER As shown	DATUM	PROJECT Swamp Road, Dunmore NSW	Approved
DRILL TYPE/METHOD Hollow Flight	DATE 16/8/2000		

#No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES: TYPE	SAMPLES: undisturbed / disturbed / lost	Moisture content %	FID Background	FID Reading ppm	CHEMICAL DATA: pH - soil	pH - H2O	pe - H2O	EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH6 (New)	FILL – clay		0										bentonite
	Medium Sand – dark brown		2										sand cuttings
	shell		4										
	Medium Sand – grey with shell		6										piezo
			8										9m
	E.O.H. @ 9.0m Bore completed with locked monument concreted in place.		10										
			12										
			14										
			16										
			18										
			20										

Type of Boring: Rotary wash boring

Bore Hole No: 6

Surface Elevation:

Location: DUNMORE TIP, NSW. south of sanitary depot

Date: 2/8/91
Logged By: CH

Checked By:

Surface Conditions: sand and dry gra

Description of Strata	Depth (m)	WATER LEVEL (bge) m.	BORE HOLE CONSTRUCTION DETAILS
			casing with locking mechanism
			vented cap
			drain hole
			cement pad
Sand - yellow brown fine grained	0		
	1		Bentonite seal
Sand - with some minor gravel	2	2.55	
	3		joint (rivet)
	4		hole 60mm Ø
Sand - grey, fine grained	5		slotted (50mm Ø) casing covered with geotextile filtersock
	6		
	7		naturally occuring sand
	8		
Hole terminated at 9.0 m	9		cap
	10		

NOT TO SCALE

Driller: Herrick & Del Santo
Commenced: 8/8/91 Drilling P/L
Completed: 8/8/91

TEST BORE LOG

AGO Woodward-Clyde Pty Limited | Date: 12/9/91 | Figure No: | Job No: 315

LOCATION: Dunmore, NSW	JOB No. 106084	BOREHOLE LOG: BH6b	LOGGED BY: AP
EASTING:	DRILL TYPE: Hollow Flight Auger		
NORTHING:	DATE STARTED: 2/02/2007	CLIENT: Shellharbour City Council	APPROVED: CM
ELEVATION:	DATE FINISHED: 2/02/2007		

Groundwater
▼ Water strike
▽ SWL during drilling
Moisture
M =Moist D =Dry W =Wet

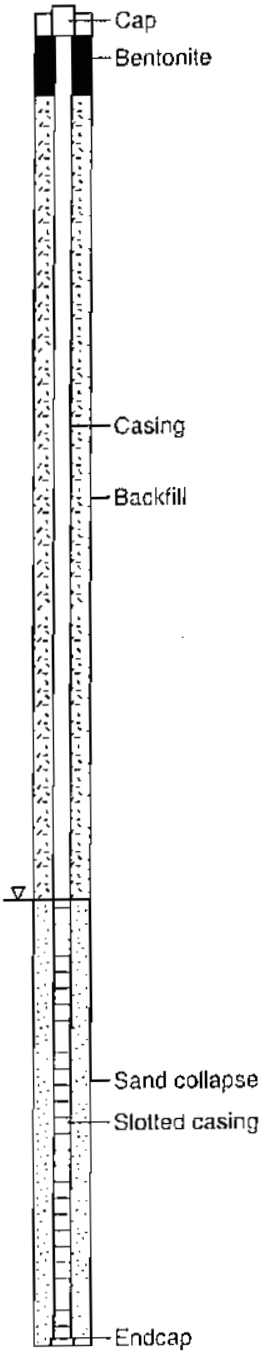
Depth metres | STRATIGRAPHY | GRAPHIC LOG | SAMPLES: TYPE, Moisture, pH, PID (ppm)

Borehole: BH6b
Stick up: 0.66 m

PAGE #: 1/1

COMMENTS

Depth metres	STRATIGRAPHY	Moisture	pH
0	Brown/dark brown silty sand with minor gravel	MD	6.5
2	Yellow/light brown sand	M	6
5	Dark brown sand, medium to coarse grained with minor coal pieces (<1cm) and shell fragments (15%)	MW	7.5
6	shell content increase (40%)	W	8
9	End of hole at 9 metres (target depth)		



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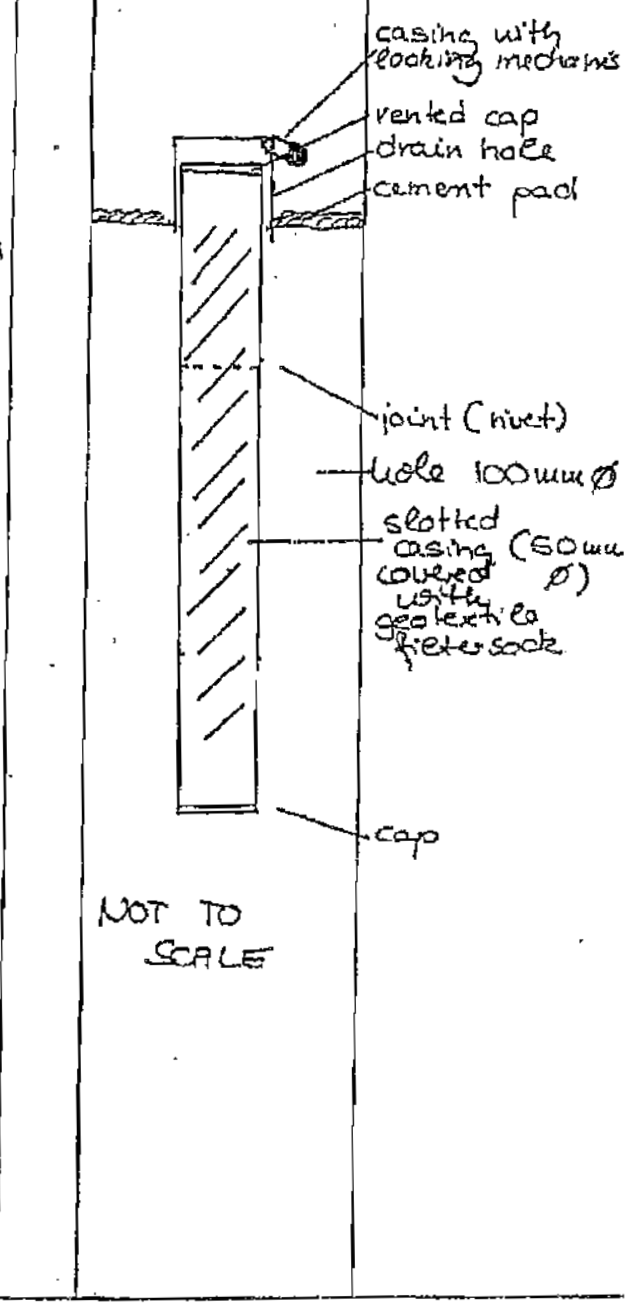
Type of Boring: Rotary wash boring | Bore Hole No: 7

Surface Elevation: | Location: DUNHORE TIP NSW east of sand mining dredge pond

Date: 8/8/91 | Surface Conditions: Sand & dry grass

Logged By: CH | Checked By:

Description of Strata	Depth (m)	WATER LEVEL (bgl) m	BORE HOLE CONSTRUCTION DETAILS
sand- fine grained with some silt content	0	0.39	
clay - sandy, grey-green	7		
Hole terminated at 8.25m	8		



Driller: Herrick & Del Santo

Commenced: 8/8/91 Drilling R/L

Completed: 8/8/91

TEST BORE LOG

AGD Woodward-Clyde Pty Limited | Date: 12/8/91 | Figure No: | Job No: 3152

Type of Boring: Rotary wash boring

Bore Hole No: 8

Surface Elevation:

Location: DUNMORE TIP, NSW NW of solid waste disposal dump

Date: 8/8/91

Logged By: CH

Checked By:

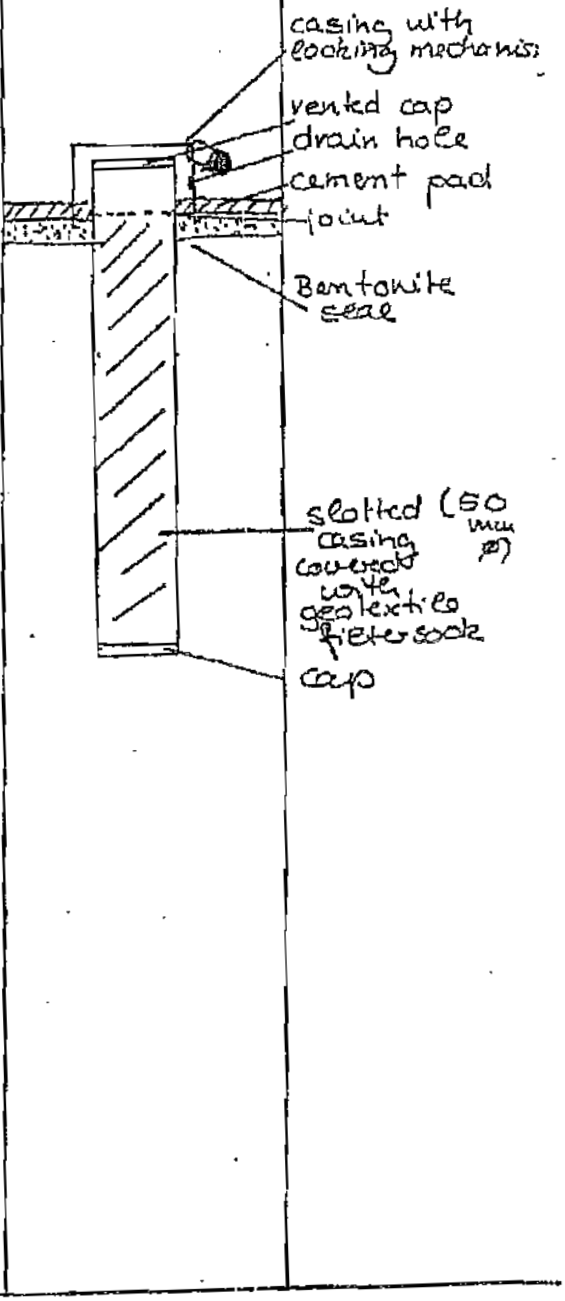
Surface Conditions: sand & fill

Description of Strata

Depth (m)

WATER LEVEL (Loge)

BORE HOLE CONSTRUCTION DETAILS



fill

swamp deposit

0.84

sand - fine grained yellow-brown

sand - fine grained and high silica content

clay - basalt scattered pebbles

terminate hole at 6.3 m

0 1 2 3 4 5 6 7 8 9 10

ler: Herrick & Del Santo

manual: 8/8/91 Drilling P/L

pleted: 8/8/91

TEST BORE LOG

AGO Woodward-Clyde Pty Limited

Date: 12/8/91 Figure No: Job No: 3150

Type of Boring: Rotary wash boring | Bore Hole No: 9

Surface Elevation: | Location: DUNMORE TIP, NSW SW of solid waste disposal ar

Date: 8/8/91 | Surface Conditions: Sand

Logged By: CH | Checked By:

Description of Strata	Depth (m)	WATER LEVEL (Loge) m	BORE HOLE CONSTRUCTION DETAILS
Sand- fine grained yellow-brown	0	0.75	casing with locking mechanism vented cap drain hole cement pad Bentonite seal joint (rivet) slotted (50mm ø) casing covered with geotextile fleece sock naturally occuring sand cap
Clay: grey green Terminate hole at 8.65	8		

Driller: Herrick & Del Santo

Commenced: 8/8/91 Drilling P/L

Completed: 8/8/91

TEST BORE LOG

LOCATION DUNMORE WASTE DISPOSAL DEPOT		DRILL HOLE No. 10C	LOGGED BY K.O.
SURFACE ELEVATION (R.L.) -	DATUM -		FIGURE
INCLINATION VERTICAL	AZIMUTH -	PROJECT SHELLHARBOUR MUNICIPAL COUNCIL	SHEET 1
DRILL TYPE / METHOD HOLLOW AUGER	DATE 15.12.92		OF 1

STRATIGRAPHY	GRAPHIC LOG	metres	SAMPLE TYPE	SAMPLE UNDISTURBED	SAMPLE DISTURBED	SAMPLE LOST	PENETRATION blows/unit depth	Approx. moisture content	CHEMICAL DATA pH - soil	CHEMICAL DATA pH - H_2O	CHEMICAL DATA pe - H_2O	CHEMICAL DATA E.C. µS/cm	CONSTRUCTION DETAILS	REMARKS
SILTY SOIL - brown,soft,moist		0						M					returns	
SILT - black,soft,wet		1						M						
SILTY CLAY - brown,soft,moist		2						M					bentonite seal	
CLAYEY SILT - brown,red,soft,wet		3						W					sand	
LIMESTONE -weathered,red (moist-dry)		4						M					slight induration; slotted with sock	Piezo 4.25m
END OF HOLE @ 4.3m Refusal on Limestone.		5												
		6												
		7												
		8												
		9												
		10												

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soil is the foundation of life

LOCATION See Sampling Plan	Borehole No. BH11	LOGGED BY MC	Project Manager MC
SURFACE ELEVATION (RL) JOB No. 102039			
GROUNDWATER As shown DATUM	PROJECT Shellharbour		Approved
DRILL TYPE/METHOD Hollow Flight DATE 4/6/02			

Hole No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed / disturbed / bags	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA eH - H2O	CHEMICAL DATA pa - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH11	Fill – Sandy Loam, brown with bluemetal & rootlets		0			M							Bentonite
	Natural – Sand, brown, fine–medium grained		1.0						7.5				Piezo installed
	yellow/brown, fine–medium grained		2.0			M			7.5-8				Slotted
			3.0										
	yellow, fine–medium grained		4.0										SWL @ 4.06m 5/6/02
			5.0										
	yellow/brown, medium sand		6.0			M			7.5				
			7.0										
	brown/grey, medium sand		8.0			W							
			9.0						8.5				
	grey medium sand with shell grit		10.0			VW							

Cont.

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LOCATION See Sampling Plan
SURFACE ELEVATION (RL) JOB No. 102039
GROUNDWATER As shown DATUM
DRILL TYPE/METHOD Hollow Flight DATE 4/6/02

Borehole No. BH11 LOGGED BY MC

PROJECT Shellharbour

Project Manager MC
Approved MS

# No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE undisturbed	SAMPLE disturbed	SAMPLE lost	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pe - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH11	Natural – Sand, grey, medium grained sand with shell fragments & some grey clay		10					VW			8.5				cap
	End of Hole @ 12m		11												
			12												
			13												
			14												
			15												
			16												
			17												
			18												
			19												
			20												

LOCATION See Sampling Plan	Borehole No. BH12	LOGGED BY MC	Project Manager MC
SURFACE ELEVATION (RL) JOB No. 102039			Approved
GROUNDWATER As shown DATUM	PROJECT Shellharbour		
DRILL TYPE/METHOD Hollow Flight DATE 4/6/02			

Bh No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed	SAMPLE Disturbed	SAMPLE Bags	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA Pe - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
	Grass		0												
BH12	Natural - Fine Silty Sand,brown							D			5				Bentonite
			1.0												Piezo Installed
	Natural - Sand, yellow/brown,fine-medium grained		2.0					M			6				Slotted
			3.0												
	brown,medium grained sand		4.0												SWL @ 4.33m 5/6/02
			5.0					M			7				
			6.0												
			7.0												
	Natural - Sand, brown,medium grained with shell fragments		8.0					M			8				
			9.0												
			10.0												

Cont.

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LOCATION See Sampling Plan	Borehole No. BH12	LOGGED BY MC	Project Manager MC
SURFACE ELEVATION (RL) JOB No. 102039			
GROUNDWATER As shown DATUM	PROJECT Shellharbour		Approved
DRILL TYPE/METHOD Hollow Flight DATE 4/6/02			

# No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed	SAMPLE Disturbed	SAMPLE Lost	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pe - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH12	Natural - Sand, brown, medium grained with shell fragments		10					W			8				cap
	End of Hole @ 11m		11												
			12												
			13												
			14												
			15												
			16												
			17												
			18												
			19												
			20												

LOCATION: Shellharbour	JOB No. 107098	BOREHOLE LOG: BH12a	LOGGED BY:
EASTING:	DRILL TYPE: Solid Flight Auger		M. Rendell
NORTHING:	DATE STARTED: 25/11/08	CLIENT: Shellharbour City Council	APPROVED:
ELEVATION:	DATE FINISHED: 25/11/08		A. Plioplis

Sample: Disturbed / Undisturbed
Moisture: M=Moist D=Dry S=Saturated
Groundwater: Water Strike / Standing Water Level

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES Type	SAMPLES Moisture	pH	PID (ppm)	Well: BH12a Stickup: 0.5m	PAGE #: 1 / 1 COMMENTS
0	NATURAL: Loose, dark brown/black silty sand, fine grained, rich in organic matter						Cap	
.5				D				No odour throughout
1	NATURAL: Loose, yellow/brown sand, fine to medium grained							
1.5							Cuttings	
2				D				
2.5								
3	NATURAL: Loose, yellow/brown sand, medium grained							
3.5								
4				D				
4.5							Bentonite	
5	NATURAL: Loose, brown sand, medium grained							
5.5				DM				
6	NATURAL: Loose, grey sand, medium grained, shell fragments (5%)							
6.5								
7				DM				
7.5	NATURAL: Loose, grey/dark grey sand, medium grained, shell fragments							
8				M			Collapsed sand	
8.5							Screen/Sock	
9				W			▼	
9.5								
10								
10.5	EOH @ 10.5m in natural sand (target depth)						EOW @ 10.5 m	
11								

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LOCATION See Sampling Plan	Borehole No. BH13	LOGGED BY MC	Project Manager MC
SURFACE ELEVATION (RL) JOB No. 102039			
GROUNDWATER As shown DATUM	PROJECT Shellharbour		Approved
DRILL TYPE/METHOD Hollow Flight DATE 4/6/02			

Hole No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed	SAMPLE Disturbed	SAMPLE Lost	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pe - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH13	Fill – Sand, yellow/brown, fine–medium grained		0					M			7				Bentonite
			1.0												Piezo installed
	Fill – Sandy Clay, grey/brown		2.0					M			6.5-7				
	Natural – Sand, yellow/brown, medium grained		3.0					M			7				Slotted
			4.0												SWL @ 4.51m 5/6/02
	Natural – Sand, brown, medium grained with some shell fragments		5.0					VM			8				
			6.0												
			7.0												
	Natural – Sand, brown/grey, medium grained with shell fragments		8.0					W			7-8				
			9.0					W			8				
	Natural – Sand, grey, medium grained with shell fragments		10.0					W			8				

Cont.

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LOCATION See Sampling Plan	Borehole No. BH13	LOGGED BY MC	Project Manager MC
SURFACE ELEVATION (RL) JOB No. 102099			
GROUNDWATER As shown DATUM	PROJECT Shellharbour		Approved
DRILL TYPE/METHOD Hollow Flight DATE 4/6/02			

# No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed	SAMPLE Disturbed	SAMPLE Test	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pe - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH13	Natural - Sandy Clay, grey/brown		10					W			B				cap
	End of Hole @ 11m		11												
			12												
			13												
			14												
			15												
			16												
			17												
			18												
			19												
			20												

LOCATION	See Sampling Plan	Borehole No. BH14	LOGGED BY MC
SURFACE ELEVATION (RL)	JOB No. 102039		Project Manager MC
GROUNDWATER	As shown DATUM	PROJECT Shellharbour	Approved MS
DRILL TYPE/METHOD	Hollow Flight DATE 4/6/02		

# No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed	SAMPLE Disturbed	SAMPLE Test	Moisture Content %	FID Background	FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA pe - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH14	Natural – Silty Sand,brown		0												Bentonite
			1.0					D-M			6				Piezo installed
	Natural – Sand, yellow/brown,fine to medium grained		2.0					M			6				Slotted
	tending more yellow		3.0					M			6.5				
			4.0												SWL @ 4.95m
	Natural – Sand, brown,medium grained		5.0					M			7				5/6/02
	Natural – Sand, grey/brown,medium grained with shell fragments		6.0												
			7.0												
			8.0					W			8				
			9.0												
	Natural – Sand, grey,medium with shell fragment		10.0					W			8				

Cont.

LOCATION See Sampling Plan	Borehole No. BH14	LOGGED BY MC	Project Manager MC
SURFACE ELEVATION (RL) JOB No. 102039			
GROUNDWATER As shown DATUM	PROJECT Shellharbour		Approved
DRILL TYPE/METHOD Hollow Flight DATE 5/6/02			

# No.	STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLE TYPE	SAMPLE Undisturbed	SAMPLE Disturbed/bag	SAMPLE Lost	Moisture Content %	FID Background	CHEMICAL DATA FID Reading ppm	CHEMICAL DATA pH - Soil	CHEMICAL DATA pH - H2O	CHEMICAL DATA ρa - H2O	CHEMICAL DATA EC uS/cm	CONSTRUCTION DETAILS / COMMENTS
BH14	Natural - Sand, grey, medium grained with shell fragments		10					W			8				cap
	End of Hole @ 11.0m		11												
			12												
			13												
			14												
			15												
			16												
			17												
			18												
			19												
			20												

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Geological Borelog

LOCATION Dunmore Recycling and Wate Disposal Depot		**Borehole Log: BH1b**	**Logged by** S. Love
SURFACE ELEVATION	**JOB NUMBER** 110072		
GROUNDWATER	**DATUM** 19/08/2010	**PROJECT:** Shellharbour	**Proj. Manager** S. Love
DRILL METHOD Hand Flight Auger	**DATE DRILLED** 19/08/2010		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES: Undisturbed	SAMPLES: Disturbed	SAMPLES: Lost	SAMPLES: Duplicate	Moisture Content	PID/FID: Background	PID/FID: Reading	pH: pH - soil	pH: pH - water	Construction Details	Comments
FILL: Black, coarse, subrounded SAND is 20mm subangular gravel (roadbase)		0.2					M						
FILL: Black, coarse SAND		0.4					M						
NATURAL: Grey/yellow, coarse, subrounded SAND		0.6											
		0.8											
		1.0											
NATURAL: Brown/yellow, coarse grained, subrounded SAND		1.2					M						
		1.4											
		1.6											
		1.8										Backfill	
		2.0											
		2.2											
		2.4											
NATURAL: Dark brown, coarse grained, subrounded SAND		2.6											
		2.8											
		3.0					W						1% shell grit
		3.2											
		3.4											
		3.6											
		3.8										Casing	
		4.0											
NATURAL: Brown/grey, coarse grained, subrounded SAND with subangular black gravel (5%) and 5% shell grit		4.2					S						
		4.4											
		4.6										Bentonite	
		4.8											
		5.0											Leachate odour
		5.2											
		5.4											
		5.6											
		5.8											
		6.0											

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

LOCATION Dunmore Recycling and Wate Disposal Depot		**Borehole Log: BH1b**	**Logged by** S. Love
SURFACE ELEVATION	**JOB NUMBER** 110072		
GROUNDWATER	**DATUM** 19/08/2010	**PROJECT:** Shellharbour	**Proj. Manager** S. Love
DRILL METHOD Hand Flight Auger	**DATE DRILLED** 19/08/2010		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	SAMPLES				Moisture Content	PID/FID		pH		Construction Details	Comments
			Undisturbed	Disturbed	Lost	Duplicate		Background	Reading	pH - soil	pH - water		
		6.2											~ 5 to 10% shell grit, small whole limpet shell found
		6.4											
		6.6											
		6.8											
		7.0											
		7.2											
		7.4											
		7.6											
		7.8											
		8.0											
		8.2											
		8.4											
		8.6											
		8.8										Sand	
		9.0											
		9.2										Screen	
		9.4											
		9.6											
		9.8											
		10.0											
		10.2											
		10.4											
		10.6											
		10.8											
		11.0											
		11.2											
		11.4											
		11.6											
		11.8											
		12.0										EOW @ 12m	
EOH @ 12m		12.2											

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

LOCATION: DUNMORE	**JOB NUMBER:** 110048	**Borehole Log: BH15**	**Logged by** Stephen Love
SURFACE ELEVATION:	**DRILL METHOD:** Sludge Pump	**PROJECT:** Shellharbour City Council	**Proj. Manager** Stephen Love
GROUNDWATER:	**DATE:** 01/06/2010		

Sample type: D = disturbed; U = undisturbed Moisture: M = moist; D = dry; S = saturated

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	Sample type	Moisture	pH (Water)	PID (ppm)	Well Construction	Comments
0	FILL - Soft, dark brown CLAY with organic matter			S			Bentonite	H2S odour throughout
	NATURAL - Loose, light brown/grey medium grained, well sorted, rounded SAND with organic matter and roots		D	S			Gravel Pack	Bone fragment @0.3m
1	NATURAL - Loose, grey medium grained, well sorted, rounded SAND with organic matter (roots), slighty silty		D	S				
2	NATURAL - Loose grey medium + coarsed grained SAND with gravel (up to 40mm in diameter)		D	S			Collapsed Sand; Screened with filter sock	
	NATURAL - Loose, grey, medium grained, well sorted SAND			S				
3	EOH @ 2.96m (target depth)						EOW @ 2.96 (target depth)	Gravel consists of rounded basalt pebbles
4								
5								
6								

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

LOCATION: DUNMORE	**JOB NUMBER:** 110048	**Borehole Log: BH16**	**Logged by** Stephen Love
SURFACE ELEVATION:	**DRILL METHOD:** Sludge Pump	**PROJECT:** Shel Harbour Council	**Proj. Manager** Stephen Love
GROUNDWATER:	**DATE:** 01/06/2010		

Sample type: D = disturbed; U = undisturbed Moisture: M = moist; D = dry; S = saturated

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	Sample type	Moisture	pH (Water)	PID (ppm)	Well Construction	Comments
0	NATURAL - dark brown/black silty TOPSOIL, rich in organic matter		D	S			Bentonite to surface	H2S odour throughout
	NATURAL - soft, dark brown CLAY with some organic matter		D	S				
1	NATURAL - loose, grey, medium grained, subrounded to rounded SAND						Sand	
	Grading to dark grey, medium grained, subrounded to rounded SAND			S			Round pebble @ ~2m	
2							Collapsed sand	
3	EOH @ 3m (Target Depth)						Screened with filter sock	
4							EOW @ 3m (target Depth)	
5								

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

LOCATION: DUNMORE	**JOB NUMBER:** 110048	**Borehole Log: BH17**	**Logged by** Stephen Love
SURFACE ELEVATION:	**DRILL METHOD:** Hollow Flight Auger	**PROJECT:** Shellharbour City Council	**Proj. Manager** Stephen Love
GROUNDWATER:	**DATE:** 01/06/2010		

Sample type: D = disturbed; U = undisturbed Moisture: M = moist; D = dry; S = saturated

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	Sample type	Moisture	pH (Water)	PID (ppm)	Well Construction	Comments
0	FILL - dark brown TOPSOIL with organic matter			M				No odour throughout
	FILL - soft, dark brown SANDY CLAY with gravel throughout		D	M				
1	FILL - loose, dark brown/grey fine to medium grained, sub rounded to rounded SAND							
	NATURAL - loose, light brown/yellow, medium grained, rounded SAND		D	M				
2							Cuttings	
3								Dense sand layer causing auger to bounce
4								Dense sand layer causing auger to bounce
5							Bentonite	Minor shell fragments (1%)
6								Minor shell fragments (2%)
7							Sand	
8	**EOH @ 9.9m (target depth)**						Sand / Screened with filter sock	Dense sand layer causing auger to bounce A few fine gravel pieces
9								
10							EOW @ 9.9m (target depth)	

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

LOCATION: DUNMORE	**JOB NUMBER:** 110048	**Borehole Log: BH18**	**Logged by** Stephen Love
SURFACE ELEVATION:	**DRILL METHOD:** Hollow Flight Auger	**PROJECT:** Shellharbour City Council	**Proj. Manager** Stephen Love
GROUNDWATER:	**DATE:** 01/06/10		

Sample type: D = disturbed; U = undisturbed Moisture: M = moist; D = dry; S = saturated

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	Sample type	Moisture	pH (Water)	PID (ppm)	Well Construction	Comments
0	FILL - roadbase		D	M			Cuttings	No odour throughout
	FILL - soft, brown CLAY with some roadbase gravel		D	M				
1	FILL - soft, dark brown CLAY		D				Bentonite	
	NATURAL - loose, dark brown, medium grained SAND			S			Sand	
2								
3								
4								
5							Sand	
6							Screened with filter sock	
7								
8								
9								
10	EOH @ 10m (target depth)						EOW @ 10m (target depth)	
11								
12								
13								
14								
15								

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

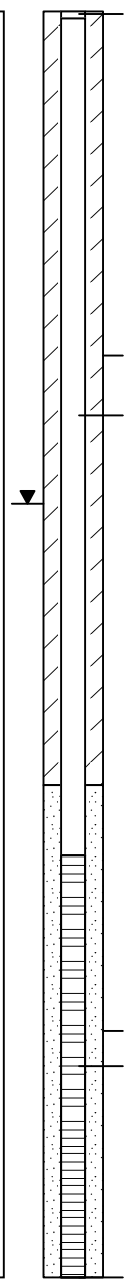
LOCATION: Shellharbour Landfill	JOB No. 113054	BOREHOLE LOG: BH19	LOGGED BY:
EASTING:	DRILL TYPE: Hollow Flight Auger		E. Graham
NORTHING:	DATE STARTED: 5/8/2013	CLIENT: Shellharbour City Council	APPROVED:
ELEVATION:	DATE FINISHED: 5/8/2013		D. Fernandez

Sample: Disturbed; Undisturbed
Moisture: M=Moist D=Dry S=Saturated
Groundwater: Water Strike; Standing Water Level

PAGE #: 1/1

Well: BH19

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES Type	Moisture	pH	PID (ppm)	COMMENTS
0	Natural: Loose, light brown, grey SAND with silt.		D				No odour throughout.
.4	Natural: Loose, light brown SAND.		D				
.8	Grading to yellow sand.		D				
2.4			M				
4			W				
4.4	Grading to light grey sand with some fine shell grit.		W				
8.			S				
9.	EOH @ 9.0m target depth reached.						



ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

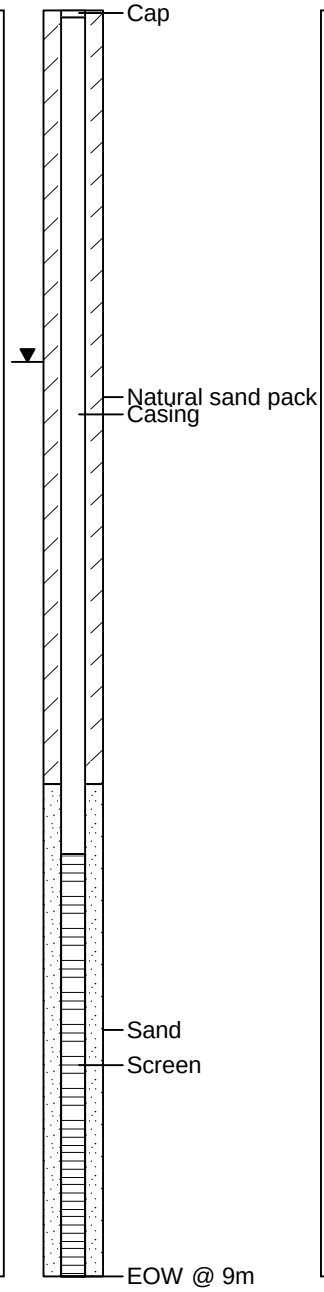
LOCATION: Shellharbour Landfill	JOB No. 113054	BOREHOLE LOG: BH20	LOGGED BY:
EASTING:	DRILL TYPE: Hollow Flight Auger		E. Graham
NORTHING:	DATE STARTED: 5/8/2013	CLIENT: Shellharbour City Council	APPROVED:
ELEVATION:	DATE FINISHED: 5/8/2013		D. Fernandez

Sample: Disturbed; Undisturbed
Moisture: M=Moist D=Dry S=Saturated
Groundwater: Water Strike; Standing Water Level

PAGE #: 1/1

Well: BH20
Monument: 0.77

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES Type	Moisture	pH	PID (ppm)	COMMENTS
0 – .2 – .4 – .6 – .8 – 1	Fill: Loose, brown, SAND with silt, plastic bags, pvc casing, rope, glass, plastic bottles and a mop head.			D/M			No odour throughout.
1 – 1.2 – 1.4 – 1.6 – 1.8 – 2	Natural: Loose, fine to medium, light brown, grey SAND			M			
2 – 2.2 – 2.4 – 2.6 – 2.8 – 3 – 3.2 – 3.4 – 3.6 – 3.8 – 4 – 4.2 – 4.4 – 4.6 – 4.8 – 5. – 5.2 – 5.4 – 5.6 – 5.8 – 6. – 6.2 – 6.4 – 6.6 – 6.8 – 7. – 7.2 – 7.4 – 7.6 – 7.8 – 8. – 8.2 – 8.4 – 8.6 – 8.8 – 9.	Grading to fine to medium, grey sand with fine shell grit.			S			
9. – 9.2 – 9.4 – 9.6 – 9.8 – 10.	EOH @ 9.0m target depth reached.						



ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

LOCATION: Shellharbour	JOB No. 117086	BOREHOLE LOG: BH20s	LOGGED BY: MB
EASTING:	DRILL TYPE: Hollow flight auger		
NORTHING:	DATE STARTED: 7/9/2017	CLIENT: Shellharbour City Council	APPROVED: MR
ELEVATION:	DATE FINISHED: 7/9/2017		

Sample: Disturbed; Undisturbed

Moisture: M=Moist D=Dry S=Saturated

Groundwater: Water Strike; Standing Water Level

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STRATIGRAPHY

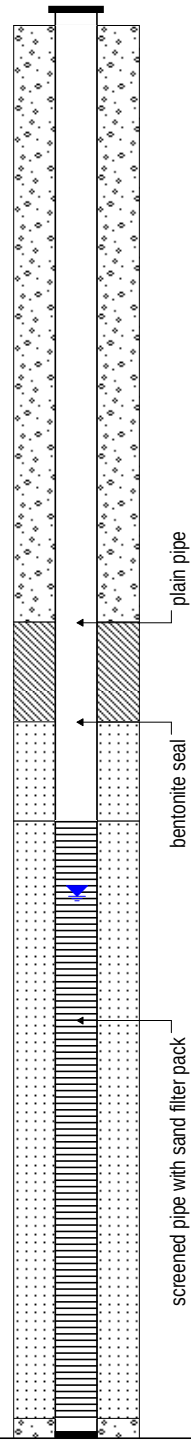
Depth (metres)	GRAPHIC LOG	SAMPLES Type	Moisture	pH	PID (ppm)	Well: BH20s	COMMENTS
0							
	NATURAL: Loose, dark brown, fine-medium SAND.					Backfill sand; Casing; Bentonite	No visual or olfactory evidence of contamination detected.
1			D				
1.5						Water strike @ approximately 1.5 m	
2	NATURAL: Loose, light brown, fine-medium SAND						
2.5			M/S			Screen; Sand Pack	
3							
3.5							
4							
4.5	EOH @ 4.5m (target depth).					EOB @4.5m	
5							
5.5							

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Geological Borelog

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION: Dunmore Recycling and Waste Disposal Depot		Borehole Log: BH12_r	Logged by: EGr
SURFACE ELEVATION:	JOB NUMBER: 119062		
GROUNDWATER:	DATUM:	PROJECT: Shellharbour	Proj. Manager: EGr
DRILL METHOD: Hollow Flight Auger	DATE DRILLED: 23/07/2019		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	Sample Depth	Sample ID	Moisture Content	PID/FID Background	PID/FID Reading	pH - soil	pH - water	Construction Details	Comments
FILL: Loose dark brown gravelly fine to medium SAND with fragments of brick, ceramic tile, glass, and plastic		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5			D D D DM						Monument SWL at 4.375 m BTOC
NATURAL: Loose brown fine to coarse SAND		5.0 5.5 6.0 6.5 7.0			M						Well complete at 7.10 m

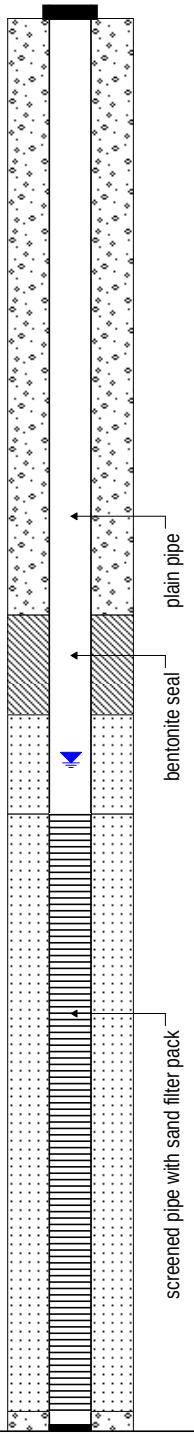
NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION: Dunmore Recycling and Waste Disposal Depot		Borehole Log: BH17b_r	Logged by: EGr
SURFACE ELEVATION:	JOB NUMBER: 119062		
GROUNDWATER:	DATUM:	PROJECT: Shellharbour	Proj. Manager: EGr
DRILL METHOD: Hollow Flight Auger	DATE DRILLED: 22/072019		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	Sample Depth	Sample ID	Moisture Content	PID/FID Background	PID/FID Reading	pH - soil	pH - water	Construction Details	Comments
FILL: Loose dark brown gravelly SAND with occasional (<35%) fine to medium gravel size limestone and fragments of brick, clinker, becoming clayey from 0.5 m		0.5									flush gatic
POTENTIAL FILL: Loose dark brown fine to medium SAND		1.0			D						
POTENTIAL FILL: Loose light brown fine to medium SAND. Obstruction at 1.80m		1.5									
NATURAL: Loose dark brown gravelly fine to coarse SAND. Gravel is round to subangulat fine to coarse gravel size latite.		2.0			D						
		2.5									
		3.0			D						
		3.5									SWL at 3.74 m below TOC
		4.0			MS						
		4.5									
		5.0			MS						
		5.5									
		6.0									
		6.5									
		7.0									Well complete at 7.10 m



NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION: Dunmore Recycling and Waste Disposal Depot		Borehole Log: BH18_r	Logged by: EGr
SURFACE ELEVATION:	JOB NUMBER: 119062		
GROUNDWATER:	DATUM:	PROJECT: Shellharbour	Proj. Manager: EGr
DRILL METHOD: Hollow Flight Auger	DATE DRILLED: 23/07/2019		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	Sample Depth	Sample ID	Moisture Content	PID/FID		pH		Construction Details	Comments
						Background	Reading	pH - soil	pH - water		
FILL: Dense dark brown gravelly (>35%) SAND. Gravel is subangular to angular fragments of brick, mortar, clinker and concrete. Refused at 1.10 m		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0									Rig relocated four times in total in vicinity. Too dense for rig/ met obstruction at <1.0 m depth. Position abandoned.

NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION: Dunmore Recycling and Waste Disposal Depot		Borehole Log: BH19_r	Logged by: EGr
SURFACE ELEVATION:	JOB NUMBER: 119062		
GROUNDWATER:	DATUM:	PROJECT: Shellharbour	Proj. Manager: EGr
DRILL METHOD: Hollow Flight Auger	DATE DRILLED: 23/07/2019		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	Sample Depth	Sample ID	Moisture Content	PID/FID Background	PID/FID Reading	pH - soil	pH - water	Construction Details	Comments
NATURAL: Loose brown fine to coarse SAND Rootlets at 0.1 to 0.3 m		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0			D D D DM					plain pipe bentonite seal	Monument. Old BH19 decommissioned
NATURAL: Loose light grey fine to coarse SAND with occasional (~25%) fine shell fragments		4.5 5.0 5.5 6.0 6.5 7.0			M					screened pipe with sand filter pack	SWL at 4.625 m BTOC Well complete at 7.0 m

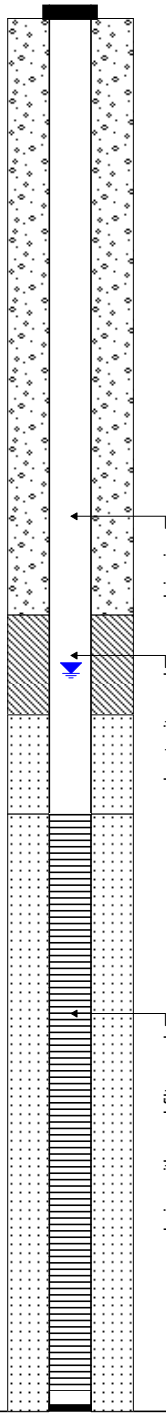
NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

Geological Borelog

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION: Dunmore Recycling and Waste Disposal Depot		Borehole Log: BHA	Logged by: EGr
SURFACE ELEVATION:	JOB NUMBER: 119062		
GROUNDWATER:	DATUM:	PROJECT: Shellharbour	Proj. Manager: EGr
DRILL METHOD: Hollow Flight Auger	DATE DRILLED: 22/072019		

STRATIGRAPHY	GRAPHIC LOG	Depth metres	Sample Depth	Sample ID	Moisture Content	PID/FID Background	PID/FID Reading	pH - soil	pH - water	Construction Details	Comments
FILL: Loose dark brown gravelly SAND with occasional (<35%) fine to medium gravel size latite (?) and fragments of metal and clinker		0.5									Flush gatic
FILL: Medium dense dark grey slightly clayey SAND with rare gravel size fragments of brick		1.0			D						
		1.5									
FILL: Medium dense dark grey gravelly SAND with rare fragment of plastic and fine gravel size fragments of clinker		2.0			D						
		2.5									
		3.0			D						
NATURAL: Loose dark brown fine to coarse SAND with occassional (~35%) shell fragments.		3.5									SWL at 3.29 m BGL
Becoming moist from approximately 4.0 m		4.0			MS						
		4.5									
		5.0									
		5.5									
		6.0									
		6.5									
		7.0									Well complete at 7.0 m



NOTE: This bore log is for environmental purposes only and is not intended to provide geotechnical information.

APPENDIX B: QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

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APPENDIX A: Calibration Certificates

1 INTRODUCTION & BACKGROUND

The aim of quality control and quality assurance (QA/QC) is to deliver data that is:

- representative of what is sampled;
- precise;
- accurate; and
- reproducible.

As investigations involve both field and laboratory QA/QC, these are similarly divided. The objective of this document is to evaluate and identify the data quality objectives (DQOs) and the data quality indicators (DQIs), which are used to assess whether the DQOs have been met.

All surface water, groundwater and soil sampling procedures to be followed are described in full in our *Soil, gas and groundwater sampling manual (*Environmental Earth Sciences Ltd 2011). This document should be referred to for field procedures for sampling and conveyance. Copies are available for inspection if required.

The NSW guideline documents used in the evaluation of the data set for this investigation are:

- Australian and New Zealand Environment and Conservation Council 1992, *Australian and New Zealand Guidelines for the assessment and management of contaminated sites,* Australia and New Zealand Environment Council, National Health and Medical Research Council, Melbourne, Vic;
- Australian and New Zealand Environment and Conservation Council (ANZECC) and ARMCANZ, (2000), *Australian and New Zealand guidelines for fresh and marine water quality*.

Data quality is typically discussed in terms of precision, accuracy, representativeness, comparability and completeness. These are referred to as the PARCC parameters. The PARCC (and additional QA) parameters are discussed within this report.

The following items form part of the QA/QC appendix:

- repeatability;
- precision;
- accuracy;
- representativeness;
- completeness;
- comparability;

- sensitivity;
- holding times;

The terms “quality assurance” and “quality control” are often confused. In any program, quality control is required before assurance can be put in place. With respect to laboratory analysis activities, these terms are defined as follows:

> *Quality Assurance (QA) is “a set of activities intended to establish confidence that quality requirements will be met” (AS/NZS ISO 9000:2005).*

This encompasses all actions, procedures, checks and decisions undertaken to ensure the accuracy and reliability of analysis results. It includes routine procedures which ensure proper sample control, data transfer, instrument calibration, the decisions required to select and properly train staff, select equipment and analytical methods, and the day to day judgements resulting from regular scrutiny and maintenance of the laboratory system.

> *Quality Control (QC) is “a set of activities intended to ensure that quality requirements are actually being met” (AS/NZS ISO 9000:2005). In other words, the operational techniques and activities that are used to fulfil the requirements for quality.*

These are the components of QA which serve to monitor and measure the effectiveness of other QA procedures by comparison with previously decided objectives. They include measurement of the quality of reagents, cleanliness of apparatus, accuracy and precision of methods and instrumentation, and reliability of all of these factors as implemented in a given laboratory from day to day.

A complete discussion of either of these terms or the steps for implementing them is beyond the scope of this document. It is widely recognised, however, that adoption of sound laboratory QA and QC procedures is essential and readers are referred to documentation available from the National Association of Testing Authorities (NATA), if further information is required.

2 DATA QUALITY OBJECTIVES

The Data Quality Objectives (DQOs) process is a systematic approach used to define the type, quantity and quality of data supporting decisions which relate to the environmental condition of a site. Undertaking DQOs for site assessment and remediation is a requirement of the Department of Environment and Conservation (2006), *Contaminated sites: Guidelines for NSW Site Auditors Scheme* (2nd edition). The DQO process was formulated by the US EPA and provides sound guidance for a consistent approach to understanding site assessment and remediation.

Table 1: Data quality objectives

Step	Description	Comment	Location in report
1	**State the problem**	The problem will be addressed directly by scientists from Environmental Earth Sciences NSW. The problem is that the site is used as a landfill and the potential exists for ground/surface water contamination to have occurred. The purpose of this monitoring is to meet the EPA license requirements of DECCW placed upon the landfill. Recommendations may be provided for further investigation or on-going environmental management at the site if required.	Sections 1 and 2
2	**Identify the decision**	A quarterly monitoring event has been commissioned to determine if the past or present landfilling activities have adversely impacted the site or environment. If required, Environmental Earth Sciences NSW will provide guidance on actions required to ensure the site becomes suitable for continued or future use.	Sections 1 and 2
3	**Identify the inputs for the decision**	The study inputs include data from quarterly monitoring, previous reports and reference to published guidelines to assist the decision-making process.	Sections 3, 4, 5, 6 and 7
4	**Define the boundaries for the study**	The site location and physical boundaries are shown on Figure 1 and Figure 2 and defined in Section 3 of the report. The temporal boundary of the project is restricted to the timing of the investigation.	Section 3, Figures 1 and 2
5	**Develop a decision rule**	All analytical data will be compared and evaluated against ANZECC (2000) deemed the most appropriate published criteria.	Section 8
6	**Specify tolerable limits on decision error**	Acceptable limits for field data analysis (relative percent differences for primary and duplicate results) are between 50 and 150 percent (depending on the origin of the sample and volatility of the chemicals present). These are summarised in Table 2 as the measurement data quality indicators (MDQIs), which will be used to establish whether the DQOs have been met.	Section 9; this document (Table 2)
7	**Optimise the design for obtaining data**	The sample locations are stipulated within NSW EPA licence 5984. As well as NSW EPA stipulated locations, other locations have been included in the monitoring program taking into account targeted areas of concern on the site (i.e. *judgemental* sampling locations). Environmental Earth Sciences NSW believes that the sampling design is optimal considering site limitations and access constraints.	Sections 5 and 6, Figure 2

Table 2: Measurement data quality indicators (MQDIS)

Parameter	Procedure	Minimum Frequency	Criteria	
			(5 to 10x LOR[4])	>10x LOR
Precision	Field Duplicates	1 in 20 - metals	<80 RPD	<50 RPD
		1 in 20 - semi-volatiles	<100 RPD	<80 RPD
		1 in 20 - volatiles	<150 RPD	<130 RPD
	Lab Replicate*	1 in 20	<50 RPD	<30 RPD
Accuracy*	Reference Material	1 in 10	60% to 140%R	80% to 120%R
	Matrix spikes			
	Surrogate spikes			
Representativeness*	Reagent Blanks	1 per batch	No detection	
	Holding Times*	Every sample	-	
Blanks**	Trip Blank	1 per batch	No detection	
	Rinsate Blanks			
Sensitivity	Limit of Reporting	Every sample	LOR < ½ site criteria	

Notes:
1. RPD – relative percentage difference
2. %R – percent recovery
3. LOR – limit of reporting
4. [4] no limit at <5x LOR
5. * the MDQI is usually specified in the standard method. If not, use the default values set out in this table
6. ** only necessary when measuring dissolved metals and volatile organic compounds in water samples

It should be noted that Standards Australia (AS4482.1) specify that typical MDQIs for precision should be ≤50% RPD, however also acknowledge that low concentrations and organic compounds in particular can be acceptably outside this range. The standard suggests that ≤50% RPD be used as a 'trigger' and values above this level of repeatability need to be noted and explained.

3 SAMPLING AND ANALYSIS PLAN

3.1 Rationale for sampling strategy and density

The groundwater sampling program was based on NSW EPA license No. 5984 and judgemental design for targeted areas of concern, as outlined in the *Sampling Design Guidelines* (NSW EPA 1995)/AS 4482.1 - *Guide to the investigation and sampling of sites with potentially contaminated soil* (Standards Australia 2005). Judgemental sampling points were located at known sources of potential chemical concern. Sampling locations are shown

in Figure 2. Table 3 has been provided as a summary of the sampling rationale for each location assessed as part of this project.

3.2 Sampling methods

Ground and surface water samples were collected in amber glass bottles, volatile vials or plastic bottles depending on the individual analytes requirements.

Table 3: Sampling location rationale

Location	Media	Sampling Pattern	Rationale
BHA	Water	Judgemental	Down-gradient of landfill
BH1c	Water	Judgemental	Within leachate plume, centre of site
BH2	Water	Judgemental	Down-gradient of landfill
BH3	Water	Judgemental	Down-gradient of landfill
BH4	Water	Judgemental	Down-gradient of landfill
BH5	Water	Judgemental	On eastern boundary of landfill, adjacent to drainage line. Decommissioned before May 2017 round
BH6b	Water	Judgemental	Adjacent to leachate pond, decommissioned before Aug 16 round
BH12	Water	Judgemental	Down-gradient of leachate plume, decommissioned before February 2017 round. Re-installed in July 2019
BH13	Water	Judgemental	Down-gradient of leachate plume
BH14	Water	Judgemental	Down-gradient of landfill
BH15	Water	Judgemental	Down-gradient of leachate plume, adjacent to drainage line
BH16	Water	Judgemental	External to eastern boundary, adjacent to streamline
BH17	Water	Judgemental	Adjacent to leachate pond, decommissioned before Aug 16 round. Re-installed July 2019
BH18	Water	Judgemental	East of landfill tipping face, decommissioned before Aug 16 round
BH19	Water	Judgemental	South West boundary of landfill. Re-installed in July 2019 following reported blockage
BH20	Water	Judgemental	South boundary of landfill, adjacent to Rocklow Creek
BH20s	Water	Judgemental	Same as BH20, except targeted at the shallow aquifer.
LP1	Water	Judgemental	Leachate pond sump from old unlined landfill cell
SWC2	Water	Judgemental	Rocklow Creek, pollution receptor
SWC_Up	Water	Judgemental	Upgradient Rocklow Creek, pollution receptor
SWC_Down	Water	Judgemental	Down gradient Rocklow Creek, pollution receptor
SWC_Down_2	Water	Judgemental	Down gradient Rocklow Creek, pollution receptor
SWP1	Water	Judgemental	Wetland, west of old unlined cell
SWP2	Water	Judgemental	Wetland, south of old unlined cell
SWP3	Water	Judgemental	Filled in and no longer a sampling point.
SWP4	Water	Judgemental	Dredging pond in the south of the site
SWP5	Water	Judgemental	Sediment pond in south east of site. Often recorded as dry and not sampled.

All sampling procedures were undertaken in accordance with our *Soil, gas & groundwater sampling manual* (Environmental Earth Sciences, 2011), which should be referred to for further detail.

3.3 Rationale for laboratory analysis schedule

Table 4 identifies the laboratory analysis schedule for groundwater samples collected each quarterly monitoring event – *the organics analyses are conducted once a year*. Four additional samples were added to the monitoring round in August 2019.

The analytes selected are based on determination of the chemicals of potential concern CoPC for the site, and their potential derivatives. The analytical methods selected are based on those recommended by the laboratories and publications such as *Standard methods for the examination of water and waste-water* (APHA 2005, 21st edition) and *Australian laboratory handbook of soil and water chemical methods* (Rayment & Higginson 1992).

Table 4: Analytical schedule per monitoring event

Analyte – Groundwater	Number of samples	Number of duplicates/splits
pH, TDS	22	1/-
Cations (Na, Ca, K, Mg,)	22	1/-
Anions (Cl, SO_4, F, PO_4, NO_2)	22	1/-
NH_4, NO_3 and HCO_3	23	1/-
Total and soluble Fe	23	1/-
Soluble Mn	17	1/-
Petroleum hydrocarbons C_6-C_9	1 (only in Nov 2018)	-/-
Petroleum hydrocarbons C_{10}-C_{36}	1 (only in Nov 2018)	-/-
BTEX	1 (only in Nov 2018)	-/-
PAHs	1 (only in Nov 2018)	-/-

Note: methods used are reported in the laboratory transcripts appended and are detailed in the *Standard methods for the examination of water and waste-water* (APHA 2005 and/or *Australian laboratory handbook of soil and water chemical methods* (Rayment & Higginson 1992).

4 QUALITY CONTROL AND QUALITY ASSURANCE

4.1 Measurement data quality objectives

Step 7 of the DQO process (Section 2.0) is a focus on the quality of the information by measurement, that is, measurement data quality objectives (MDQOs). The aim of a quality control and quality assurance (QA/QC) is to deliver data that is representative of what is sampled, precise, accurate and reproducible. As investigations involve both field and laboratory QA/QC, these are similarly divided. The objective of this section is to provide the MDQOs and the measurement data quality indicators (MDQIs), which will be used to establish whether the DQOs have been met.

All surface water, and groundwater sampling procedures need to be undertaken according to a standard procedure, for example those procedures set out in:

- National Environment Protection Council (NEPC) 2013, *National environment protection (assessment of site contamination) measure*, National Environment Protection Council, Adelaide, SA;

- NSW Environment Protection Authority (EPA) 1995, *Contaminated sites: Sampling design guidelines,* EPA NSW, Chatswood, NSW;
- NSW EPA 1994, *Contaminated sites: Guidelines for the assessment of service station sites,* EPA NSW, Chatswood, NSW.
- NSW EPA 1997, *Contaminated sites: Guidelines for consultants reporting on contaminated sites,* EPA NSW, Chatswood, NSW.

Measurement data quality is typically discussed in terms of precision, accuracy, representativeness, comparability and completeness. Although not necessarily considered in list order, the following items should form part of the QA/QC data evaluation:

- Measured Parameters: precision, accuracy, repeatability (comparability), blanks; and
- Assessed Parameters: completeness, representative of site conditions, sensitivity, and holding times.

The laboratories used should be NATA accredited for the analytical methods performed. Containers, sample preservation (if necessary) and holding times should be consistent with industry practices as set out in NEPM and as defined by ASTM.

The QA parameters selected and the criteria used to evaluate the analytical data are defined below and presented in Table 2 of this report.

4.1.1 Repeatability (field collected intra-laboratory duplicates)

These samples provide a check on the analytical performance of the laboratory. At least 5 percent of soil samples (1 in 20) per day of sampling from a site are collected in duplicate. For comparability of data, it is important that there is little delay in the sample submission. For split samples, because of error associated with field splitting, an RPD of between 80 and 150% (depending on the substance) will be allowed as the MDQI.

Any value >50% RPD will be noted and discussed, as per Standards Australia requirements, with respect to its acceptability for inclusion in the data-set.

4.1.2 Precision

Precision is a measure of the reproducibility of results, and is assessed on the basis of agreement between a set of replicate results obtained from duplicate analyses. The precision of a duplicate determination can be measured as relative percentage difference (RPD), and is calculated from the following equation:

$$RPD = \left[\frac{X1 - X2}{\left(\frac{X1 + X2}{2} \right)} \right] \times 100$$

where: X1 is the first duplicate value
X2 is the second duplicate value

The field blind duplicate results and calculated RPDs are presented in Table 5. All results are considered to be within the acceptable range.

Table 5: Field blind duplicate results – November 2018 to August 2019

Locations	BH4	FD1	RPD(%)	BH13	FD1	RPD(%)	BH4	FD1	RPD(%)	BH4	FD1	RPD(%)
Date	15/11/2018			14/02/2019			16/05/2019			23/08/2019		
Report No	SAL26997			SAL27113			SAL27214			SAL27330		
pH	7.00	7.10	1.42	7.30	7.50	2.70	7.1	7.2	1.40	7.1	7.2	1.40
TDS	1910	1890	1.05	975	965	1.03	1100	1130	2.69	1100	1130	2.69
Na+	360	355	1.40	100	105	4.88	145	140	3.51	145	140	3.51
Ca++	195	200	2.53	185	180	2.74	190	200	5.13	190	200	5.13
Mg++	78	77	1.29	40	41	2.47	36	36	0.00	36	36	0.00
K+	44	46	4.44	30	32	6.45	24	25	4.08	24	25	4.08
NH4-N	43	43	0.00	1	1.2	18.18	8.9	9.3	4.40	8.9	9.3	4.40
Cl-	475	465	2.13	105	105	0.00	215	215	0.00	215	215	0.00
SO4--	120	120	0.00	195	190	2.60	155	150	3.28	155	150	3.28
HCO3-	1190	1220	2.49	625	640	2.37	675	670	0.74	675	670	0.74
NO3-	0.05	0.05	0.00	0.05	0.05	0.00	<0.1	<0.1	0.00	<0.1	<0.1	0.00
PO4---	0.1	0.1	0.00	0.1	0.1	0.00	<0.1	<0.1	0.00	<0.1	<0.1	0.00
F-	0.31	0.31	0.00	0.22	0.23	4.44	<0.1	<0.1	0.00	<0.1	<0.1	0.00
BOD	1	1	0.00	1	1	0.00	3	<2	NC	3	<2	NC
Fe.D	0.73	0.76	4.03	0.29	0.26	10.91	0.19	0.22	14.63	0.19	0.22	14.63
Fe.T	12	11	8.70	1.2	1.2	0.00	5.6	5.6	0.00	5.6	5.6	0.00
Mn.D	0.4	0.39	2.53	0.26	0.25	3.92	0.21	0.23	9.09	0.21	0.23	9.09
TOC	4	4	0.00	3	2	40.00	20	20	0.00	20	20	0.00

4.1.3 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. The determination of accuracy can be achieved through the analysis of known reference materials or assessed by the analysis of matrix spikes. Accuracy is measured in terms of percentage recovery as defined by the following equation:

$$\%R = \frac{SSR - SR}{SA} \times 100$$

where: %R = percentage recovery of the spike
SSR = spiked sample result
SR = sample result (native)
SA = spike added

Laboratories calculate percentage recoveries of spiked compounds, which are evaluated against control or acceptance limits taken from the appropriate method or the Contract Laboratory Program Statement of Work. If the spike recovery for a sample does not fall within the prescribed control limits, laboratory based corrective action is required.

Surrogate spikes consist of spiking non-target compounds into the sample prior to analysis. The spiked compounds are expected to behave during analysis in the same way as the target compounds. Every sample is spiked prior to extraction or analysis with surrogate compounds that are representative of the analysis. If surrogate spike recovery does not meet the prescribed control limits, samples should be reanalysed.

For inorganic analyses, certified reference materials are analysed (for SAL this is AGAL-10).

4.1.4 Representativeness

Data Point Evaluation

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition.

Representativeness is primarily dependent on the design and implementation of the sampling program. Representativeness of the data is partially ensured by the avoidance of contamination, adherence to sample handling and analysis protocols, and use of proper chain-of-custody and documentation procedures. Blanks, holding times and field duplicates are all QA parameters that can assist in the analysis of representativeness for data point evaluation and will need to be analysed as part of the measurement data quality assessment.

Data Set Evaluation

Whether the data is representative of the site is checked in part by undertaking an evaluation of the whole data set to establish the data is compatible. Data compatibility is authenticated by confirming that the laws of chemistry are upheld (i.e. nitrate is not present when Eh is -250 mV), that intra-laboratory analysis relationships are consistent (i.e. BTEX is a subset of the TPH C_6-C_9 fraction), that observations and field measurements are in agreement with other field data and the laboratory data and that results are consistent with the geology, history and logic.

4.1.5 Completeness

The following information is required to check for completeness of data sets:

- chain-of-custody forms (completed by Environmental Earth Sciences and the laboratory);
- sample receipt forms;
- all requested sample results reported;

- all blank data reported;
- all laboratory duplicates reported and relative percent differences (RPDs) calculated;
- all surrogate spike data reported;
- all matrix spike data reported; and
- NATA stamp on reports.

4.1.6 Comparability

Comparability is the evaluation of the similarity of conditions (e.g. sample depth, sample homogeneity, sampling procedures) under which separate sets of data are produced to ensure minimal common error. Data comparability should be demonstrated by the use of standardised sampling and analysis procedures. Data comparability was maintained by undertaking the investigations as follows:

- sampling during the monitoring program was conducted by trained Environmental Earth Sciences field team using Environmental Earth Sciences' standard operating procedures;
- groundwater samples were collected using dedicated whale pumps valves, tubing and bailers; and
- the same laboratories (NMI and SAL) were used for organic and inorganic analysis for all relevant samples using the same NATA approved analytical methods.

4.1.7 Sensitivity

When interferences are present in the sample, a loss of sensitivity can occur resulting in an increase in the method detection limit. In some instances (e.g. where one or more compounds have particularly high concentrations) the sample must be diluted for analysis. This increases the method detection limit by the dilution factor.

The detection limits achieved by the laboratory, when adjusted for dry weight and interferences from the presence of other chemicals within the sampled matrix, must be less than half the site criteria for all analytes tested (i.e. 2 x LOR <site criteria).

4.1.8 Blanks

To meet the QC acceptance criteria, laboratory blanks should have no detectable concentrations of the target compounds. Trip blanks (taken to and returned from the field) and rinsate blanks (taken in the field) will only be necessary for analysing dissolved metals and volatile organic compounds in water samples where the threshold value is near the detection limit for an individual compound or element.

4.1.9 Holding times

Where standard holding times are exceeded, a discussion, using professional judgement, as to the integrity of the data will be required, taking into account such factors as field storage, laboratory storage and even sample bottle characteristics.

4.1.10 Procedures for anomalous samples and confirmation checking

All results should be checked for discrepancies by the project manager against the anticipated results and all other results within 8 hours of receipt of the results from the laboratory.

Any result that is considered by the supervising scientist to be unusually high or at variance with other results is automatically reanalysed. A significantly different result requires immediate remedial action on the whole sample batch (retesting or using an alternative analytical method) at the laboratory's expense.

After appropriate checking by laboratories, all sample analysis result work-sheets, including those of duplicates and replicate analyses, should be checked by the consultant.

For blind duplicates, if one sample has more than two analytes exceeding the data quality objectives, the sample is carefully checked. If the error is not apparent, the sample is rejected. If more than three samples are rejected all the samples collected at that time are rejected. These samples are then re-sampled and reanalysed.

4.2 Field QA/QC

4.2.1 Details of sampling team

Fieldwork was conducted over the monitoring year using experienced and qualified Environmental Earth Sciences NSW personnel.

4.2.2 Sampling controls

Decontamination procedures carried out between sampling events

All sampling equipment to be re-used and which came into contact with groundwater or soil samples, were thoroughly washed with detergent (Decon 90 or similar) water, then rinsed with clean water before the collection of each sample. Any items accidentally contaminated were similarly washed before re-use.

Where boreholes were sampled using the same pump/bailer, these were rinsed with the proceeding boreholes groundwater or with detergent and water, if the preceding borehole was potentially chemically impacted. Between each location the flow cell and water quality metres were rinsed using a mixture of orange based surfactant and distilled water, followed by a rinse with distilled water. Groundwater samples were collected directly from the pump tubing/bailer and did not pass through the flow cell.

Sample notation details

The borehole logs details for each sample collected (including time, location, initials of sampler, duplicate locations, duplicate type and field screening details) are presented in Appendix A (QAQC document). The chemical analyses performed on each sample are presented on the chain of custody documentation (Appendix D), nature of the sample, collection date, analyses to be performed, sample preservation method (if any), departure time from the site and dispatch courier.

Blanks, spikes and rinsate samples

The scope of this project did not include analysis of trip and field blanks, background samples, rinsate samples or laboratory prepared trip spikes for the sampling program.

4.2.3 Field instrument calibration

The following field instruments were calibrated for the groundwater sampling program:

Table 6: Instrument calibration

Date	Meter	Parameter	Calibration
8 Nov 2018	ILU	Gas concentration	1000 ppm CH_4 (valid for 12 months)
12 Nov 2018	YSI	pH, mV, EC, D.O, Temp	3-point (pH 4.00& 7.00 & 10.00), Standard Solution (234 mV), 1-point (2.76 mS/cm) & 1-point (0 ppm)
11 Jan 2019	YSI	pH, mV, EC, D.O, Temp	3-point (pH 4.00& 7.00 & 10.00), Standard Solution (234 mV), 1-point (2.76 mS/cm) & 1-point (0 ppm)
11 Feb 2019	GA5000	Gas concentration	60% CH_4; 25 ppm H_2S; 20.9% O_2; 100 ppm CO; 40% CO_2
15 Aug 2018	TPS 90-FLT	pH, mV, EC, D.O,	32-point (pH 4.00 & 7.00), Standard Solution (240 mV), 12.88 (mS/cm), 36 ppk
15 Aug 2018	GA5000	Gas concentration	60% CH_4; 25 ppm H_2S; 20.9% O_2; 100 ppm CO; 40% CO_2

The instruments were calibrated in accordance with the manufacturer specifications and Environmental Earth Sciences NSW's field procedure and QA/QC documentation. Calibration certificates are attached.

4.3 Laboratory QA/QC

Organic analysis for this project was completed by the National Measurement Institute (NMI) and inorganic analysis was completed by Sydney Analytical Laboratories. Both laboratories are accredited by NATA for the methods used, details of this accreditation can be viewed at http://www.nata.asn.au/, while details of the samples sent to each laboratory and the analysis requested are contained in the chain of custody documentation held in Appendix D. The analytical methods are noted on the laboratory transcripts.

SAL complete a laboratory blank a laboratory duplicate. These results are reported in SAL report numbers:

- SAL26997
- SAL27119
- SAL27241; and
- SAL27330.

Although extracted and analysed dates have not been provided for SAL at the time of this report (can be provided later) it is assumed that to comply with NATA accreditation all analyses were performed within relevant holding times. All inter-laboratory trials completed by SAL were within the acceptance criteria set by the laboratory.

NMI complete laboratory control samples, laboratory blanks, sample duplicates, surrogate spikes and matrix spikes. These results are presented in the NMI report RN1214657, (**Appendix D**).

These reports include details of surrogates and spikes used, percent recoveries of surrogates and spikes used, the instrument detection limits, the method detection limits, the practical quantification limits and the reference samples results.

4.4 QA/QC data evaluation

All RPD values for intra- and inter-laboratory samples are within the acceptable defined in Table 5**Error! Reference source not found.**.

Sample analysis of hydrocarbons was undertaken during the February 2018 round were extracted and analysed within holding time. Hydrocarbons were detected within the sample and reported upon.

Based on information presented in Sections 4.1, 4.2 and 4.3 it can be confidently stated that the MDQO's for this project have been met and the data set is considered to be reliable.

5 QA/QC APPENDIX REFERENCES

American Public Health Association (APHA) 2005, *Standard methods for the examination of water and waste-water*, 21st edition, APHA, Washington DC.

Australian and New Zealand Environment and Conservation Council 1992, *Australian and New Zealand Guidelines for the assessment and management of contaminated sites,* Australia and New Zealand Environment Council, National Health and Medical Research Council, Melbourne, Victoria.

Australian/New Zealand Standard 2008, *Quality management systems - Requirements* (AS/NZS ISO 9001:2008) Standards Australia/Standards New Zealand, Sydney/Wellington.

Environmental Earth Sciences 2011, *Soil, gas and groundwater sampling manual,* Unpublished.

International Organisation for Standardisation 2005, *Quality management systems – Fundamentals and vocabulary*, (ISO 9000:2005).Lock, WH 1996, *Composite sampling*, National Environmental Health Forum (NEHF), Adelaide, SA.

National Environment Protection Council (NEPC) 1999, *National environment protection (assessment of site contamination) measure*, National Environment Protection Council, Adelaide, SA.

NSW Department of Environment and Conservation (2006), Contaminated sites: Guidelines for NSW Site Auditors Scheme (2nd edition).

NSW Environment Protection Authority (EPA) 1995, *Contaminated sites: Sampling design guidelines,* EPA NSW, Chatswood, NSW.

NSW EPA 1994, *Contaminated sites: Guidelines for the assessment of service station sites,* EPA NSW, Chatswood, NSW.

NSW EPA 1997, *Contaminated sites: Guidelines for consultants reporting on contaminated sites,* EPA NSW, Chatswood, NSW.

Rayment, GE & Higginson, FR 1992, Australian laboratory handbook of soil and water chemical methods, Inkarta Press, Melbourne.

APPENDIX A: CALIBRATION CERTIFICATES

Multi Parameter Water Meter

Instrument **YSI Quatro Pro Plus**
Serial No. **10H100325**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. pH 10.00		pH 10.00		320322	pH 9.55
2. pH 7.00		pH 7.00		307928	pH 6.98
3. pH 4.00		pH 4.00		307927	pH 4.23
4. mV		234mV		306263/311903	234.7mV
5. EC		2.76mS		306341	2.74mS
6. D.O		0.00ppm		5253	0.00ppm
7. Temp		20.7°C		MultiTherm	20.3°C

Calibrated by: Sarah Lian **Sarah Lian**

Calibration date: **13/08/2018**

Next calibration due: **12/09/2018**

FID Calibration Certificate

Instrument Photovac MicroFID
Serial No. CZPF326

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
	Recharge OK?	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
Pump	Operation	✓	
	Filter	✓	
	Flow	✓	
	Valves, Diaphragm	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Alarms	Beeper	✓	
	Settings	✓	
Software	Version		
Datalogger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Calibration gas and concentration	Certified	Gas bottle No	Instrument Reading
FID		500ppm CH4	NIST	SY143	498.9ppm

Calibrated by: Sarah Lian

Calibration date: **13/08/2018**

Next calibration due: **12/02/2019**

Gas Calibration Certificate

airmet

Air-Met Scientific Pty Ltd
1300 137 067

Instrument GFM430
Serial No. 11259
Sensors CH_4, CO_2, O_2, H_2S, LEL

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
	Recharge OK?	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
Pump	Operation	✓	
	Filter	✓	
	Flow	✓	
	Valves, Diaphragm	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	CH_4	✓	
	CO_2	✓	
	O_2	✓	
	H_2S	✓	
	LEL	✓	
	CO	✓	
Alarms	Beeper	✓	
	Settings	✓	
Software	Version		
Datalogger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Calibration gas and concentration	Certified	Gas bottle No	Instrument Reading
O_2		20.9% Vol O2		Fresh Air	20.9%
CO_2		40% Vol CO2	NATA	SY136	39.6%
CH_4		60% Vol CH4	NATA	SY136	59.7%

Calibrated by: Sarah Lian **Sarah Lian**

Calibration date: **13/08/2018**

Next calibration due: **12/02/2019**

Equipment Calibration Record – YSI Pro Plus

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

This equipment calibration record is to be stored in your job folder

Equipment Type: ~~YSI Pro Plus with Quatro Sensor~~ TPS 90FL-T

Equipment Number: 235586

Date Calibrated: 21/8/19

Calibrated By: EG Ellie Griffiths (name)

Job Number: 119037

Details of Calibration:

Temperature:	~~Ambient~~ 13.8	°C
pH at 4.01 Reading:	3.76	
pH at ~~7.01~~ 10 Reading (~~or 6.88~~):	9.91	
ORP in Redox solution (240 mV):	259	(mV)
Conductivity in 2.76 mS/cm: @25°C mS/cm	1953	mS/cm
Conductivity in 12.88 mS/cm:		mS/cm
Dissolved Oxygen in 0.00 ppm in Sodium sulfate:	0.00 ppm	%
Dissolved Oxygen 100% Air Saturation:		%

EQUIPMENT CERTIFICATION REPORT

KENNARDS HIRE

PGN9003871 WATER QUALITY METER – MULTIFUNCTION (TPS 90-FLT)

Plant Number: 235586

SENSOR	CONCENTRATION	SPAN 1	SPAN 2	TRACEABILITY	PASS
pH	pH 4.00 / pH 7.00	4.00 pH	7.00 pH	323358 / 326964	☑
Conductivity	12.88 mS/cm	0.0 mS/cm	12.88 mS/cm	327912	☑
Dissolvent Oxygen	Sodium Sulphite / Air	0.0ppm in Sodium Sulphite	10.0 ppm Saturation in Air	10175	☑
Turbidity	NTU	0 NTU	360 NTU	125204.	☑

Redox (ORP) **240mV ☑ Lot 3640. Electrode Operability Test 240mV ± 10%. Actual: 238 mV

Battery Status 8.4 (min 7.2V)	Temperature 19.5 °C
Electrical Test & Tag (AS/NZS 3760)	Electrodes Cleaned and Checked

Note: Calibration solution traceability information is available upon request.

Please clean/decontaminate instrument and accessories before returning. A minimum 'Cleaning Fee' $55.00 (Inc GST) may apply if instrument is returned contaminated.

Checked By: BRAD ALLORS Date: 15/08/2019 Signed: _____

Accessories List:

User's Manual	pH Sensor with Wetting Cap	Conductivity Sensor
Dissolved Oxygen Sensor with Wetting Cap	Redox (ORP) Sensor with Wetting Cap	pH and ORP Storage Solution
Charger Adaptor	Desiccant Satchel	Transit Case
Turbidity Sensor		

EQUIPMENT CERTIFICATION REPORT

KENNARDS HIRE

PGN9003823 GAS ANALYSER – LANDFILL GA2000-3000-5000

Plant Number: 234908

SENSOR	CONCENTRATION	INSTRUMENT READING	TRACEABILITY	PASS
CH4	60 %	60 %	Lot # 1061344	☑
CO2	40 %	40 %	Lot # 1061344	☑
O2	15 %	15 %	Lot # 845159	☑
CO	100 ppm	100 ppm	Lot # 845159	☑
H2S	40 ppm	40 ppm	Lot # 845159	☑

Data Cleared ☑

Battery Status 100. (%)	Temperature 18.5 °C
Electrical Test & Tag (AS/NZS 3760)	Inlet Filter Cleaned/Replaced

Note: Calibration traceability information is available upon request.

Please clean/decontaminate instrument and accessories before returning. A minimum 'Cleaning Fee' $55.00 (Inc GST) may apply if instrument is returned contaminated.

Checked By: BRAD ALCOR Date: 15/08/2019 Signed: _____

Accessories List:

User's Manual & USB	1x Gas Inlet Hoses	1X Gas Inlet Hose With Filter
1x Gas Inlet Hose & Clip Fitting	2x Spare Inlet Filters	1x Flow Through Desiccant
1x Wall Charger	Carry Pouch With Neck Strap	1x USB Comms Cable
Carry Transit Case	Calibration Certificate	

Multi Parameter Water Meter

airmet

Air-Met Scientific Pty Ltd
1300 137 067

Instrument YSI Quatro Pro Plus
Serial No. 14D101796

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. pH 10.00		pH 10.00		324189	pH 9.78
2. pH 7.00		pH 7.00		317272	pH 7.01
3. pH 4.00		pH 4.00		324985	pH 4.08
4. mV		231.8mV		325420/325421	231.7mV
5. EC		2.76mS		324347	2.76mS
6. D.O		0.00ppm		10175	0.00ppm
7. Temp		21.8°C		MultiTherm	21.6°C

Calibrated by: **Maria Orlova**

Calibration date: **11/01/2019**

Next calibration due: **10/07/2019**

Calibration certificate number 45143

Instrument laserOne **Huberg serial number** 19251.18

Description of the calibration procedure

The calibration is verified using certified gas bottle. The maximum error of the instrument is specified in the datasheet.

Check of the instrument between 0 ÷ 10000 ppm CH4

Full scale (ppm)	Gas concentration (ppm)	Response1 (ppm)	Response2 (ppm)	Response3 (ppm)	Average response (ppm)	Max error (ppm)	Max error (% F.s.)
1000	0	0	0	0	0,00	0,00	0,00
1000	100	103	102	100	101,00	3,00	0,30
1000	1000	1004	1002	1000	1.002,00	4,00	0,40

Uncertainty	0,40	%
Max % error	0,40	% Fs

Ambient condition by calibration

Temperature : 23 °C
Pressure : 1012 mBar
U.R. : 42 %

Calibration gas cylinders[1]

Gas	Serial number	Date of expire	GAS
Aria sintetica	152328	21/02/2022	AIR
100 PPM	AD0F9E6	14/06/2020	CH4
1000 PPM	ADM2728	10/08/2020	CH4

Calibration results : POSITIVE
Calibration date : 8/11/2018
Next scheduled calibration : 8/11/2019
Calibration supervisor : Foldi Andrea

[1] **The certificate of the gases could be downloaded at the following address http://www.huberg.com/certificati**

Gas Calibration Certificate

Instrument GA5000
Serial No. G505732
Sensors CH4, CO2, O2, CO, H2S

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
	Recharge OK?	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
Pump	Operation	✓	
	Filter	✓	
	Flow	✓	
	Valves, Diaphragm	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	O2	✓	
	CH4	✓	
	CO2	✓	
	CO	✓	
	H2S	✓	
Alarms	Beeper	✓	
	Settings	✓	
Software	Version		
Datalogger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Diffusion mode Aspirated mode

Sensor	Serial no	Calibration gas and concentration	Certified	Gas bottle No	Instrument Reading
O2		20.9% Vol O2		Fresh Air	20.9% O2
CH4		60% CH4	NATA	SY244	59.7% CH4
CO2		40% CO2	NATA	SY244	39.7% CO2
CO		95ppm CO	NATA	SY174	93ppm CO
H2S		25ppm H2S	NATA	SY174	24ppm H2S

Calibrated by: **Sarah Lian**

Calibration date: **11/02/2019**

Next calibration due: **10/08/2019**

Multi Parameter Water Meter

Instrument YSI Quatro Pro Plus
Serial No. 11K101271

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper	✓	
	Settings	✓	
Software	Version	✓	
Data logger	Operation	✓	
Download	Operation	✓	
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. pH 10.00		pH 10.00		320322	pH 9.30
2. pH 7.00		pH 7.00		307928	pH 6.77
3. pH 4.00		pH 4.00		320612	pH 4.03
4. mV		234mV		320334/311902	233.6mV
5. EC		2.76mS		320326	2.73mS
6. D.O		0.00 ppm		10175	0.00ppm
7. Temp		20°C		MultiTherm	19.8°C

Calibrated by: Sarah Lian **Sarah Lian**

Calibration date: 12/11/2018

Next calibration due: 11/05/2019

APPENDIX C: LABORATORY TRANSCRIPTS

SONIC
FOOD & WATER TESTING

MICROBIOLOGY FINAL REPORT

CERTIFICATE OF ANALYSIS

W1918325
[]

SYDNEY ANALYTICAL LABS
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147

Lab Number:	299896124
Customer Reference Number:	118109
Site:	SHELLHARBOUR LP1
Sample Type:	WATER
Sample Notes:	
Date and Time of Collection:	21/08/19,1050
Date and Time of Testing:	24/08/19,0800
Collected By:	The Client
Tested:	As Received

TESTS	RESULTS	UNITS
FAECAL COLIFORM COUNT:	20	most probable number per 100ml
ESCHERICHIA COLI COUNT:	20	most probable number per 100ml

METHODS

* Thermotolerant (Faecal) Coliform Count - Australian Standard 4276.6 by Most Probable Number Method.
* Escherichia coli Count - Australian Standard 4276.6 by Most Probable Number Method.

The time between collection and the commencement of testing should not exceed 24 hours. Samples tested outside this time may have their results compromised.

END OF REPORT

Signed:. Date:27/08/19

T.Morgan	K.McClenahan	H.Sialepis	L.Vanhoff	P.Campora	R.Bhatt	N.Mecsery	S.Leelakrishnan
Laboratory Manager	Quality Manager	Technical Officer	Technical Officer	Scientific Officer	Scientific Officer	Technical Officer	Scientific Officer

NATA WORLD RECOGNISED ACCREDITATION
Accreditation No. 4034
Accredited for compliance with ISO/IEC 17025 – Testin

SYDNEY
ANALYTICAL
LABORATORIES

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: SAL27330

CLIENT ORDER: 118109

DATE RECEIVED: 23/08/19

DATE COMPLETED: 06/09/19

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 23

.....
Issued on 06/09/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		21/08/19	20/08/19
SAMPLES		BH1c	BH2
pH		7.2	7.2
Total Dissolved Solids	mg/L	4690	1800
Biochemical Oxygen Demand	mg/L	9	3
Total Organic Carbon	mg/L	195	60
Iron (Total)	mg/L	15	10
Iron (Dissolved)	mg/L	2.1	1.2
Manganese (Dissolved)	mg/L	0.12	0.41

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	930	40.455	345	15.008
Calcium Ca++	145	7.236	180	8.982
Potassium K+	250	6.400	48	1.229
Magnesium Mg++	110	9.053	74	6.090
Ammonia (Total)	330	23.562	42	2.999
TOTAL CATIONS		86.706		34.308
Chloride Cl-	850	23.970	400	11.280
Fluoride F-	0.51	0.027	0.28	0.015
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	35	0.728	130	2.704
Bicarbonate HCO3-	4030	66.092	1180	19.352
Phosphate PO4---	0.16	0.005	<0.1	
TOTAL ANIONS		90.822		33.351

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		20/08/19	20/08/19
SAMPLES		BH3	BH4
pH		7.4	7.3
Total Dissolved Solids	mg/L	1120	1140
Biochemical Oxygen Demand	mg/L	7	<2
Total Organic Carbon	mg/L	15	21
Iron (Total)	mg/L	13	4.5
Iron (Dissolved)	mg/L	0.35	0.20
Manganese (Dissolved)	mg/L	0.22	0.19

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	135	5.873	155	6.743
Calcium Ca++	165	8.233	205	10.230
Potassium K+	33	0.845	26	0.666
Magnesium Mg++	31	2.551	40	3.292
Ammonia (Total)	41	2.927	6.7	0.478
TOTAL CATIONS		20.429		21.409
Chloride Cl-	290	8.178	220	6.204
Fluoride F-	0.20	0.011	0.15	0.008
Nitrate NO3-	26	0.419	<0.1	
Sulphate SO4--	87	1.810	150	3.120
Bicarbonate HCO3-	640	10.496	720	11.808
Phosphate PO4---	<0.1		<0.1	
Nitrite NO2-			<0.1	
TOTAL ANIONS		20.914		21.140

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		20/08/19	21/08/19
SAMPLES		BH13	BH14
pH		7.2	6.9
Total Dissolved Solids	mg/L	1050	1200
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	26	30
Iron (Total)	mg/L	1.6	3.8
Iron (Dissolved)	mg/L	0.18	1.4
Manganese (Dissolved)	mg/L	0.23	0.32

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	105	4.568	185	8.047
Calcium Ca++	180	8.982	200	9.980
Potassium K+	46	1.178	21	0.538
Magnesium Mg++	44	3.621	48	3.950
Ammonia (Total)	3.0	0.214	2.7	0.193
TOTAL CATIONS		18.563		22.708
Chloride Cl-	88	2.482	200	5.640
Fluoride F-	0.23	0.012	0.41	0.022
Nitrate NO3-	2.3	0.037	3.6	0.058
Sulphate SO4--	255	5.304	97	2.018
Bicarbonate HCO3-	675	11.070	880	14.432
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		18.905		22.170

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		21/08/19	20/08/19
SAMPLES		BH16	BH20
pH		7.1	7.6
Total Dissolved Solids	mg/L	385	970
Biochemical Oxygen Demand	mg/L	2	<2
Total Organic Carbon	mg/L	19	20
Iron (Total)	mg/L	4.9	1.6
Iron (Dissolved)	mg/L	0.22	0.15
Manganese (Dissolved)	mg/L	0.09	0.08

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	64	2.784	59	2.567
Calcium Ca++	24	1.198	175	8.733
Potassium K+	11	0.282	46	1.178
Magnesium Mg++	33	2.716	34	2.798
Ammonia (Total)	0.2	0.014	24	1.714
TOTAL CATIONS		6.994		16.990
Chloride Cl-	120	3.384	160	4.512
Fluoride F-	0.26	0.014	0.16	0.008
Nitrate NO3-	0.22	0.004	<0.1	
Sulphate SO4--	52	1.082	225	4.680
Bicarbonate HCO3-	170	2.788	465	7.626
Phosphate PO4---	<0.1		0.18	0.006
TOTAL ANIONS		7.272		16.832

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		20/08/19	20/08/19
SAMPLES		BH20s	BHA
pH		7.7	6.9
Total Dissolved Solids	mg/L	810	790
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	18	21
Iron (Total)	mg/L	0.09	2.9
Iron (Dissolved)	mg/L	0.07	0.89
Manganese (Dissolved)	mg/L	0.06	0.12

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	37	1.610	76	3.306
Calcium Ca++	120	5.988	145	7.236
Potassium K+	82	2.099	14	0.358
Magnesium Mg++	41	3.374	35	2.881
Ammonia (Total)	1.2	0.086	0.4	0.029
TOTAL CATIONS		13.157		13.810
Chloride Cl-	52	1.466	76	2.143
Fluoride F-	0.15	0.008	0.12	0.006
Nitrate NO3-	55	0.886	9.8	0.158
Sulphate SO4--	200	4.160	235	4.888
Bicarbonate HCO3-	410	6.724	385	6.314
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		13.244		13.509

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		20/08/19	20/08/19
SAMPLES		BHA DUP	BH12-R
pH		7.0	6.9
Total Dissolved Solids	mg/L	800	1580
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	22	16
Iron (Total)	mg/L	3.1	3.5
Iron (Dissolved)	mg/L	0.91	2.4
Manganese (Dissolved)	mg/L	0.12	0.76

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	72	3.132	155	6.743
Calcium Ca++	150	7.485	295	14.721
Potassium K+	15	0.384	62	1.587
Magnesium Mg++	36	2.963	65	5.350
Ammonia (Total)	0.4	0.029	1.5	0.107
TOTAL CATIONS		13.993		28.508
Chloride Cl-	75	2.115	280	7.896
Fluoride F-	0.11	0.006	0.13	0.007
Nitrate NO3-	9.5	0.153	130	2.093
Sulphate SO4--	240	4.992	300	6.240
Bicarbonate HCO3-	395	6.478	705	11.562
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		13.744		27.798

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		20/08/19	20/08/19
SAMPLES		BH17-R	BH19-R
pH		6.9	7.3
Total Dissolved Solids	mg/L	1340	1060
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	26	24
Iron (Total)	mg/L	17	2.5
Iron (Dissolved)	mg/L	3.2	0.19
Manganese (Dissolved)	mg/L	0.23	0.14

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	200	8.700	190	8.265
Calcium Ca++	180	8.982	155	7.735
Potassium K+	51	1.306	22	0.563
Magnesium Mg++	45	3.704	39	3.210
Ammonia (Total)	9.6	0.685	5.5	0.393
TOTAL CATIONS		23.377		20.166
Chloride Cl-	380	10.716	230	6.486
Fluoride F-	0.11	0.006	0.11	0.006
Nitrate NO3-	1.6	0.026	<0.1	
Sulphate SO4--	175	3.640	185	3.848
Bicarbonate HCO3-	545	8.938	590	9.676
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		23.326		20.016

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		20/08/19	21/08/19
SAMPLES		FD1	LP1
pH		7.3	7.9
Total Dissolved Solids	mg/L	1120	11700
Biochemical Oxygen Demand	mg/L	<2	110
Total Organic Carbon	mg/L	20	790
Turbidity	NTU		50
Iron (Total)	mg/L	4.6	5.9
Iron (Dissolved)	mg/L	0.18	4.6
Manganese (Dissolved)	mg/L	0.20	0.49
E.Coli	cfu/100mL		20
Faecal Coliforms	cfu/100mL		20

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	150	6.525	2390	103.965
Calcium Ca++	210	10.479	160	7.984
Potassium K+	27	0.691	590	15.104
Magnesium Mg++	42	3.457	145	11.934
Ammonia (Total)	6.7	0.478	970	69.258
TOTAL CATIONS		21.630		208.245
Chloride Cl-	220	6.204	2100	59.220
Fluoride F-	0.10	0.005	0.72	0.038
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	155	3.224	120	2.496
Bicarbonate HCO3-	705	11.562	9310	152.684
Phosphate PO4---	<0.1		33	1.043
TOTAL ANIONS		20.995		215.481

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		21/08/19	21/08/19
SAMPLES		SWP1	SWP2
pH		7.2	8.1
Total Dissolved Solids	mg/L	250	1270
Turbidity	NTU	27	6.4
Iron (Total)	mg/L	5.6	0.20
Iron (Dissolved)	mg/L	0.45	0.05

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	41	1.784	295	12.833
Calcium Ca++	30	1.497	95	4.741
Potassium K+	13	0.333	29	0.742
Magnesium Mg++	12	0.988	51	4.197
Ammonia (Total)	0.7	0.050	0.1	0.007
TOTAL CATIONS		4.652		22.520
Chloride Cl-	68	1.918	330	9.306
Fluoride F-	<0.1		0.14	0.007
Nitrate NO3-	0.18	0.003	0.84	0.014
Sulphate SO4--	10	0.208	180	3.744
Bicarbonate HCO3-	145	2.378	565	9.266
Phosphate PO4---	0.24	0.008	<0.1	
TOTAL ANIONS		4.515		22.337

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		21/08/19	21/08/19
SAMPLES		SWP4	SWC2
pH		8.4	
Total Dissolved Solids	mg/L	1400	
Biochemical Oxygen Demand	mg/L	4	
Total Organic Carbon	mg/L	35	
Turbidity	NTU	10	4.3
Iron (Total)	mg/L	0.17	0.35
Iron (Dissolved)	mg/L	0.04	0.20

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	340	14.790		
Calcium Ca++	71	3.543		
Potassium K+	20	0.512		
Magnesium Mg++	67	5.514		
Ammonia (Total)	2.1	0.150	1.4	
TOTAL CATIONS		24.509		
Chloride Cl-	360	10.152		
Fluoride F-	0.30	0.016		
Nitrate NO3-	4.2	0.068	0.18	
Sulphate SO4--	310	6.448		
Bicarbonate HCO3-	455	7.462	240	
Phosphate PO4---	<0.1			
Nitrite NO2-			0.23	
TOTAL ANIONS		24.146		

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION			21/08/19		21/08/19
SAMPLES			SWC-UP		SWC-UP DUP
pH			7.4		7.5
Total Dissolved Solids	mg/L		26700		26600
Turbidity	NTU		21		21
Iron (Total)	mg/L		1.0		0.97
Iron (Dissolved)	mg/L		0.15		0.17
		mg/L	meq/L	mg/L	meq/L
Sodium Na+		7980	347.130	8030	349.305
Calcium Ca++		375	18.713	370	18.463
Potassium K+		290	7.424	295	7.552
Magnesium Mg++		1000	82.300	1020	83.946
Ammonia (Total)		0.8	0.057	0.8	0.057
TOTAL CATIONS			455.624		459.323
Chloride Cl-		14600	411.720	14200	400.440
Fluoride F-		0.47	0.025	0.49	0.026
Nitrate NO3-		0.35	0.006	0.40	0.006
Sulphate SO4--		2100	43.680	2140	44.512
Bicarbonate HCO3-		235	3.854	235	3.854
Phosphate PO4---		<0.1		<0.1	
TOTAL ANIONS			459.285		448.838

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		21/08/19	21/08/19
SAMPLES		SWC-DOWN	SWC-DOWN 2
pH		7.7	7.9
Total Dissolved Solids	mg/L	37400	37600
Turbidity	NTU	14	2.2
Iron (Total)	mg/L	0.75	0.22
Iron (Dissolved)	mg/L	0.24	0.17

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	11400	495.900	11300	491.550
Calcium Ca++	440	21.956	450	22.455
Potassium K+	425	10.880	420	10.752
Magnesium Mg++	1290	106.167	1380	113.574
Ammonia (Total)	0.2	0.014	<0.1	
TOTAL CATIONS		634.917		638.331
Chloride Cl-	20600	580.920	20700	583.740
Fluoride F-	0.49	0.026	0.48	0.025
Nitrate NO3-	0.18	0.003	<0.1	
Sulphate SO4--	2780	57.824	2860	59.488
Bicarbonate HCO3-	215	3.526	200	3.280
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		642.299		646.533

ANALYTICAL REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

DATE OF COLLECTION		21/08/19	21/08/19
SAMPLES		FD2	BLANK
pH		8.5	7.3
Total Dissolved Solids	mg/L	1420	<1
Biochemical Oxygen Demand	mg/L		<2
Total Organic Carbon	mg/L		<1
Turbidity	NTU		<0.2
Iron (Total)	mg/L	0.20	<0.01
Iron (Dissolved)	mg/L	0.03	<0.01
Manganese (Dissolved)	mg/L		<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	340	14.790	<0.1	
Calcium Ca++	69	3.443	<0.1	
Potassium K+	21	0.538	<0.1	
Magnesium Mg++	68	5.596	<0.1	
Ammonia (Total)	2.1	0.150	<0.1	
TOTAL CATIONS		24.517		
Chloride Cl-	370	10.434	<1	
Fluoride F-	0.35	0.018	<0.1	
Nitrate NO3-	4.2	0.068	<0.1	
Sulphate SO4--	300	6.240	<2	
Bicarbonate HCO3-	455	7.462	<1	
Phosphate PO4---	<0.1		<0.1	
Nitrite NO2-			<0.1	
TOTAL ANIONS		24.222		

LABORATORY DUPLICATE REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
BHA	pH		0.1	6.9	7.0	1
SWC-UP	pH		0.1	7.4	7.5	1
BHA	TDS	mg/L	1	790	800	1
SWC-UP	TDS	mg/L	1	26700	26600	0
BHA	Sodium	mg/L	0.1	76	72	5
SWC-UP	Sodium	mg/L	0.1	7980	8030	1
BHA	Calcium	mg/L	0.1	145	150	3
SWC-UP	Calcium	mg/L	0.1	375	370	1
BHA	Potassium	mg/L	0.1	14	15	7
SWC-UP	Potassium	mg/L	0.1	290	295	2
BHA	Magnesium	mg/L	0.1	35	36	3
SWC-UP	Magnesium	mg/L	0.1	1000	1020	2
BHA	Chloride	mg/L	1	76	75	1
SWC-UP	Chloride	mg/L	1	14600	14200	3
BHA	Fluoride	mg/L	0.1	0.12	0.11	8
SWC-UP	Fluoride	mg/L	0.1	0.47	0.49	4
BHA	Nitrate	mg/L	0.1	9.8	9.5	3
SWC-UP	Nitrate	mg/L	0.1	0.35	0.40	13
BHA	Sulphate	mg/L	2	235	240	2
SWC-UP	Sulphate	mg/L	2	2100	2140	2
BHA	Bicarbonate	mg/L	1	385	395	3
SWC-UP	Bicarbonate	mg/L	1	235	235	0
BHA	Phosphate	mg/L	0.1	<0.1	<0.1	0
SWC-UP	Phosphate	mg/L	0.1	<0.1	<0.1	0
BHA	Ammonia	mg/L	0.1	0.4	0.4	0
SWC-UP	Ammonia	mg/L	0.1	0.8	0.8	0
BHA	BOD	mg/L	2	<2	<2	0
BHA	TOC	mg/L	1	21	22	5
SWC-UP	Turbidity	NTU	0.2	21	21	0

LABORATORY DUPLICATE REPORT

JOB NO: SAL27330
CLIENT ORDER: 118109

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
BHA	Fe (Total)	mg/L	0.01	2.9	3.1	7
SWC-UP	Fe (Total)	mg/L	0.01	1.0	0.97	3
BHA	Fe Dissolved	mg/L	0.01	0.89	0.91	2
SWC-UP	Fe Dissolved	mg/L	0.01	0.15	0.17	13
BHA	Mn Dissolved	mg/L	0.01	0.12	0.12	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: SAL27330
CLIENT ORDER: 118109

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	Nitrite NO2-
5210B	Biochemical Oxygen Demand
5310C	Total Organic Carbon
2130B	Turbidity
3111B	Iron (Total)
3111B	Iron (Dissolved)
3111B	Manganese (Dissolved)

E.Coli/Faecal Coliforms Determined by BARRATT & SMITH (4034)
Report No.: W1918325

SYDNEY
ANALYTICAL
LABORATORIES

Office:
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Laboratory:
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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:	SAL27330B
CLIENT ORDER:	118109
DATE RECEIVED:	23/08/19
DATE COMPLETED:	06/09/19
TYPE OF SAMPLES:	DUST GAUGE
NO OF SAMPLES:	1

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 06/09/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27330B
CLIENT ORDER: 118109

SAMPLES	ASH CONTENT g/m2/mth	COMBUSTIBLE CONTENT g/m2/mth	INSOLUBLES CONTENT g/m2/mth	SOLUBLES CONTENT g/m2/mth
DG1	0.3	0.2	0.5	0.1
MDL	0.1	0.1	0.1	0.1
Method Code	S14	S17	S15	S16
Preparation	P7	P7	P7	P7

ANALYTICAL REPORT

JOB NO: SAL27330B
CLIENT ORDER: 118109

SAMPLES	TOTAL SOLIDS CONTENT g/m2/mth	PARTICULATES CONTENT g/m2/mth	FUNNEL DIAMETER mm	TIME EXPOSURE days
DG1	0.6	<0.1	150	100
MDL	0.1	0.1		
Method Code	S8	S19		
Preparation	P7	P7		

Sampling Dates: 14/05/19-22/08/19

ANALYTICAL REPORT

JOB NO: SAL27330B
CLIENT ORDER: 118109

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P7	Analysis performed on sample as received (total contents)
S14	Total Ash Content - AS3580.10.1
S17	Total Combustibles Content - AS3580.10.1
S15	Total Insoluble Solids Content - AS3580.10.1
S16	Total Soluble Solids Content - AS3580.10.1
S8	Total Solids Content - AS3580.10.1
S19	Total Particulates Content - AS3580.10.1

SYDNEY
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NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: ELIN GRIFFITHS

JOB NO:	SAL27113B
CLIENT ORDER:	118109
DATE RECEIVED:	14/02/19
DATE COMPLETED:	27/02/19
TYPE OF SAMPLES:	DUST GAUGE
NO OF SAMPLES:	1

NATA
Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 27/02/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27113B
CLIENT ORDER: 118109

SAMPLES	ASH CONTENT g/m2/mth	COMBUSTIBLE CONTENT g/m2/mth	INSOLUBLES CONTENT g/m2/mth	SOLUBLES CONTENT g/m2/mth
DG1	1.1	0.4	1.5	0.2
MDL	0.1	0.1	0.1	0.1
Method Code	S14	S17	S15	S16
Preparation	P7	P7	P7	P7

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL27113B
CLIENT ORDER: 118109

SAMPLES	TOTAL SOLIDS CONTENT g/m2/mth	PARTICULATES CONTENT g/m2/mth	FUNNEL DIAMETER mm	TIME EXPOSURE days
DG1	1.7	<0.1	150	92
MDL	0.1	0.1		
Method Code	S8	S19		
Preparation	P7	P7		

Sampling Dates: 13/11/18-13/02/19

ANALYTICAL REPORT

JOB NO: SAL27113B
CLIENT ORDER: 118109

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P7	Analysis performed on sample as received (total contents)
S14	Total Ash Content - AS3580.10.1
S17	Total Combustibles Content - AS3580.10.1
S15	Total Insoluble Solids Content - AS3580.10.1
S16	Total Soluble Solids Content - AS3580.10.1
S8	Total Solids Content - AS3580.10.1
S19	Total Particulates Content - AS3580.10.1

SYDNEY
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NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: ELIN GRIFFITHS

JOB NO: SAL27113

CLIENT ORDER: 118109

DATE RECEIVED: 14/02/19

DATE COMPLETED: 27/02/19

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 18

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 27/02/19
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		BH1c	BH2
pH		7.4	7.2
Total Dissolved Solids	mg/L	4020	1790
Total Organic Carbon	mg/L	175	64
Biochemical Oxygen Demand	mg/L	25	2
Iron (Total)	mg/L	15	13
Iron (Dissolved)	mg/L	2.9	3.2
Manganese (Dissolved)	mg/L	0.16	0.47

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	695	30.233	340	14.790
Calcium Ca++	140	6.986	195	9.730
Potassium K+	240	6.144	52	1.331
Magnesium Mg++	105	8.642	73	6.008
Ammonia (Total)	355	25.347	39	2.785
TOTAL CATIONS		77.352		34.644
Chloride Cl-	820	23.124	450	12.690
Fluoride F-	0.25	0.013	0.26	0.014
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	13	0.270	130	2.704
Bicarbonate HCO3-	3250	53.300	1150	18.860
Phosphate PO4---	0.15	0.005	<0.1	
TOTAL ANIONS		76.712		34.268

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		BH3	BH4
pH		6.8	7.1
Total Dissolved Solids	mg/L	730	1060
Total Organic Carbon	mg/L	13	19
Biochemical Oxygen Demand	mg/L	5	<2
Iron (Total)	mg/L	3.0	5.1
Iron (Dissolved)	mg/L	0.11	0.17
Manganese (Dissolved)	mg/L	0.18	0.22

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	61	2.654	135	5.873
Calcium Ca++	125	6.238	170	8.483
Potassium K+	32	0.819	26	0.666
Magnesium Mg++	20	1.646	37	3.045
Ammonia (Total)	19	1.357	6.7	0.478
TOTAL CATIONS		12.714		18.545
Chloride Cl-	185	5.217	210	5.922
Fluoride F-	0.11	0.006	<0.1	
Nitrate NO3-	56	0.902	<0.1	
Sulphate SO4--	75	1.560	140	2.912
Bicarbonate HCO3-	290	4.756	575	9.430
Phosphate PO4---	0.12	0.004	<0.1	
Nitrite NO2-			9.6	0.208
TOTAL ANIONS		12.445		18.472

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		BH13	BH14
pH		7.3	7.2
Total Dissolved Solids	mg/L	975	1360
Total Organic Carbon	mg/L	23	27
Biochemical Oxygen Demand	mg/L	3	<2
Iron (Total)	mg/L	1.2	5.4
Iron (Dissolved)	mg/L	0.29	0.32
Manganese (Dissolved)	mg/L	0.26	0.36

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	100	4.350	215	9.352
Calcium Ca++	185	9.232	210	10.479
Potassium K+	30	0.768	24	0.614
Magnesium Mg++	40	3.292	57	4.691
Ammonia (Total)	1.0	0.071	1.7	0.121
TOTAL CATIONS		17.713		25.257
Chloride Cl-	105	2.961	245	6.909
Fluoride F-	0.22	0.012	0.44	0.023
Nitrate NO3-	3.1	0.050	0.66	0.011
Sulphate SO4--	195	4.056	78	1.622
Bicarbonate HCO3-	625	10.250	1000	16.400
Phosphate PO4---	<0.1		0.10	0.003
TOTAL ANIONS		17.329		24.968

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		BH16	BH20
pH		7.5	7.1
Total Dissolved Solids	mg/L	245	815
Total Organic Carbon	mg/L	10	19
Biochemical Oxygen Demand	mg/L	9	<2
Iron (Total)	mg/L	2.6	1.7
Iron (Dissolved)	mg/L	0.25	0.06
Manganese (Dissolved)	mg/L	0.09	0.10

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	29	1.262	43	1.871
Calcium Ca++	22	1.098	150	7.485
Potassium K+	11	0.282	30	0.768
Magnesium Mg++	21	1.728	38	3.127
Ammonia (Total)	0.1	0.007	21	1.499
TOTAL CATIONS		4.377		14.750
Chloride Cl-	48	1.354	150	4.230
Fluoride F-	0.34	0.018	0.13	0.007
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	35	0.728	220	4.576
Bicarbonate HCO3-	135	2.214	355	5.822
Phosphate PO4---	<0.1		0.34	0.011
TOTAL ANIONS		4.314		14.646

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		BH20s	FD1
pH		7.6	7.5
Total Dissolved Solids	mg/L	800	965
Total Organic Carbon	mg/L	17	22
Biochemical Oxygen Demand	mg/L	<2	<2
Iron (Total)	mg/L	0.11	1.2
Iron (Dissolved)	mg/L	0.05	0.26
Manganese (Dissolved)	mg/L	0.10	0.25

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	45	1.958	105	4.568
Calcium Ca++	110	5.489	180	8.982
Potassium K+	105	2.688	32	0.819
Magnesium Mg++	41	3.374	41	3.374
Ammonia (Total)	<0.1		1.2	0.086
TOTAL CATIONS		13.509		17.829
Chloride Cl-	67	1.889	105	2.961
Fluoride F-	0.12	0.006	0.23	0.012
Nitrate NO3-	33	0.531	3.0	0.048
Sulphate SO4--	200	4.160	190	3.952
Bicarbonate HCO3-	445	7.298	640	10.496
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		13.884		17.469

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		FD1 DUP	LP1
pH		7.4	8.1
Total Dissolved Solids	mg/L	970	8870
Total Organic Carbon	mg/L	23	695
Biochemical Oxygen Demand	mg/L	<2	130
Turbidity	NTU		700
Iron (Total)	mg/L	1.1	48
Iron (Dissolved)	mg/L	0.27	3.0
Manganese (Dissolved)	mg/L	0.27	0.42

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	100	4.350	1490	64.815
Calcium Ca++	180	8.982	120	5.988
Potassium K+	31	0.794	590	15.104
Magnesium Mg++	40	3.292	100	8.230
Ammonia (Total)	1.2	0.086	1070	76.398
TOTAL CATIONS		17.504		170.535
Chloride Cl-	105	2.961	1840	51.888
Fluoride F-	0.23	0.012	0.77	0.041
Nitrate NO3-	3.0	0.048	<0.1	
Sulphate SO4--	190	3.952	110	2.288
Bicarbonate HCO3-	630	10.332	7170	117.588
Phosphate PO4---	<0.1		29	0.916
TOTAL ANIONS		17.305		172.721

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION			13/02/19		13/02/19
SAMPLES			SWP1		SWP2
pH			7.2		8.1
Total Dissolved Solids	mg/L		325		1290
Turbidity	NTU		950		1.1
Iron (Total)	mg/L		47		0.15
Iron (Dissolved)	mg/L		2.3		0.05
		mg/L	meq/L	mg/L	meq/L
Sodium Na+		47	2.045	290	12.615
Calcium Ca++		42	2.096	79	3.942
Potassium K+		11	0.282	36	0.922
Magnesium Mg++		16	1.317	58	4.773
Ammonia (Total)		<0.1		0.2	0.014
TOTAL CATIONS			5.740		22.266
Chloride Cl-		66	1.861	360	10.152
Fluoride F-		0.15	0.008	0.15	0.008
Nitrate NO3-		<0.1		<0.1	
Sulphate SO4--		12	0.250	185	3.848
Bicarbonate HCO3-		230	3.772	510	8.364
Phosphate PO4---		<0.1		<0.1	
TOTAL ANIONS			5.891		22.372

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		SWP4	SWC2
pH		9.0	
Total Dissolved Solids	mg/L	1270	
Total Organic Carbon	mg/L	38	
Biochemical Oxygen Demand	mg/L	4	
Turbidity	NTU	16	4.8
Iron (Total)	mg/L	0.46	0.38
Iron (Dissolved)	mg/L	0.11	0.13

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	325	14.138		
Calcium Ca++	44	2.196		
Potassium K+	25	0.640		
Magnesium Mg++	61	5.020		
Ammonia (Total)	<0.1		0.6	
TOTAL CATIONS		21.994		
Chloride Cl-	390	10.998		
Fluoride F-	0.30	0.016		
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	320	6.656		
Bicarbonate HCO3-	210	3.444	185	
Phosphate PO4---	<0.1			
Nitrite NO2-			0.33	
Carbonate CO3--	25	0.833		
TOTAL ANIONS		21.947		

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		SWC-UP	SWC-DOWN
pH		7.3	7.3
Total Dissolved Solids	mg/L	35200	36500
Turbidity	NTU	1.0	1.0
Iron (Total)	mg/L	0.28	0.25
Iron (Dissolved)	mg/L	0.15	0.11

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	10700	465.450	11400	495.900
Calcium Ca++	445	22.206	430	21.457
Potassium K+	500	12.800	475	12.160
Magnesium Mg++	1250	102.875	1220	100.406
Ammonia (Total)	0.2	0.014	0.1	0.007
TOTAL CATIONS		603.345		629.930
Chloride Cl-	19100	538.620	20600	580.920
Fluoride F-	0.45	0.024	0.46	0.024
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	2490	51.792	2510	52.208
Bicarbonate HCO3-	235	3.854	230	3.772
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		594.290		636.924

ANALYTICAL REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

DATE OF COLLECTION		13/02/19	13/02/19
SAMPLES		SWC-DOWN 2	BLANK
pH		7.3	7.2
Total Dissolved Solids	mg/L	36800	<1
Total Organic Carbon	mg/L		<1
Biochemical Oxygen Demand	mg/L		<2
Turbidity	NTU	1.2	<0.2
Iron (Total)	mg/L	0.23	<0.01
Iron (Dissolved)	mg/L	0.10	<0.01
Manganese (Dissolved)	mg/L		<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	11600	504.600	<0.1	
Calcium Ca++	440	21.956	<0.1	
Potassium K+	480	12.288	<0.1	
Magnesium Mg++	1240	102.052	<0.1	
Ammonia (Total)	<0.1		<0.1	
TOTAL CATIONS		640.896		
Chloride Cl-	20600	580.920	<1	
Fluoride F-	0.47	0.025	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	2520	52.416	<2	
Bicarbonate HCO3-	210	3.444	<1	
Phosphate PO4---	<0.1		<0.1	
Nitrite NO2-			<0.1	
Carbonate CO3--			<1	
TOTAL ANIONS		636.805		

SYDNEY ANALYTICAL LABORATORIES

LABORATORY DUPLICATE REPORT

JOB NO: SAL27113
CLIENT ORDER: 118109

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
FD1	pH		0.1	7.5	7.4	1
FD1	TDS	mg/L	1	965	970	1
FD1	Sodium	mg/L	0.1	105	100	5
FD1	Calcium	mg/L	0.1	180	180	0
FD1	Potassium	mg/L	0.1	32	31	3
FD1	Magnesium	mg/L	0.1	41	40	2
FD1	Chloride	mg/L	1	105	105	0
FD1	Fluoride	mg/L	0.1	0.23	0.23	0
FD1	Nitrate	mg/L	0.1	3.0	3.0	0
FD1	Sulphate	mg/L	2	190	190	0
FD1	Bicarbonate	mg/L	1	640	630	2
FD1	Phosphate	mg/L	0.1	<0.1	<0.1	0
FD1	Ammonia	mg/L	0.1	1.2	1.2	0
FD1	TOC	mg/L	1	22	23	4
FD1	BOD	mg/L	2	<2	<2	0
FD1	Fe (Total)	mg/L	0.01	1.2	1.1	8
FD1	Fe Dissolved	mg/L	0.01	0.26	0.27	4
FD1	Mn Dissolved	mg/L	0.01	0.25	0.27	8

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: SAL27113
CLIENT ORDER: 118109

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)
5310C	Total Organic Carbon
5210B	Biochemical Oxygen Demand
4500B	Nitrite NO2-
2130B	Turbidity
3111B	Iron (Total)
3111B	Iron (Dissolved)
3111B	Manganese (Dissolved)
2320B	Carbonate CO3--

SONIC
FOOD & WATER TESTING

MICROBIOLOGY FINAL REPORT

CERTIFICATE OF ANALYSIS

W1903456
[]

. ENVIRON & EARTH SCI.JB
P O BOX 380
NORTH SYDNEY NSW 2060

Lab Number:	295799029
Customer Reference Number:	
Site:	JOB NO:118109 SHELLHABOUR LP1
Sample Type:	WATER
Sample Notes:	
Date and Time of Collection:	15/02/19,0000
Date and Time of Testing:	16/02/19,0800
Collected By:	The Client
Tested:	As Received

TESTS	RESULTS	UNITS
FAECAL COLIFORM COUNT:	170	most probable number per 100ml
ESCHERICHIA COLI COUNT:	140	most probable number per 100ml

METHODS

* Escherichia coli Count - Australian Standard 4276.6-2007 by Most Probable Number Method.
* Thermotolerant (Faecal) Coliform Count - Australian Standard 4276.6-2007 by Most Probable Number Method.

The time between collection and the commencement of testing should not exceed 24 hours. Samples tested outside this time may have their results compromised.

END OF REPORT

Signed:. Date:20/02/19

T.Morgan	K.McClenahan	H.Sialepis	L.Vanhoff	P.Campora	R.Bhatt	N.Mecsery	S.Leelakrishnan
Laboratory Manager	Quality Manager	Technical Officer	Technical Officer	Scientific Officer	Scientific Officer	Technical Officer	Scientific Officer

NATA
WORLD RECOGNISED ACCREDITATION
Accreditation No. 4034
Accredited for compliance with ISO/IEC 17025 – Testing

SONIC
FOOD & WATER TESTING

MICROBIOLOGY FINAL REPORT

CERTIFICATE OF ANALYSIS

W1910626
[]

. ENVIRON & EARTH SCI.JB
P O BOX 380
NORTH SYDNEY NSW 2060

Lab Number:	295796364
Customer Reference Number:	
Site:	JOB NO:118109 LP1
Sample Type:	WATER
Sample Notes:	
Date and Time of Collection:	16/05/19,1445
Date and Time of Testing:	17/05/19,0800
Collected By:	The Client
Tested:	As Received

TESTS	RESULTS	UNITS
FAECAL COLIFORM COUNT:	Less than 20	most probable number per 100ml
FAECAL COLIFORMS NOT DETECTED BY THE METHOD		
ESCHERICHIA COLI COUNT:	Less than 20	most probable number per 100ml
ESCHERICHIA COLI NOT DETECTED BY THE METHOD		

METHODS

* Thermotolerant (Faecal) Coliform Count - Australian Standard 4276.6-2007 by Most Probable Number Method.
* Escherichia coli Count - Australian Standard 4276.6-2007 by Most Probable Number Method.

END OF REPORT

Signed: AV Date:21/05/19

T.Morgan	K.McClenahan	H.Sialepis	L.Vanhoff	P.Campora	R.Bhatt	N.Mecsery	S.Leelakrishnan
Laboratory Manager	Quality Manager	Technical Officer	Technical Officer	Scientific Officer	Scientific Officer	Technical Officer	Scientific Officer

Sampling was conducted by the customer and results reported pertain only to the samples submitted. Sample Identification obtained from container/COC as received at the laboratory.

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NATA
Accreditation No. 4034
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SYDNEY
ANALYTICAL
LABORATORIES

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: SAL27214B

CLIENT ORDER: 118109

DATE RECEIVED: 16/05/19

DATE COMPLETED: 31/05/19

TYPE OF SAMPLES: DUST GAUGE

NO OF SAMPLES: 1

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....

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

ANALYTICAL REPORT

JOB NO: SAL27214B
CLIENT ORDER: 118109

SAMPLES	ASH CONTENT g/m2/mth	COMBUSTIBLE CONTENT g/m2/mth	INSOLUBLES CONTENT g/m2/mth	SOLUBLES CONTENT g/m2/mth
DG1	0.6	0.3	0.9	0.2
MDL	0.1	0.1	0.1	0.1
Method Code	S14	S17	S15	S16
Preparation	P7	P7	P7	P7

ANALYTICAL REPORT

JOB NO: SAL27214B
CLIENT ORDER: 118109

SAMPLES	TOTAL SOLIDS CONTENT g/m2/mth	PARTICULATES CONTENT g/m2/mth	FUNNEL DIAMETER mm	TIME EXPOSURE days
DG1	1.1	<0.1	150	89
MDL	0.1	0.1		
Method Code	S8	S19		
Preparation	P7	P7		

Sampling Dates: 14/02/19-14/05/19

ANALYTICAL REPORT

JOB NO: SAL27214B
CLIENT ORDER: 118109

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P7	Analysis performed on sample as received (total contents)
S14	Total Ash Content - AS3580.10.1
S17	Total Combustibles Content - AS3580.10.1
S15	Total Insoluble Solids Content - AS3580.10.1
S16	Total Soluble Solids Content - AS3580.10.1
S8	Total Solids Content - AS3580.10.1
S19	Total Particulates Content - AS3580.10.1

SONIC
FOOD & WATER TESTING

MICROBIOLOGY FINAL REPORT

CERTIFICATE OF ANALYSIS

W1822913
[]

. ENVIRON & EARTH SCI.JB
P O BOX 380
NORTH SYDNEY NSW 2060

Lab Number:	294451458
Customer Reference Number:	
Site:	JOB:118109 LP1
Sample Type:	WATER
Sample Notes:	
Date and Time of Collection:	Unknown,0000
Date and Time of Testing:	16/11/18,0930
Collected By:	The Client
Tested:	As Received

TESTS	RESULTS	UNITS
FAECAL COLIFORM COUNT:	20	most probable number per 100ml
ESCHERICHIA COLI COUNT:	Less than 20	most probable number per 100ml

ESCHERICHIA COLI NOT DETECTED BY THE METHOD

METHODS

* Thermotolerant (Faecal) Coliform Count - Australian Standard 4276.6-2007 by Most Probable Number Method.
* Escherichia coli Count - Australian Standard 4276.6-2007 by Most Probable Number Method.

The time between sampling and the commencement of testing should not exceed 24 hours.

END OF REPORT

Signed:. . . . . PC Date:19/11/18

T.Morgan	K.McClenahan	H.Sialepis	L.Vanhoff	P.Campora	R.Bhatt	N.Mecsery	S.Leelakrishnan
Laboratory Manager	Quality Manager	Technical Officer	Technical Officer	Scientific Officer	Scientific Officer	Technical Officer	Scientific Officer

NATA
Accreditation No. 4034
Accredited for compliance with ISO/IEC 17025 – Testing

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NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: M.NARRACOTT

JOB NO:	SAL26997B
CLIENT ORDER:	118109
DATE RECEIVED:	15/11/18
DATE COMPLETED:	28/11/18
TYPE OF SAMPLES:	DUST GAUGE
NO OF SAMPLES:	1

NATA Accredited for compliance with ISO/IEC 17025 Testing

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

ANALYTICAL REPORT

JOB NO: SAL26997B
CLIENT ORDER: 118109

SAMPLES	ASH CONTENT g/m2/mth	COMBUSTIBLE CONTENT g/m2/mth	INSOLUBLES CONTENT g/m2/mth	SOLUBLES CONTENT g/m2/mth
DG1	0.3	0.2	0.5	0.1
MDL	0.1	0.1	0.1	0.1
Method Code	S14	S17	S15	S16
Preparation	P7	P7	P7	P7

ANALYTICAL REPORT

JOB NO: SAL26997B
CLIENT ORDER: 118109

SAMPLES	TOTAL SOLIDS CONTENT g/m2/mth	PARTICULATES CONTENT g/m2/mth	FUNNEL DIAMETER mm	TIME EXPOSURE days
DG1	0.6	<0.1	150	104
MDL	0.1	0.1		
Method Code	S8	S19		
Preparation	P7	P7		

Sampling Dates: 1/8/18-13/11/18

ANALYTICAL REPORT

JOB NO: SAL26997B
CLIENT ORDER: 118109

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P7	Analysis performed on sample as received (total contents)
S14	Total Ash Content - AS3580.10.1
S17	Total Combustibles Content - AS3580.10.1
S15	Total Insoluble Solids Content - AS3580.10.1
S16	Total Soluble Solids Content - AS3580.10.1
S8	Total Solids Content - AS3580.10.1
S19	Total Particulates Content - AS3580.10.1

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NATA No: 1884

ANALYTICAL REPORT for:

ENVIRONMENTAL & EARTH SCIENCES

PO BOX 380
NORTH SYDNEY 2059

ATTN: M.NARRACOTT

JOB NO:	SAL27041B
CLIENT ORDER:	118109
DATE RECEIVED:	07/12/18
DATE COMPLETED:	18/12/18
TYPE OF SAMPLES:	WATER
NO OF SAMPLES:	1

NATA Accredited for compliance with ISO/IEC 17025 Testing

.....
Issued on 18/12/18
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL27041B
CLIENT ORDER: 118109

DATE OF COLLECTION		27/11/18	27/11/18
SAMPLES		SWP1	BLANK
pH		6.8	7.2
Total Dissolved Solids	mg/L	370	<1
Iron (Total)	mg/L	24	<0.01
Iron (Dissolved)	mg/L	3.1	<0.01
Turbidity	NTU	380	<0.2

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	53	2.306	<0.1	
Calcium Ca++	45	2.246	<0.1	
Potassium K+	25	0.640	<0.1	
Magnesium Mg++	19	1.564	<0.1	
Ammonia (Total)	3.5	0.250	<0.1	
TOTAL CATIONS		7.006		
Chloride Cl-	76	2.143	<1	
Fluoride F-	0.19	0.010	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	5	0.104	<2	
Bicarbonate HCO3-	280	4.592	<1	
Phosphate PO4---	1.3	0.041	<0.1	
TOTAL ANIONS		6.890		

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL27041B
CLIENT ORDER: 118109

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)
3111B	Iron (Total)
3111B	Iron (Dissolved)
2130B	Turbidity

Australian Government

National Measurement Institute

QUALITY ASSURANCE REPORT

Client: ENVIRONMENTAL & EARTH SCIENCES (NSW)

NMI QA Report No: ENVI10/181115 **Sample Matrix:** Liquid

Analyte	Method	LOR	Blank	Sample Duplicates			Recoveries	
				Sample	Duplicate	RPD	LCS	Matrix Spike
		ug/L	ug/L	ug/L	ug/L	%	%	%
Organics Section								
BTEX								
Benzene	NGCMS_1121	1	<1	NA	NA	NA	93	NA
Toluene	NGCMS_1121	1	<1	NA	NA	NA	94	NA
Ethyl Benzene	NGCMS_1121	1	<1	NA	NA	NA	94	NA
m, p - Xylene	NGCMS_1121	2	<2	NA	NA	NA	93	NA
o-Xylene	NGCMS_1121	1	<1	NA	NA	NA	95	NA
TRH								
TRH C6-C10	NGCMS_1121	25	<25	NA	NA	NA	94	NA
TRH >C10-C16	NGCMS_1112	25	<25	NA	NA	NA	78	NA
TRH >C16-C34	NGCMS_1112	100	<100	NA	NA	NA	60	NA
TRH >C34-C40	NGCMS_1112	100	<100	NA	NA	NA	-	NA
Surrogate: TOL-D8	NGCMS_1121	-	-	NA	NA	NA	100	NA
PAH								
Naphthalene	NGCMS_1111	0.5	<0.5	NA	NA	NA	100	NA
Acenaphthylene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Acenaphthene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Fluorene	NGCMS_1111	0.5	<0.5	NA	NA	NA	118	NA
Phenanthrene	NGCMS_1111	0.5	<0.5	NA	NA	NA	109	NA
Anthracene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Fluoranthene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Pyrene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Benz[a]anthracene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Chrysene	NGCMS_1111	0.5	<0.5	NA	NA	NA	122	NA
Benzo[b]&[k]fluoranthene	NGCMS_1111	1	<1	NA	NA	NA	-	NA
Benzo[a]pyrene	NGCMS_1111	0.5	<0.5	NA	NA	NA	108	NA
Indeno[1_2_3-cd]pyrene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Dibenz[ah]anthracene	NGCMS_1111	0.5	<0.5	NA	NA	NA	118	NA
Benzo[ghi]perylene	NGCMS_1111	0.5	<0.5	NA	NA	NA	-	NA
Surrogate: TER-D14	NGCMS_1111	-	-	NA	NA	NA	122	NA
Phenols								
Phenol	NGCMS_1111	1	<1	NA	NA	NA	44	NA
2-Chlorophenol	NGCMS_1111	1	<1	NA	NA	NA	-	NA
2-Methyl phenol	NGCMS_1111	1	<1	NA	NA	NA	-	NA
3 & 4-methyl phenol	NGCMS_1111	2	<2	NA	NA	NA	45	NA
2-Nitrophenol	NGCMS_1111	1	<1	NA	NA	NA	-	NA
2,4-Dimethyl phenol	NGCMS_1111	1	<1	NA	NA	NA	-	NA
2,4-Dichlorophenol	NGCMS_1111	1	<1	NA	NA	NA	-	NA
2,6-Dichlororphenol	NGCMS_1111	1	<1	NA	NA	NA	82	NA
4-Chloro-3-methyl phenol	NGCMS_1111	2	<2	NA	NA	NA	-	NA
2,4,5-Trichlorophenol	NGCMS_1111	2	<2	NA	NA	NA	-	NA
2,4,6-Trichlorophenol	NGCMS_1111	2	<2	NA	NA	NA	-	NA
2,3,4,6-Tetrachlorophenol	NGCMS_1111	2	<2	NA	NA	NA	-	NA
Pentachlorophenol	NGCMS_1111	2	<2	NA	NA	NA	126	NA
Surrogate: PHENOL-D6	NGCMS_1111	-	-	NA	NA	NA	41	NA

Results expressed in percentage (%) or ug/L wherever appropriate.
Acceptable Spike recovery is 70-130% (BTEX and TRH C6-C10); 50-150% (PAH and TRH >C10-C40); 30-150% (Phenols).
Maximum acceptable RPDs on spikes and duplicates is 40%.
'NA ' = Not Applicable.
RPD= Relative Percentage Difference.

Signed:

Danny Slee
Organics Manager, NMI-North Ryde

Date: **22/11/2018**

Australian Government

National Measurement Institute

QUALITY ASSURANCE REPORT

Client: ENVIRONMENTAL & EARTH SCIENCES (NSW)

NMI QA Report No: ENVI10/181115 **Sample Matrix:** Liquid

Analyte	Method	LOR	Blank	Sample Duplicates			Recoveries	
				Sample	Duplicate	RPD	LCS	Matrix Spike
		ug/L	ug/L	ug/L	ug/L	%	%	%
Organics Section								
Monocyclic Aromatic Hydrocarbons								
Benzene	NGCMS_1120	1	<1	NA	NA	NA	106	NA
Toluene	NGCMS_1120	1	<1	NA	NA	NA	100	NA
Ethylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
m,p-Xylene	NGCMS_1120	2	<2	NA	NA	NA	-	NA
o-Xylene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Styrene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Isopropylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
n-Propylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,3,5-Trimethylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
tert-Butylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2,4-Trimethylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
sec-Butylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
4-Isopropyltoluene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
n-Butylbenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Halogenated Aliphatic Hydrocarbons								
Chloromethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Vinyl chloride	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Bromomethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Chloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Trichlorofluoromethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1-Dichloroethene	NGCMS_1120	1	<1	NA	NA	NA	93	NA
Dichloromethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
trans-1,2-Dicloroethene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1-Dichloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
2,2-Dichloropropane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
cis-1,2-Dichloroethene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Bromochloromethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1,1-Trichloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Carbon tetrachloride	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1-Dichloropropene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2-Dichloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Trichloroethene	NGCMS_1120	1	<1	NA	NA	NA	99	NA
1,2-Dichloropropane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Dibromomethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
cis-1,3-Dichloropropene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
trans-1,3-Dichloropropene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1,2-Trichloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Tetrachloroethene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,3-Dichloropropane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2-Dibromoethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1,1,2-Tetrachloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,1,2,2-Tetrachloroethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2,3-Trichloropropane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2-Dibromo-3-chloropropane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Hexachlorobutadiene	NGCMS_1120	1	<1	NA	NA	NA	-	NA

Australian Government

National Measurement Institute

QUALITY ASSURANCE REPORT

Analyte	Method	LOR	Blank	Sample Duplicates			Recoveries	
				Sample	Duplicate	RPD	LCS	Matrix Spike
		ug/L	ug/L	ug/L	ug/L	%	%	%
Organics Section								
Halogenated Aromatic Hydrocarbons								
Chlorobenzene	NGCMS_1120	1	<1	NA	NA	NA	101	NA
Bromobenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
2-Chlorotoluene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
4-Chlorotoluene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,3-Dichlorobenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,4-Dichlorobenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2-Dichlorobenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2,4-Trichlorobenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
1,2,3-Trichlorobenzene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Trihalomethanes								
Chloroform	NGCMS_1120	1	<1	NA	NA	NA	108	NA
Bromodichloromethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Dibromochloromethane	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Bromoform	NGCMS_1120	1	<1	NA	NA	NA	-	NA
PAH (volatile)								
Naphthalene	NGCMS_1120	1	<1	NA	NA	NA	-	NA
Oxygenated Compounds								
Acetone	NGCMS_1120	5	<5	NA	NA	NA	-	NA
Vinylacetate	NGCMS_1120	5	<5	NA	NA	NA	-	NA
2-Butanone (MEK)	NGCMS_1120	5	<5	NA	NA	NA	-	NA
4-Methyl-2-pentanone (MIBK)	NGCMS_1120	5	<5	NA	NA	NA	-	NA
2-Hexanone (MBK)	NGCMS_1120	5	<5	NA	NA	NA	-	NA
Methyl tert-Butyl Ether (MTBE)	NGCMS_1120	5	<5	NA	NA	NA	-	NA
Sulfonated Compounds								
Carbon disulfide	NGCMS_1120	5	<5	NA	NA	NA	-	NA
Surrogate: DBFM	NGCMS_1120	-	-	NA	NA	NA	104	NA
Surrogate: TOL-D8	NGCMS_1120	-	-	NA	NA	NA	99	NA
Surrogate: 4-BFB	NGCMS_1120	-	-	NA	NA	NA	98	NA

Results expressed in percentage (%) or ug/L wherever appropriate.
Acceptable Spike recovery is 70-130%
Maximum acceptable RPDs on spikes and duplicates is 40%.
'NA ' = Not Applicable.
RPD= Relative Percentage Difference.

Signed:

Danny Slee
Organics Manager, NMI-North Ryde

Date: **22/11/2018**

Nov18

ENVIO/181115
Due 22/11/18
MN

CHAIN OF CUSTODY - INORGANIC ANALYSIS REQUEST FORM

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Job #: 118109 Site Location: Shellharbour Sampler: MN

Date: 13/11/2018 Laboratory: NMI Report To: elin griffiths

Sample ID	pH	Sample Description: SOIL	WATER	SEDIMENT	Analysis Required: HEAVY METALS	IONIC BALANCE	PHENOLS	CEC AND EXCHANGEABLES	LEACH PROCEDURE	CYANIDE TOTAL/FREE	TRH (C_6-C_{40})	PAH	BTEX	HVC	Phenols	ANTICIPATED RESULTS/ TURNAROUND TIME
LP1			X								X	X	X	X	X	
N18/032129 MN																
TOTAL			1								1	1	1	1	1	

Turn Around: **NORMAL / 3 DAYS / 48 HRS / 24 HRS** Sheet: 1 of 1

Comments: Standard turn-around please

Report to: egriffiths@eesigroup.com mnarracott@eesigroup.com

Invoice: accounts@eesigroup.com egriffiths@eesigroup.com

	Time	Date	Lab Supervisor:
Left EES Site:			
Transported By:			
Received Lab:			
Fax Results Rec'd			
Typed Results Rec'd			

We can be contacted on:

Phone: (02) 9922 1777

Fax: (02) 9922 1010

PROJECT FORMS/QF34 Chain of Custody_Inorganics 1 May 2007 Version 4 Page 1 of 1

RECEIVED
15 NOV 2018
BY: ..N.N..... 16:20

Australian Government
Department of Industry, Innovation and Science

National Measurement Institute

SAMPLE RECEIPT NOTIFICATION

CUSTOMER DETAILS

Attention: ELIN GRIFFITHS

Customer: ENVIRONMENTAL & EARTH SCIENCES (NSW)

Address: 82 - 84 DICKSON AVENUE
ARTARMON NSW 2064

Email: Egriffiths@eesigroup.com

Telephone:

Fax:

LABORATORY DETAILS

Lab: National Measurement Institute

Contact: Susanne Neuman

Address: 105 Delhi Road, North Ryde, NSW
NSW 2113

Email: Susanne.Neuman@measurement.gov.au

Telephone: 02 9449 0181

Fax:

SAMPLE DETAILS

NMI Job Name: **ENVI10/181115**

Total No. of Samples: **1**

LRNs	Customer Sample ID	Lab Sample Description
N18/032129	LP1	WATER SHELLHARBOUR JOB: 118109

SAMPLE RECEIVED CONDITION

Date samples received: 15-NOV-2018

Sample received in good order: Yes

NMI Quotation no. provided:

Client purchase order number:

Temperature of samples: Chilled

Comments: ALL OK

Estimated report date: 22-NOV-2018

Mode of Delivery: Courier

Additional Terms and Conditions

Incomplete / unclear information about samples or required testing will delay the start of the analysis work

If you require your Purchase Order (PO) number to be included on our invoice, please provide the number during sample submission and before the completion of work to avoid unnecessary delays and/or additional processing/handling fees.

The lodgement of an order or receipt of samples for NMI services referenced in this Sample Receipt Notification constitutes an acceptence of the current version of NMI Terms and Conditions or other applicable Terms referenced in the NMI Quotation. NMI Terms and Conditions are available on the web at http://www.measurement.gov.au/Services/EnvironmentalTesting/Pages/Terms-and-Conditions.aspx

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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:	SAL26997B
CLIENT ORDER:	118109
DATE RECEIVED:	15/11/18
DATE COMPLETED:	28/11/18
TYPE OF SAMPLES:	DUST GAUGE
NO OF SAMPLES:	1

NATA Accredited for compliance with ISO/IEC 17025 Testing

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

ANALYTICAL REPORT

JOB NO: SAL26997B
CLIENT ORDER: 118109

SAMPLES	ASH CONTENT g/m2/mth	COMBUSTIBLE CONTENT g/m2/mth	INSOLUBLES CONTENT g/m2/mth	SOLUBLES CONTENT g/m2/mth
DG1	0.3	0.2	0.5	0.1
MDL	0.1	0.1	0.1	0.1
Method Code	S14	S17	S15	S16
Preparation	P7	P7	P7	P7

ANALYTICAL REPORT

JOB NO: SAL26997B
CLIENT ORDER: 118109

SAMPLES	TOTAL SOLIDS CONTENT g/m2/mth	PARTICULATES CONTENT g/m2/mth	FUNNEL DIAMETER mm	TIME EXPOSURE days
DG1	0.6	<0.1	150	104
MDL	0.1	0.1		
Method Code	S8	S19		
Preparation	P7	P7		

Sampling Dates: 1/8/18-13/11/18

ANALYTICAL REPORT

JOB NO: SAL26997B
CLIENT ORDER: 118109

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P7	Analysis performed on sample as received (total contents)
S14	Total Ash Content - AS3580.10.1
S17	Total Combustibles Content - AS3580.10.1
S15	Total Insoluble Solids Content - AS3580.10.1
S16	Total Soluble Solids Content - AS3580.10.1
S8	Total Solids Content - AS3580.10.1
S19	Total Particulates Content - AS3580.10.1

SYDNEY
ANALYTICAL
LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
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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: SAL26997

CLIENT ORDER: 118109

DATE RECEIVED: 15/11/18

DATE COMPLETED: 28/11/18

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 18

NATA Accredited for compliance with ISO/IEC 17025 Testing

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

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		BH1c	BH2
pH		7.3	7.2
Total Dissolved Solids	mg/L	3850	1940
Biochemical Oxygen Demand	mg/L	8	<2
Total Organic Carbon	mg/L	170	32
Iron (Total)	mg/L	15	15
Iron (Dissolved)	mg/L	1.4	1.0
Manganese (Dissolved)	mg/L	0.12	0.52

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	670	29.145	325	14.138
Calcium Ca++	130	6.487	220	10.978
Potassium K+	220	5.632	39	0.998
Magnesium Mg++	105	8.642	71	5.843
Ammonia (Total)	350	24.990	44	3.142
TOTAL CATIONS		74.896		35.099
Chloride Cl-	780	21.996	460	12.972
Fluoride F-	0.31	0.016	0.31	0.016
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	15	0.312	79	1.643
Bicarbonate HCO3-	3270	53.628	1300	21.320
Phosphate PO4---	0.55	0.017	<0.1	
TOTAL ANIONS		75.969		35.951

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		BH3	BH4
pH		7.1	7.1
Total Dissolved Solids	mg/L	875	1100
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	14	19
Iron (Total)	mg/L	2.2	5.2
Iron (Dissolved)	mg/L	0.06	0.17
Manganese (Dissolved)	mg/L	0.11	0.19

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	67	2.915	125	5.438
Calcium Ca++	160	7.984	190	9.481
Potassium K+	26	0.666	22	0.563
Magnesium Mg++	23	1.893	34	2.798
Ammonia (Total)	29	2.071	16	1.142
TOTAL CATIONS		15.529		19.422
Chloride Cl-	195	5.499	205	5.781
Fluoride F-	0.12	0.006	<0.1	
Nitrate NO3-	64	1.030	0.18	0.003
Sulphate SO4--	73	1.518	130	2.704
Bicarbonate HCO3-	445	7.298	650	10.660
Phosphate PO4---	0.24	0.008	<0.1	
Nitrite NO2-			0.13	0.003
TOTAL ANIONS		15.359		19.151

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		BH13	BH14
pH		7.2	7.0
Total Dissolved Solids	mg/L	1050	1360
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	21	29
Iron (Total)	mg/L	2.4	5.6
Iron (Dissolved)	mg/L	0.13	1.5
Manganese (Dissolved)	mg/L	0.24	0.37

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	91	3.959	215	9.352
Calcium Ca++	190	9.481	220	10.978
Potassium K+	32	0.819	25	0.640
Magnesium Mg++	42	3.457	48	3.950
Ammonia (Total)	1.2	0.086	0.9	0.064
TOTAL CATIONS		17.802		24.984
Chloride Cl-	92	2.594	265	7.473
Fluoride F-	0.25	0.013	0.46	0.024
Nitrate NO3-	31	0.499	<0.1	
Sulphate SO4--	270	5.616	90	1.872
Bicarbonate HCO3-	605	9.922	990	16.236
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		18.644		25.605

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		BH15	BH16
pH		6.9	7.4
Total Dissolved Solids	mg/L	6620	195
Biochemical Oxygen Demand	mg/L	3	<2
Total Organic Carbon	mg/L	160	18
Iron (Total)	mg/L	38	6.1
Iron (Dissolved)	mg/L	15	0.65
Manganese (Dissolved)	mg/L	0.92	0.02

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	1350	58.725	47	2.045
Calcium Ca++	320	15.968	9.3	0.464
Potassium K+	605	15.488	4.5	0.115
Magnesium Mg++	145	11.934	4.1	0.337
Ammonia (Total)	105	7.497	0.2	0.014
TOTAL CATIONS		109.612		2.975
Chloride Cl-	3170	89.394	27	0.761
Fluoride F-	0.18	0.009	0.64	0.034
Nitrate NO3-	0.80	0.013	<0.1	
Sulphate SO4--	420	8.736	38	0.790
Bicarbonate HCO3-	985	16.154	98	1.607
Phosphate PO4---	0.12	0.004	0.37	0.012
Nitrite NO2-	0.23	0.005		
TOTAL ANIONS		114.315		3.204

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		BH20	BH20s
pH		7.5	7.7
Total Dissolved Solids	mg/L	1000	820
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	19	15
Iron (Total)	mg/L	2.0	1.8
Iron (Dissolved)	mg/L	0.05	0.14
Manganese (Dissolved)	mg/L	0.09	0.06

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	42	1.827	30	1.305
Calcium Ca++	175	8.733	150	7.485
Potassium K+	36	0.922	70	1.792
Magnesium Mg++	34	2.798	33	2.716
Ammonia (Total)	39	2.785	0.2	0.014
TOTAL CATIONS		17.065		13.312
Chloride Cl-	94	2.651	52	1.466
Fluoride F-	0.14	0.007	0.11	0.006
Nitrate NO3-	<0.1		105	1.691
Sulphate SO4--	400	8.320	140	2.912
Bicarbonate HCO3-	365	5.986	435	7.134
Phosphate PO4---	0.24	0.008	<0.1	
TOTAL ANIONS		16.972		13.209

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		BH20s DUP	FD1
pH		7.7	7.2
Total Dissolved Solids	mg/L	830	1080
Biochemical Oxygen Demand	mg/L	<2	<2
Total Organic Carbon	mg/L	14	20
Iron (Total)	mg/L	1.7	5.2
Iron (Dissolved)	mg/L	0.12	0.15
Manganese (Dissolved)	mg/L	0.06	0.20

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	32	1.392	120	5.220
Calcium Ca++	155	7.735	185	9.232
Potassium K+	70	1.792	23	0.589
Magnesium Mg++	31	2.551	33	2.716
Ammonia (Total)	0.2	0.014	16	1.142
TOTAL CATIONS		13.484		18.899
Chloride Cl-	52	1.466	210	5.922
Fluoride F-	0.10	0.005	<0.1	
Nitrate NO3-	105	1.691	0.18	0.003
Sulphate SO4--	145	3.016	125	2.600
Bicarbonate HCO3-	450	7.380	655	10.742
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		13.558		19.267

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		LP1	SWP2
pH		7.8	8.0
Total Dissolved Solids	mg/L	9840	1260
Biochemical Oxygen Demand	mg/L	110	
Total Organic Carbon	mg/L	740	
Turbidity	NTU	18	1.3
Iron (Total)	mg/L	2.5	0.19
Iron (Dissolved)	mg/L	2.4	0.16
Manganese (Dissolved)	mg/L	0.52	

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	1530	66.555	265	11.528
Calcium Ca++	105	5.240	88	4.391
Potassium K+	750	19.200	29	0.742
Magnesium Mg++	81	6.666	46	3.786
Ammonia (Total)	1180	84.252	0.3	0.021
TOTAL CATIONS		181.913		20.468
Chloride Cl-	1830	51.606	320	9.024
Fluoride F-	0.44	0.023	0.15	0.008
Nitrate NO3-	0.71	0.011	0.22	0.004
Sulphate SO4--	120	2.496	175	3.640
Bicarbonate HCO3-	8270	135.628	520	8.528
Phosphate PO4---	24	0.758	0.12	0.004
TOTAL ANIONS		190.522		21.208

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		SWP4	SWC2
pH		8.4	
Total Dissolved Solids	mg/L	1310	
Biochemical Oxygen Demand	mg/L	<2	
Total Organic Carbon	mg/L	30	
Turbidity	NTU	13	2.6
Iron (Total)	mg/L	0.25	0.55
Iron (Dissolved)	mg/L	0.10	0.11

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	305	13.268		
Calcium Ca++	58	2.894		
Potassium K+	25	0.640		
Magnesium Mg++	56	4.609		
Ammonia (Total)	1.0	0.071	0.6	0.043
TOTAL CATIONS		21.482		0.043
Chloride Cl-	345	9.729		
Fluoride F-	0.30	0.016		
Nitrate NO3-	8.0	0.129	0.22	0.004
Sulphate SO4--	270	5.616		
Bicarbonate HCO3-	395	6.478	235	3.854
Phosphate PO4---	<0.1			
Nitrite NO2-			<0.1	
TOTAL ANIONS		21.968		3.858

>5% balance

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		SWC-UP	SWC-DOWN
pH		7.3	7.5
Total Dissolved Solids	mg/L	25400	30300
Turbidity	NTU	2.7	2.0
Iron (Total)	mg/L	0.57	0.31
Iron (Dissolved)	mg/L	0.10	0.09

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	7490	325.815	9060	394.110
Calcium Ca++	345	17.216	400	19.960
Potassium K+	360	9.216	405	10.368
Magnesium Mg++	880	72.424	985	81.066
Ammonia (Total)	0.6	0.043	0.1	0.007
TOTAL CATIONS		424.714		505.511
Chloride Cl-	13900	391.980	16600	468.120
Fluoride F-	0.45	0.024	0.47	0.025
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	1830	38.064	2120	44.096
Bicarbonate HCO3-	215	3.526	175	2.870
Phosphate PO4---	<0.1		<0.1	
TOTAL ANIONS		433.594		515.111

ANALYTICAL REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

DATE OF COLLECTION		13/11/18	13/11/18
SAMPLES		SWC-DOWN 2	BLANK
pH		7.7	7.1
Total Dissolved Solids	mg/L	31400	<1
Biochemical Oxygen Demand	mg/L		<2
Total Organic Carbon	mg/L		<1
Turbidity	NTU	1.2	<0.2
Iron (Total)	mg/L	0.25	<0.01
Iron (Dissolved)	mg/L	0.11	<0.01
Manganese (Dissolved)	mg/L		<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	9570	416.295	<0.1	
Calcium Ca++	385	19.212	<0.1	
Potassium K+	400	10.240	<0.1	
Magnesium Mg++	1070	88.061	<0.1	
Ammonia (Total)	<0.1		<0.1	
TOTAL CATIONS		533.808		
Chloride Cl-	17700	499.140	<1	
Fluoride F-	0.50	0.026	<0.1	
Nitrate NO3-	<0.1		<0.1	
Sulphate SO4--	2230	46.384	<2	
Bicarbonate HCO3-	155	2.542	<1	
Phosphate PO4---	<0.1		<0.1	
Nitrite NO2-			<0.1	
TOTAL ANIONS		548.092		

LABORATORY DUPLICATE REPORT

JOB NO: SAL26997
CLIENT ORDER: 118109

Sample Number	Analyte	Units	MDL	Sample Result	Duplicate Result	%RPD
BH20s	pH		0.1	7.7	7.7	0
BH20s	TDS	mg/L	1	820	830	1
BH20s	Sodium	mg/L	0.1	30	32	6
BH20s	Calcium	mg/L	0.1	150	155	3
BH20s	Potassium	mg/L	0.1	70	70	0
BH20s	Magnesium	mg/L	0.1	33	31	6
BH20s	Chloride	mg/L	1	52	52	0
BH20s	Fluoride	mg/L	0.1	0.11	0.10	9
BH20s	Nitrate	mg/L	0.1	105	105	0
BH20s	Sulphate	mg/L	2	140	145	3
BH20s	Bicarbonate	mg/L	1	435	450	3
BH20s	Phosphate	mg/L	0.1	<0.1	<0.1	0
BH20s	Ammonia	mg/L	0.1	0.2	0.2	0
BH20s	BOD	mg/L	2	<2	<2	0
BH20s	TOC	mg/L	1	15	14	7
BH20s	Fe (Total)	mg/L	0.01	1.8	1.7	6
BH20s	Fe Dissolved	mg/L	0.01	0.14	0.12	15
BH20s	Mn Dissolved	mg/L	0.01	0.06	0.06	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: SAL26997
CLIENT ORDER: 118109

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	Nitrite NO2-
5210B	Biochemical Oxygen Demand
5310C	Total Organic Carbon
2130B	Turbidity
3111B	Iron (Total)
3111B	Iron (Dissolved)
3111B	Manganese (Dissolved)

REPORT OF ANALYSIS

Report No. RN1214657

Client	: ENVIRONMENTAL & EARTH SCIENCES (NSW) 82 - 84 DICKSON AVENUE ARTARMON NSW 2064	**Job No.**	: ENVI10/181115
		Quote No.	: QT-02018
		Order No.	:
		Date Received	: 15-NOV-2018
Attention	: ELIN GRIFFITHS	**Sampled By**	: CLIENT
Project Name	:		
Your Client Services Manager	: Tony Lattari	**Phone**	: 02 9449 0196

Lab Reg No.	Sample Ref	Sample Description
N18/032129	LP1	WATER SHELLHARBOUR JOB: 118109

Lab Reg No.		N18/032129				
Date Sampled		Not Provided				
Sample Reference	Units	LP1				Method
Polycyclic Aromatic Hydrocarbons						
Naphthalene	ug/L	4.6				NGCMS_1111
Acenaphthylene	ug/L	<0.5				NGCMS_1111
Acenaphthene	ug/L	<0.5				NGCMS_1111
Fluorene	ug/L	<0.5				NGCMS_1111
Phenanthrene	ug/L	<0.5				NGCMS_1111
Anthracene	ug/L	<0.5				NGCMS_1111
Fluoranthene	ug/L	<0.5				NGCMS_1111
Pyrene	ug/L	<0.5				NGCMS_1111
Benz(a)anthracene	ug/L	<0.5				NGCMS_1111
Chrysene	ug/L	<0.5				NGCMS_1111
Benzo(b)&(k)fluoranthene	ug/L	<1				NGCMS_1111
Benzo(a)pyrene	ug/L	<0.5				NGCMS_1111
Indeno(1,2,3-cd)pyrene	ug/L	<0.5				NGCMS_1111
Dibenz(ah)anthracene	ug/L	<0.5				NGCMS_1111
Benzo(ghi)perylene	ug/L	<0.5				NGCMS_1111
Surrogate: TER-D14	%REC	65				NGCMS_1111
Halogenated Aliphatic Compounds						
Chloromethane	ug/L	<1				NGCMS_1120
Vinyl chloride	ug/L	<1				NGCMS_1120
Bromomethane	ug/L	<1				NGCMS_1120
Chloroethane	ug/L	<1				NGCMS_1120
Trichlorofluoromethane	ug/L	<1				NGCMS_1120
1,1-Dichloroethane	ug/L	<1				NGCMS_1120
Dichloromethane	ug/L	<1				NGCMS_1120
trans-1,2-Dichloroethene	ug/L	<1				NGCMS_1120
1,1-Dichloroethene	ug/L	<1				NGCMS_1120
2,2-Dichloropropane	ug/L	<1				NGCMS_1120
cis-1,2-Dichloroethene	ug/L	<1				NGCMS_1120
Bromochloromethane	ug/L	<1				NGCMS_1120

REPORT OF ANALYSIS

Lab Reg No.		N18/032129				
Date Sampled		Not Provided				
Sample Reference	Units	LP1				Method
Halogenated Aliphatic Compounds						
1,1,1-Trichloroethane	ug/L	<1				NGCMS_1120
Carbon tetrachloride	ug/L	<1				NGCMS_1120
1,1-Dichloropropene	ug/L	<1				NGCMS_1120
1,2-Dichloroethane	ug/L	<1				NGCMS_1120
Trichloroethene	ug/L	<1				NGCMS_1120
1,2-Dichloropropane	ug/L	<1				NGCMS_1120
Dibromomethane	ug/L	<1				NGCMS_1120
cis-1,3-Dichloropropene	ug/L	<1				NGCMS_1120
trans-1,3-Dichloropropene	ug/L	<1				NGCMS_1120
1,1,2-Trichloroethane	ug/L	<1				NGCMS_1120
Tetrachloroethene	ug/L	<1				NGCMS_1120
1,3-Dichloropropane	ug/L	<1				NGCMS_1120
1,2-Dibromoethane	ug/L	<1				NGCMS_1120
1,1,1,2-Tetrachloroethane	ug/L	<1				NGCMS_1120
1,1,2,2-Tetrachloroethane	ug/L	<1				NGCMS_1120
1,2,3-Trichloropropane	ug/L	<1				NGCMS_1120
1,2-Dibromo-3-chloropropane	ug/L	<1				NGCMS_1120
Hexachlorobutadiene	ug/L	<1				NGCMS_1120
Surrogate: 4-BFB	%REC	97				NGCMS_1120
Phenols						
Phenol	ug/L	<1				NGCMS_1111
2-Chlorophenol	ug/L	<1				NGCMS_1111
2-Methylphenol	ug/L	3.5				NGCMS_1111
3-& 4-Methylphenols	ug/L	<2				NGCMS_1111
2,4-Dimethyphenol	ug/L	<1				NGCMS_1111
2-Nitrophenol	ug/L	<1				NGCMS_1111
4-Nitrophenol	ug/L	<1				NGCMS_1111
2,4-Dichlorophenol	ug/L	<1				NGCMS_1111
2,6-Dichlorophenol	ug/L	<1				NGCMS_1111
4-Chloro-3-methylphenol	ug/L	<2				NGCMS_1111
2,4,6-Trichlorophenol	ug/L	<2				NGCMS_1111
2,4,5-Trichlorophenol	ug/L	<2				NGCMS_1111
2,3,4,6-Tetrachlorophenol	ug/L	<2				NGCMS_1111
Pentachlorophenol	ug/L	<2				NGCMS_1111
Surrogate: PHENOL-D6	%REC	50				NGCMS_1111
BTEX						
Benzene	ug/L	4.3				NGCMS_1121
Toluene	ug/L	5.9				NGCMS_1121
Ethyl Benzene	ug/L	4.1				NGCMS_1121
m, p - Xylene	ug/L	21				NGCMS_1121

REPORT OF ANALYSIS

Lab Reg No.		N18/032129				
Date Sampled		Not Provided				
Sample Reference	Units	LP1				Method
BTEX						
o - Xylene	ug/L	22				NGCMS_1121
Surrogate: TOL-D8	%REC	92				NGCMS_1121
Total Recoverable Hydrocarbons (formerly TPH)						
TRH C6 - C9	ug/L	150				NGCMS_1121
TRH C10 - C14	ug/L	2100				NGCMS_1112
TRH C15 - C28	ug/L	7400				NGCMS_1112
TRH C29 - C36	ug/L	1200				NGCMS_1112
NEPM Total Recoverable Hydrocarbons						
TRH C6 - C10	ug/L	150				NGCMS_1121
TRH C6 - C10 less BTEX(F1)	ug/L	96				NGCMS_1121
TRH>C10 - C16	ug/L	2900				NGCMS_1112
TRH>C10 - C16 less Naph(F2)	ug/L	2900				NGCMS_1112
TRH>C16 - C34(F3)	ug/L	7100				NGCMS_1112
TRH>C34 - C40(F4)	ug/L	2600				NGCMS_1112
Surrogate: TOL-D8	%REC	92				NGCMS_1121
Dates						
Date extracted		20-NOV-2018				
Date analysed		21-NOV-2018				

Danny Slee, Section Manager
Organic - NSW
Accreditation No. 198

22-NOV-2018

REPORT OF ANALYSIS

This Report supersedes reports: *RN1214648*

Measurement Uncertainty is available upon request.

Note: Where sampling dates are not provided NMI is unable to determine compliance to any applicable Holding Time requirements

Chemical Accreditation 198: 105 Delhi Road, North Ryde, NSW, 2113

CHAIN OF CUSTODY - INORGANIC ANALYSIS REQUEST FORM

ENVIRONMENTAL EARTH SCIENCES

Job #: 118109 Site Location: Shellharbour Sampler: LV & MN

Date: 13/11/2018 Laboratory: SAL Report To: Loretta Visintin

Sample ID	pH	Sample Description: SOIL	WATER	SEDIMENT	Analysis Required: HEAVY METALS	IONIC BALANCE	PHENOLS	CEC AND EXCHANGEABLES	LEACH PROCEDURE	COMBUSTIBLE MATTER	INSOLUBLE ASH	ASH				ANTICIPATED RESULTS/ TURNAROUND TIME
DUST			X							X	X	X				
TOTAL			1							1	1	1				

Turn Around: **NORMAL / 3 DAYS / 48 HRS / 24 HRS** Sheet: 1 of 1

Comments:

Date collected 13/11/2018 Date installed: 1/08/2018

Report to: egriffith@eesigroup.com; mnarracott@eesigroup.com

Invoice to: accounts@eesi.biz; egriffith@eesigroup.com

	Time	Date	Lab Supervisor:
Left EES Site:			
Transported By:			
Received Lab:			
Fax Results Rec'd			
Typed Results Rec'd			

We can be contacted on:

Phone: (02) 9922 1777

Fax: (02) 9922 1010

PROJECT FORMS/QF34 Chain of Custody_Inorganics 1 May 2007 Version 4 Page 1 of 1

Job No.: SAL26997B
Received By: A.S
Date: 15/11/18
Temp: Warm Ambient Cool
Date Due: 29/11/18

CHAIN OF CUSTODY - INORGANIC ANALYSIS REQUEST FORM

Job #: 118109 Site Location: Shellharbour Sampler: EG + MN

Date: 16/05/2019 Laboratory: SAL

Sample ID	DATE SAMPLED	Sample Description: SOIL	WATER	SEDIMENT	Analysis Required: HEAVY METALS	IONIC BALANCE	TOC	CEC AND EXCHANGEABLES	LEACH PROCEDURE	Sol. Zn	BOD	TURBIDITY	Tot. & Sol. Fe	Sol. Mn	NO3, NO2, HCO3, NH4	Sol. Al	ANTICIPATED RESULTS/ TURNAROUND TIME
BH1c	14/5/19		x			x	x				x		x	x			
BH2	14/5/19		x			x	x				x		x	x			
BH3	14/5/19		x			x	x				x		x	x			
BH4	14/5/19		x			x	x				x		x	x	x		
BH13	14/5/19		x			x	x				x		x	x			
BH14	14/5/19		x			x	x				x		x	x			
BH16	14/5/19		x			x	x				x		x	x			
BH20	14/5/19		x			x	x				x		x	x			
BH20s	14/5/19		x			x	x				x		x	x			
FD1	14/5/19		x			x	x				x		x	x			
LP1	14/5/19		x			x	x				x	x	x	x			
SWP1	14/5/19		x			x						x	x				
SWP2	14/5/19		x			x						x	x				
SWP4	14/5/19		x			x	x				x	x	x				
SWC2	14/5/19		x									x	x		x		
SWC_UP	14/5/19		x			x						x	x				
SWC_down	14/5/19		x			x						x	x				
SWC_down_2	14/5/19		x			x						x	x				
TOTAL																	

Turn Around: NORMAL Sheet: 1 of 1

Comments:

Report to: egriffith@eesigroup.com mnarracott@eesigroup.com

Invoice to: accounts@eesi.biz egriffith@eesigroup.com

	Time	Date	Lab Supervisor:
Left EES Site:			
Transported By:			
Received Lab:			
Fax Results Rec'd			
Typed Results Rec'd			

We can be contacted on:
Phone: (02) 9922 1777
Fax: (02) 9922 1010

Job No.: SAL27214
Received By: A.S
Date: 16/5/19
Temp: Warm ~~Ambient~~ Cool
Date Due: 30/5/19

CHAIN OF CUSTODY - INORGANIC ANALYSIS REQUEST FORM

ENVIRONMENTAL EARTH SCIENCES

Job #: 118109 | Site Location: Shellharbour | Sampler: EG & MN

Date: 16/05/2019 | Laboratory: SAL | Report To: Elin Griffiths

Sample ID	pH	Sample Description: Dust gauge	Analysis Required: HEAVY METALS	IONIC BALANCE	PHENOLS	CEC AND EXCHANGEABLES	LEACH PROCEDURE	COMBUSTIBLE MATTER	INSOLUBLE ASH	ASH	ANTICIPATED RESULTS/ TURNAROUND TIME
DG1		X						X	X	X	
TOTAL		1						1	1	1	

Turn Around: NORMAL | Sheet: 1 of 1

Comments:

Date collected: 14/05/2019 | Date installed: 14/02/2019

Report to: egriffith@eesigroup.com; mnarracott@eesigroup.com

Invoice to: accounts@eesi.biz; egriffith@eesigroup.com

	Time	Date	Lab Supervisor:
Left EES Site:			
Transported By:			
Received Lab:			
Fax Results Rec'd			
Typed Results Rec'd			

We can be contacted on:

Phone: (02) 9922 1777

Fax: (02) 9922 1010

PROJECT FORMS/QF34 Chain of Custody_Inorganics | 1 May 2007 Version 4 | Page 1 of 1

Job No.: SAL27214B

Received By: A.S

Date: 16/5/19

Temp: Warm Ambient Cool

Date Due: 23/5/19

CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Job No: 118109 Laboratory: SAL

Project Manager: Egr Sampler: Site Location: Shellharbour Sheet: ____ of ____

No. of samples	Sample ID/ Depth	Anticipated Result (PID)/EC reading	Date sampled	Time sampled	Sample Matrix: Soil	Water	Sediment	Analysis Required: Ionic balance	TOC	Tot & Sol Fe	Sol Mn	NO3,NO2,HCO3,NH4	BOD	turbidity							Sample-specific instructions/ notes
	BH1c					x		x	x	x	x		x								EXTRAS
	BH2					x		x	x	x	x		x								* 118015
	BH3					x		x	x	x	x		x								↓
	BH4					x		x	x	x	x	x	x								SITE 6
	BH13					x		x	x	x	x		x								RC
	BH14					x		x	x	x	x		x								
	BH16					x		x	x	x	x		x								
	BH20					x		x	x	x	x		x								
	BH20s					x		x	x	x	x		x								
	BHA					x		x	x	x	x		x								
	BH12_r					x		x	x	x	x		x								
	BH17_r					x		x	x	x	x		x								
	BH19_r					x		x	x	x	x		x								
	FD1					x		x	x	x	x		x								Job No.: SAL 27330/29
	LP1					x		x	x	x	x		x	x							Received By: K.S.
	SWP1					x		x		x				x							Date: 23/8/19
	SWP2					x		x		x				x							Temp: Warm Ambient (Cool)
	SWP4					x		x	x	x			x	x							Date Due: 5/9/19
	SWC2					x				x				x							
	SWC-UP					x		x		x				x							
	SWC_down					x		x		x				x							
	SWC_dow2					x		x		x				x							
	TOTALS * FD2 EXTRA							21	16	22	15	1	16	8							

Turn Around *(circle)*: **NORMAL / 3 DAYS / 48 HRS / 24 HRS** *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions: _____

Lab Quotation No. *(if applicable)*: _____

Send report to *(email address)*: _____

Cc: report to *(email address)*: _____

Cc: invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:				
Receiving Lab:				
Receiving Lab:				

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED
Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box: 380, North Sydney NSW 2059
Email: eesNSW@eesigroup.com

118109

CHAIN OF CUSTODY - INORGANIC ANALYSIS REQUEST FORM

Job #: 118109 Site Location: Shellharbour Sampler: EGR

Date: 23/8/19 Laboratory: SAL Report To: Elin Griffiths

Sample ID	pH	Sample Description			Analysis Required											ANTICIPATED RESULTS/ TURNAROUND TIME
			Dust gauge		HEAVY METALS	IONIC BALANCE	PHENOLS	CEC AND EXCHANGEABLES	LEACH PROCEDURE	COMBUSTIBLE MATTER	INSOLUBLE ASH	ASH				
DG1			X							X	X	X				
TOTAL			1							1	1	1				

Turn Around: NORMAL Sheet: 1 of 1

Comments:

Date collected 22/08/2019 Date installed: 14/05/2019

Report to: egriffiths@eesigroup.com; mnarracott@eesigroup.com

Invoice to: accounts@eesi.biz; egriffith@eesigroup.com

Time Date Lab Supervisor:

Job No.: SAL 27330
Received By: K.S.
Date: 23/8/19
Temp: Warm Ambient Cool
Date Due: 5/9/19

ENVIRONMENTAL EARTH SCIENCES
"THE RIGHT MIND TO THE RIGHT"

Job No: 118109 Site Location: Shellharbour Sampler: EG/ZZ

Date: 21/9/19 Laboratory: Sonic

Sample ID	pH	Sample Description: SOIL	WATER	SEDIMENT			Analysis Required: Faecal Coliforms	E. Coli					ANTICIPATED RESULTS/ TURNAROUND TIME
LP1			X				X	X					
TOTAL			1				1	1					

TURN / Turn Around: NORMAL 1 of 1

Comments:

Report to: egriffiths@eesigroup.com mnarracott@eesigroup.com

Invoice: accounts@eesi.biz egriffiths@eesigroup.com

	Time	Date	Lab Supervisor:
Left E& Left EES Site:			
Transpo Transported By:			
Receive Received Lab:			
Fax Re: Fax Results Rec'd			
Typed F Typed Results Rec'd			

We can be contacted on:

Phone: (02) 9922 1777

Fax: (02) 9922 1010

Job No.: SAL 27330
Received By: K.S.
Date: 23/E/19
Temp: Warm Ambient (C)
Date Due: 5/9/19
to SONIC

APPENDIX D: BOREHOLE DESCRIPTIONS

To aid the borehole chemistry descriptions, Schoeller Plots of the major ions for each of the bores have been provided for all the previous monitoring events.

BHA
BHA is located off the north-western corner of the resource recycling building as an alternative location to BH18, to the east of the landfill and positioned to be hydraulically upgradient of the leachate plume migrating to the southeast.

Field observations recorded a redox potential of 6 ppm and dissolved oxygen content of -0.27 ppm, indicative of a slight oxidative to reducing environment. Both ammonium and nitrate levels were relatively low to moderate (0.4 mg/L and 9.8 mg/L respectively). In addition, groundwater was also low in Na^+ (76 mg/L) with an elevated Ca/K ratio (20.20) and moderate K/TDS ratio (1.77%) (**Table 13**).

Borehole BH1c
Borehole BH1c is located near the old unlined landfill cell and intercepts leachate influenced groundwater. As such the chemical signature of this well has historically contained elevated leachate indicators in comparison to other monitoring wells.

Field observations in the last monitoring year revealed that groundwater had a consistent leachate odour, light amber to brown colour, high (>6 mS/cm) electrical conductivity (EC) and negative redox potential during all monitoring events. Field parameters indicate leachate presence at this location (**Table 7**).

Concentrations of leachate indicators (TDS, K^+, NH_4^+, BOD, TOC and L/N ratio) remained high and consistent over the monitoring year. These have remained similar to previous monitoring rounds. The absence of oxygen (negative redox) and presence of soluble Fe^{2+} indicate a high chemical or biological demand in response to microbial respiration. This suggests some degradation of the leachate plume has occurred and/or is occurring within this monitoring well.

Concentrations of NH_4^+ and soluble Fe exceed the ANZECC (2000) guidelines for the 95% protection of marine ecosystems (ANZECC, 2000) for all monitoring rounds.

Borehole BH2
Field observations in the last monitoring year revealed that groundwater had a consistent sweet leachate odour, yellow to brown colour, relatively high (>3 mS/cm) electrical conductivity (EC) and negative redox potential during all monitoring events. Field parameters indicate leachate presence at this location (**Table 7**).

Total dissolved solids concentrations were <1940 mg/L and leachate indicators BOD, TOC, NH_4^+ and K^+ had remained steady throughout the monitoring year. The L/N ratio over the past monitoring year has remained relatively stable at <16.

Ammonia (NH_4^+) and soluble iron were above the ANZECC (2000) guidelines for 95% protection of marine ecosystems (ANZECC, 2000) throughout the monitoring year. The elevated NH_4^+ (>30 mg/L) within this borehole may not indicate sole leachate migration from the landfill. Ammonia in BH2 groundwater potentially could be constituted by additional external influences such as historical uncontrolled waste disposal in the local area, or fill material.

Borehole BH3
Field conditions in BH3 over the past 12-month monitoring period were relatively stable. NO_3^- was the dominant nitrogen species with concentrations as high as 105 mg/ L recorded.

TOC and BOD levels were low throughout the sampling period. The L/N ratio at this site is elevated (>30) which can be mainly attributed to the high NO_3^-. It should, however, be noted that the TDS concentrations has been in low levels (between 730 - 1120 mg/L) during 2018-2019; therefore, there is also a possibility that high L/N ratios may be misleading.

Concentrations of NH_4^+ and NO_3^-exceeded the ANZECC (2000) guideline at this location for all monitoring rounds. Conditions over the past 12 months suggest groundwater chemistry fluctuates which is consistent with the previous year's data. Groundwater at this location is dominated by equilibrium concentrations of native ions Ca^{2+}-HCO_3^-.

Field observations at this location did note significant color change from previous years with black to grey to clear colour of water, with absense of odour. Future observations will be particularly important for this location to understand the trend of the leachate impact near this point.

Borehole BH4
The odour of groundwater recorded a mild sweet leachate odour, but no colour at this location. Negative redox values and low dissolved oxygen measurements showed the groundwater was in a reducing state throughout the year.

Groundwater quality is generally consistent with natural conditions of the aquifer with a chemistry dominated by the native ions Ca^{2+}- HCO_3^- >Na^+- Cl except for the moderate levels of NH_4^+.

Borehole 12-r
BH12-r is located to the southeast of the leachate pond and green waste stockpiles, installed in July 2019. The August 2019 was the first monitoring round. Field observations did not record odour or colour associated with leachate impact; however, negative redox and dissolved oxygen show the groundwater was in a reducing state. Nitrate was shown to be the dominant species and was in excess of the trigger value. The chemical signature of the groundwater at this location is indicative of leachate impact (elevated TDS (1580mg/L), K^+(62 mg/L), which is in keeping with the migration of leachate from the main landfill to the southeast.

Borehole BH13
Field observations show BH13 with a negative redox potential. A sweet odour was observed during the November 2018 round and colour of groundwater was recorded as clear.

During the first half of the 2018-2019 monitoring period, nitrate was the dominating nitrogen species which indicates the occurrence of nitrification at this location. L/N ratios over the sampling period were within the historical range. Groundwater at this location was dominated by the native ions Ca^{2+}-HCO_3^-.

As this location is strategically down gradient of the landfill the ionic balance within borehole BH13 will continue to be closely monitored as any future leachate front should be noticeable here.

Borehole BH14
Field measurements over the 2018-2019 period indicate a limited influence of leachate at BH14. Redox potential varied over the monitoring period from -117 to 14 mV. During the periods of highest redox values (November 2018 – 14 mV and August 2019 – 12mV) sweet leachate odours were observed.

Borehole BH14 groundwater is dominated by the native ions Ca^{2+}- HCO_3^- - Na^+, and previously nitrate dominance was apparent due to an apparent connectivity with SWP3 (since backfilled) providing an oxygenated environment. Since backfilling, nitrate levels have ranged between <0.1 and 3.6 mg/L.

As a result of decreased nitrate in water, L/N ratios declined in the 2017-2018 rounds and have remained stable (5.14 to 6.3 %) during the 2018-2019 annual rounds.

It is possible that, traces of nutrient impacts at this location may be sourced from the shallow old landfill near this location (see Figure 1) which are exacerbated during times of above average rainfall leading to nutrient transport through surface water infiltration and groundwater flow.

Borehole BH15
Field measurements indicated elevated EC >10 mS/cm) compared to other bores (**Table 7**), acidic pH, and light brown colour with swee odour. A high L/N ratio was present at BH15 associated with elevated K^+ and NH_4^+ levels. Due to BH15's location near a drainage line there is the potential for groundwater to be influenced by surface water flow and local onsite and offsite works. It is likely that high L/N values occur at BH15 from nutrient rich runoff that is transported through the drainage channel during times of rainfall.

Dominant ionic species indicate Na^+- Cl^- > with HCO_3^-- Ca^{2+} being subdominant within the groundwater.

Concentrations of NH_4^+ and soluble iron exceeded the ANZECC (2000) guidelines over the monitoring period. TDS (6620mg/L) remained elevated compared to other bores at the site with individual ion concentrations remaining stable, including K^+ which remained high (605 mg/L).

A data review report issued in August 2017 (Environmental Earth Sciences, 2017) reported a mobile leachate plume at BH15. This plume may be associated with the leachate pond overflow incident that was recorded on 2003 or a potential leachate migration from the landfill.

Borehole BH16
Field measurements showed a relatively low EC (between 0.27 to 0.5 mS/cm) during the 2018-2019 monitoring rounds. Groundwater varied from light brown to clear with a sweet and sulfuric odour. The redox condition of groundwater was negative at an average of -178 mV.

Native cations have showed an increase and non-native ions including NH_4^+ have decreased causing a decrease in the L/N ratio at this location. Relative concentrations of ionic species indicated Na^+- Cl^- > HCO_3^- - Ca^{2+} within the groundwater.

Concentrations of NH_4^+ remained low (0.2 mg/L) throughout the 2018-2019 monitoring rounds. Nitrate did not exceed in any monitoring rounds whilst soluble iron exceeded in the November 2018 round.

The groundwater intercepted by this location may be connected to surface water and be influenced by infiltration of water travelling along the drainage line at the eastern border of the site. Sources may be stockpiling activities on the neighbouring site or leachate influence from the landfill across-hydraulic gradient. As such, the decreasing trend of L/N and increase in native ions may be due to the lower volume of runoff infiltrating into groundwater at this location.

Groundwater at BH16 should continue to be closely monitored to see if leachate indicators increase over time, particularly after rainfall.

Borehole BH19
Borehole BH19 was installed to measure any leachate migration past BH4 in the south west corner of the site and was reinstalled in July 2019 following a blockage recorded in August 2018. The August 2019 was the first monitoring round. Chemical characteristics included a moderate EC (1.79 mS/cm), no odour, neutral pH and light cloudy brown colour. No significant leachate indicators were noted within this area.

Dominant ionic species indicate that Ca^{2+}- HCO_3^- > Na^+- Cl^- dominate the groundwater. Concentrations of NH_4^+ exceeded the ANZECC (2000) guidelines (5.5mg/L).

Borehole BH20
BH20 was positioned to assess the chemical characteristics on the boundary of the landfill site. The field observations of BH20 were found to have a negative redox, very light brown colour with slight sulphuric odour. The L/N ratio gives the indication of a leachate impacted site with the L/N in the range of 17-29, associated with elevated NH_4^+ (ranging between 14 and 39 mg/L) above the trigger value.

Low TDS levels (<1,000 mg/L) introduce susceptibility of the L/N ratio to large fluctuations, however elevated K^+ and PO_4 also suggested that a leachate influence was present.

Chemical characteristics of the bore show groundwater is low in Na^+, moderate Ca/K and a moderate K/TDS ratio. Elevated concentrations of HCO_3^- present in groundwater is potentially due to microbiological activity and/or shell grit found within the marine sediments of the area. Given the field observations and chemical characteristics, leachate influence is likely to be occurring in this area. Close monitoring of ionic trends will assist in detecting any future leachate influences.

Borehole BH20s
Bore BH20s is located directly adjacent to BH20 but at a shallower depth – *screened intervals of BH20 and BH20s are 6.0-9.0 mBGL and 1.5-4.5 mBGL respectively*. Similarly, this bore was positioned to compare the chemical characteristics on the boundary of the landfill site in order to locate potential transport pathways to Rocklow Creek.

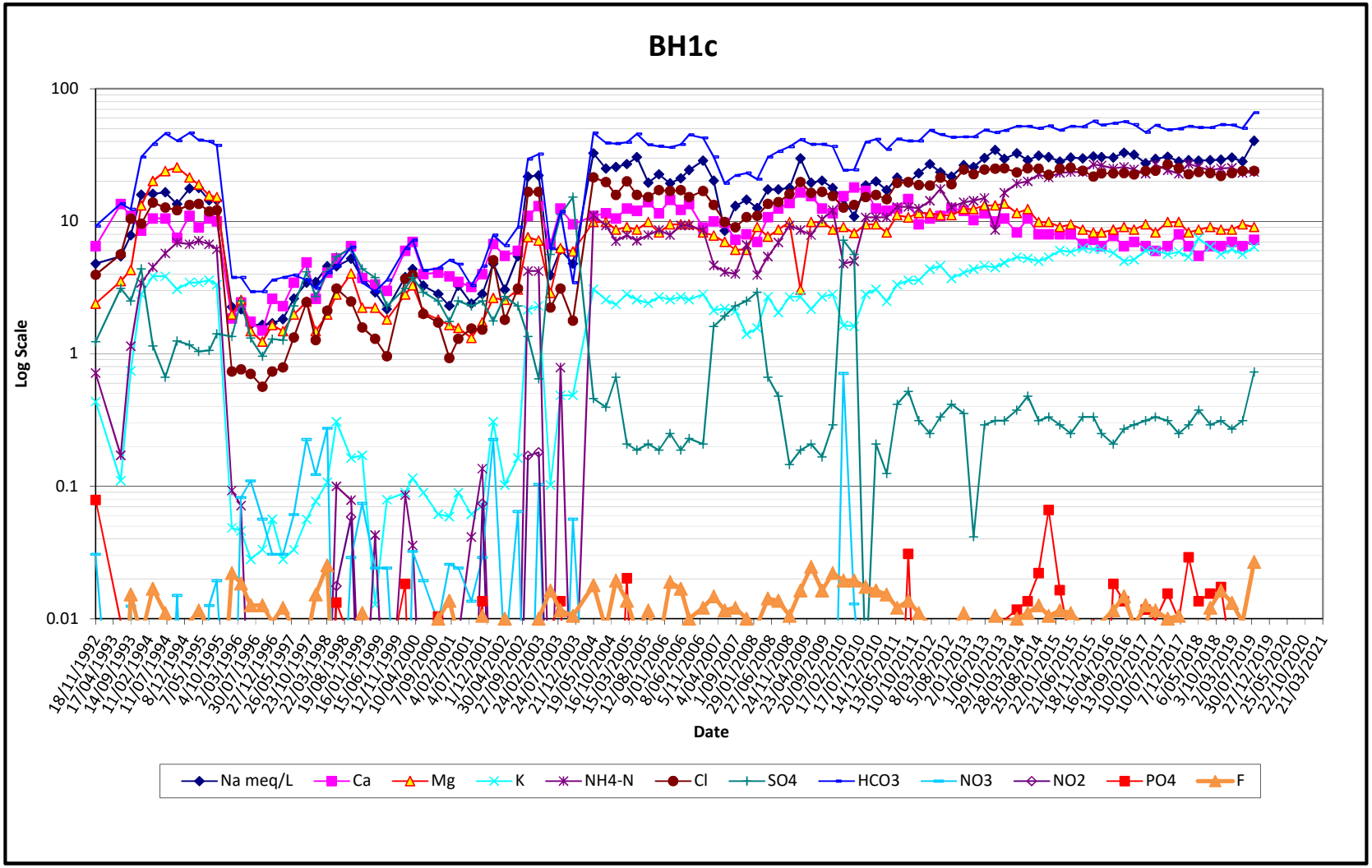
Chemical characteristics of the bore show groundwater was low in Na^+, with a low Ca/K and high K/TDS ratio (**Table 13**). Nitrate was the dominant nitrogen species within groundwater at BH20s, converse to the deeper monitoring location, BH20. Exceedances of the adopted site criteria for nitrate occurred in all occurrences during the 2018- 1029 monitoring rounds, with a subsequent large L/N ratio recorded in these events (ranging between 69 and 82%). Due to low TDS (<1,000 mg/L), however, the L/N is susceptible to large fluctuations.

Redox potential ranged from -210 mV to 32 mV, likely due to the below average rainfall and thus less infiltration of oxygenated water into the shallow part of aquifer. Evidence of this occurring was low dissolved oxygen over the 2018-2019 monitoring period from ranging from -0.34 to 1.29 ppm.

It was previously thought that high nitrate levels in this shallower bore location was indicative of nitrification of the diluted ammonium plume present in the deeper aquifer throughout the soil profile, however, it is more likely that it is caused by the transport of nutrients from the

up-gradient old shallow landfill. Continued monitoring at this location will be necessary to determine potential leachate transport to Rocklow Creek.

APPENDIX E: SCHOELLER PLOTS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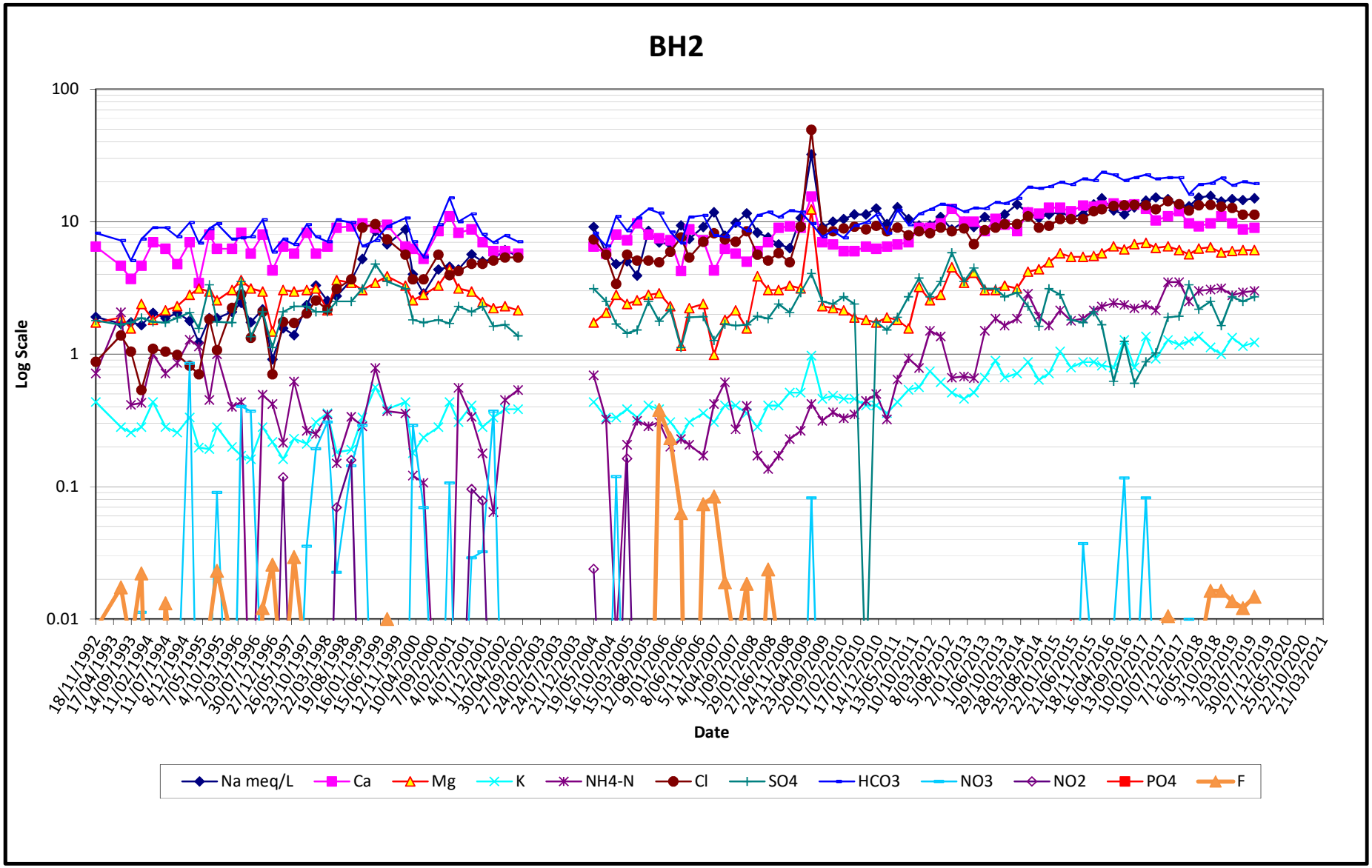
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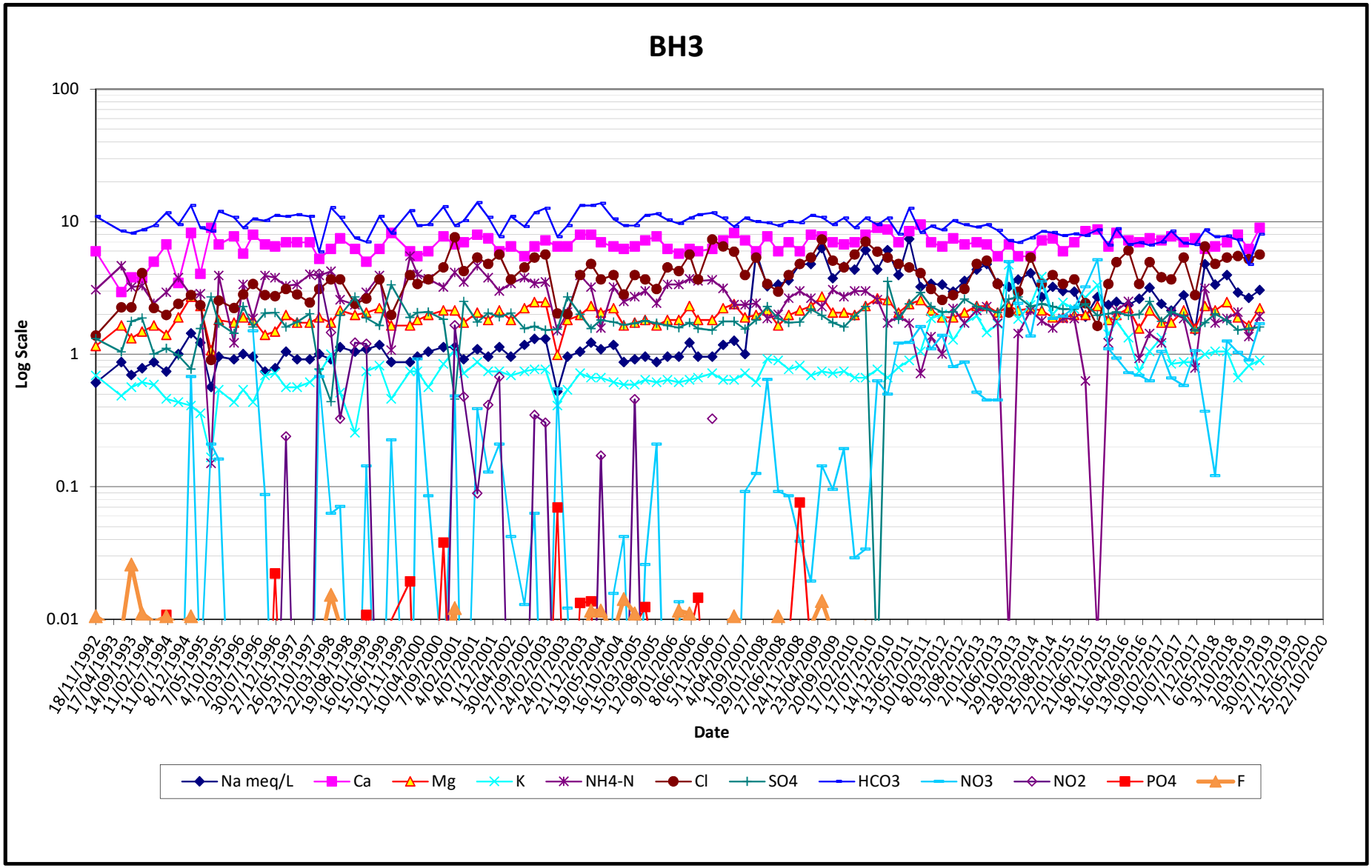
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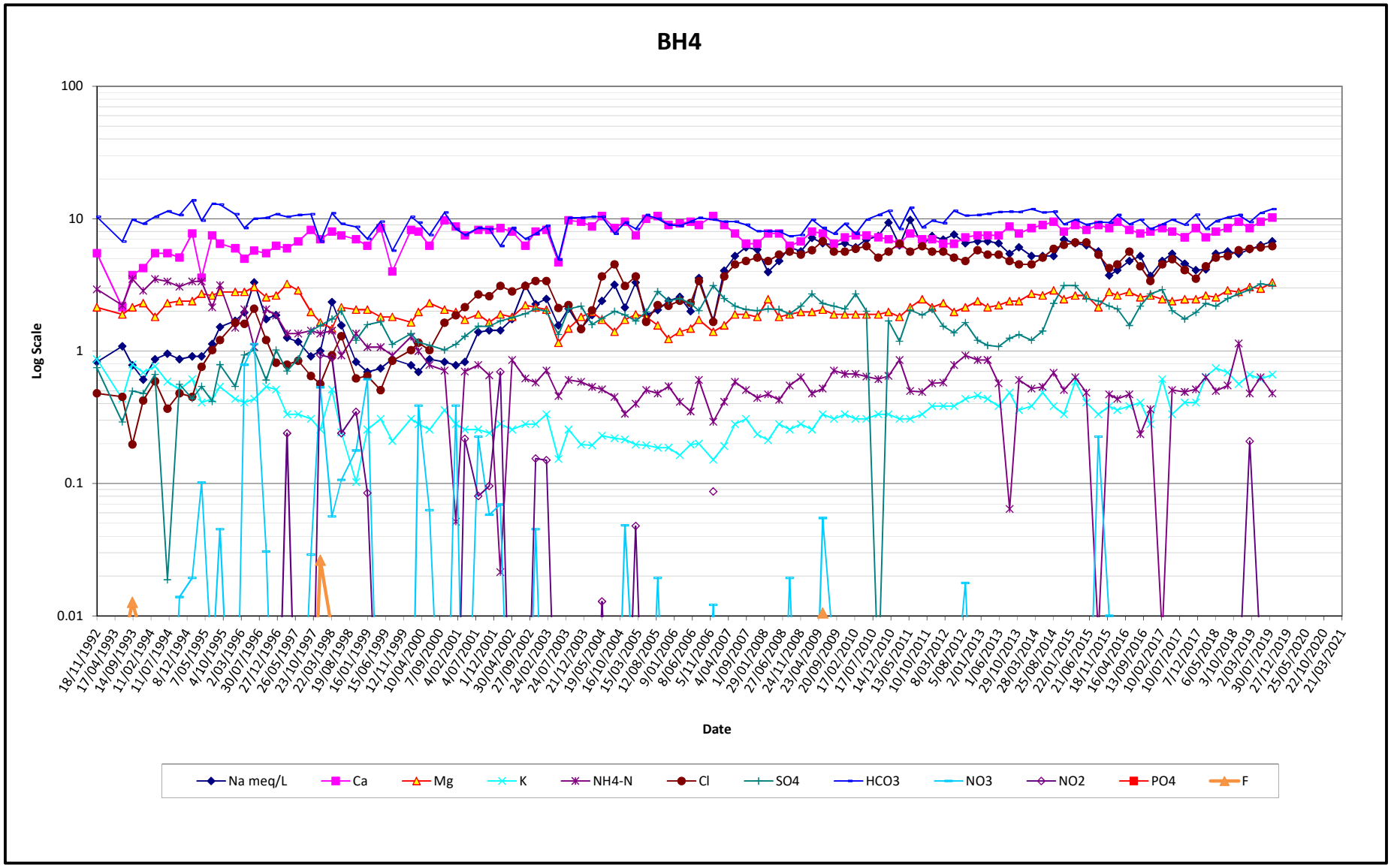
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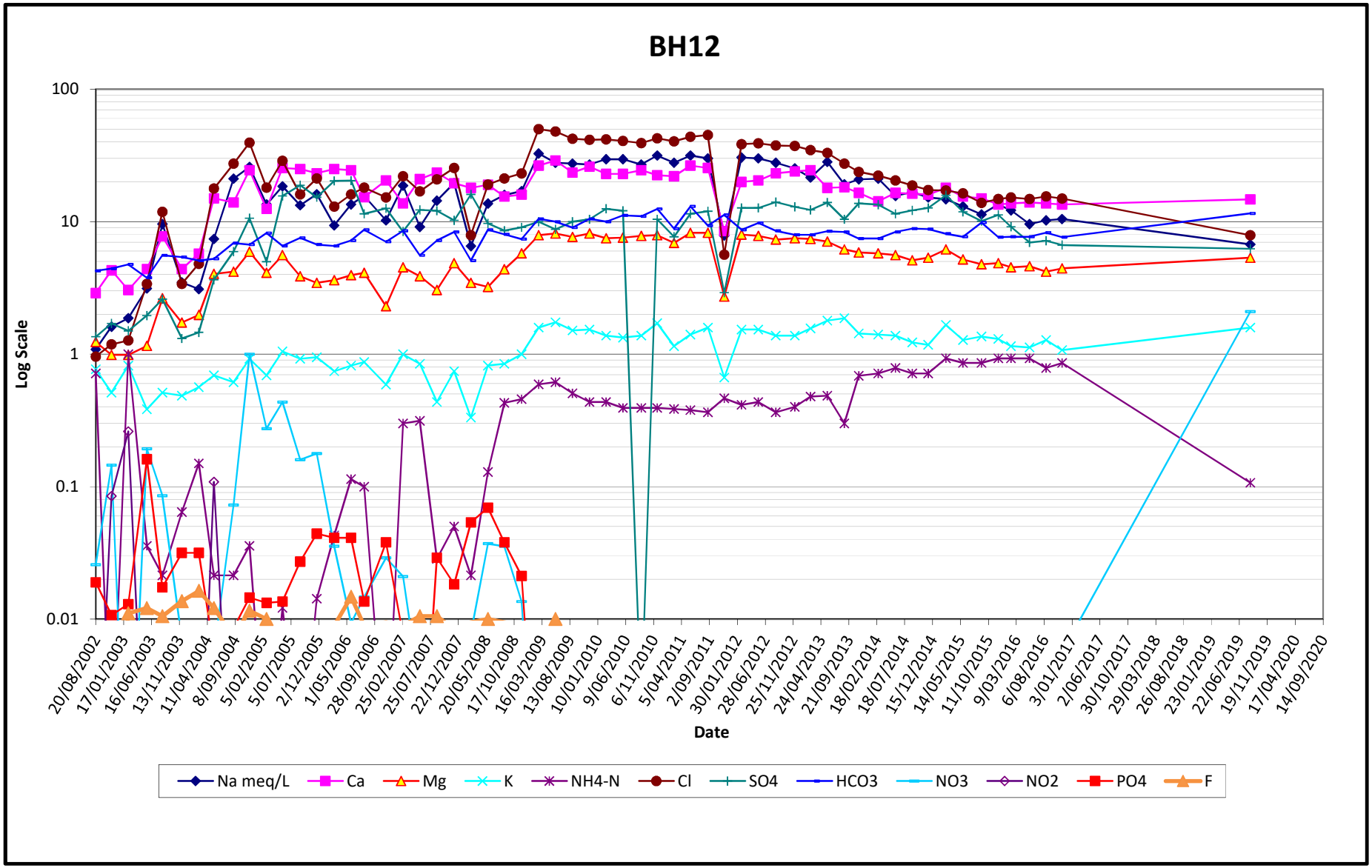
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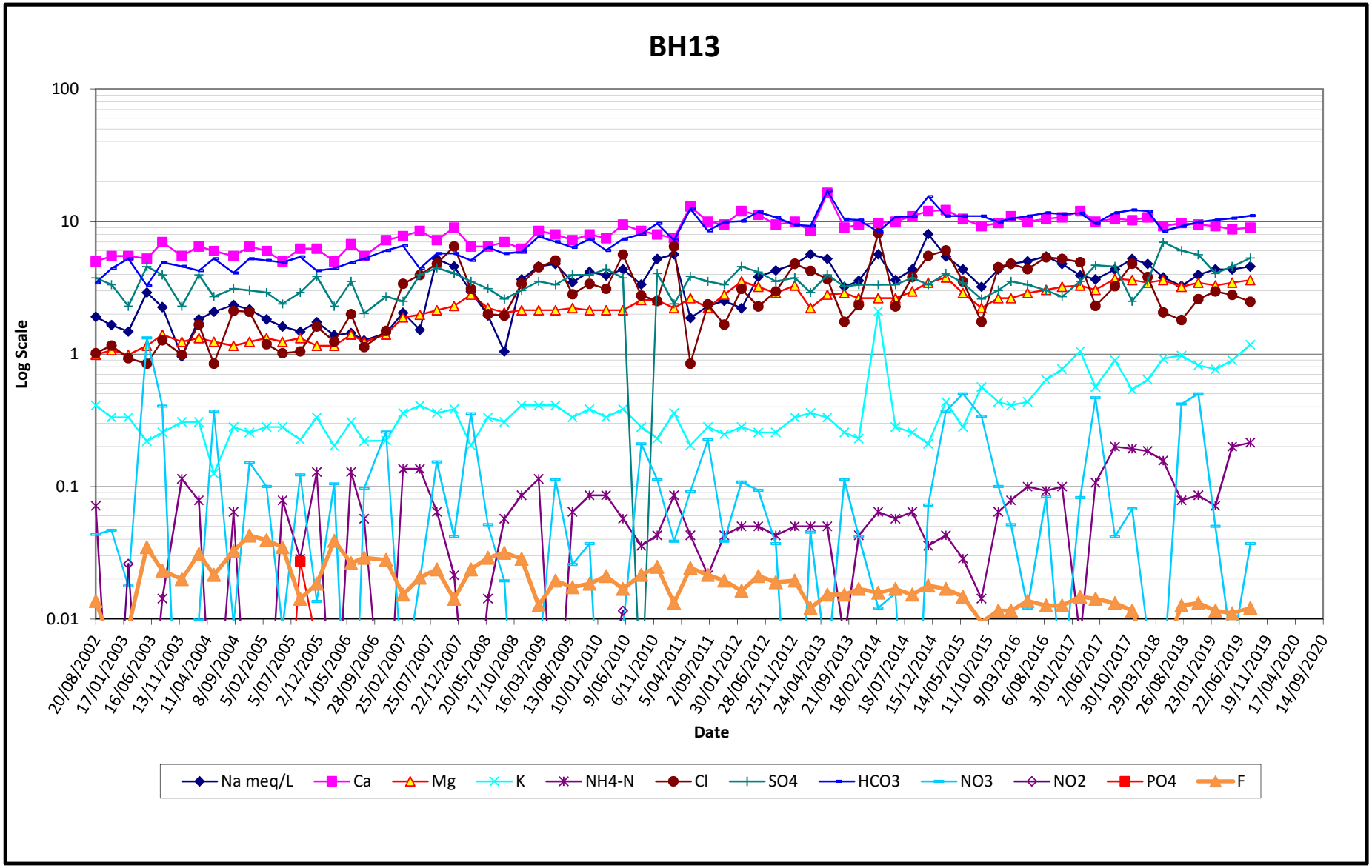
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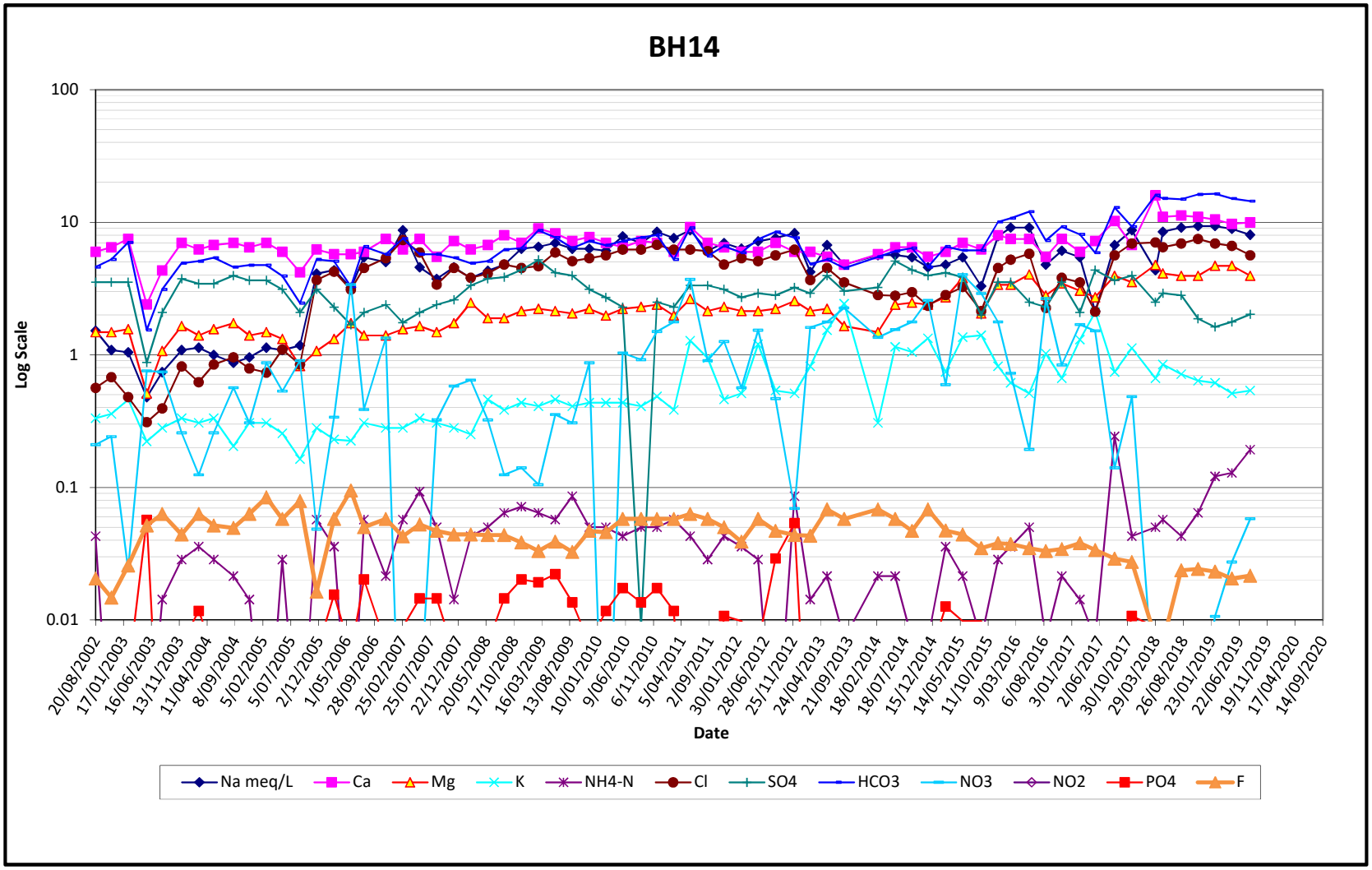
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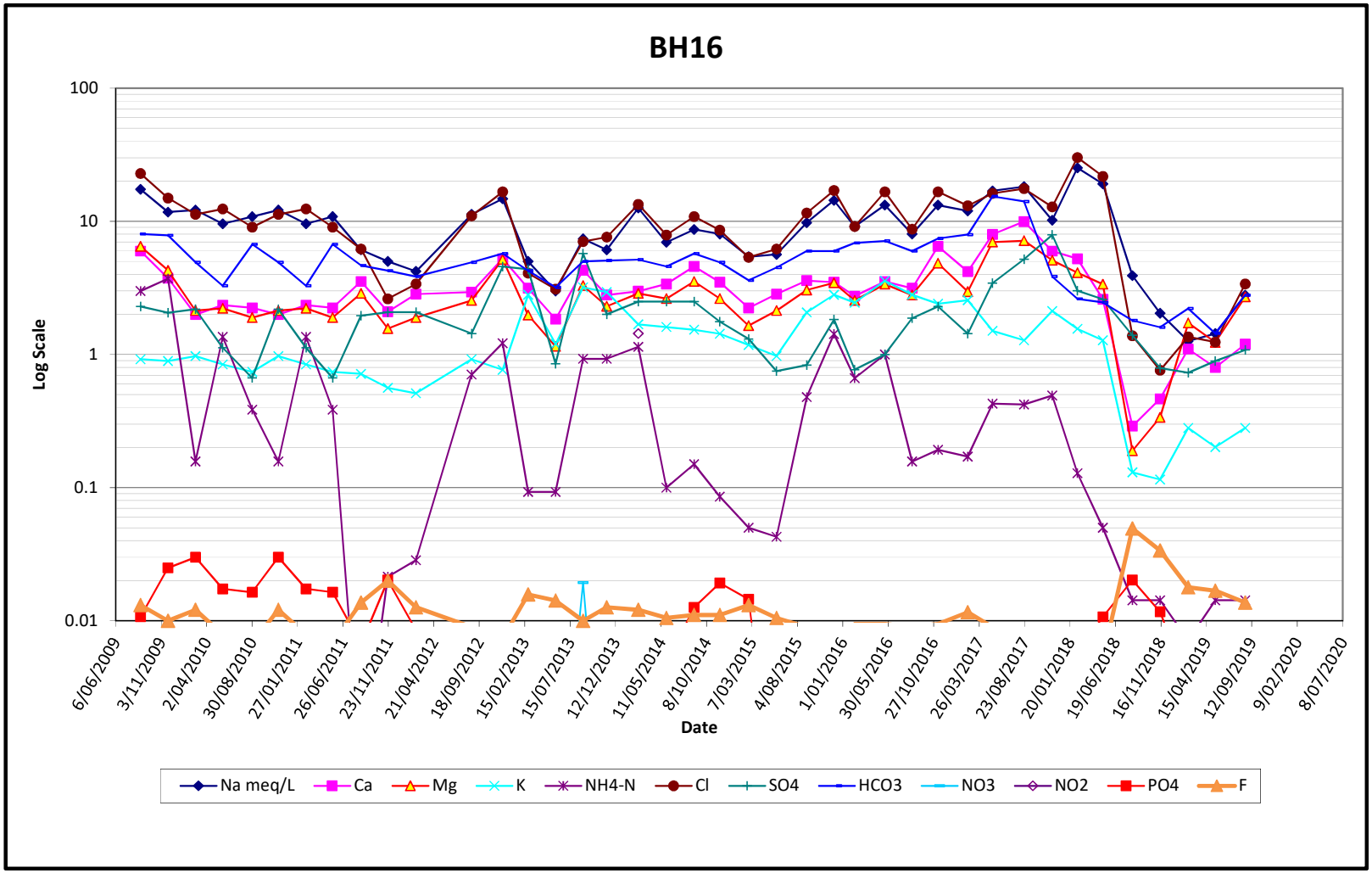
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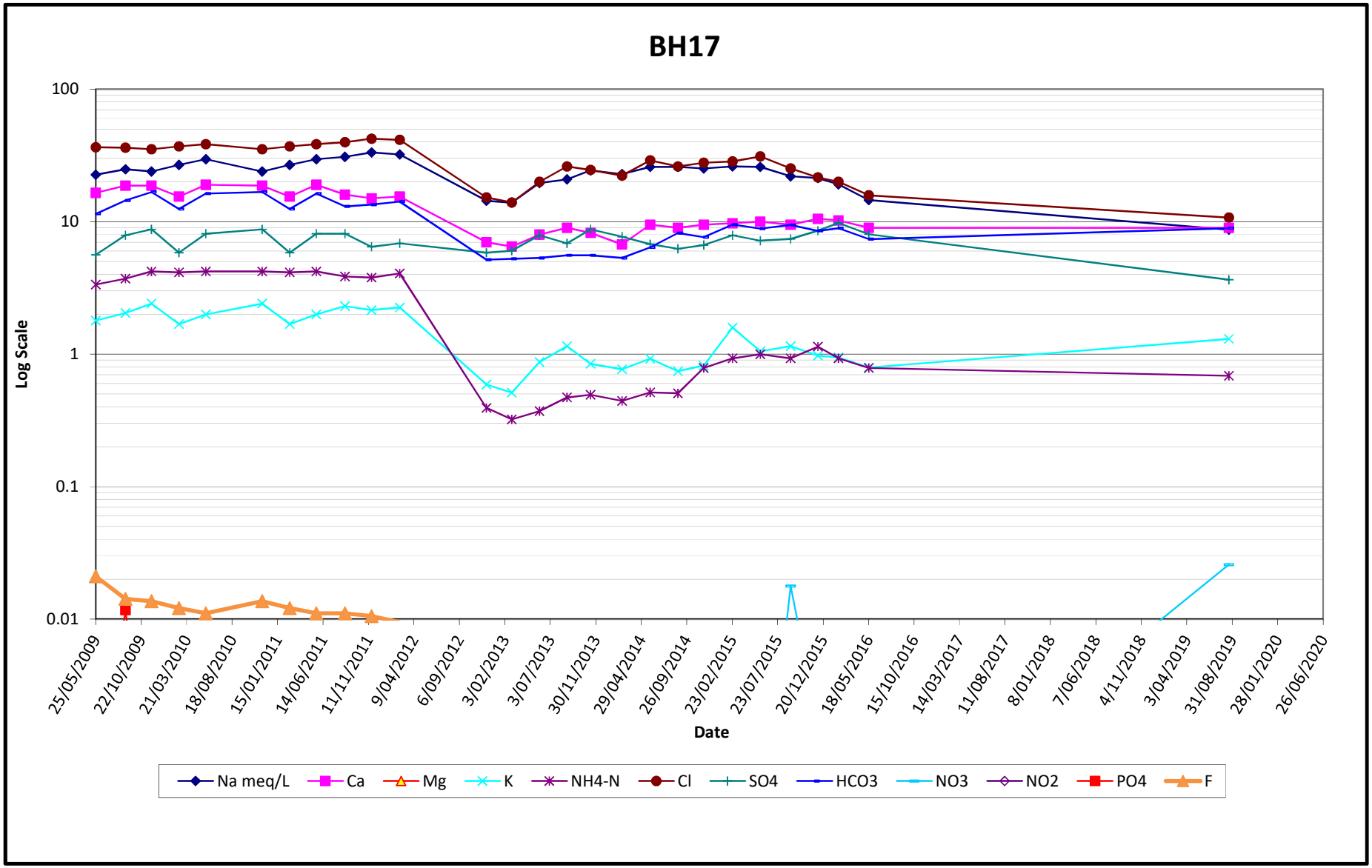
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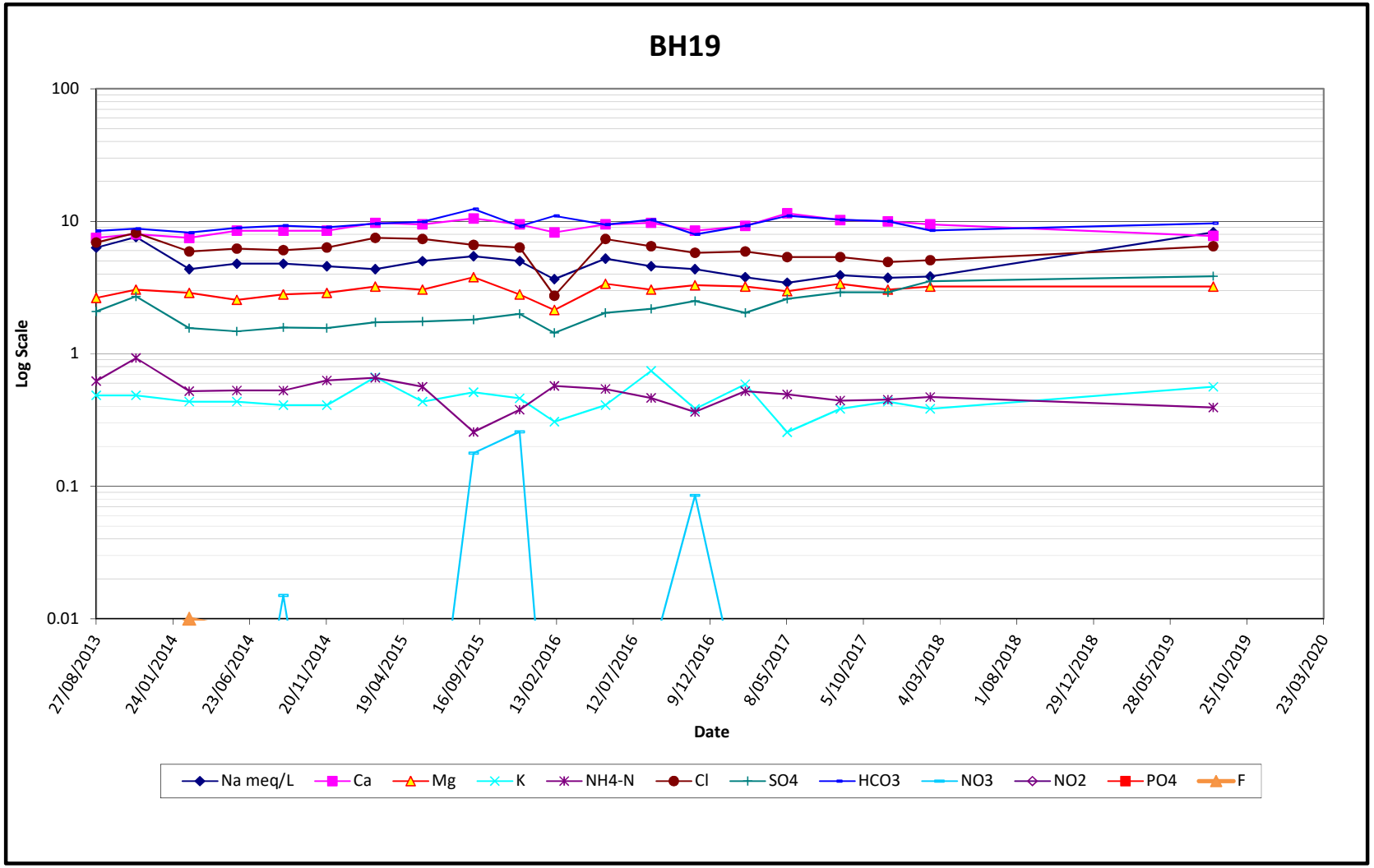
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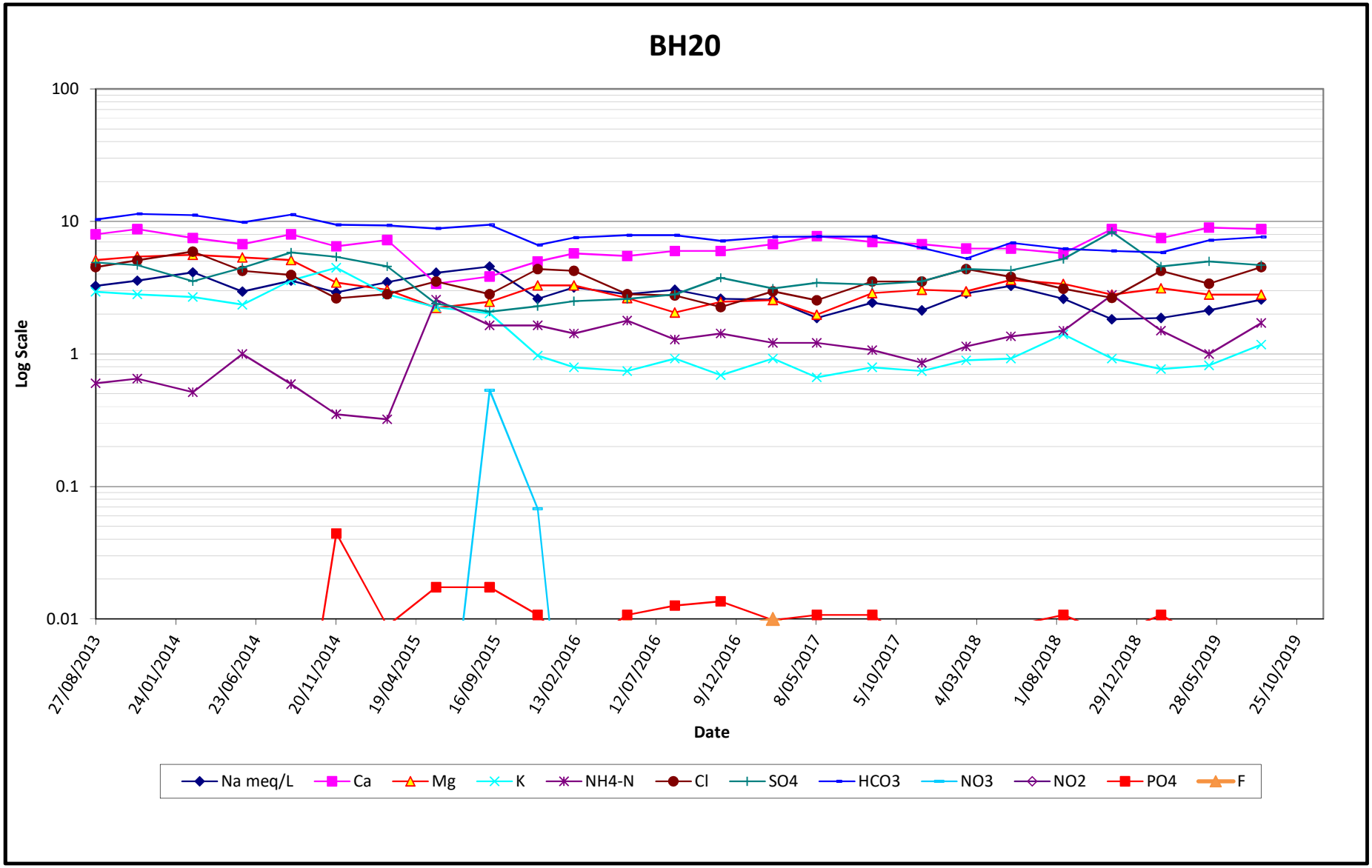
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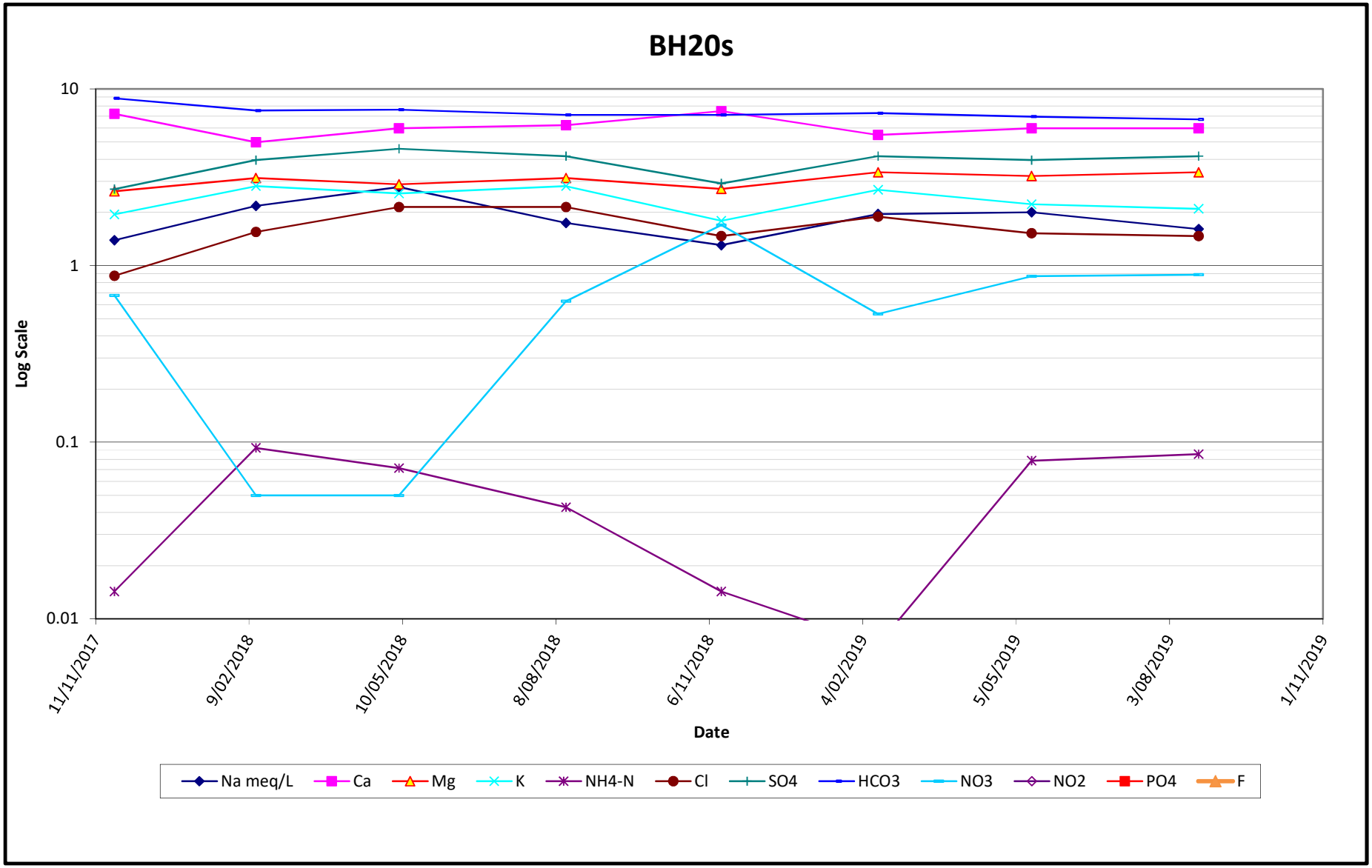
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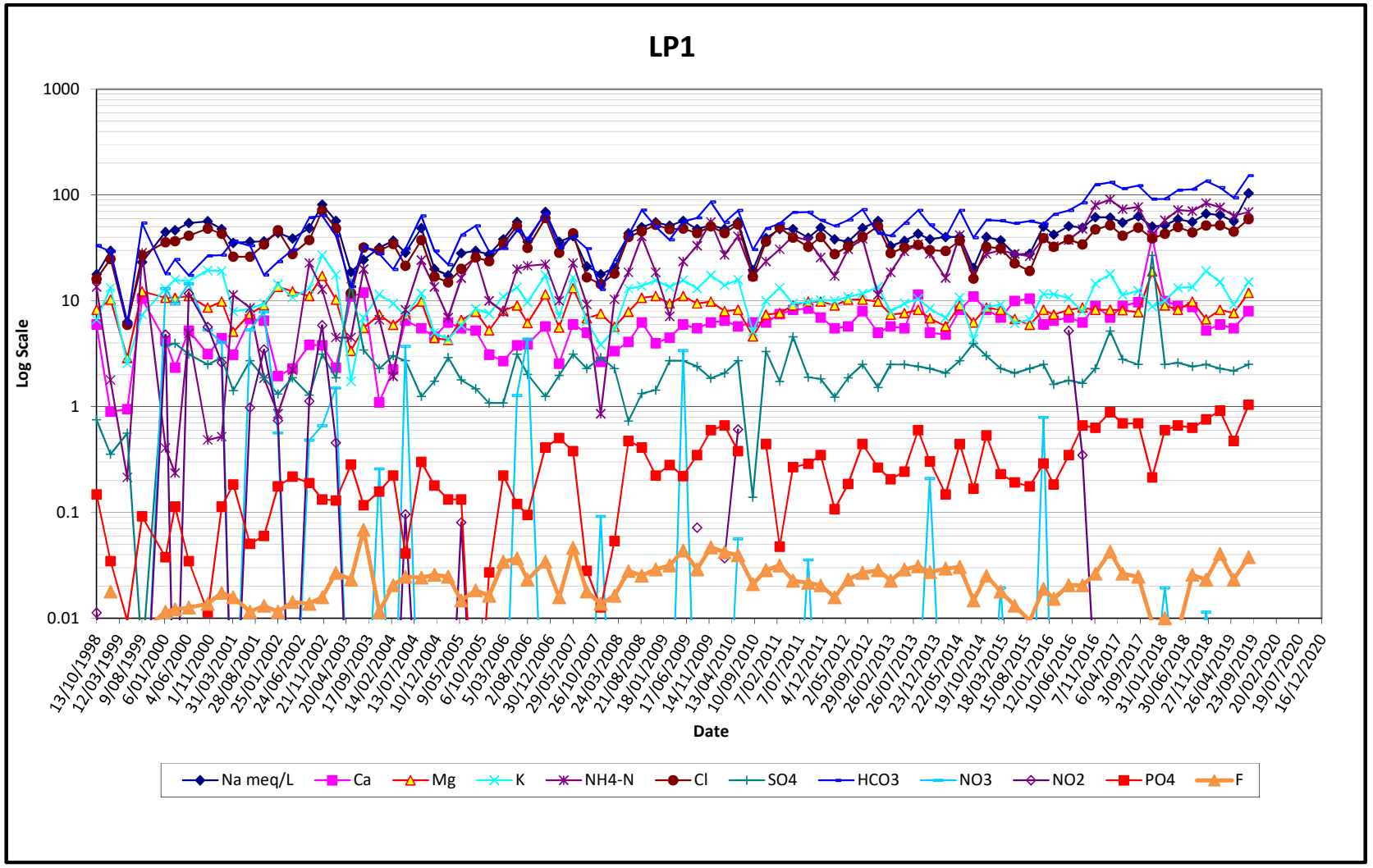
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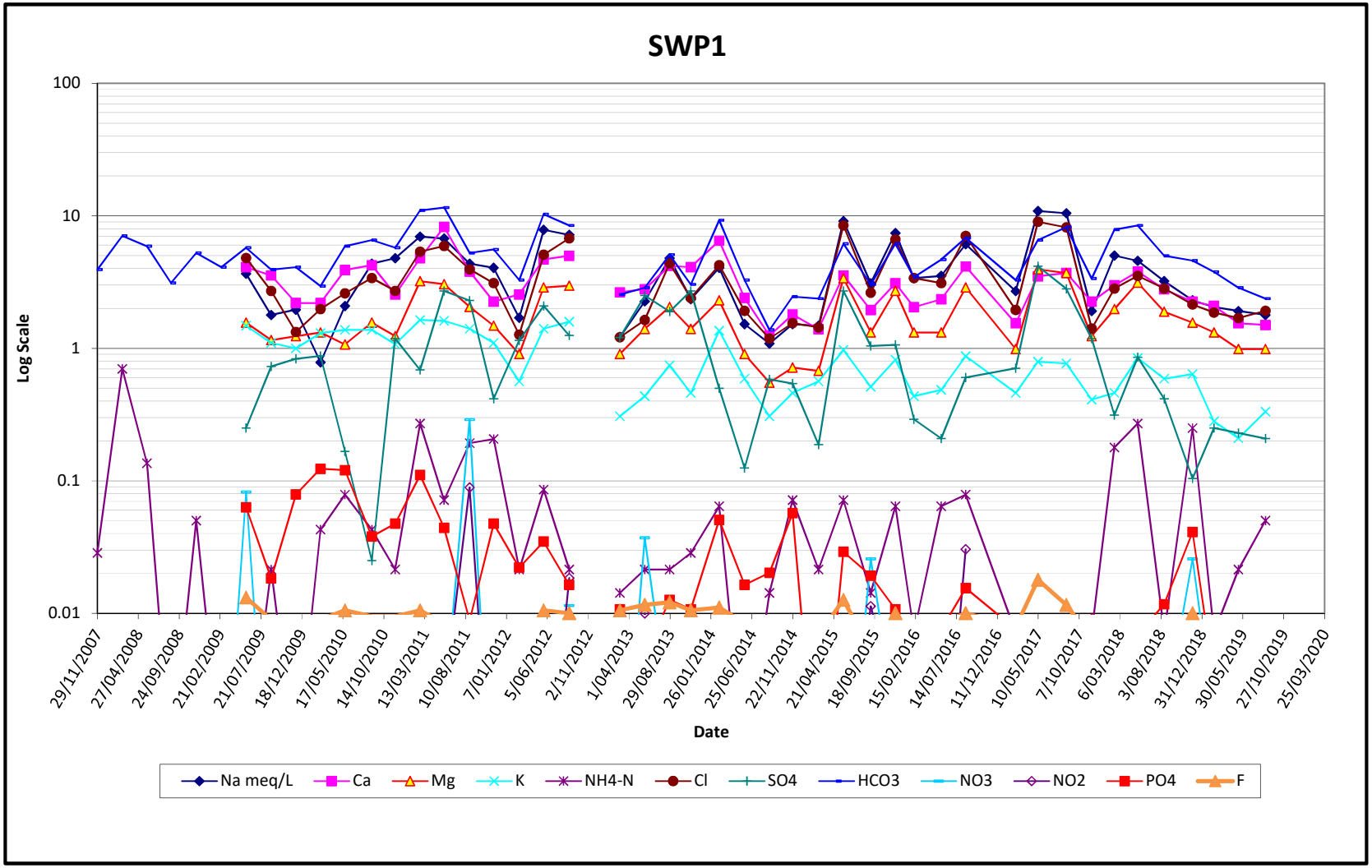
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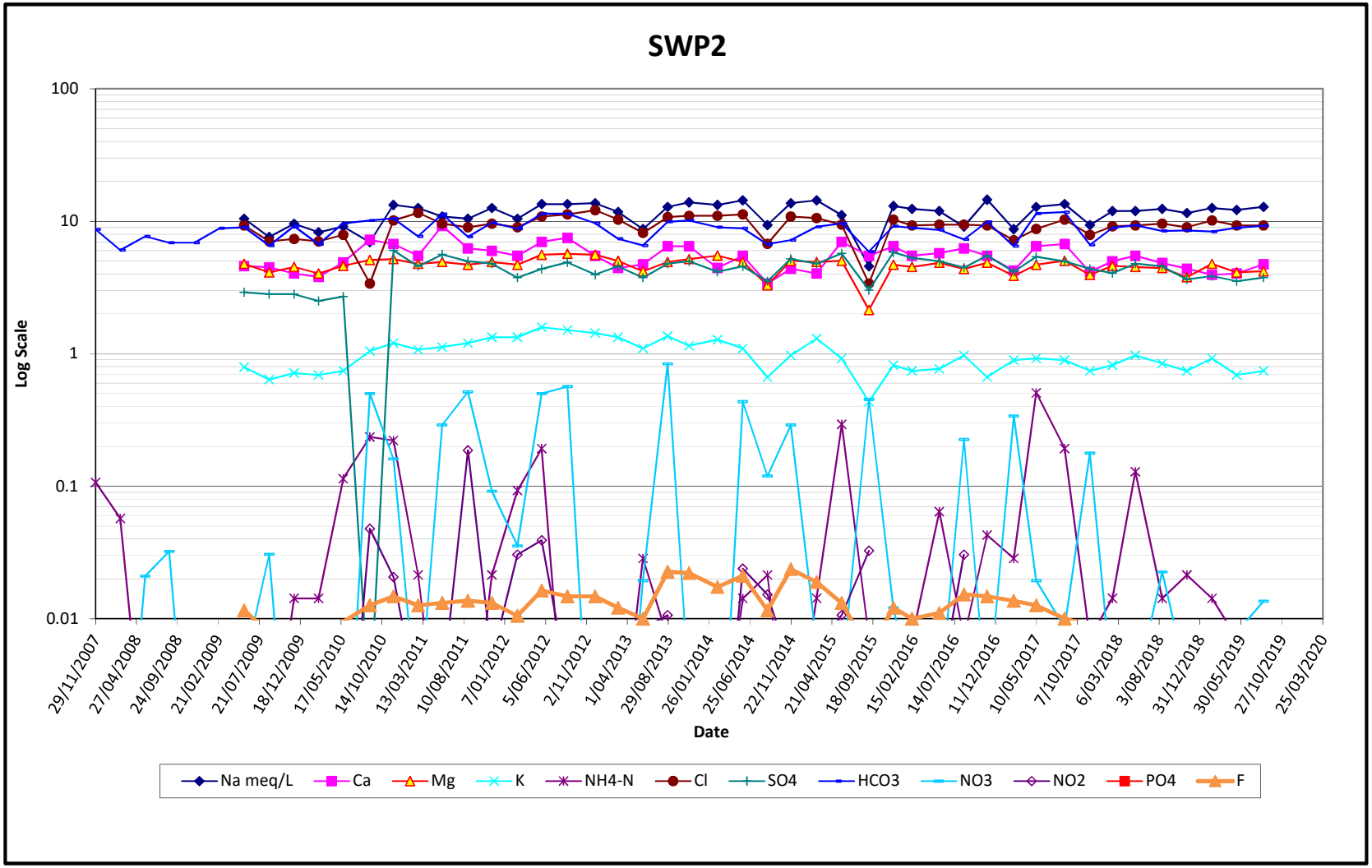
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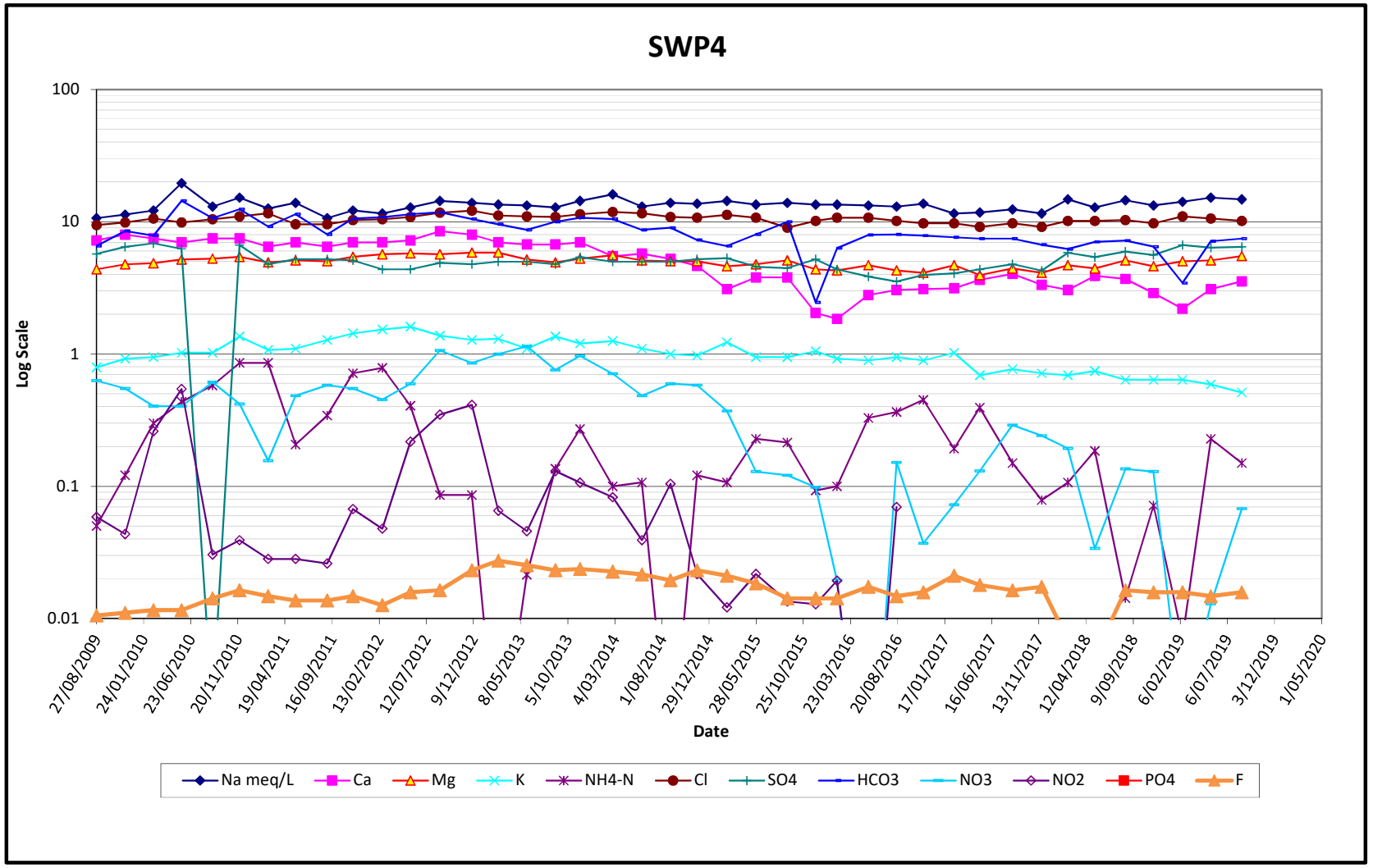
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