Kooragang Island resource recovery facility

Surface water discharge characterisation assessment

Prepared for Boral Recycling Pty Limited
November 2019

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1 November 2019

Executive Summary

ES1 Introduction

Boral engaged EMM Consulting Pty Limited (EMM) to undertake surface water sampling at the facility and prepare a Surface Water Discharge Characterisation Assessment (SWDCA). The SWDCA included, collection of water samples and field observations on five occasions between June 2018 to August 2019; laboratory analyses of the collected water samples; and collection and interpretation of the results to characterise the quality of surface water within the site.

This report documents a SWDCA that addresses:

- Environment Protection Licence (EPL) 11968 requirements for the SWDCA; and
- Development Consent SSD 15_7038 Condition B13.

ES2 Existing water management system

The facility's water management system manages stormwater runoff and provides water for operational uses such as dust suppression and product conditioning. The system's key functionality is described as follows:

- The yard has been established on compacted fill that is assessed to have moderate permeability when saturated and sits above a shallow unconfined groundwater system.
- Surface water runoff from the yard drains through several discrete surface drains to an infiltration swale located along the northern boundary. Water in the swale slowly infiltrates into the underlying groundwater system.
- The swale overflows into a concrete-lined basin.
- Water captured in the concrete-lined basin is used for operational uses such as access roads dust suppression and product conditioning. During dry periods, additional water is sourced from the underlying groundwater system (via a spearpoint well located near the basin) or from the mains potable water supply. Boral were not using the spearpoint well during the SWDCA period (June 2018 to August 2019).

Figure ES1 shows the conceptual framework of the water management system.

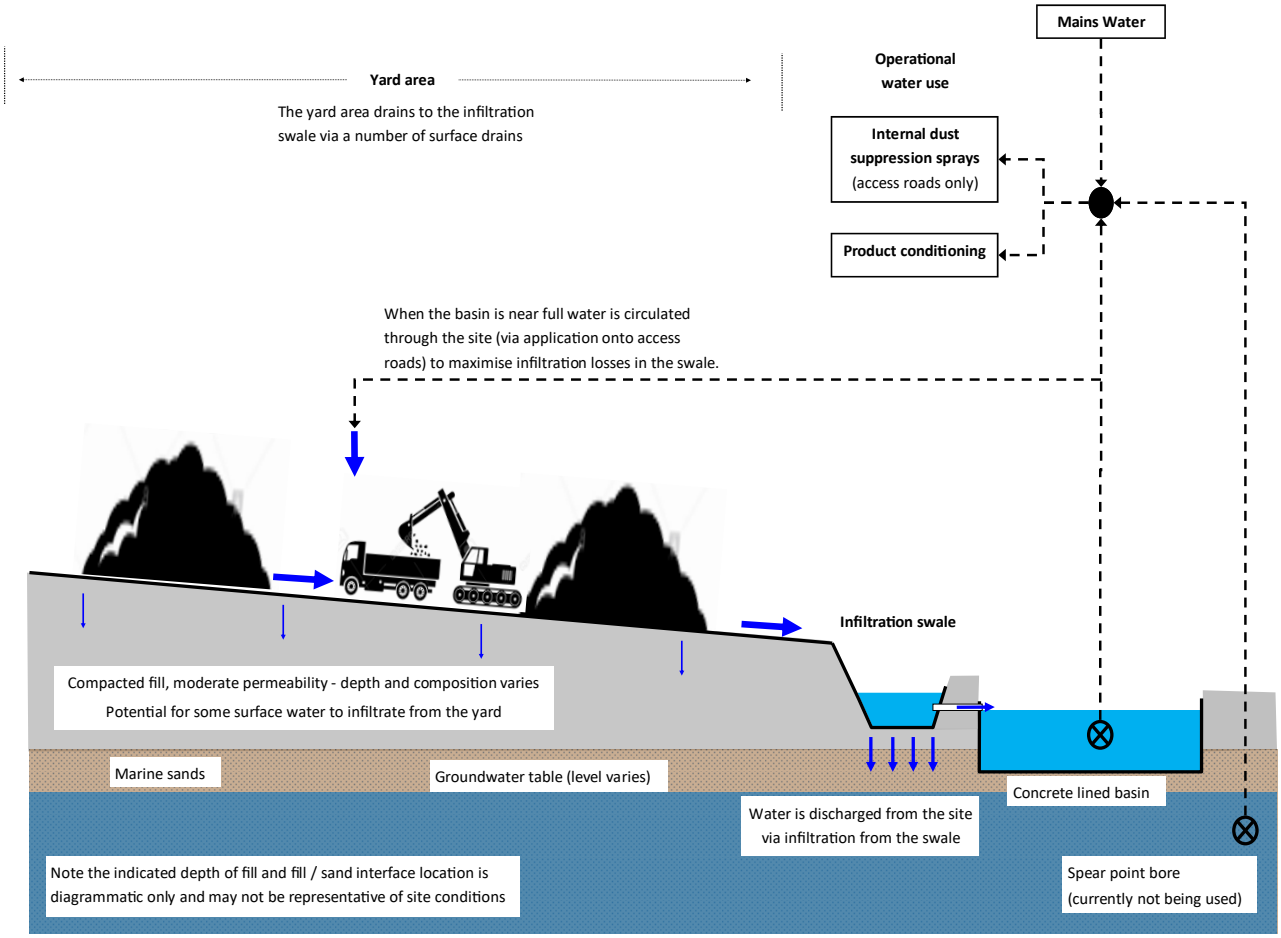

Figure ES1 Conceptual framework of the water management system

ES3 Surface water characterisation program

A surface water quality characterisation program was completed by EMM to inform this SWDCA. The program comprised sampling and analysis of surface water within the facility from five independent rainfall events between June 2018 and August 2019. For each sampling event, samples were collected from the concrete-lined basin, the infiltration swale and small puddles adjacent to incoming and processed material stockpiles.

Surface water runoff from the facility is characterised as being alkaline (ie high pH) and containing elevated concentrations (relative to default guideline values for slightly-moderately disturbed fresh water systems) of nitrogen (primarily in oxidised form), cyanide and several metals: aluminium, chromium (primarily in hexavalent form), cobalt, copper, molybdenum, vanadium and zinc. These water quality characteristics are interpreted to be associated with water contact with concrete washout, which is one of the materials processed at the facility. The concentrations of nitrogen and metals are generally higher in the yard samples (which were collected from small puddles near stockpiled material) than the swale samples (which include runoff from access roads as well as stockpiles). This indicates that the stockpiled material is the primary source of the high pH, nitrogen, cyanide and metals.

ES4 Receiving water impacts

ES4.1 Receiving environment

Surface water is discharged via infiltration from the swale that is located along the northern boundary of the facility. Hence, the underlying shallow groundwater system is the immediate receiving environment. Regional groundwater flow is interpreted to be in a southerly direction towards the southern arm of the Hunter River Estuary (SLR 2015), which is located 700 m from the facility. However, some groundwater from the facility area may also flow into the existing drain that is located immediately to the west of the facility. This drain also flows in a southerly direction and enters the southern arm of Hunter River Estuary near the coal loading facilities.

The receiving environment is a highly disturbed ecosystem due to the known groundwater contamination issues and surrounding industrial land uses, which include coal terminals and a harbour port.

ES4.2 Potential impacts

There is insufficient data available to establish the extent and nature of any impacts to the underlying groundwater system due to infiltration from the swale. The potential for material impacts to occur would be a function of:

- Potential absorption of pollutants in infiltration media – infiltration-based systems, such as bioretention systems, are a commonly used stormwater treatment approach in NSW. Stormwater is treated as it percolates through an infiltration media (typically a sandy loam), primarily through absorption and other bio-chemical processes. While the infiltration swale is not a bioretention system, there is potential that similar processes occur.

- Mixing within the underlying groundwater system – the infiltration of surface water from the swale only occurs occasionally (during and immediately after significant rainfall events). The potential for the occasional infiltration of surface water to materially impact the water quality in the underlying groundwater system is a function of the volume of water infiltrated relative to the volume of water in the groundwater system and the mixing of the two water categories.

Groundwater quality monitoring undertaken by SLR in 2015 did not identify any evidence of impacts due to surface water infiltration from the facility at the time of sampling.

ES4.3 Assessment approach

Boral proposes to discuss the application of ANZECC/ARMCANZ (2000) methods for assessing water quality impacts associated with discharge with the EPA. Key considerations include:

- potential changes to discharge mechanisms due to potential modifications to the water management system (such as sealing the infiltration swale to reduce / eliminate infiltration);

- how to set an appropriate level of protection given the receiving environment is a highly disturbed system and includes both freshwater and marine environments; and

- the application of a mixing zone within the underlying groundwater system (to the facility boundary) to account for:

    - potential absorption of pollutants by infiltration media; and

    - mixing within the groundwater system near discharge locations.

ES5 Water management system review

Boral proposes to review the existing water management system and site practices as part of a Surface Water Mitigation and Monitoring Plan. The review will consider all practical mitigation and management measures to prevent stormwater and groundwater contamination including:

- changes to historic operating practices such as irrigating stockpiles and the yard area to manage stormwater volumes;
- covering and sealing waste stockpile and storage areas;
- sealing the infiltration swale;
- increasing the surface water storage capacity to reduce the frequency and volume of surface water discharges;
- alternative options for using captured surface water such as exporting water to the nearby Boral concrete batching plant; and
- water treatment.

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1 Introduction

1.1 Background

Boral Recycling Pty Limited (Boral) owns and operates a resource recovery facility at 1/24 Egret Street, Kooragang Island (the 'facility' or 'site'). The facility historically operated under a consent granted by Newcastle City Council in 2003 (DA 01/2716) and Environment Protection Licence (EPL) No. 11968. The historical consent allowed for the processing of up to 100,000 tonnes per annum of building and demolition, asphalt and concrete waste.

In 2015, Boral applied to expand operations through a State Significant Development (SSD 15_7038). Key aspects of the proposal included:

- an increase in the facility footprint from approximately 2.1 to 3.45 ha;
- an increase in the permissible stockpile height and maximum waste storage limit (from 100,000 to 144,000 tonnes);
- a modification to the materials permitted to be processed onsite; and
- an increase in processing capacity (from 100,000 to 350,000 tonnes of material per year).

The *Materials Recycling Facility Expansion: Environmental Impact Statement* (EPS 2015) provides further information on the proposal.

Following a review of the SSD application, and in consultation with Boral, on 25 May 2018 the NSW Environment Protection Authority (EPA) varied EPL 11968 to include the requirement for a Surface Water Discharge Characterisation Assessment (SWDCA). Subsequently, Boral engaged EMM Consulting Pty Limited (EMM) to undertake surface water sampling at the facility and prepare a SWDCA. The SWDCA included, collection of water samples and field observations on five occasions between June 2018 to August 2019; laboratory analyses of the collected water samples; and collection and interpretation of the results to characterise the quality of surface water within the site.

The SSD application was approved by the Minister for Planning on 10 July 2019 (SSD 15_7038). The approval requires the expansion to be staged as follows:

- Stage 1 – an increase in processing capacity and some site modifications.
- Stage 2 – expansion of the facility footprint and increase in the maximum material storage limit.

Schedule 2 of the consent includes 14 water management related conditions. Condition B13 requires that a Surface Water Characterisation Plan (SWCP) is prepared prior to the commencement of Stage 1 construction. The scope of the SWCP is similar to the scope of the SWDCA that is included in EPL 11968.

1.2 Report purpose

This report documents a SWDCA that addresses:

- EPL 11968 requirements for the SWDCA (EPL Conditions U1.1–1.5); and
- Development Consent SSD 15_7038 Condition B13.

This report also outlines the proposed approach to the preparation of the Surface Water Mitigation and Monitoring Plan (SWMMP) that is required by Consent Condition B15.

1.3 Report structure

This report is structured as follows:

- Chapter 2 describes the existing operation and water management system.
- Chapter 3 describes the receiving environment and establishes water quality objectives.
- Chapter 4 describes the surface water monitoring program and results.
- Chapter 5 describes Boral's proposed approach to preparing a SWMMP.

Table 1.1 reproduces the requirements of SWDCA (EPL Conditions U1.1–1.5) and Consent Condition B13 and explains how each requirement has been addressed.

Table 1.1 Summary of EPL and consent condition B13

EPL reference	Consent condition B13 reference	Condition[1]	Assessment overview
U1.1	a)	The Licensee must engage a suitably qualified and experienced person to prepare a Surface Water Discharge Characterisation Assessment.	This assessment has been prepared by Chris Kuczera (Associate Water Resources Engineer at EMM) who is suitably qualified and experienced. Chris has recently been endorsed by the Department of Planning, Environment and Industry to undertake similar assessments on other projects.
	b)	Be prepared in consultation with the EPA	Boral has consulted with the EPA throughout the SWDCA process.
U1.2	N/A	The Surface Water Discharge Characterisation Assessment must be submitted to the EPA by 31 October 2019.	This condition is to be address by Boral when this SWDCA is submitted.
U1.3		The Surface Water Discharge Characterisation Assessment must include, at a minimum:	
a)	C)	Identification of all the potential pollutants of concern which may be present in the sediment basin and in surface water generated and/or discharged from the Premises. This list is to be developed in consultation with the EPA.	This SWDCA considers a full suite of potential pollutants that are known to occur at waste management facilities (see Section 4.1.3).

Table 1.1 Summary of EPL and consent condition B13

EPL reference	Consent condition B13 reference	Condition[1]	Assessment overview
b)	d)	Water sampling and reference to all relevant existing data for all identified potential pollutants of concern in the sediment basin and in surface waters generated and/or discharged from the Premises, including but not limited to: i. a full suite of metals, polycyclic aromatic hydrocarbons (PAHs) and Total Recoverable Hydrocarbons (TRHs); and ii. any other potential pollutants such as current or proposed treatment chemical residuals.	Water sampling has included a full suite of metals, PAHs and TRHs (see Section 4.1.3). No water treatment chemicals were used during the SWDCA period (June 2018 to August 2019).
U1.3 c)	e)	Sufficient sampling to capture the full variability of water quality at the Premises, including average or typical through to worst case scenarios, guided by protocols to ensure that sampling events are triggered by the full range of operational processes that would materially impact water quality, and be linked to ongoing implementation of mitigation measures, e.g. representative data before and after dewatering and desilting sediment basins. At a minimum the Licensee must: i. undertake 5 independent sampling events (at sampling locations to be determined); and ii. collect samples that coincide with at least two significant runoff events.	Water quality samples were collected on five occasions during the SWDCA period (June 2018 to August 2019). Samples were collected shortly after wet weather events (see Section 4.1.2). Significant runoff occurred during two of the events.
U1.4 d)	f)	An assessment of the potential impact of discharges on receiving water, based on the surface water characterisation and with reference to ANZECC (2000) assessment criteria for freshwater and marine ecosystems (note that the ANZECC (2000) toxicant decision tree can be used to refine the default trigger values).	Surface water discharge mechanisms are described, and surface water discharge quality is characterised relative to the default guideline values (DGVs) for slightly-moderately disturbed freshwater ecosystems that are documented in ANZECC/ARMCANZ (2000) (see Section 4.2). Potential impacts to receiving water are discussed (see Section 4.3.2).
U1.5 e)	g)	Specify the analytical limits of reporting used for any existing and new data that is being assessed and: i. compare that limit of reporting to the relevant ANZECC (2000) assessment criteria for freshwater and marine ecosystems; and ii. where the limit of reporting does not provide a suitable basis for assessing risk of water pollution, propose alternative options to characterise the risk, including more sensitive laboratory testing or risk mitigation options.	The analytical limit of reporting was below the default guideline values for slightly-moderately disturbed freshwater ecosystems (ANZECC/ARMCANZ 2000) for most analytes assessed. Appendix A provides the analytical limit of reporting and guideline values (where established) for all analytes.
N/A	h)	Consider the human health risks associated with the proposed surface water reuse process at the site.	Human health risks are discussed in Section 4.3.1.

1. For some conditions there is a minor difference in the wording in the EPL and consent condition 13. For consistency, the wording from the EPL has been used in this table.

2 Existing facility

This chapter describes the existing facility (Section 2.1) and the water management system (Section 2.2).

2.1 Facility description

2.1.1 Location

The facility is located centrally within the industrial precinct on Kooragang Island (Figure 2.1). Surrounding land uses include:

- the Newcastle Coal Terminal – immediately to the west of the facility;
- the Kooragang Coal Terminal – to the north of the facility;
- a Boral-operated concrete batching plant – immediately to the east of the facility; and
- Origin and Boral cement operations – to the south of the facility.

The facility is located within the northern portion of Lot 12 DP 1032146 (the lot), which is wholly owned by Boral Cement. The lot has an area of approximately 12.45 ha. The Boral-operated concrete batching plant, and the Origin and Boral cement operations are also located within this lot. A surface drain is located to the west of the facility and the lot. The drain flows to the south into the southern arm of the Hunter River Estuary and outlets adjacent to coal ship loading infrastructure.

Source: EMM (2019); Nearmap (2019); DFSI (2017); GA (2011)

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KEY

- Facility area
- Lot 12 DP1032146
- Existing surface drain
- Main road
- Local road
- Vehicular track
- Cadastral boundary

Facility location

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Surface water discharge characterisation assessment
Figure 2.1

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2.1.2 Facility description

The facility broadly includes (Figure 2.2):

- incoming material stockpiles;
- processed material stockpiles;
- access roads;
- water management infrastructure;
- a weighbridge and wheel wash; and
- a car parking area.

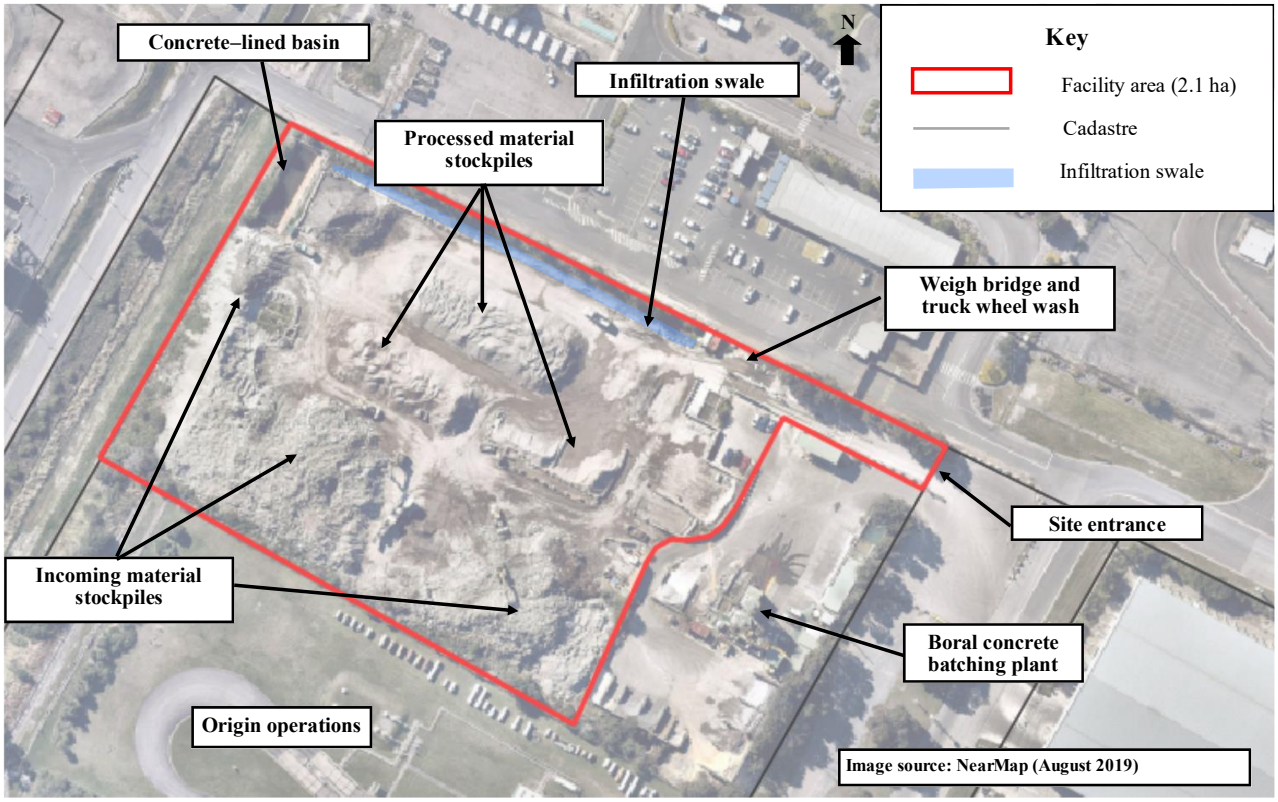

Figure 2.2 Existing facility

Most of the facility is utilised to stockpile incoming and processed materials (Figure 2.2). This area is referred to as the 'yard' in the remainder of this report. Surface water runoff from the yard eventually drains to the swale along the northern boundary.

During the SWDCA period (June 2018 to August 2019), the incoming materials were:

- asphalt waste;

- construction and demolition waste (predominantly concrete and brick materials); and
- concrete washout waste.

Incoming materials were processed to produce a range of road-base products.

2.2 Geotechnical characteristics

Boral engaged Douglas Partners to undertake a geotechnical assessment to characterise the near-surface ground conditions and estimate infiltration rates within the yard and swale. The report is provided as Appendix B (DP 2018).

This section describes the assessment method and conclusions.

2.2.1 Assessment method

The geotechnical investigation compromised the following field work and laboratory testing:

- Five shallow bores were augured to depths of between 0.7 to 1.1 m. Constant-head permeameter infiltration tests were undertaken within each hole. This method was used to estimate the permeability of material that is approximately 0.5 m below ground level. Selected samples from each bore hole were analysed in the laboratory to establish the substrate particle size distribution.
- Nine double-ring infiltration tests were completed to estimate surface permeability and associated infiltration rates.

The permeability of the yard and swale was estimated using the field work and laboratory results.

2.2.2 Conclusions

The geotechnical assessment concluded that:

- Encountered subsurface conditions comprised sandy gravel, gravelly sand and sand and gravel fill material. The material in the yard was interpreted to be compacted. No groundwater was intercepted in any of the shallow bores.
- The yard was assessed to have a moderate permeability, with the measured saturated hydraulic conductivity ranging from 2.2×10^{-5} to 8.0×10^{-7} m/s and averaging 6.8×10^{-6} m/s.
- The swale was assessed to have a moderate to high permeability, with the saturated hydraulic conductivity ranging from 3.5×10^{-5} to 1.5×10^{-6} m/s and averaging 4.8×10^{-5} m/s. Note this is incorrectly stated as 1.6×10^{-5} m/sec in DP (2018).
- The measured saturated hydraulic conductivity was lower than expected for the material encountered. This was interpreted to be due to apparent compaction of the yard and the potential presence of thin lower-permeability layers within the fill strata.
- The permeability of unsaturated material could be up to one order of magnitude lower than the saturated hydraulic conductivity.

2.3 Water management system

The facility's water management system manages stormwater runoff from the yard area and provides water for operational uses such as dust suppression and product conditioning. This section describes the system functionality, operating practices, and EMM site observations over the SWDCA period.

As described in Section 2.2, the yard has been established on compacted fill that is assessed to have moderate permeability when saturated and sits above a shallow unconfined groundwater system (see Section 3.1). Surface levels range from approximately 6 m AHD in the southern portion of the yard to approximately 4 m AHD in the norther portion of the yard (see topographic survey provided in Appendix C). Surface water runoff from the yard drains through several discrete surface drains to the infiltration swale located along the northern boundary (see Photograph 2.1 - taken after 50 and 80 mm of rain). Water in the swale slowly infiltrates into the underlying groundwater system (described in Section 3.1).

The swale overflows into a concrete-lined basin (see Photograph 2.2). Water captured in the basin is used for operational uses such as access roads dust suppression and product conditioning. During dry periods, additional water is sourced from the underlying groundwater system (via a spearpoint well located near the basin) or from the mains potable water supply. Boral were not using the spearpoint well during the SWDCA period.

Photograph 2.1 **Infiltration swale - the image on the left was taken in March 2019, after 50 to 60 mm of rainfall. Only minor amounts of surface water runoff occurred from this event. The image on the right was taken in August 2019 after approximately 80 mm of rain. Significant surface runoff from the yard occurred from this event.**

Photograph 2.2 Concrete-lined basin

The site was visited by EMM numerous times over the SWDCA period to collect samples. Site visits were undertaken either during or shortly after wet weather conditions. Key observations are:

- There is minimal surface water runoff from rainfall events with less than 50 mm of rainfall. This is interpreted to be due to the high water-absorption capacity of the stockpiles and because the yard is not sealed.
- There was significant surface water runoff from the yard for rainfall events with more than 50 mm of rainfall and for smaller rainfall events shortly following earlier rainfall events. During these conditions, the swale was observed to fill and spill into the basin.
- Puddles were observed to remain within the yard for several days following the cessation of rainfall – indicating rapid infiltration from the yard does not occur.
- No surface water discharge from the site was observed.

During extended periods of wet weather, Boral have historically applied surplus water to stockpiles to maximise water absorption in the stockpiles. Boral ceased this practice following a review of initial water quality results which indicated that applying water to stockpiles can increase the mobilisation of metals (discussed in Section 4.3). When the basin is full, Boral currently spray water centrally within the site (not on stockpiles) to manage surplus water volumes.

Figure 2.3 shows the conceptual framework of the water management system and Figure 2.4 shows the water management system layout. Indicated surface levels were sourced from a 2015 survey that is provided as Appendix C.

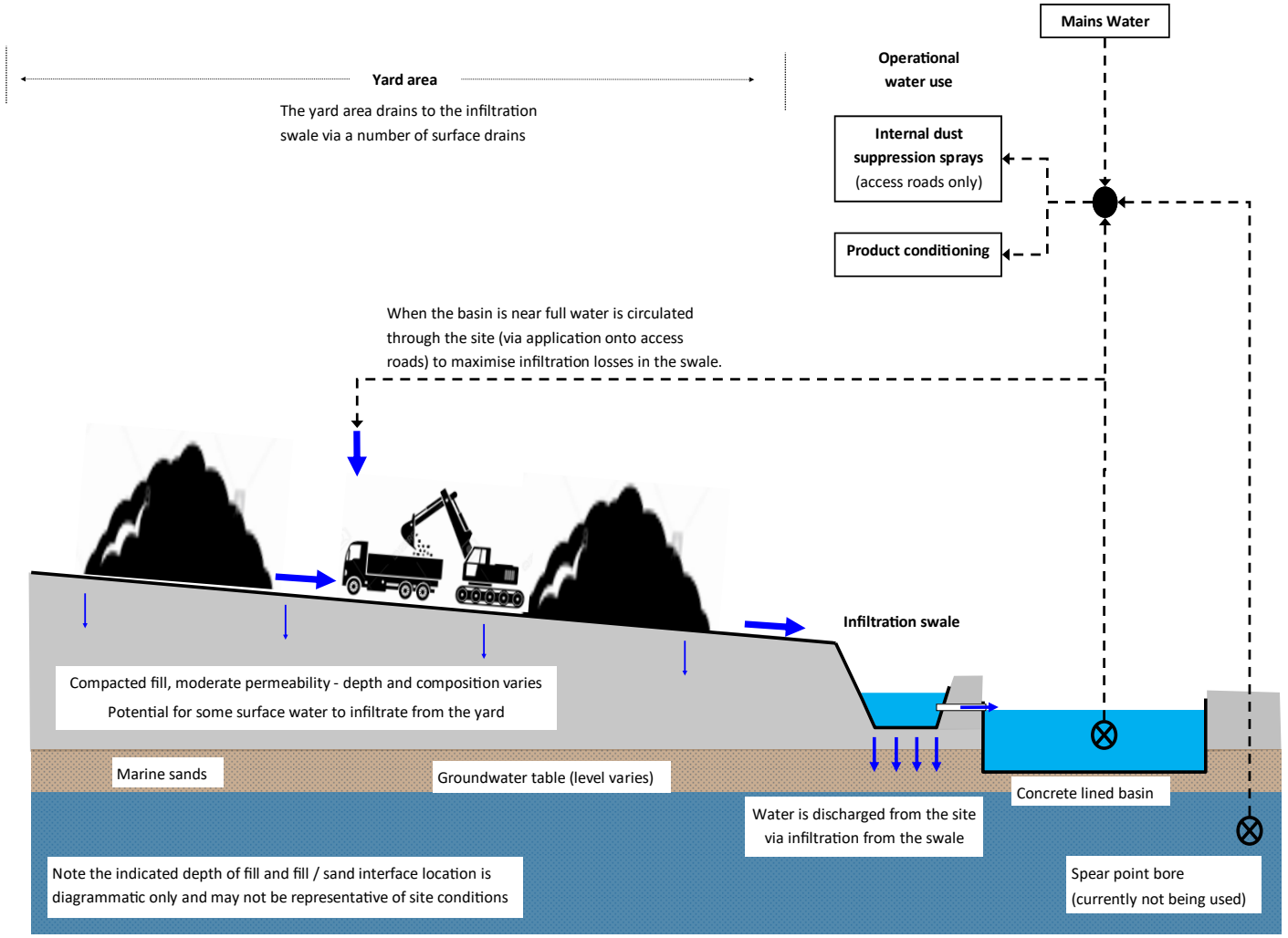

Figure 2.3 Conceptual framework of the water management system

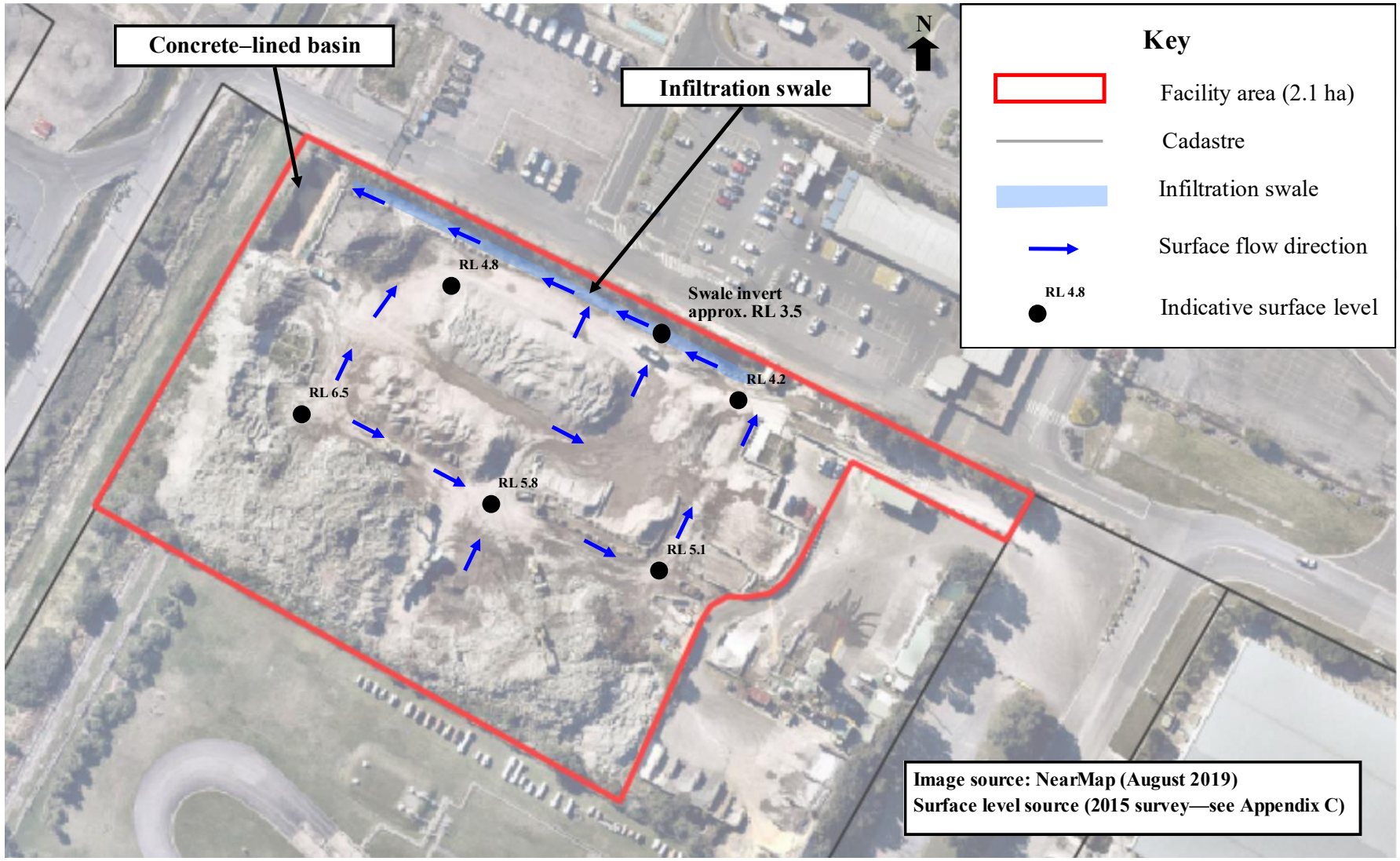

Figure 2.4 **Water management system layout**

3 Receiving environment

3.1 Receiving environment

As described in Section 2.2, surface water is discharged via infiltration from the swale that is located along the northern boundary of the facility. Hence, the underlying groundwater system is the immediate receiving environment.

The receiving groundwater system is characterised in the *Soil and Water Assessment: Kooragang Recycling Facility* EIS (SLR 2015) which references a 2012 groundwater investigation that was undertaken by Aecom. Collectively these studies were informed by installing three monitoring bores within Lot 12 DP 1032146 and a single round of monitoring groundwater level and quality. Monitoring bore locations are shown in Figure 3.1.

The local groundwater system is characterised in these studies as follows:

- Lot 12 DP 1032146 is recorded as being partly located on man-made fill, comprising spoil and slag deposited as part of the reclamation of the south-eastern section of Kooragang Island in the mid-1900s. Where present, the fill is recorded to be underlain by a mixture of silt, clay and estuarine sediments that are natural deposits of Kooragang Island.

- The groundwater table across the site ranged from 2.53 to 2.62 m AHD, which is approximately 1 m below the invert of the infiltration swale and 1.5 to 3.5 m below the yard surface levels.

- Two water-bearing zones, separated by a low permeability unit of clay, were encountered when drilling monitoring bore C1 adjacent to the offices of Boral Cement Works (the bore location is shown in Figure 3.1). An unconfined shallow perched aquifer was observed within an upper sand unit (2.6 to 2.8 m below ground level) and a deeper confined aquifer within a lower sand unit (4.5 to 4.5 m below ground level). Both zones are interpreted to have high permeability due to the sand media.

- Groundwater monitoring was undertaken by SLR in 2015 (SLR 2015) from monitoring bores R1 and C1 (the bore locations are shown in Figure 3.1). The monitoring identified non-trivial concentrations of PAH and TRHs. These were interpreted to be associated with the former use of spoil and slag as fill. All analysed metal concentrations were below ANZECC/ARMCANZ (2000) Default Guideline Values (DGVs) for 95% species protection (freshwater) except for zinc.

- Regional groundwater flow is interpreted to be in a southerly direction towards the southern arm of the Hunter River Estuary, which is located 700 m from the facility. However, some groundwater from the facility area may also flow into the existing drain that is located immediately to the west of the facility. This drain also flows in a southerly direction and enters the southern arm of Hunter River Estuary near the coal loading facilities (see Figure 3.1).

Source: EMM (2019); Nearmap (2019); DFSI (2017); GA (2011)

0 50 100 m
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KEY

- Existing monitoring bore
- Facility area
- Lot 12 DP1032146
- Existing surface drain
- Infiltration swale
- Main road
- Local road
- Vehicular track
- Cadastral boundary

Groundwater monitoring bores

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Figure 3.1

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3.2 Water quality objectives

The receiving groundwater environment is a highly disturbed ecosystem due to the known groundwater contamination issues and surrounding industrial land uses, which include coal terminals and a harbour port. The ANZECC/ARMCANZ (2000) guideline recommends that guideline trigger values for slightly–moderately disturbed ecosystems are applied to highly disturbed ecosystems on the basis that long-term ecosystem recovery may occur due to improvements in environmental management overtime. However, the guideline acknowledges that lower protection levels may be accepted by stakeholders where, for practical reasons, ecosystem recovery may not be feasible.

For the purposes of characterising surface water, all water quality results are compared to DGVs for slightly–moderately disturbed freshwater ecosystems.

Boral proposes to discuss the application of ANZECC/ARMCANZ (2000) methods for assessing water quality impacts associated with discharge with the EPA. Key considerations include:

- potential changes to discharge mechanisms due to potential modifications to the water management system - such as sealing the infiltration swale to reduce/eliminate infiltration (discussed in Chapter 5);
- setting an appropriate level of protection given the receiving environment is a highly disturbed system and includes both freshwater and marine environments; and
- the application of a mixing zone within the underlying groundwater system (to the facility boundary) to account for:
    - potential absorption of pollutants by infiltration media; and
    - mixing within the groundwater system near discharge locations.

These aspects are discussed further in Section 4.3.2.

4 Surface water characterisation

4.1 Surface water characterisation program

A surface water quality characterisation program was completed by EMM to inform this SWDCA. The program comprised sampling and analysis of surface water within the facility from five independent rainfall events between June 2018 and August 2019 (the SWDCA period).

This section describes the sampling locations, methods and weather and site context for each sampling event.

4.1.1 Sampling locations

For each sampling event, samples were collected from the concrete-lined basin, the infiltration swale and small puddles adjacent to incoming and processed material stockpiles (Table 4.1).

Table 4.1 Surface water sampling locations

ID	Location	Sampling objective
Basin	Concrete-lined basin that receives overflows from the infiltration swale	To characterise the quality of water that is captured in the concrete-lined basin (see Section 2.2).
Swale	The infiltration swale along northern boundary of the facility	To characterise the quality of water that infiltrates from the infiltration swale. Note, some absorption of pollutants may occur in the infiltration media.
Yard	Small puddles adjacent to incoming and processed material stockpiles (locations varied)	To characterise the quality of water seeping from stockpiles.

4.1.2 Sampling context

There was below average rainfall in the greater Newcastle region over the SWDCA period, in line with generally dry conditions in NSW. Sampling was generally only undertaken when sufficient rainfall occurred to generate enough runoff to at least partially fill the infiltration swale to enable representative samples to be collected. Following site observations during initial sampling events, 50 mm of rainfall was established as a minimum threshold for sampling.

There is no rainfall gauge located at the facility. Recorded rainfall at the following regional gauges was reviewed to establish estimates of rainfall at the facility for each sampling event:

- BoM (61390 Newcastle University) – located 5 km to the south-west of the site.
- BoM (61055 Nobbys Signal Station AWS) – located 6 km to the south-east of the site.
- BoM (61078 Williamtown RAAF) – located 12 km to the north-east of the site.

A summary of the rainfall estimates, site context and sampling locations for each sampling event is provided in Table 4.2.

Table 4.2 Sampling context and objectives

Sampling event	Rainfall context	Site conditions (at time of sampling)	Sampling locations
Event 1 20 June 2018	**Wet weather**: **significant rainfall** 70 to 90 mm of rainfall was recorded at regional gauges[1] 48 hours prior to sampling.	• Stockpiles were being irrigated with water from the concrete-lined basin. • Seepage from irrigated stockpiles was occurring at a number of locations indicating that the stockpile was not absorbing all of the water that was being applied. • Surface flow from the yard area was discharging to the swale in several locations.	Basin, swale and two yard samples
Event 2 5 September 2018	**Wet weather**: **moderate rainfall** 40 to 50 mm of rainfall was recorded at regional gauges[1] 48 hours prior to sampling. 50 mm was recorded at the University of Newcastle gauge, which is the closest gauge to the site.	• Minimal surface water runoff was generated from this event. • No irrigation of stockpiles had been undertaken prior to sampling. • No surface flow from the yard was occurring at the time of sampling.	Basin and swale, no yard samples were collected.
Event 3 5 October 2018	**Wet weather**: **moderate rainfall** 50 to 70 mm of rainfall was recorded at regional gauges[1] 48 hours[2] prior to sampling and was continuing at the time of sampling.	• Stockpiles had been irrigated with water from the concrete-lined basin prior to sampling. • Surface flow from the yard area was discharging to the swale in several locations. • Flow was occurring along the swale and into the concrete-lined basin.	Basin, swale and one yard sample.
Event 4 18 March 2019	**Wet weather**: **moderate rainfall** 20 to 60 mm of rainfall was recorded at regional gauges[1] 48 hours prior to sampling. 30 mm was recorded at the University of Newcastle gauge, which is the closest gauge to the site.	• Minimal surface water runoff was generated from this event. • No surface flow from the yard was occurring at the time of sampling.	Basin, swale and three yard samples.
Event 5 31 August 2019	**Wet weather**: **significant rainfall** 70 to 90 mm of rainfall was recorded at regional gauges[1] 48 hours prior to sampling and was continuing at the time of sampling 70 mm was recorded at the University of Newcastle gauge, which is the closest gauge to the site.	• Flow was occurring along the swale and towards the concrete lined basin. • Surface flow from the yard area was discharging to the swale in several locations. • Water was being pumped from the concrete lined basin and applied to the access roads.	Basin, swale and four yard samples.

Notes: 1. Regional rainfall data refers to data from BoM 61055 (Newcastle Nobbys Signal Station AWS), BoM 61078 (Williamtown RAAF), BoM 61390 (Newcastle University).
2. Event 3 Sampling was carried out at 3.30pm on 5 October 2018. Substantial rainfall fell on the morning of the 5 October. Therefore, the total rainfall depths from 5 and 6 October have been used.

4.1.3 Methods

Analytes, sampling and analysis methods are listed in Table 4.3. All analytes were measured in all basin and swale samples. All analytes were measured in six yard samples, while only metals were only analysed in four yard samples.

Table 4.3 Monitoring analytes and methods

Category	Analytes	Sampling and analysis methods
Physio-chemical parameters	pH, turbidity, electrical conductivity, total suspended solids and total dissolved solids Total alkalinity and hardness	Analysis was undertaken by a NATA-certified laboratory.
Nutrients	Ammonia, nitrite, nitrate, oxidised nitrogen (NOx), total kjeldahl nitrogen (TKN) and total nitrogen Reactive and total phosphorus	Analysis was undertaken by a NATA-certified laboratory.
Metals and metalloids	Aluminium (Al), arsenic (As), barium (Ba), Boron (B), cadmium (Cd), chromium (Cr(III)), chromium (Cr(VI)), total chromium (Cr), cobalt (Co), copper (Cu), Iron (Fe), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), strontium (Sr), vanadium (V) and zinc (Zn)	Samples were filtered in the field using a 0.45 µm filter. Analysis was undertaken by a NATA-certified laboratory.
Organics	Benzene, toluene, ethylbenzene and xylene (BTEX) Polyaromatic hydrocarbons (PAHs) Phenols Total petroleum hydrocarbons (TPH) Total recoverable hydrocarbons (TRH)	Samples were filtered in the field using a 0.45 µm filter. Analysis was undertaken by a NATA-certified laboratory.
Miscellaneous	Fluoride, chlorine (residual) cyanide and anionic surfactants	Analysis was undertaken by a NATA-certified laboratory.

4.2 Results

Water quality results are presented in Table 4.4, Table 4.5 and Table 4.6. Table 4.6 presents the combined yard water quality results from all five sampling events and includes the number of samples and calculated 20th, 50th and 80th percentile values.

The tables include the DGVs established in Section 3.2. The following analytes were either below the analytical limit of reporting and/or DGVs in all samples so are not presented:

- metals - arsenic, lead, mercury and silver; and
- inorganics – chlorine (residual) and fluoride.

Detailed results, including the analytical limit of reporting and adopted DGV for each analyte are provided in Appendix A and laboratory reports are provided in Appendix D.

Organic chemicals (BTEX, Phenols, TRH, PAH and TPH) and anionic surfactants were above the analytical limit of reporting in Event 4 sampling only and are therefore not included in the summary table. The results are presented and discussed in Section 4.3.1.

Table 4.4 Water quality summary – Basin

			Sample event						
	Unit	**DGV[1]**	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Minimum**	**Maximum**
Physio-chemical parameters									
pH	-	6.5-8.0	**10.6**	**9.4**	**8.5**	**8.3**	6.7	6.7	**10.6**
Electrical conductivity	µS/cm	200-300	**667**	**2,890**	**4,540**	**4,760**	**415**	**415**	**4,760**
Turbidity	NTU	6-50	**63**	31	24	16	**61**	16	**63**
Suspended solids	mg/L	-	56	46	26	16	47	16	56
Total dissolved solids	mg/L	-	402	1,710	2,430	2,500	241	241	2,500
Total hardness (as $CaCO_3$)	mg/L	-	-	268	417	420	41	41	420
Total alkalinity (as $CaCO_3$)	mg/L	-	54	-	-	-	29	29	54
Analytical results – nutrients (as N or P)									
Ammonia	mg/L	0.02	**0.07**	**0.04**	**0.16**	**0.15**	**0.08**	**0.04**	**0.16**
Oxidised nitrogen	mg/L	0.04	**0.90**	**0.43**	**0.52**	**1.16**	**1.12**	**0.43**	**1.16**
Total kjeldahl nitrogen	mg/L	-	0.5	8.6	0.9	1.0	0.5	0.5	8.6
Total nitrogen	mg/L	0.35	**1.4**	**9.0**	**1.4**	**2.2**	**1.6**	**1.4**	**9.0**
Reactive phosphorus	mg/L	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total phosphorus	mg/L	0.025	<0.01	0.02	**0.05**	0.01	0.02	<0.01	**0.05**
Analytical results – inorganics									
Cyanide	mg/L	0.007	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004
Analytical results – metals (0.45µm field filtered)									
Aluminium (Al)	mg/L	0.055	**0.64**	**0.41**	0.05	**0.13**	**0.38**	0.05	**0.64**
Boron (B)	mg/L	0.37	<0.05	0.24	**0.40**	**0.43**	<0.05	<0.05	**0.43**
Hexavalent chromium (Cr)	mg/L	0.001	**0.02**	**0.01**	**0.02**	**0.02**	-	<0.01	**0.02**
Total chromium (Cr)	mg/L	0.001[2]	**0.020**	**0.013**	**0.018**	**0.014**	**0.011**	**0.011**	**0.020**
Cobalt (Co)	mg/L	0.0014[3]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (Cu)	mg/L	0.0014	**0.011**	**0.003**	**0.002**	**0.007**	**0.008**	**0.002**	**0.011**
Iron (Fe)	mg/L	0.3[3]	<0.05	0.25	<0.05	<0.05	<0.05	<0.05	0.25
Molybdenum (Mo)	mg/L	0.034[3]	0.010	0.013	0.018	0.012	0.006	0.018	0.006
Nickel (Ni)	mg/L	0.011	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.002
Vanadium (V)	mg/L	0.006[3]	**0.02**	**0.01**	**0.01**	<0.01	<0.01	<0.01	**0.02**
Zinc (Zn)	mg/L	0.008	<0.005	<0.005	0.007	0.007	0.008	<0.005	0.008

Notes: 1. The DGV for physico-chemical parameters and nutrients refer to the values for physical and chemical stressors in south-east Australia (lowland river) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC/ARMCANZ (2000). The DGV for toxicants refer to the values for slightly – moderately disturbed freshwater ecosystems that are reported in Table 3.4.1 of ANZECC/ARMCANZ (2000) unless otherwise stated.
2. For Cr (VI).
3. Refers to a low reliability DGV.or an indicative working level sourced from ANZECC/ARMCANZ (2000) Volume 2.
Bold denotes DGV is exceeded.

Table 4.5 Water quality summary – Swale

			Sample date						
	Unit	**DGV[1]**	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Minimum**	**Maximum**
Physio-chemical parameters									
pH	-	6.5-8.0	**10.8**	**10.9**	**9.6**	**10.6**	**10.0**	**9.6**	**10.9**
Electrical conductivity	µS/cm	200-300	**891**	**5,860**	**4,960**	**9,080**	**716**	**716**	**9,080**
Turbidity	NTU	6-50	**87**	34	**125**	13	**107**	13	**125**
Suspended solids	mg/L	-	72	49	104	<5	103	<5	104
Total dissolved solids	mg/L	-	542	3,070	2,530	4,680	367	367	4,680
Total hardness (as $CaCO_3$)	mg/L	-	-	363	321	15	70	15	363
Total alkalinity (as $CaCO_3$)	mg/L	-	62	-	-	-	43	43	62
Analytical results – nutrients (as N or P)									
Ammonia	mg/L	0.02	**0.10**	**0.20**	**0.13**	**2.78**	**0.12**	**0.10**	**2.78**
Oxidised nitrogen	mg/L	0.04	**2.59**	**2.66**	**1.51**	**12.80**	**2.36**	**1.51**	**12.80**
Total kjeldahl nitrogen	mg/L	-	1	2.1	1.2	10.8	0.9	0.9	10.8
Total nitrogen	mg/L	0.35	**3.6**	**4.8**	**2.7**	**23.6**	**3.3**	**2.7**	**23.6**
Reactive phosphorus	mg/L	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total phosphorus	mg/L	0.025	<0.01	0.02	**0.04**	**0.05**	**0.03**	<0.01	**0.05**
Analytical results – inorganics									
Cyanide	mg/L	0.007	<0.004	0.006	0.004	**0.026**	-	<0.004	**0.026**
Analytical results – metals (0.45µm field filtered)									
Aluminium (Al)	mg/L	0.055	**0.76**	**1.07**	**0.40**	**3.38**	**0.92**	**0.40**	**3.38**
Boron (B)	mg/L	0.37	<0.05	0.14	0.24	0.17	<0.05	<0.05	0.24
Hexavalent chromium (Cr)	mg/L	0.001	**0.02**	**0.08**	**0.04**	**0.07**	-	**0.02**	**0.08**
Total chromium (Cr)	mg/L	0.001[2]	**0.027**	**0.093**	**0.043**	**0.278**	**0.026**	**0.026**	**0.278**
Cobalt (Co)	mg/L	0.0014[3]	0.001	<0.001	<0.001	**0.031**	<0.001	<0.001	**0.031**
Copper (Cu)	mg/L	0.0014	**0.018**	**0.019**	**0.008**	**0.312**	**0.013**	**0.008**	**0.312**
Iron (Fe)	mg/L	0.3[3]	<0.05	**0.34**	<0.05	**0.36**	<0.05	<0.05	**0.36**
Nickel (Ni)	mg/L	0.011	0.004	0.001	0.001	**0.055**	0.001	0.001	**0.055**
Molybdenum (Mo)	mg/L	0.034[3]	0.012	**0.167**	0.014	**0.042**	**0.055**	0.012	**0.167**
Vanadium (V)	mg/L	0.006[3]	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**	<0.01	**0.02**
Zinc (Zn)	mg/L	0.008	<0.005	**0.009**	<0.005	0.006	<0.005	<0.005	**0.009**

Notes: 1. The DGV for physico-chemical parameters and nutrients refer to the values for physical and chemical stressors in south-east Australia (lowland river) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC/ARMCANZ (2000). The DGV for toxicants refer to the values for slightly – moderately disturbed freshwater ecosystems that are reported in Table 3.4.1 of ANZECC/ARMCANZ (2000) unless otherwise stated.
2. For Cr (VI).
3. Refers to a low reliability DGV.or an indicative working level sourced from ANZECC/ARMCANZ (2000) Volume 2.
Bold denotes DGV is exceeded.

Table 4.6 Water quality summary – Yard

	Unit	DGV[1]	Number of samples	Min/20P[4]	Median	Max/80P[4]
Physio-chemical parameters						
pH	-	6.5-8.0	6	**9.4**	**11.3**	**12.3**
Electrical conductivity	µS/cm	200-300	6	**3,690**	**6,435**	**15,400**
Turbidity	NTU	6-50	6	24	**60**	**146**
Suspended solids	mg/L	-	6	41	86	193
Total dissolved solids	mg/L	-	6	1,340	2,920	10,300
Total hardness (as $CaCO_3$)	mg/L	-	4	597	662	1,180
Total alkalinity (as $CaCO_3$)	mg/L	-	2	204	466	728
Analytical results – nutrients (as N or P)						
Ammonia	mg/L	0.02	6	**0.33**	**0.54**	**1.04**
Oxidised nitrogen	mg/L	0.04	6	**3.35**	**9.93**	**32.80**
Total kjeldahl nitrogen	mg/L	-	6	1.7	3.9	5.9
Total nitrogen	mg/L	0.35	6	**9.2**	**13.3**	**36.4**
Reactive phosphorus	mg/L	0.02	6	<0.01	<0.01	<0.01
Total phosphorus	mg/L	0.025	6	0.02	**0.06**	**0.26**
Analytical results – inorganics						
Cyanide	mg/L	0.007	6	0.006	**0.008**	**0.030**
Analytical results – metals (0.45µm field filtered)						
Aluminium (Al)	mg/L	0.055	10	**1.05**	**2.45**	**2.57**
Boron (B)	mg/L	0.37	10	<0.05	<0.05	0.10
Hexavalent chromium (Cr)	mg/L	0.001	6	**0.08**	**0.13**	**0.16**
Total chromium (Cr)	mg/L	0.001[2]	10	**0.068**	**0.082**	**0.134**
Cobalt (Co)	mg/L	0.0014[3]	10	**0.002**	**0.003**	**0.006**
Copper (Cu)	mg/L	0.0014	10	**0.025**	**0.039**	**0.058**
Iron (Fe)	mg/L	0.3[3]	10	<0.05	0.07	0.21
Molybdenum (Mo)	mg/L	0.034[3]	10	0.024	**0.055**	**0.065**
Nickel (Ni)	mg/L	0.011	10	0.004	0.005	0.008
Vanadium (V)	mg/L	0.006[3]	10	<0.01	**0.02**	**0.02**
Zinc (Zn)	mg/L	0.008	10	<0.005	<0.005	**0.019**

Notes:
1. The DGV for physico-chemical parameters and nutrients refer to the values for physical and chemical stressors in south-east Australia (lowland river) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC/ARMCANZ (2000). The DGV for toxicants refer to the values for slightly – moderately disturbed freshwater ecosystems that are reported in Table 3.4.1 of ANZECC/ARMCANZ (2000) unless otherwise stated.
2. For Cr (VI).
3. Refers to a low reliability DGV.or an indicative working level sourced from ANZECC/ARMCANZ (2000) Volume 2.
4. If less than 10 samples are available, the minimum value is reported instead of the 20th percentile value and the maximum value is reported instead of the 80th percentile value. **Bold** denotes DGV is exceeded.

4.3 Discussion

4.3.1 Surface water characterisation

i General water quality

Surface water runoff from the facility is characterised as being alkaline (ie high pH) and containing elevated concentrations (relative to DGVs) of nitrogen (primarily in oxidised form), cyanide and several metals: aluminium, chromium (primarily in hexavalent form), cobalt, copper, molybdenum, vanadium and zinc. These water quality characteristics are interpreted to be associated with water contact with concrete washout, which is one of the materials processed at the facility. The concentrations of nitrogen and metals are generally higher in the yard samples (which were collected from small puddles near stockpiled material) than the swale samples (which include runoff from access roads as well as stockpiles). This indicates that the stockpiled material is the primary source of the high pH, nitrogen, cyanide and metals.

Typically, concrete washout is allowed to age (or hydrate) for approximately six to eight weeks in incoming stockpiles before it is suitable for use in blended road base products. The following preliminary analysis indicates that surface water runoff / leachate from incoming and processed material stockpiles have similar water quality:

- Samples collected from puddles near incoming and processed material stockpiles had similar water quality.
- Boral laboratories applied the AMIRA leaching method to assess metal concentrations in leachate from two washout samples over an eight-week period. This analysis did not identify any decline in metal concentrations over the eight-week period.

These results indicate that source controls such as covering incoming washout areas will have limited effectiveness.

The water quality results from the concrete lined basin were more variable than the swale results. This is likely to be because the basin was used to hold imported potable water during dry periods over the SWDCA period and only received surface water inflows when the swale was full and overflowing into the basin. Material overflows into the basin did not occur in all sampling events.

ii Organic and surfactant results

As noted in Section 4.2, organic chemicals (BTEX, Phenols, TRH, PAH and TPH) and anionic surfactants (a detergent related chemical) were below the analytical limit of reporting (or for anionic surfactants the DGV) for all events except for Event 4 where the following detections were recorded:

- swale – TRH (0.21 mg/L), TPH (0.26 mg/L) and anionic surfactants (0.6 mg/L); and
- a single yard sample – TRH (0.10 mg/L), TPH (0.13 mg/L) and anionic surfactants (0.3 mg/L).

For both detections, the TRH was identified in the C_{16}-C_{34} fraction range. This is indicative of diesel or oil lubricant and indicates that a spill or leak of these hydrocarbons occurred. Given that TRH were not detected in any other samples, the Event 4 results are likely to be associated with an isolated incident and is not interpreted to be a contributing factor to the known hydrocarbon related contamination in the underlying shallow groundwater system (discussed in Section 3.1). As the anionic surfactants results are correlated with the detection of TRH and TPH, it is likely that they are associated with the same source.

iii Human health risks

Human contact with surface water would be limited to occasional contact during routine maintenance of the water management system and when water is used for dust suppression and product conditioning.

Chapter 5 of ANZECC/ARMCANZ (2000) provides water quality guidelines for recreational purposes. These guidelines include values for a range of chemicals that were established based on exposure during normal swimming activity, where it is assumed that a person ingests 100 mL of water. The guideline states that "higher concentrations of toxicants may be tolerated occasionally if it is assumed that no person will ingest more than a maximum of 100 mL water" (ANZECC/ARMCANZ 2000).

Concentrations of four analytes (pH, aluminium, chromium and surfactants) sampled as part of the SWDCA program exceeded the guideline values for recreational water quality. Table 4.7 provides the guideline values and the range of concentrations recorded for each of these analytes.

Table 4.7 Guidelines for recreational water quality: summary of exceedances

Analyte	Guideline value for recreation water quality	Observed range (all samples)
pH	6.5 to 8.5	6.7 to 11.5
Aluminium	0.2 mg/L	0.05 to 3.38 mg/L
Chromium	0.05 mg/L	0.020 to 0.278 mg/L
Surfactants	0.2 mg/L	<0.1 to 0.6 mg/L

Despite the concentration of some analytes exceeding the guideline values for recreational water quality, the risks to human health are considered to be low as no water is ingested and contact is limited to occasional skin contact.

The risks could be further reduced by:

- applying surface water using downwards facing nozzles only to avoid producing fine airborne spray or mist; and
- wearing appropriate personal protection equipment (ie gloves) when contacting surface water.

4.3.2 Impacts to receiving environment

There is insufficient data available to establish the extent and nature of any impacts to the underlying groundwater system due to infiltration from the swale. The potential for material impacts to occur would be a function of:

- The existing groundwater quality – see below.
- Potential absorption of pollutants in infiltration media – infiltration-based systems, such as bioretention systems, are a commonly used stormwater treatment approach in NSW. Stormwater is treated as it percolates through an infiltration media (typically a sandy loam), primarily through absorption and other bio-chemical processes. While the infiltration swale is not a bioretention system, there is potential that similar processes occur.
- The volume of surface water that infiltrates to groundwater and mixing within the groundwater system – as described in Section 2.2, the infiltration of surface water from the swale only occurs occasionally (during and immediately after significant rainfall events). The potential for the occasional infiltration of surface water to materially impact the water quality in the underlying groundwater system is a function of the volume of water infiltrated relative to the volume of water in the groundwater system and the mixing of the two water categories.

As discussed in Section 3.1, groundwater quality monitoring was undertaken by SLR in 2015. A single sample was collected from:

- monitoring bore R1 (located within the infiltration swale and screened from 1 to 4 m below ground level in the shallow groundwater system); and
- monitoring bore C1, which is located approximately 100 m to the south of the facility.

Monitoring bore locations are indicated in Figure 3.1.

As discussed in Section 3.1, the monitoring identified non-trivial levels of PAH and TRHs, which are interpreted to be associated with the former use of spoil and slag as fill. Metal concentrations were below ANZECC/ARMCANZ (2000) trigger levels for 95% species protection (freshwater) for all metals analysed expect for zinc, which exceeded the trigger level. Copper and chromium (which with reference to Section 4.2 occur at proportionally higher concentrations in surface water relative to the DGVs than other metals) were all below the analytical limit of reporting indicating that there was no measurable degradation of groundwater quality due to surface water infiltration from the facility at the time of sampling.

5 Water management system review

Boral proposes to review the existing water management system and site practices as part of the SWMMP, as required by Consent Condition B15 (see Section 1.1).

The review will consider all practical mitigation and management measures to prevent stormwater and groundwater contamination including:

- changes to historical operating practices such as irrigating stockpiles and the yard area to manage stormwater volumes;
- covering (ie roof) and sealing waste stockpile and storage areas;
- sealing the infiltration swale;
- increasing the surface water storage capacity to reduce the frequency and volume of surface water discharges;
- considering alternative uses for the captured surface water such as exporting the water to the nearby Boral concrete batching plant; and
- water treatment.

The SWMMP will address Consent Condition B15 and will include:

- assessment of the above options, supported by appropriate technical assessments (including a water balance);
- clear commitments to upgrade the water management system, including timeframes for implementation; and
- a proposed monitoring plan and trigger action response plan.

6 References

Aecom 2012, *Underground Storage Tank – Investigation and Decommissioning, Boral Cement Works, Kooragang Island.*

ANZECC/ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australian and New Zealand.

DP 2018, *Report on Infiltration Assessment: Boral Kooragang Waste Management Facility, Egret Street, Kooragang.* Report prepared by Douglas Partners.

Environmental Property Services 2015, *Materials Recycling Facility Expansion: Environmental Impact Statement*

SLR 2015, *Soil and Water Assessment: Kooragang Recycling Facility EIS.*

Appendix A

Water quality results

			Sample location	Concrete-lined basin					Yard										Infiltration Swale						
			Sample ID[2]	SW1					SW4			SW5	SW7	SW8	YARD 1	YARD 2	YARD 3	YARD 4	SW2			SW3			
			Date	20/06/2018	5/09/2018	5/10/2018	18/03/2019	31/08/2019	20/06/2018	5/10/2018	18/03/2019	20/06/2018	18/03/2019	18/03/2019	31/08/2019	31/08/2019	31/08/2019	31/08/2019	20/06/2018	18/03/2019	31/08/2019	20/06/2018	5/09/2018	5/10/2018	18/03/2019
	Unit	Analytical limit of reporting	Default Guideline Value (DGV)[1]																						
Analytical results – general																									
TDS	mg/L	10		402	1,710	2,430	2,500	241	2,410	2,500	3,340	1,340	5,370	10,300					542	4,680	367	1,370	3,070	2,530	4,790
Hardness as CaCO3 (filtered)	mg/L	1			268	417	420	41		712	612		597	1,180						15	70		363	321	492
Turbidity	NTU	0.1	6 -50	63	31	24	16	61	76	146	34	146	43	24					87	13	107	92	34	125	85
Electrical Conductivity (Lab)	uS/cm	1	200-300	667	2,890	4,540	4,760	415	3,890	6,810	6,060	3,690	9,760	15,400					891	9,080	716	2,340	5,860	4,960	8,740
TSS	mg/L	5		56	46	26	16	47	88	120	41	193	57	84					72	<5	103	80	49	104	74
pH (Lab)	-	0.01	6.5-8.0	10.6	9.4	8.5	8.3	6.7	11.6	12.1	10.9	12.3	10.8	9.4					10.8	10.6	10.0	11.5	10.9	9.6	10.1
Analytical results – alkalinity																									
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		4				29	<1			<1							<1		<1	<1			
Alkalinity (Carbonate as CaCO3)	mg/L	1		50				<1	63			79							57		37	46			
Alkalinity (Hydroxide) as CaCO3	mg/L	1		<1				<1	140			648							5		6	79			
Alkalinity (total) as CaCO3	mg/L	1		54				29	204			728							62		43	125			
Analytical results – nutrients																									
Ammonia as N	mg/L	0.01	0.02	0.07	0.04	0.16	0.15	0.08	0.71	0.33	1.04	0.94	0.36	0.34					0.1	2.78	0.12	0.17	0.2	0.13	0.28
Nitrite + Nitrate as N	mg/L	0.01	0.04	0.9	0.43	0.52	1.16	1.12	32.8	3.35	13.3	9.86	7.37	10					2.59	12.8	2.36	6.6	2.66	1.51	6.14
Kjeldahl Nitrogen Total	mg/L	0.1		0.5	8.6	0.9	1	0.5	3.6	5.9	4.1	5	1.8	1.7					1	10.8	0.9	1.5	2.1	1.2	2.1
Nitrite (as N)	mg/L	0.01		0.25	0.09	0.09	0.47	0.16	1.95	0.59	5.31	2.91	2.36	1.76					0.5	10.9	0.36	1.38	0.52	0.59	2.17
Nitrate (as N)	mg/L	0.01		0.65	0.34	0.43	0.69	0.96	30.8	2.76	7.99	6.95	5.01	8.24					2.09	1.9	2.00	5.22	2.14	0.92	3.97
Nitrogen (Total)	mg/L	0.1	0.35	1.4	9.0	1.4	2.2	1.6	36.4	9.2	17.4	14.9	9.2	11.7					3.6	23.6	3.3	8.1	4.8	2.7	8.2
Reactive Phosphorus as P	mg/L	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus	mg/L	0.01	0.025	<0.01	0.02	0.05	0.01	0.02	0.02	0.03	0.09	0.26	0.11	0.02					<0.01	0.05	0.03	0.02	0.02	0.04	0.14
Inorganics																									
Cyanide Total	mg/L	0.004	0.007	<0.004	<0.004	<0.004	<0.004		0.029	0.006	0.007	0.03	0.007	0.009					<0.004	0.026		0.008	0.006	0.004	0.006
Fluoride	mg/L	0.1	2.4[3]	0.2	0.3	0.4	0.4	0.7	0.2	0.2	3.6	0.3	0.2	0.1					0.2	0.2	0.4	0.2	0.2	0.2	0.2
Chlorine (Total Residual)	mg/L	0.02	0.003	<0.2	<0.02		<0.2	<0.2	<0.2		<0.2	<0.2	<0.2	<0.2					<0.2	<0.2	,0.2	<0.2	<0.02		<0.2
Free Chlorine	mg/L	0.02				0.06				0.07														0.1	
Metals																									
Aluminium (filtered)	mg/L	0.01	0.055	0.64	0.41	0.05	0.13	0.38	1.07	0.98	2.55	2.64	1.49	0.29	3.36	2.48	2.51	2.42	0.76	3.38	0.92	2.01	1.07	0.4	1.03
Arsenic (filtered)	mg/L	0.001	0.013[4]	0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.002	0.004	0.003	0.002	0.002	0.006	0.003	0.002	0.002	0.002	0.011	0.001	0.002	0.001	0.001	0.002
Barium (filtered)	mg/L	0.001		0.004	0.008	0.011	0.012	0.004	0.05	0.26	0.107	0.099	0.105	0.144	0.006	0.060	0.156	0.016	0.008	0.022	0.007	0.023	0.045	0.025	0.068
Boron (filtered)	mg/L	0.05	0.37	<0.05	0.24	0.4	0.43	<0.05	0.13	<0.05	<0.05	<0.05	0.09	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	0.17	<0.05	0.06	0.14	0.24	0.14
Chromium (Trivalent) (filtered)	mg/L	0.01	0.003[3]	<0.01	<0.01	<0.01	<0.01		<0.01	0.01	<0.01	<0.01	<0.01	<0.01					<0.01	0.21		<0.01	0.01	<0.01	<0.01
Chromium (hexavalent) (filtered)	mg/L	0.01	0.001	0.02	0.01	0.02	0.02		0.15	0.12	0.14	0.16	0.09	0.08					0.02	0.07		0.1	0.08	0.04	0.08
Cadmium (filtered)	mg/L	0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum (filtered)	mg/L	0.001	0.034[4]	0.01	0.013	0.018	0.012	0.006	0.075	0.06	0.082	0.063	0.054	0.056	0.033	0.024	0.014	0.023	0.012	0.167	0.014	0.042	0.055	0.037	0.05
Chromium (III+VI) (filtered)	mg/L	0.001	0.001[5]	0.02	0.013	0.018	0.014	0.011	0.147	0.131	0.127	0.162	0.076	0.068	0.067	0.064	0.087	0.072	0.027	0.278	0.026	0.107	0.093	0.043	0.066
Cobalt (filtered)	mg/L	0.001	0.0014[3]	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	<0.001	0.003	0.004	0.003	0.003	0.006	0.002	0.008	0.002	0.001	0.031	<0.001	0.003	<0.001	<0.001	0.002
Copper (filtered)	mg/L	0.001	0.0014	0.011	0.003	0.002	0.007	0.008	0.037	0.022	0.079	0.03	0.026	0.019	0.104	0.053	0.047	0.041	0.018	0.312	0.013	0.031	0.019	0.008	0.027
Iron (filtered)	mg/L	0.05	0.3[6]	<0.05	0.25	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	0.06	<0.05	<0.05	0.38	0.12	0.24	0.20	<0.05	0.36	<0.05	<0.05	0.34	<0.05	<0.05
Lead (filtered)	mg/L	0.001	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
Mercury (filtered)	mg/L	0.0001	0.00006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Strontium (filtered)	mg/L	0.001		0.105	0.376	0.591	0.693	0.093	0.815	2.11	1.47	1.1	1.53	2.9	0.285	0.651	1.64	0.312	0.14	0.339	0.147	0.337	0.765	0.529	1.14
Nickel (filtered)	mg/L	0.001	0.011	<0.001	<0.001	<0.001	0.002	<0.001	0.008	0.002	0.008	0.003	0.004	0.004	0.016	0.006	0.007	0.004	0.004	0.055	0.001	0.004	0.001	0.001	0.004
Selenium (filtered)	mg/L	0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver (filtered)	mg/L	0.001	0.00005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium (filtered)	mg/L	0.01	0.006[3]	0.02	0.01	0.01	<0.01	<0.01	0.06	<0.01	0.02	<0.01	0.02	0.02	0.02	<0.01	<0.01	0.02	0.02	0.02	0.01	0.03	0.02	0.02	0.02
Zinc (filtered)	mg/L	0.005	0.008	<0.005	<0.005	0.007	0.007	0.008	0.02	<0.005	<0.005	<0.005	<0.005	0.024	<0.005	0.019	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	0.009	<0.005	<0.005
Surfactants																									
Anionic Surfactants as MBAS	mg/L	0.1	0.28		<0.1	0.2	0.1			0.1	0.3		0.1	0.3						0.6			<0.1	0.1	0.2
BTEX																									
Benzene	µg/L	1	950	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1					<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	µg/L	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2					<2	<2	<2	<2	<2	<2	<2
Toluene	µg/L	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2					<2	<2	<2	<2	<2	<2	<2
Total BTEX	µg/L	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1					<1	<1	<1	<1	<1	<1	<1
Xylene (m & p)	µg/L	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2					<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	2	350	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2					<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2					<2	<2	<2	<2	<2	<2	<2
Phenols																									
2,4,5-Trichlorophenol	µg/L	1					<1				<1		<1	<1						<1					<1
2,4,6-Trichlorophenol	µg/L	1	3				<1				<1		<1	<1						<1					<1
2,4-Dichlorophenol	µg/L	1	120				<1				<1		<1	<1						<1					<1
2,4-Dimethylphenol	µg/L	1			<1	<1	<1			<1	<1		<1	<1						<1			<1	<1	<1
2,6-Dichlorophenol	µg/L	1					<1				<1		<1	<1						<1					<1
2-Chlorophenol	µg/L	1	340				<1				<1		<1	<1						<1					<1
2-Nitrophenol	µg/L	1					<1				<1		<1	<1						<1					<1
2-Methylphenol	µg/L	1			<1	<1	<1			<1	<1		<1	<1						<1			<1	<1	<1
3&4-Methylphenol (m&p-cresol)	µg/L	2			<2	<2	<2			<2	<2		<2	<2						<2			<2	<2	<2
Pentachlorophenol	µg/L	2	3.6				<2				<2		<2	<2						<2					<2
4-chloro-3-methylphenol	µg/L	1			<1	<1	<1			<1	<1		<1	<1						<1			<1	<1	<1
Phenol	µg/L	1	320				<1				<1		<1	<1						<1					<1
TRH																									
C10-C16	µg/L	100		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100					<100	<100	<100	<100	<100	<100	<100
C10-C16 (F2 minus Naphthalene)	µg/L	100		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100					<100	<100	<100	<100	<100	<100	<100
C10-C40 (Sum of total)	µg/L	100		<100	<100	<100	<100	<100	<100	<100	100	<100	<100	<100					<100	210	<100	<100	<100	<100	<100
C16-C34	µg/L	100		<100	<100	<100	<100	<100	<100	<100	100	<100	<100	<100					<100	210	<100	<100	<100	<100	<100
C34-C40	µg/L	100		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100					<100	<100	<100	<100	<100	<100	<100
C6-C10	µg/L	20		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20					<20	<20	<20	<20	<20	<20	<20
C6-C10 (F1 minus BTEX)	µg/L	20		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20					<20	<20	<20	<20	<20	<20	<20
PAH																									
Naphthalene	µg/L	5	16	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5					<5	<5	<5	<5	<5	<5	<5
TPH																									
+C10-C36 (Sum of total)	µg/L	50		<50	<50	<50	<50	<50	<50	<50	130	<50	<50	<50					<50	260	<50	<50	<50	<50	<50
C15-C28	µg/L	100		<100	<100	<100	<100	<100	<100	<100	130	<100	<100	<100					<100	260	<100	<100	<100	<100	<100
C10-C14	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50					<50	<50	<50	<50	<50	<50	<50
C29-C36	µg/L	50		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50					<50	<50	<50	<50	<50	<50	<50
C6-C9	µg/L	20		<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20					<20	<20	<20	<20	<20	<20	<20

Notes

1. The DGV for physico-chemical parameters and nutrients refer to the values for physical and chemical stressors in south-east Australia (lowland river) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC/ARMCANZ (2000). The DGV for toxicants refer to the values for slightly – moderately disturbed freshwater ecosystems that are reported in Table 3.4.1 of ANZECC/ARMCANZ (2000) unless otherwise stated.
2. Sample ID refers the sample ID provided on the Laboratory Certificates of Analysis (see Appendix D)
3. DGV is a low reliability trigger value sourced from ANZECC/ARMCANZ (2000):Volume 2
4. Refers to the DGV for As(V)
4. Refers to the DGV for Cr (VI)
6. DGV is an interim indicative working level sourced from ANZECC/ARMCANZ (2000):Volume 2

0.001 orange text indicates the analytical limit of reporting is greater than the DGV

grey shading denotes DGV exceeded

Appendix B

Geotechnical report

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Boral Construction Materials
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Project 91452.00
15 January 2018
R.001.Rev1
DJW:jah

Attention: Richard Haskett

Email: Richard.Haskett@boral.com.au

Dear Richard,

Report on Infiltration Assessment
Boral Kooragang Waste Management Facility
Egret Street, Kooragang

1. Introduction

This report presents the result of an infiltration assessment undertaken at Boral Kooragang Waste Management Facility. The assessment was commissioned by Boral Construction Materials and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal NCL180649.P.001.Rev1 dated 1 November 2018.

It is understood that infiltration testing is required at the site in order to understand the permeability of the upper soils of the subsurface profile.

The investigation comprised the drilling of five shallow bores, five constant head permeameter infiltration tests, nine double ring infiltration tests, laboratory testing on selected samples, engineering analysis and the presentation of the estimated hydraulic conductivities at each test location.

2. Site Description and Regional Geology

The Boral Kooragang Waste Management Facility is located in the northern part of Lot 12 DP 1032146, Egret Street, Kooragang. The site is bound by Egret Street to the east, commercial properties to the north and south and Kooragang Coal Terminal to the west as shown on Drawing 1, attached.

At the time of the investigation the site was an active recycling facility comprising numerous construction material stockpiles and unsealed access roads. The eastern area of the site comprises a sealed asphalt car park / hardstand area with the administration building and weighbridge located near the north-eastern corner of the site.

There is an existing drainage swale running along the northern boundary of the site. At the time of the investigation, water was observed to be ponding at the eastern end of the drainage swale.

The ground surface levels varied across the site and is likely associated with the construction material stockpiles that occupy the site. The site surface levels typically fall towards the drainage swale along the northern boundary of the site.

Features of the site are shown in Figures 1 to 4 below.

Figure 1: Looking north-west from near test Location 6.

Figure 2: Looking north-west along drainage swale from near the weighbridge.

Figure 3: Looking south-west from near Test Location 9, towards Test Location 4 (orange cones)

Review of the 1:100,000 Newcastle Soil Land Scape Sheet indicates that the site is underlain by disturbed terrain. Reference to the 1:100,000 Newcastle Coalfields Geology Sheet indicates that the disturbed terrain is further underlain by Quaternary alluvial soils comprising sand, silt clay and gravel. The investigation bores encountered filling to the depth of investigation.

Douglas Partners Pty Ltd (DP) has completed geotechnical investigations in the southern part of the Boral site, as well as immediately north within the Newcastle Coal Infrastructure Group (NCIG) car park area. Previous cone penetration testing (CPT) indicated upper sand filling from reclamation works and a shallow groundwater table.

3. Field Work Methods

The field work was carried out from 4 December and 5 December 2018 and comprised constant head permeameter testing and double ring infiltrometer testing. The test locations were set out in consultation with the client at accessible locations clear of buried services and active stockpiles. The tests were positioned in order to achieve sufficient coverage across the site. Test locations designated 2 (P2 and DR2) and 9 (DR9) were positioned within the drainage swale running along the northern boundary of the site. The remainder of the test locations were positioned within the yard of the recycling plant.

The position of the test locations was recorded with a hand held GPS with a nominal accuracy ± 10 m. The test locations are shown on the attached Drawing 1.

The prevailing weather conditions at the time of the investigation ranged from fine to overcast conditions. Reference to the Bureau of Meteorology website indicates that the rain gauge at the at The University of Newcastle Callaghan Campus recorded 0.6 mm of rainfall was recorded on 5 December 2018 and approximately 45 mm of rainfall was recorded on 29 November 2018 (five days prior to the commencement of the fieldwork).

The methodology of each infiltration test methods is discussed below in Sections 3.1 and 3.2.

3.1 Constant Head Permeameter Infiltration Testing

A total of five constant head infiltration tests (designated P1 to P5) were undertaken. The tests were carried out in bores drilled using a 3.5 tonne Kobelco excavator equipped with a 200 mm diameter solid flight auger to depths of between 0.7 m and 1.1 m. The permeameter testing was undertaken with reference to the procedures outlined in AS1547:2012 Appendix 4.1F (Ref 1).

Samples of the subsurface soils encountered in the Bores P1 to P5 were collected at regular depth intervals by a geotechnical engineer who also logged the subsurface profile in each bore.

3.2 Double Ring Infiltrometer Testing

A total of nine double ring infiltration tests (designated DR1 to DR9) were undertaken. The double ring infiltrometer test utilises a constant head test method and consists of an inner and outer ring.

Due to the nature of the apparently compacted sandy gravel filling across the site, the concentric rings were not able to achieve sufficient penetration below the ground surface to form an adequate seal with the exception of DR 9. Therefore the outer ring was substituted with a bund constructed from quickset concrete and the inner steel ring was hammered to refusal and sealed with a quickset concrete barrier at the base of the inner steel ring. Both rings were filled with water and maintained throughout the test and depth of water below the top of the inner ring at each time interval is recorded before refilling.

Once testing was completed the depth to which the water had penetrated below the original ground surface was recorded, although this depth should be considered approximate only as the saturation front was difficult to measure within the materials encountered at the site. The data gathered was then used to estimate the hydraulic conductivity (or permeability) of the soils.

4. Field Work Results

The subsurface conditions encountered in the pits and bores are presented in detail in the logs attached. These should be read in conjunction with the accompanying notes preceding them which explain the descriptive terms and classification methods used in the reports.

In summary, the subsurface conditions encountered in Bores P1 to P5 typically comprised sandy gravel, gravelly sand, sand and gravel filling to the depth of investigation ranging from 0.7 m to 1.1 m. No free groundwater was observed in the bores during the time that they remained open. It should be noted that groundwater levels are affected by factors such as climatic conditions and soil permeability and will therefore vary with time.

Detailed results of the constant head permeameter and double ring infiltrometer testing are attached and are summarised in Table 1 below:

Table 1: Summary In situ Testing

Test Location	Type of Test	Site Area	Depth of Test (m BGL)	Estimated Hydraulic Conductivity	
				m/sec	m/day
P1	Permeameter	Yard	0.5	1.48×10^{-5}	1.28
P2	Permeameter	Drainage Swale	0.5	1.45×10^{-6}	0.12
P3	Permeameter	Yard	0.5	1.7×10^{-6}	0.15
P4	Permeameter	Yard	0.55	1.32×10^{-6}	0.11
P5	Permeameter	Yard	0.6	8.0×10^{-7}	0.07
DR 1	Double Ring	Yard	0	4.81×10^{-6}	0.42
DR 2	Double Ring	Drainage Swale	0	1.08×10^{-5}	0.93
DR 3	Double Ring	Yard	0	2.24×10^{-5}	1.94
DR 4	Double Ring	Yard	0	1.19×10^{-5}	1.03
DR 5	Double Ring	Yard	0	1.15×10^{-5}	0.99
DR 6	Double Ring	Yard	0	1.08×10^{-6}	0.09
DR 7	Double Ring	Yard	0	3.17×10^{-6}	0.27
DR 8	Double Ring	Yard	0	1.62×10^{-6}	0.14
DR 9	Double Ring	Drainage Swale	0	3.54×10^{-5}	3.06

Notes to Table 1:

mBGL – metres below ground level

5. Laboratory Testing

Laboratory testing comprised five particle size distribution tests. Detailed results of the laboratory testing are attached and are summarised in Table 2 below.

Table 2: Results of Particle Size Distribution (PSD)

Bore	Depth (m)	Description	Gravel Fraction (%)	Sand Fraction (%)	Silt and Clay Fraction (%)
P1	0.1 – 0.5	FILLING: Sand Gravel	52	38	10
P2	0.1 – 0.4	FILLING: Sand and Gravel	62	34	4
P3	0.1 – 0.5	FILLING: Gravel and Sand	44	48	8
P4	0.8	FILLING: Gravelly Sand	39	45	16
P5	0.1 – 0.4	FILLING: Sand and Gravel	51	42	7

The Hazen method, as described by Fetter (1994), was then adapted on these results to estimate the hydraulic conductivity (or permeability) of the samples. The results are presented in Table 3 below:

Table 3: Estimated Permeability from PSD

Bore	Depth	Description	Effective Grain Size (d_{10}) (mm)	Calculated Hydraulic Conductivity	
				m/day	m/sec
P1	0.1 – 0.5	FILLING: Sand Gravel	0.075*	NA	NA
P2	0.1 – 0.4	FILLING: Sand and Gravel	0.225	17-34	2 to 4 x 10^{-4}
P3	0.1 – 0.5	FILLING: Gravel and Sand	0.1125	4.3 to 8.7	5 to 10 x 10^{-5}
P4	0.8	FILLING: Gravelly Sand	<0.075*	NA	NA*
P5	0.1 – 0.4	FILLING: Sand and Gravel	0.131	6 to 11.9	7 to 13 x 10^{-5}

Nots to Table 3:

* Effective grain size $d_{(10)}$ is below the normal range to allow an estimate in hydraulic conductivity

6. Comments

The estimated infiltration rates are influenced by several factors including the following:

- The subsurface profile. It is considered likely that infiltration rates will vary across the site due to the inherent variability of the filling that was encountered all test locations;
- The presence of thin less permeable layers, i.e. layers with a higher percentage of fines (particle size <0.075 mm) cemented bands that may be present within the subsurface profile. Such layers lower the permeability (hydraulic conductivity) of the subsurface profile by several orders of magnitude;
- Infiltration rates within unsaturated sands could be up to one order of magnitude lower than saturated permeability. If infiltration occurs when the sand is dry then the infiltration rates will be less than expected, prior to the soil becoming saturated.
- Climatic conditions during testing; and
- The presence of groundwater.

Based on the results of the double ring infiltrometer and permeameter testing (attached) and subsurface profile encountered within the bores, the existing fill strata in the yard area of the site is estimated to have a hydraulic conductivity in the range of 2.2×10^{-5} m/sec to 8.0×10^{-7} m/sec. The average of hydraulic conductivity in the yard area of the site based on the above results was approximately 6.8×10^{-6} m/sec. The existing fill strata in the drainage swale area of the site is estimated to have a hydraulic conductivity in the range of 3.5×10^{-5} m/sec to 1.5×10^{-6} m/sec. The average of hydraulic conductivity in the drainage swale area based on the test results was approximately 1.6×10^{-5} m/sec.

Based on the results of the above infiltration testing, the existing fill strata in the yard area of the site would be considered to have a moderate hydraulic conductivity relative to the range of typical soil hydraulic conductivites. The drainage swale would be considered to have a moderate to high hydraulic conductivity.

The above rate of infiltration rates are lower than that indicated by the results of the particle size distribution laboratory testing and Hazen's method of analysis. It is considered that the discrepancy between the calculated laboratory hydraulic conductivity and in-situ hydraulic conductivity may be attributed to the apparent compaction of the filling and fines content and therefore the estimated hydraulic conductivity using the Hazen method (Table 3) should be used with caution or as a sensitivity check.

7. References

1. Australian Standard AS1547-2012, *Disposal Systems for Effluent from Domestic Premises*, Standards Association of Australia.

8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Boral Waste Management Facility, Egret Street in accordance with DP's proposal NCL180469 dated 1 November 2018 and acceptance received from Richard Haskett of Boral Construction Materials with Purchase Order Number 5995967. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Boral Construction Materials for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical / groundwater components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd Reviewed by

Daniel West **Scott McFarlane**
Geotechnical Engineer Principal

Attachments:
About this Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations
Borehole Logs (P1 to P5)
Constant Head Permeameter Test Reports (P1 to P5)
Double Ring Infiltrometer Test Reports (DR1 to DR9)
Laboratory Test Results
Drawing 1 – Test Location Plan

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

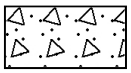
Symbols & Abbreviations

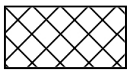
Graphic Symbols for Soil and Rock

General

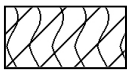

Asphalt

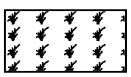

Road base

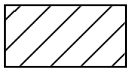

Concrete

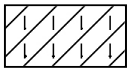

Filling

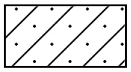
Soils


Topsoil

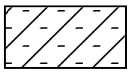

Peat

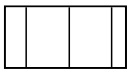

Clay

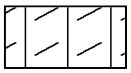

Silty clay

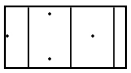

Sandy clay

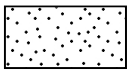

Gravelly clay

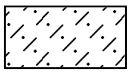

Shaly clay

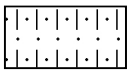

Silt


Clayey silt


Sandy silt

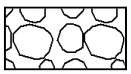

Sand

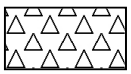

Clayey sand


Silty sand


Gravel

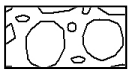

Sandy gravel


Cobbles, boulders

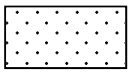

Talus

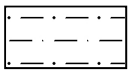
Sedimentary Rocks

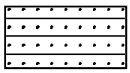

Boulder conglomerate

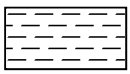

Conglomerate


Conglomeratic sandstone

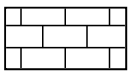

Sandstone


Siltstone

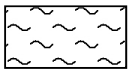

Laminite

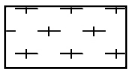

Mudstone, claystone, shale

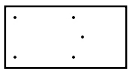

Coal


Limestone

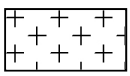
Metamorphic Rocks

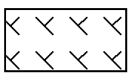

Slate, phyllite, schist

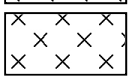

Gneiss

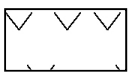

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Boral Construction Materials
PROJECT: Infiltration Assessment
LOCATION: Egret Street, Kooragang

SURFACE LEVEL: --
EASTING: 384397
NORTHING: 6361396
DIP/AZIMUTH: 90°/--

BORE No: P1
PROJECT No: 91452.00
DATE: 4/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - Generally comprising brown sandy gravel, recycled concrete and brick filling, with fine to medium grained sand and subrounded to subangular gravel up to 40mm in size, some silt, humid		B	0.1				
					0.5				
	0.75	FILLING - Generally comprising dark grey sandy gravel, recycled concrete and brick filling, with fine to medium grained sand and subrounded to subangular gravel (40mm) and timber and some silt and clay, moist		D	0.8				
	0.9	FILLING - Generally comprising brown gravelly sand recycled concrete and brick filling, with fine grained sand and subrounded to subangular gravel up to 35mm in size, some silt, moist		D	1.0				
	1								1
	1.1	Bore discontinued at 1.1m, limit of investigation							
	2								2

RIG: 3.5 tonne Kobelco Excavator **DRILLER:** Leidan Excavations **LOGGED:** Hartigan / West **CASING:** Nil
TYPE OF BORING: 200mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Hand held GPS ± 10m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Boral Construction Materials
PROJECT: Infiltration Assessment
LOCATION: Egret Street, Kooragang

SURFACE LEVEL: --
EASTING: 384411
NORTHING: 6361473
DIP/AZIMUTH: 90°/--

BORE No: P2
PROJECT No: 91452.00
DATE: 4/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	FILLING - Generally comprising grey brown clayey gravel filling, with subrounded to subangular gravel up to 40mm insize, with concrete brick and asphalt fragments, some fine to medium grained sand, moist			0.1				
		FILLING - Generally comprising grey brown sandy gravel filling, with subrounded to subangular gravel up to 40mm in size, and some fine to medium grained sand, moist		B					
		From 0.5m to 0.7m, gravelly clay			0.4				
		From 0.7m, with subrounded to subangular gravel, up to 60mm in size							
	0.9	Bore discontinued at 0.9m, refusal							
	1								1
	2								2

RIG: 3.5 tonne Kobelco Excavator **DRILLER:** Leidan Excavations **LOGGED:** Hartigan / West **CASING:** Nil
TYPE OF BORING: 200mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Hand held GPS ± 10m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Boral Construction Materials
PROJECT: Infiltration Assessment
LOCATION: Egret Street, Kooragang

SURFACE LEVEL: --
EASTING: 384309
NORTHING: 6361444
DIP/AZIMUTH: 90°/--

BORE No: P3
PROJECT No: 91452.00
DATE: 4/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - Generally comprising grey gravel and sand, recycled concrete and brick, filling with fine to medium grained sand and subrounded to subangular gravel up to 40mm in size, moist			0.1				
				B					
					0.5				
				D	0.6				
	0.8	FILLING - Generally comprising dark grey gravelly sand, recycled concrete and brick filling, with fine to medium grained sand and subrounded to subangular up to 30mm in sie, with some silt, moist							
	1 1.0	Bore discontinued at 1.0m, limit of investigation							1
	2								2

RIG: 3.5 tonne Kobelco Excavator **DRILLER:** Leidan Excavations **LOGGED:** Hartigan / West **CASING:** Nil
TYPE OF BORING: 200mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Hand held GPS ± 10m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Boral Construction Materials
PROJECT: Infiltration Assessment
LOCATION: Egret Street, Kooragang

SURFACE LEVEL: --
EASTING: 384308
NORTHING: 6361489
DIP/AZIMUTH: 90°/--

BORE No: P4
PROJECT No: 91452.00
DATE: 4/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - Generally comprising brown sandy gravel, recycled concrete and brick filling, with fine to medium grained sand and subrounded to subangular gravel up to 40mm in size, some silt, moist		B	0.1				
					0.5				
	0.6	FILLING - Generally comprising brown gravelly sand, recycled concrete and brick with fine to medium sand and subangular to subrounded gravel up to 30mm in size, some silt, moist		D	0.8				
	1 1.0	Bore discontinued at 1.0m, limit of investigation							1
	2								2

RIG: 3.5 tonne Kobelco Excavator **DRILLER:** Leidan Excavations **LOGGED:** Hartigan / West **CASING:** Nil
TYPE OF BORING: 200mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Hand held GPS ± 10m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Boral Construction Materials
PROJECT: Infiltration Assessment
LOCATION: Egret Street, Kooragang

SURFACE LEVEL: --
EASTING: 384379
NORTHING: 6361449
DIP/AZIMUTH: 90°/--

BORE No: P5
PROJECT No: 91452.00
DATE: 4/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - Generally comprising brown sand and gravel, recycled concrete and brick filling, with fine to medium grained sand and subrounded to subangular gravel up to 30mm in size, some silt and trace asphalt, moist		B	0.1 0.4				
	0.5	FILLING - Generally comprising brown gravelly sand, recycled concrete and brick filling, fine to medium sand and subrounded to subangular gravel up to 20mm in size, some silt, moist							
	0.7	Bore discontinued at 0.7m, limit of investigation		D	0.7				
	1								1
	2								2

RIG: 3.5 tonne Kobelco Excavator **DRILLER:** Leidan Excavations **LOGGED:** Hartigan / West **CASING:** Nil
TYPE OF BORING: 200mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Hand held GPS ± 10m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Constant Head Permeameter Test Report [AS1547 App 4.1F]

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	4-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** P1

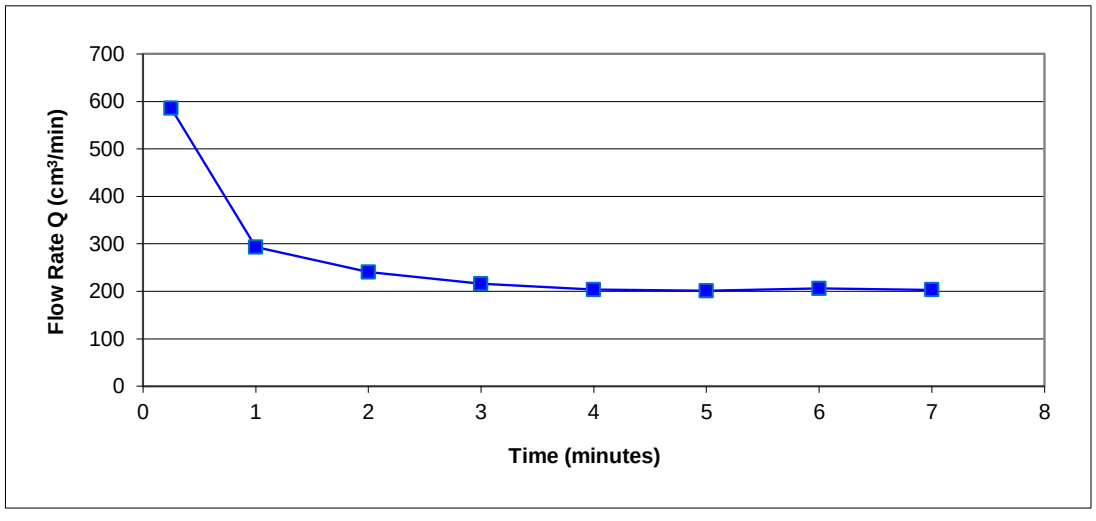
Description:	P1	Easting:	384397 m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6362396 m
Condition of ground surface before test:	Humid	Surface Level:	m AHD
Weather during test:	Fine		

Details of Bore Installation

Depth of augered hole	500	mm	Depth to impermeable layer	-	m
Depth of constant water below permeameter	250	mm	Time from filling to start	2	minutes
Diameter of hole	220	mm			
Diameter of permeameter	73	mm			

Test Results

Time (minutes)	Level below top (mm)	Flow Volume (cm^3)	Rate of Loss [Q] (cm^3/min)
0	0	0	
0	35	146	586
1	70	293	293
2	115	481	241
3	155	649	216
4	195	816	204
5	240	1004	201
6	295	1235	206
7	340	1423	203
Totals	340	1423	203 Overall



Saturated Hydraulic Conductivity - From 3 minutes to 7 minutes

k = 8.89E-02 cm/min where $K = 4.4Q[0.5 \sinh^{-1}(H/2r)-\sqrt{[(r/H^2)+0.25]+r/H]/2\pi H^2}$

= 1.48E-05 m/sec ref. AS1547-2012 App 4.1F

= 1.28 m/day

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Constant Head Permeameter Test Report [AS1547 App 4.1F]

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** P2

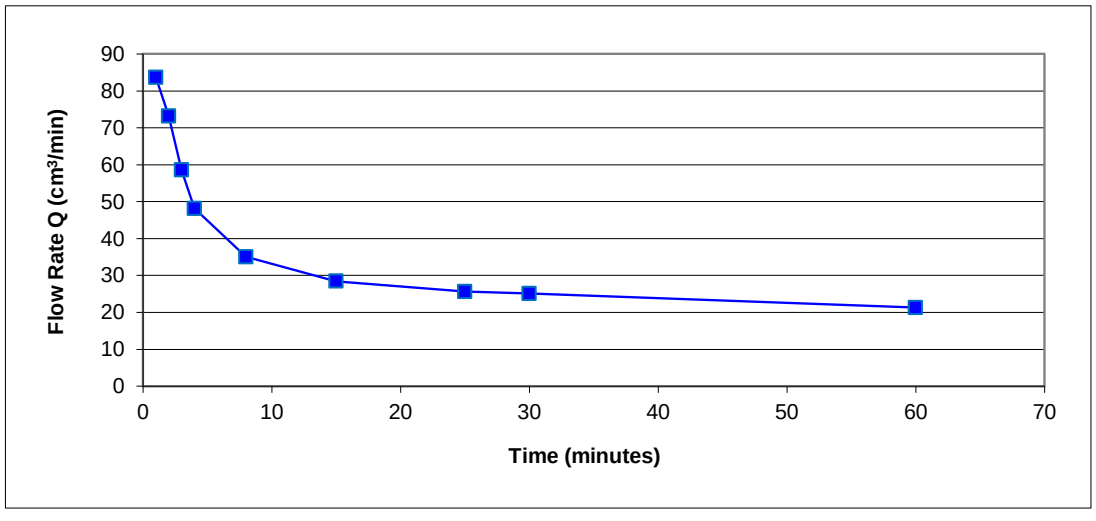
Description:	P2	Easting:	384411	m
Material type:	Clayey Gravel Filling	Northing	6361473	m
Condition of ground surface before test:	Humid to moist	Surface Level:		m AHD
Weather during test:	Overcast			

Details of Bore Installation

Depth of augered hole	500	mm	Depth to impermeable layer	-	m
Depth of constant water below permeameter	250	mm	Time from filling to start	2	minutes
Diameter of hole	220	mm			
Diameter of permeameter	73	mm			

Test Results

Time (minutes)	Level below top (mm)	Flow Volume (cm^3)	Rate of Loss [Q] (cm^3/min)
0	0	0	
1	20	84	84
2	35	146	73
3	42	176	59
4	46	193	48
8	67	280	35
15	102	427	28
25	153	640	26
30	180	753	25
60	305	1277	21
Totals	305	1277	21 Overall



Saturated Hydraulic Conductivity - From 15 minutes to 60 minutes

k = 8.67E-03 cm/min where $K = 4.4Q[0.5 \sinh^{-1}(H/2r)-\sqrt{[(r/H^2)+0.25]+r/H]/2\pi H^2}$

= 1.45E-06 m/sec ref. AS1547-2012 App 4.1F

= 0.12 m/day

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Constant Head Permeameter Test Report [AS1547 App 4.1F]

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** P3

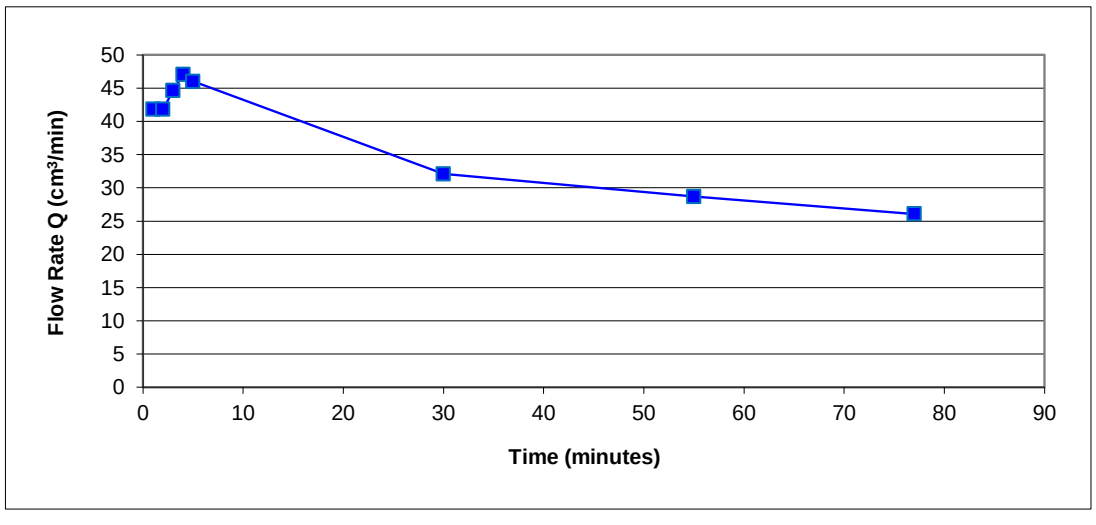
Description:	P3	Easting:	384309	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361444	m
Condition of ground surface before test:	Humid	Surface Level:		m AHD
Weather during test:	Overcast			
Diameter of permeameter	73 mm			

Details of Bore Installation

Depth of augered hole	500	mm	Depth to impermeable layer	-	m
Depth of constant water below permeameter	250	mm	Time from filling to start	2	minutes
Diameter of hole	220	mm			
Diameter of permeameter	73	mm			

Test Results

Time (minutes)	Level below top (mm)	Flow Volume (cm^3)	Rate of Loss [Q] (cm^3/min)
0	0	0	
1	10	42	42
2	20	84	42
3	32	134	45
4	45	188	47
5	55	230	46
30	230	963	32
55	377	1578	29
77	480	2009	26
Totals	480	2009	26 Overall



Saturated Hydraulic Conductivity - From 30 minutes to 77 minutes

k = 1.02E-02 cm/min where $K = 4.4Q[0.5 \sinh^{-1}(H/2r)-\sqrt{[(r/H^2)+0.25]+r/H]/2\pi H^2}$

= 1.70E-06 m/sec ref. AS1547-2012 App 4.1F

= 0.15 m/day

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Constant Head Permeameter Test Report [AS1547 App 4.1F]

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** P4

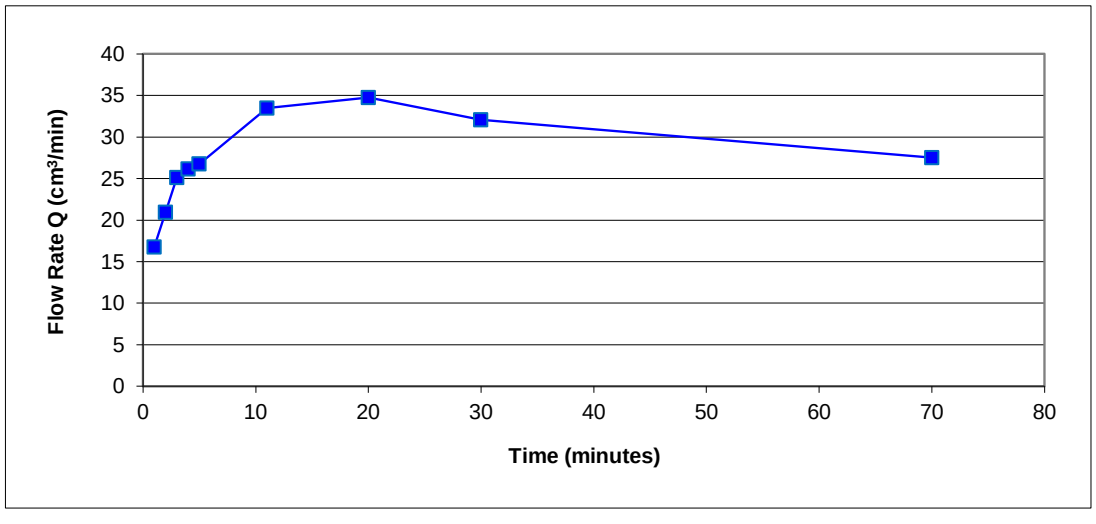
Description:	P4	Easting:	384308 m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361489 m
Condition of ground surface before test:	Humid	Surface Level:	m AHD
Weather during test:	overcast		

Details of Bore Installation

Depth of augered hole	550	mm	Depth to impermeable layer	-	m
Depth of constant water below permeameter	300	mm	Time from filling to start	2	minutes
Diameter of hole	220	mm			
Diameter of permeameter	73	mm			

Test Results

Time (minutes)	Level below top (mm)	Flow Volume (cm^3)	Rate of Loss [Q] (cm^3/min)
0	0	0	
1	4	17	17
2	10	42	21
3	18	75	25
4	25	105	26
5	32	134	27
11	88	368	33
20	166	695	35
30	230	963	32
70	460	1925	28
Totals	460	1925	28 Overall



Saturated Hydraulic Conductivity - From 20 minutes to 70 minutes

k = 7.91E-03 cm/min where $K = 4.4Q[0.5 \sinh^{-1}(H/2r)-\sqrt{[(r/H^2)+0.25]+r/H]/2\pi H^2}$

= 1.32E-06 m/sec ref. AS1547-2012 App 4.1F

= 0.11 m/day

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Constant Head Permeameter Test Report [AS1547 App 4.1F]

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** P5

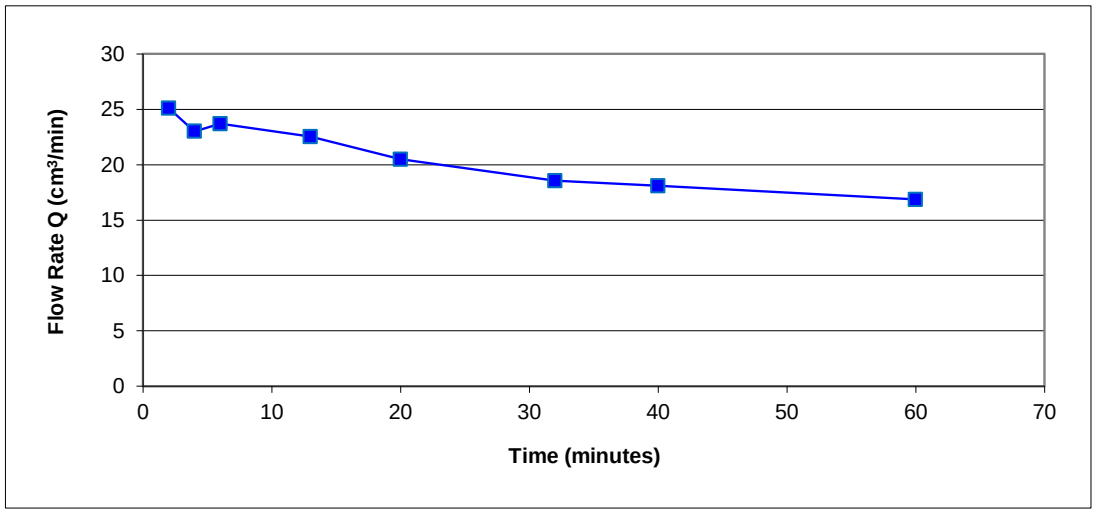
Description:	P5	Easting:	384379 m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361449 m
Condition of ground surface before test:	Humid	Surface Level:	m AHD
Weather during test:	Fine		

Details of Bore Installation

Depth of augered hole	600	mm	Depth to impermeable layer	-	m
Depth of constant water below permeameter	300	mm	Time from filling to start	2	minutes
Diameter of hole	220	mm			
Diameter of permeameter	73	mm			

Test Results

Time (minutes)	Level below top (mm)	Flow Volume (cm^3)	Rate of Loss [Q] (cm^3/min)
0	0	0	
2	12	50	25
4	22	92	23
6	34	142	24
13	70	293	23
20	98	410	21
32	142	594	19
40	173	724	18
60	242	1013	17
Totals	-242	1013	17 Overall



Saturated Hydraulic Conductivity - From 32 minutes to 60 minutes

k = 4.80E-03 cm/min where $K = 4.4Q[0.5 \sinh^{-1}(H/2r)-\sqrt{[(r/H^2)+0.25]+r/H]/2\pi H^2}$

= 8.00E-07 m/sec ref. AS1547-2012 App 4.1F

= 0.07 m/day

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 1

Description:	DR 1	Easting:	384397	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361396	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

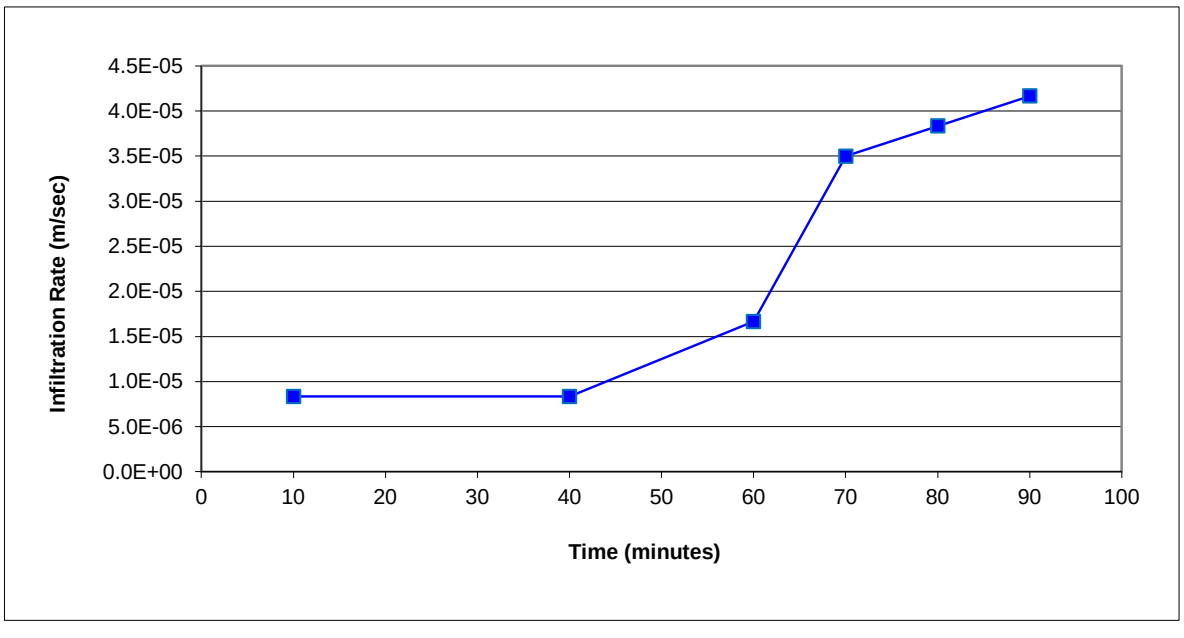
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 50 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
10		5	8.33E-06
40		15	8.33E-06
60		20	1.67E-05
70		21	3.50E-05
80		23	3.83E-05
90		25	4.17E-05
Totals	0	109	2.02E-05 Overall



Hydraulic Conductivity - Over total duration of test

k = 4.81E-06 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Testing	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 2

Description:	DR 2	Easting:	384411	m
Material type:	Clayey Gravel Filling	Northing	6361473	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

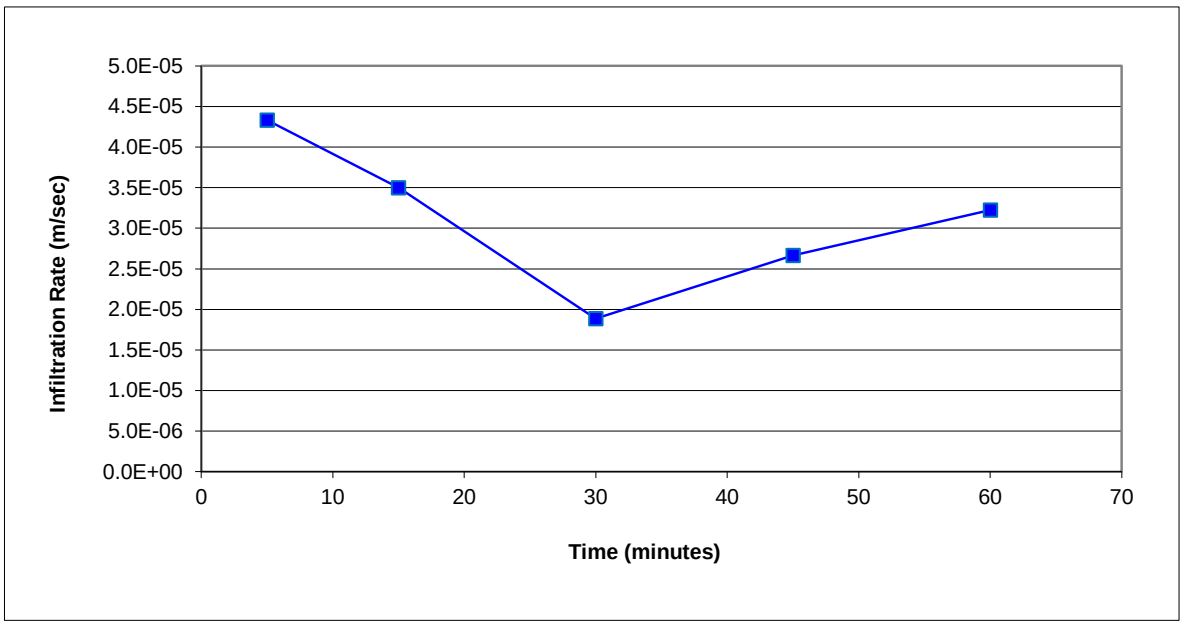
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 80 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
5		13	4.33E-05
15		21	3.50E-05
30	600	30	1.89E-05
45		24	2.67E-05
60		29	3.22E-05
Totals	600	117	3.25E-05 Overall



Hydraulic Conductivity - Over total duration of test

k = 1.08E-05 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 3

Description:	DR 3	Easting:	384309	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361444	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

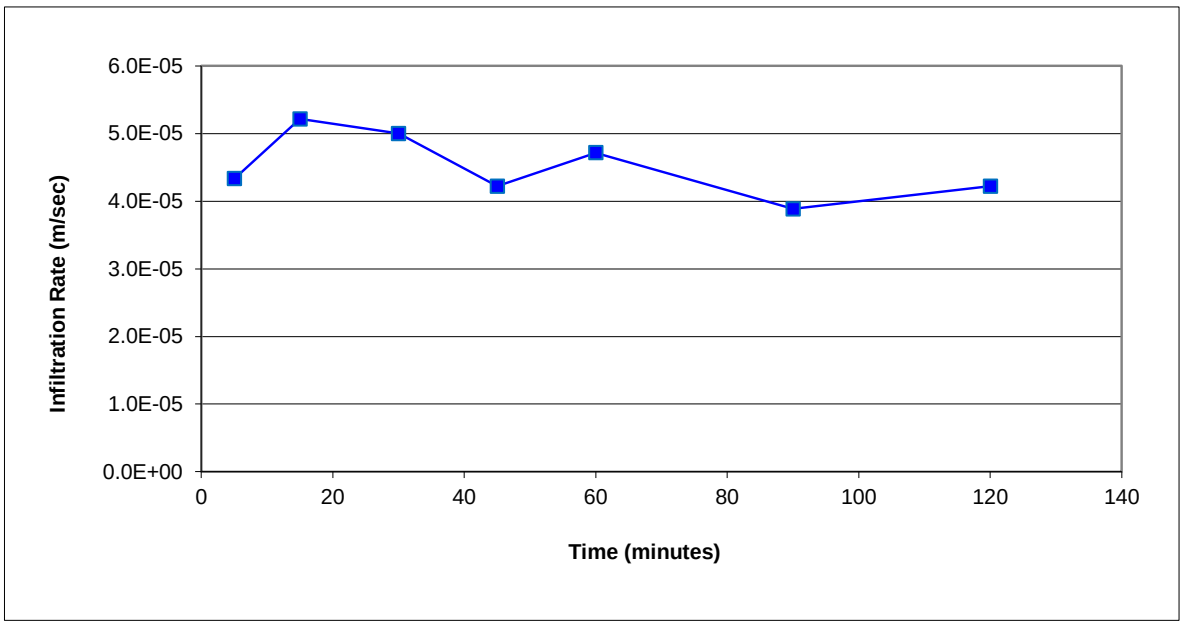
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	150	mm	Height of ring above ground	80	mm
Depth of ring embedment	30	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 150 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
5		13	4.33E-05
15	830	34	5.22E-05
30	795	45	5.00E-05
45		38	4.22E-05
60	1500	47	4.72E-05
90	1236	70	3.89E-05
120		76	4.22E-05
Totals	4361	323	4.49E-05 Overall



Hydraulic Conductivity - Over total duration of test

k = 2.24E-05 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 4

Description:	DR 4	Easting:	384308	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361489	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Overcast			

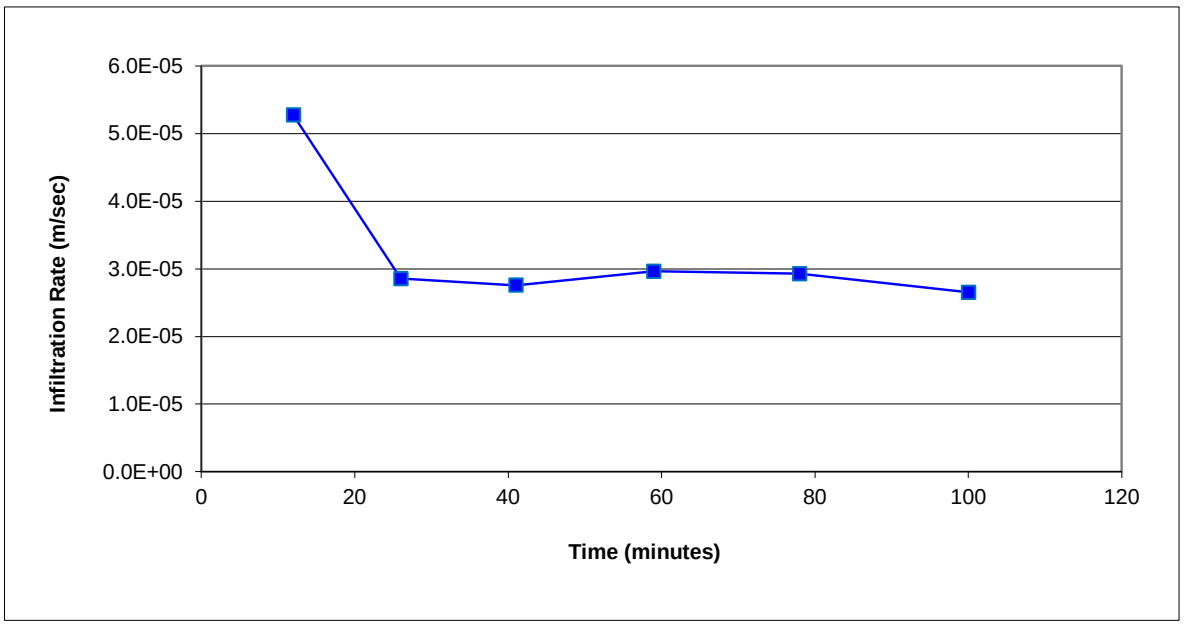
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 100 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
12	671	38	5.27E-05
26		24	2.86E-05
41	848	24	2.76E-05
59		32	2.96E-05
78	1148	33	2.93E-05
100		35	2.65E-05
Totals	2667	186	3.10E-05 Overall



Hydraulic Conductivity - Over total duration of test

k = 1.19E-05 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 5

Description:	DR 5	Easting:	384379	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361449	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

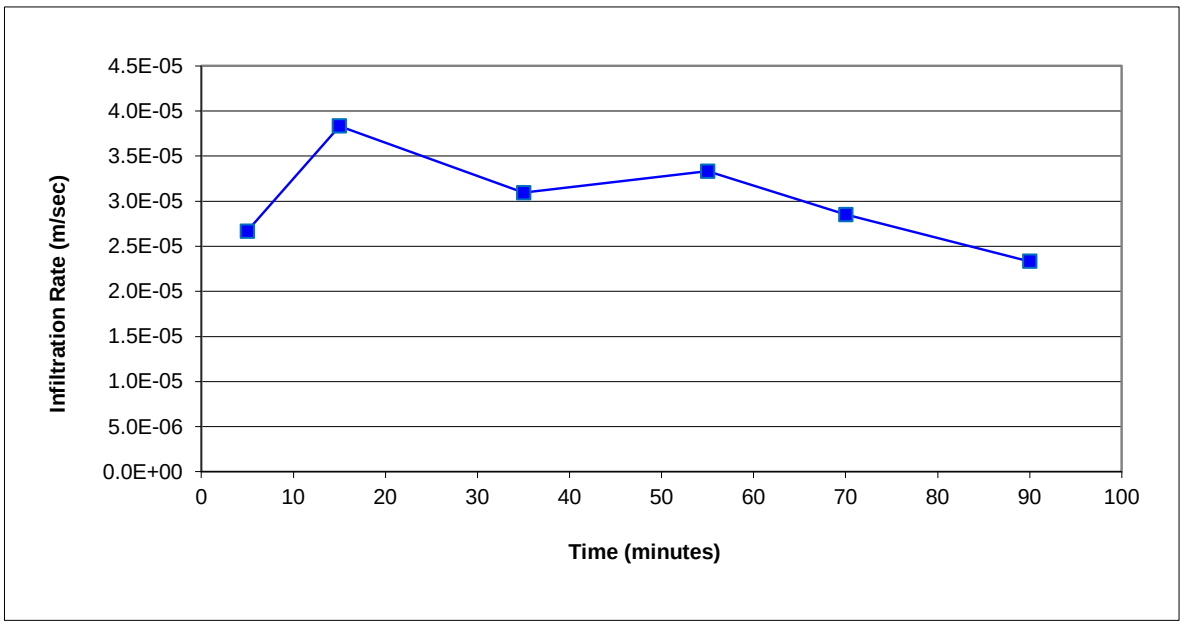
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 100 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
5		8	2.67E-05
15		23	3.83E-05
35	1148	42	3.09E-05
55		40	3.33E-05
70	1059	20	2.85E-05
90		28	2.33E-05
Totals	2207	161	2.98E-05 Overall



Hydraulic Conductivity - Over total duration of test

k = 1.15E-05 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 6

Description:	DR 6	Easting:	384427	m
Material type:	Gravelly Sand Filling (recycled concrete and brick)	Northing	6361443	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

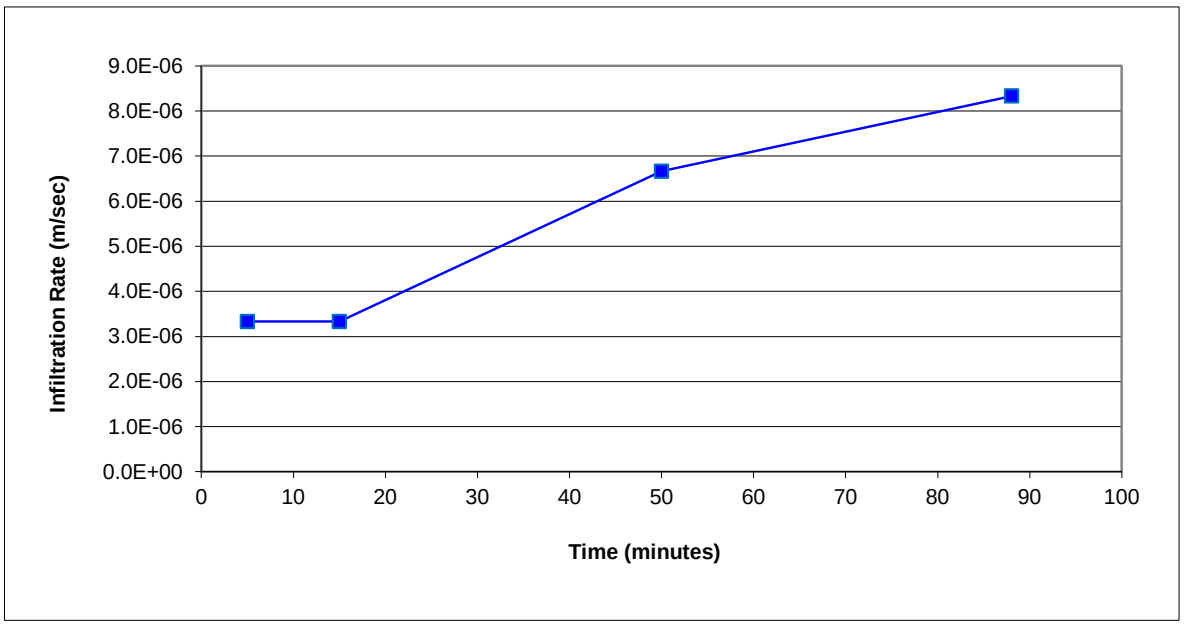
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 30 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
5		1	3.33E-06
15		2	3.33E-06
50		14	6.67E-06
88		19	8.33E-06
Totals	0	36	6.82E-06 Overall



Hydraulic Conductivity - Over total duration of test

k = 1.08E-06 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 7

Description:	DR 7	Easting:	384333	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361395	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

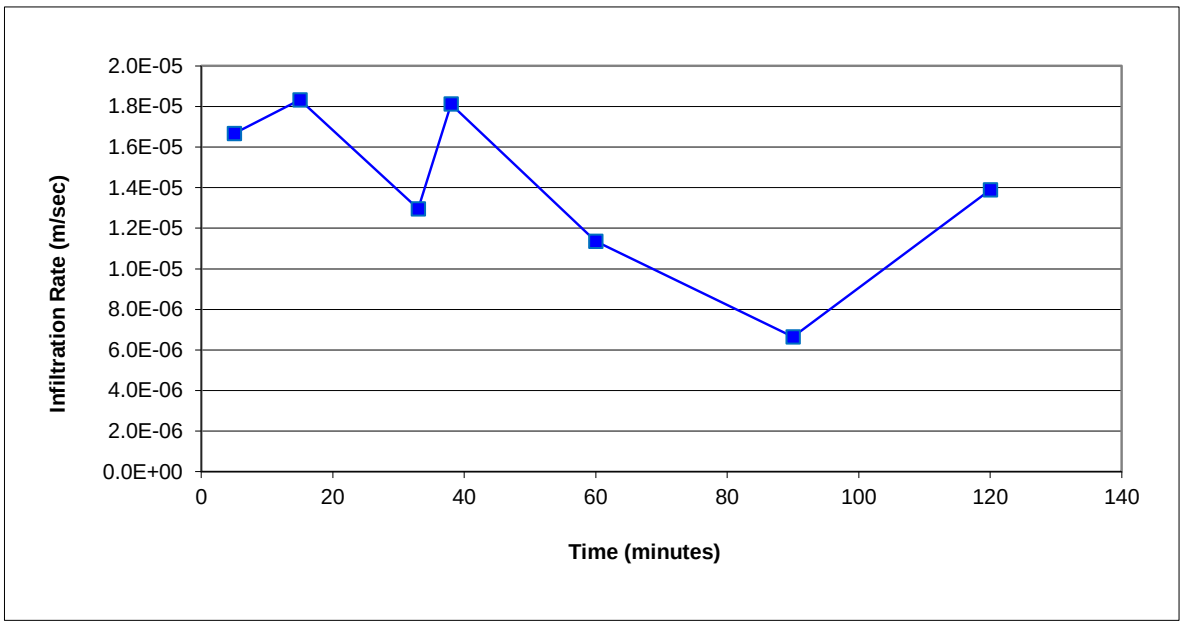
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 50 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)	
0	0	0		
5		5	1.67E-05	
15		11	1.83E-05	
33		14	1.30E-05	
38	730	5	1.81E-05	
60		15	1.14E-05	
90	634	21	6.64E-06	
120		25	1.39E-05	
Totals	1364	96	1.33E-05	Overall



Hydraulic Conductivity - Over total duration of test

k = 3.17E-06 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 8

Description:	DR 8	Easting:	384349	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361492	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Overcast / Fine			

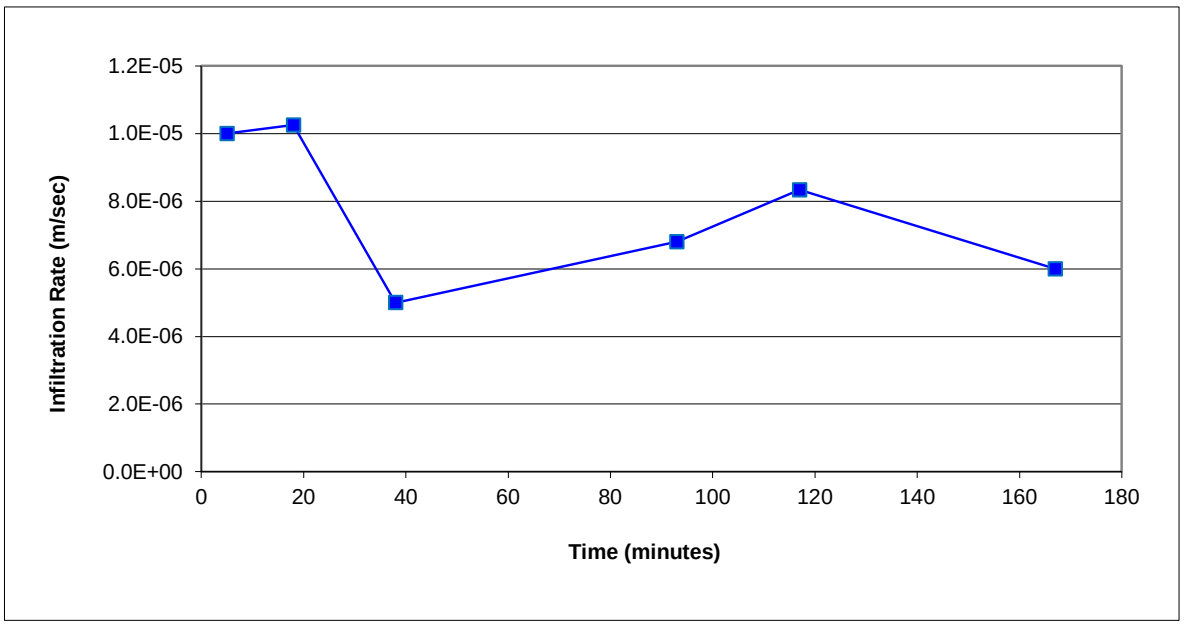
Details of Ring Installation

Inner Ring			**Outer Ring**		
Diameter	150	mm	Diameter	350	mm
Height of ring above ground (H)	160	mm	Height of ring above ground	80	mm
Depth of ring embedment	20	mm	Depth of ring embedment	-	mm

Water penetration below ground surface (L_f) after test & rings removed 50 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
5		3	1.00E-05
18		8	1.03E-05
38		6	5.00E-06
93	671	21	6.80E-06
117		12	8.33E-06
167		18	6.00E-06
Totals	671	68	6.79E-06 Overall



Hydraulic Conductivity - Over total duration of test

k = 1.62E-06 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

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Double Ring Infiltrometer Test Report

Client:	Boral Construction Materials	Project No:	91452
Project:	Infiltration Assessment	Date:	5-Dec-18
Location:	Egret Street, Kooragang Island	Tested by:	DJW

Test Location **Test No.** DR 9

Description:	DR 9	Easting:	384329	m
Material type:	Sandy Gravel Filling (recycled concrete and brick)	Northing	6361511	m
Condition of ground surface before test:	Moist	Surface Level:		m AHD
Weather during test:	Fine			

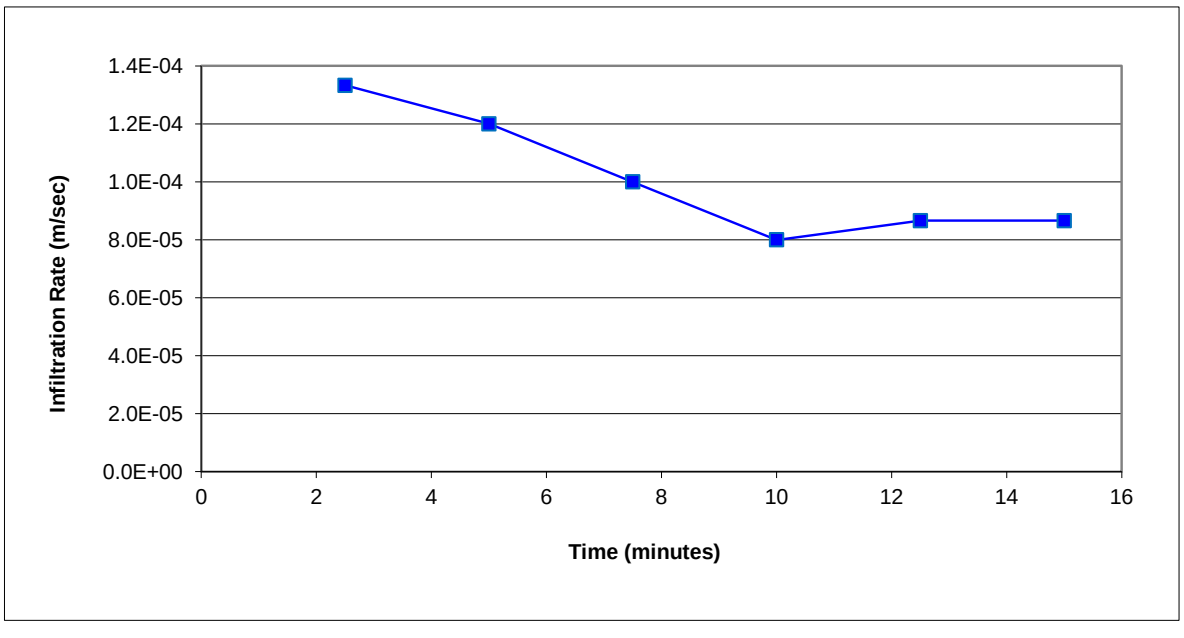
Details of Ring Installation

Inner Ring			Outer Ring		
Diameter	150	mm	Diameter	250	mm
Height of ring above ground (H)	85	mm	Height of ring above ground	185	mm
Depth of ring embedment	95	mm	Depth of ring embedment	30	mm

Water penetration below ground surface (L_f) after test & rings removed 50 mm

Test Results

Time (minutes)	Volume added (ml)	Depth fell (mm)	Infiltration Rate [F/t] (m/sec)
0	0	0	
2.5		20	1.33E-04
5		18	1.20E-04
7.5	795	10	1.00E-04
10		12	8.00E-05
12.5		13	8.67E-05
15		13	8.67E-05
Totals	795	86	9.56E-05 Overall



Hydraulic Conductivity - Over total duration of test

k = 3.54E-05 m/sec where $k = F/t / [(H+L_f)/L_f]$ Dingman 2002

Material Test Report

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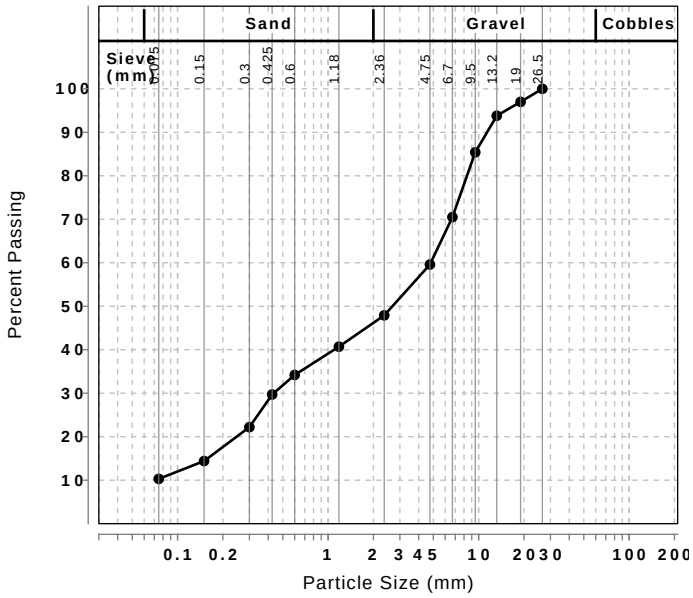
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Peter Gorseski
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **91452.00-1**
Issue Number: 1
Date Issued: 18/12/2018
Client: Boral Construction Materials
PO Box 6041, North Ryde NSW 2113
Project Number: 91452.00
Project Name: Infiltration Assessment
Project Location: Egret Street, Kooragang
Work Request: 2861
Sample Number: 18-2861A
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **P1 (0.1 - 0.5m)**
Material: FILLING: Sandy Gravel

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
26.5 mm	**100**		
19 mm	**97**		
13.2 mm	**94**		
9.5 mm	**85**		
6.7 mm	**71**		
4.75 mm	**60**		
2.36 mm	**48**		
1.18 mm	**41**		
0.6 mm	**34**		
0.425 mm	**30**		
0.3 mm	**22**		
0.15 mm	**14**		
0.075 mm	**10**		

Particle Size Distribution



Material Test Report

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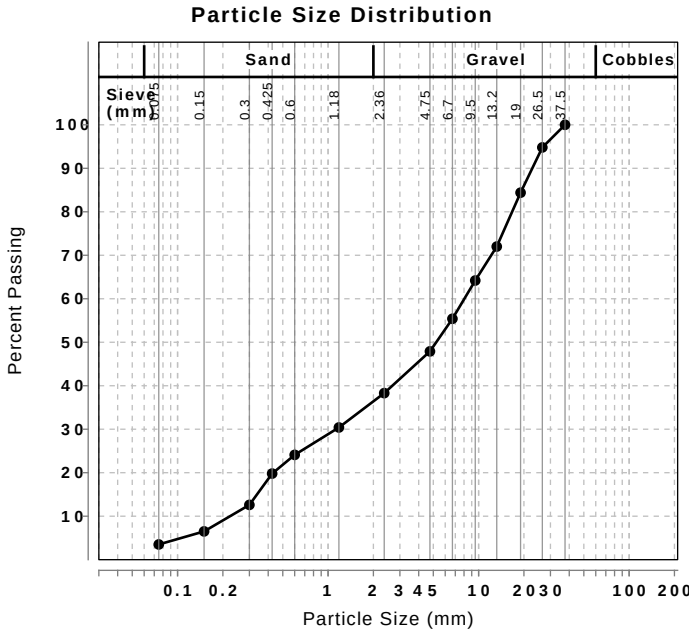
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **91452.00-1**
Issue Number: 1
Date Issued: 18/12/2018
Client: Boral Construction Materials
PO Box 6041, North Ryde NSW 2113
Project Number: 91452.00
Project Name: Infiltration Assessment
Project Location: Egret Street, Kooragang
Work Request: 2861
Sample Number: 18-2861B
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **P2 (0.1 - 0.4m)**
Material: FILLING: Sandy Gravel

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
37.5 mm	**100**		
26.5 mm	**95**		
19 mm	**84**		
13.2 mm	**72**		
9.5 mm	**64**		
6.7 mm	**55**		
4.75 mm	**48**		
2.36 mm	**38**		
1.18 mm	**30**		
0.6 mm	**24**		
0.425 mm	**20**		
0.3 mm	**13**		
0.15 mm	**7**		
0.075 mm	**4**		



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WORLD RECOGNISED ACCREDITATION

Approved Signatory: Peter Gorseski
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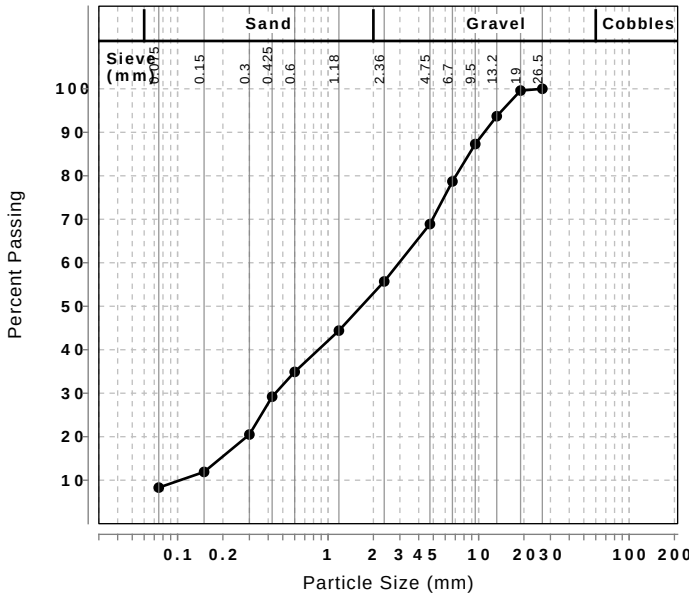
NATA Accredited Laboratory Number: 828

Report Number: **91452.00-1**
Issue Number: 1
Date Issued: 18/12/2018
Client: Boral Construction Materials
PO Box 6041, North Ryde NSW 2113
Project Number: 91452.00
Project Name: Infiltration Assessment
Project Location: Egret Street, Kooragang
Work Request: 2861
Sample Number: 18-2861C
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **P3 (0.1 - 0.5m)**
Material: FILLING: Gravel and Sand

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
26.5 mm	**100**		
19 mm	**100**		
13.2 mm	**94**		
9.5 mm	**87**		
6.7 mm	**79**		
4.75 mm	**69**		
2.36 mm	**56**		
1.18 mm	**44**		
0.6 mm	**35**		
0.425 mm	**29**		
0.3 mm	**21**		
0.15 mm	**12**		
0.075 mm	**8**		

Particle Size Distribution



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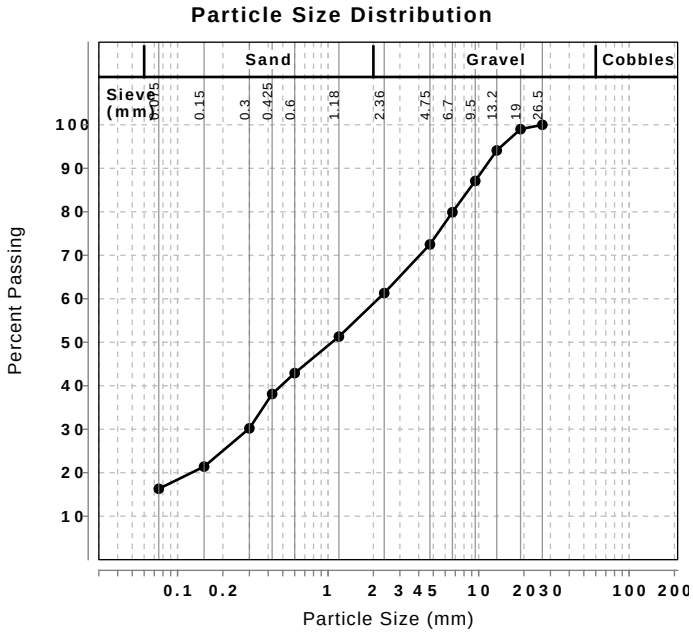
Report Number: **91452.00-1**
Issue Number: 1
Date Issued: 18/12/2018
Client: Boral Construction Materials
PO Box 6041, North Ryde NSW 2113
Project Number: 91452.00
Project Name: Infiltration Assessment
Project Location: Egret Street, Kooragang
Work Request: 2861
Sample Number: 18-2861D
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **P4 (0.8m)**
Material: FILLING: Gravelly Sand

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
26.5 mm	**100**		
19 mm	**99**		
13.2 mm	**94**		
9.5 mm	**87**		
6.7 mm	**80**		
4.75 mm	**73**		
2.36 mm	**61**		
1.18 mm	**51**		
0.6 mm	**43**		
0.425 mm	**38**		
0.3 mm	**30**		
0.15 mm	**21**		
0.075 mm	**16**		



Material Test Report

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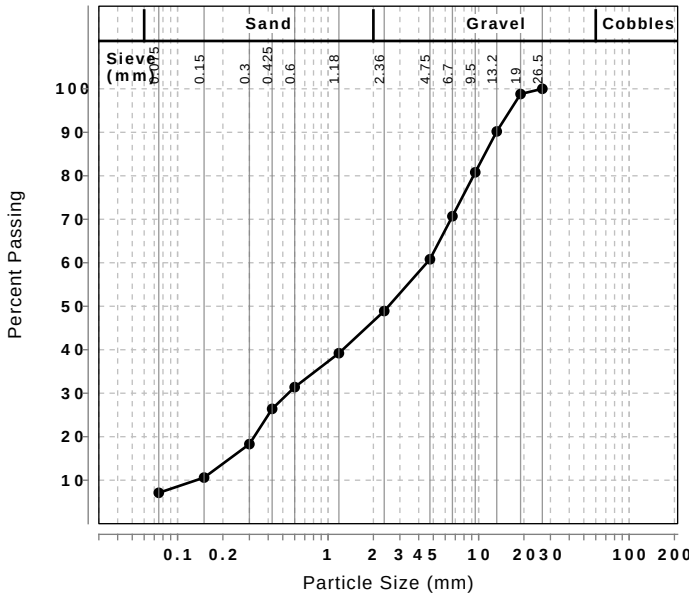
Approved Signatory: Peter Gorseski
Laboratory Manager
NATA Accredited Laboratory Number: 828

Report Number: **91452.00-1**
Issue Number: 1
Date Issued: 18/12/2018
Client: Boral Construction Materials
PO Box 6041, North Ryde NSW 2113
Project Number: 91452.00
Project Name: Infiltration Assessment
Project Location: Egret Street, Kooragang
Work Request: 2861
Sample Number: 18-2861E
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **P5 (0.1 - 0.4m)**
Material: FILLING: Sand and Gravel

Particle Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
26.5 mm	**100**		
19 mm	**99**		
13.2 mm	**90**		
9.5 mm	**81**		
6.7 mm	**71**		
4.75 mm	**61**		
2.36 mm	**49**		
1.18 mm	**39**		
0.6 mm	**31**		
0.425 mm	**26**		
0.3 mm	**18**		
0.15 mm	**11**		
0.075 mm	**7**		

Particle Size Distribution



Locality Plan

0 25 50 75 100 m

Approximate Test Location - Double Ring Infiltrometer

Approximate Test Location - Permeameter and Double Ring Infiltrometer

Drawing adapted fromNearmap Aerial Image, dated 8 December 2018

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Boral Construction Materials		
OFFICE:	Newcastle	DRAWN BY:	DJW
SCALE:	1:1500 @ A3	DATE:	18.12.18

TITLE: **Test Location Plan**
Infiltration Assessment
Boral Waste Management Facility, Egret Street, Kooragang

N

PROJECT No:	91452.00
DRAWING No:	1
REVISION:	0

Appendix C

Topographic survey

M.G.A.

N

LOT 1
DP 1119752

116°14'50" 228.95

RAVEN STREET

LOT 15
DP 1119752

61.055

116°14'50"

LOT 113
DP 740637

29°26'30" 541.4

LOT 16
DP 1119752

LOT 12
DP 1032146

209°26'10" 489.49

29°26' 251.965

STREET

LOT 114
DP 740637

LOT 2
DP 1195449

LOT 118
DP 832729

EGRET

LOT 5
DP 1015754

299°26'15" 106.69

299°26'15" 31.24

LOT 11
DP 1032146

LOT 2 DP 594332

342°54'05" 124.432

209°26'15" 152.4

LOT 1
DP 1195449

31.665
303°12'05"

CORMORANT

ROAD

29°26'25" 384.13

29°26'25" 143.005

LOT 4
DP 1015754

29.72
119°49'35"

TRACK
BITUMEN
KERB
PIT
INV.4.50
Ø0.35 PIPE
Ø0.3 PIPE
SIGN

BASIN
SCRUB
EDGE OF BITUMEN
LEASE BOUNDARY
RECYCLING STOCKPILES
(GROUND LEVEL ONLY)
MOUND OF TANKS
GAS PIPES
RAIL
HYDRANT
SHED
LOADER
CONCRETE
METAL SHED
LIGHT RODS
WEIGH BRIDGE
CONCRETE
BUILDING
SEPTIC TANK
BITUMEN
GATE
POST
BLOCK WALL
STOCKPILES FOR CEMENT PLANT
CONCRETE WALL
SILO
CONCRETE
WASH DOWN BAY
PIPE INV.2.84
PIPE INV.2.86
PIPE INV.2.93
TPOST
SIGN
TREES
WELL
SAC
ELEC
STORMW
GRAVEL TRACK
HYDRANT BOX
KERB & GUTTER
UPRIGHT KERB & GUTTER
FLAG POLE
SIGNS
GAS MAIN
PEG
PP
TEL

WELL
E 384146.84
N 6361131.41

WELL
E 384330.95
N 6361093.86

LOT 12
DP 1032146

LOT 2
DP 1195449

Ø0.25 PIPE
INV.3.34
PIT
INV.3.32
DITUMEN DRIVEWAY
GATE & DRAIN
CONCRETE DRIVEWAY

LEGEND

- FENCE
- (TELP) TELSTRA POST
- (TEL) TELSTRA PIT
- (ELEC) ELECTRICITY BOX
- (PP) POWER POLE
- (LP) STREET LIGHT
- (SS) SIGN
- (WM) WATER METER
- (SAC) SEWER ACCESS CHAMBER
- (RW) ROOF WATER DRAIN
- (SV) STOP VALVE
- KIP KERB INLET PIT

NOTES:
1. SURVEY IS FOR CONTOUR PURPOSES ONLY
2. LEVELS ARE AHD, ORIGIN SSM 35963 (RL 3.098)
3. CONTOUR INTERVAL IS 0.25m
4. SERVICES LOCATED BY FIELD SURVEY ONLY
5. TREE SPREADS ARE DIAGRAMMATIC ONLY AND MAY NOT BE SYMMETRICAL

NOTE: NO SUBTERRANEAN INVESTIGATIONS HAVE BEEN UNDERTAKEN. IT IS THE CONTRACTORS RESPONSIBILITY TO CONTACT DIAL BEFORE YOU DIG ON PHONE No. 1100 PRIOR TO ANY EXCAVATION OR EARTHWORKS.

DATE	REVISION	BY

0 2 4 6 8 10 12 14 16 18 20

SCALE 1:200 @ A1

DRAWN KF | SHEET 1 OF 1 SHEETS

RENNIE GOLLEDGE PTY. LTD.
SURVEYORS & PLANNERS
P.O. BOX 132
36 St ANDREWS ST
MAITLAND NSW 2320
ABN: 55 002 622 317
PH (02) 49334977
FAX (02) 49338579
mail@renniegolledge.com.au

CLIENT
BORAL SHARED BUSINESS SERVICES PTY. LTD.

THIS PLAN WAS PRODUCED SOLELY FOR THIS CLIENT.

CONTOUR AND DETAIL PLAN
LOT 12 DP 1032146 & LOT 2 DP 1195449
CORMORANT RD & EGRET ST, KOORAGANG

FILE NO. 208.07 | RATIO 1:1000 | DATE 10/07/15 | SURVEYED AF | DATUM AHD

Appendix D

Laboratory certificates of analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1817937**	Page	: 1 of 6
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR CHRIS KUCZERA	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: H180253 BORAL KOORAGANG	Date Samples Received	: 20-Jun-2018 13:48
Order number	:	Date Analysis Commenced	: 20-Jun-2018
C-O-C number	: ----	Issue Date	: 27-Jun-2018 16:01
Sampler	: CHRIS KUCZERA		
Site	: ----		
Quote number	: SYBQ/407/18		
No. of samples received	: 5		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW

General Comments

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

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

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

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

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

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

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

- EA015 TDS, result has been confirmed for sample 5 by re-analysis.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	SW3	SW4	SW5
			Client sampling date / time	20-Jun-2018 12:30	20-Jun-2018 12:45	20-Jun-2018 13:00	20-Jun-2018 13:15	20-Jun-2018 13:30
Compound	CAS Number	LOR	Unit	ES1817937-001	ES1817937-002	ES1817937-003	ES1817937-004	ES1817937-005
				Result	Result	Result	Result	Result
EA005: pH								
pH Value	----	0.01	pH Unit	**10.6**	**10.8**	**11.5**	**11.6**	**12.3**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**667**	**891**	**2340**	**3890**	**3690**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**402**	**542**	**1370**	**2410**	**1340**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**56**	**72**	**80**	**88**	**193**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**63.0**	**86.9**	**91.7**	**76.1**	**146**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	**5**	**79**	**140**	**648**
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**50**	**57**	**46**	**63**	**79**
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**4**	<1	<1	<1	<1
Total Alkalinity as CaCO3	----	1	mg/L	**54**	**62**	**125**	**204**	**728**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.64**	**0.76**	**2.01**	**1.07**	**2.64**
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.002**	**0.002**	**0.004**	**0.003**
Barium	7440-39-3	0.001	mg/L	**0.004**	**0.008**	**0.023**	**0.050**	**0.099**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	**0.020**	**0.027**	**0.107**	**0.147**	**0.162**
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.001**	**0.003**	**0.012**	**0.004**
Copper	7440-50-8	0.001	mg/L	**0.011**	**0.018**	**0.031**	**0.037**	**0.030**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L	**0.010**	**0.012**	**0.042**	**0.075**	**0.063**
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.004**	**0.004**	**0.008**	**0.003**
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	**0.105**	**0.140**	**0.337**	**0.815**	**1.10**
Vanadium	7440-62-2	0.01	mg/L	**0.02**	**0.02**	**0.03**	**0.06**	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	**0.020**	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	**0.06**	**0.13**	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	**0.06**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW5
				Client sampling date / time	20-Jun-2018 12:30	20-Jun-2018 12:45	20-Jun-2018 13:00	20-Jun-2018 13:15	20-Jun-2018 13:30
Compound	CAS Number	LOR	Unit		ES1817937-001	ES1817937-002	ES1817937-003	ES1817937-004	ES1817937-005
					Result	Result	Result	Result	Result
EG049F: Dissolved Trivalent Chromium									
Trivalent Chromium	16065-83-1	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		**0.02**	**0.02**	**0.10**	**0.15**	**0.16**
EK010: Chlorine									
Chlorine - Total Residual	----	0.2	mg/L		<0.2	<0.2	<0.2	<0.2	<0.2
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	**0.008**	**0.029**	**0.030**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.2**	**0.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.07**	**0.10**	**0.17**	**0.71**	**0.94**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.25**	**0.50**	**1.38**	**1.95**	**2.91**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.65**	**2.09**	**5.22**	**30.8**	**6.95**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.90**	**2.59**	**6.60**	**32.8**	**9.86**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.5**	**1.0**	**1.5**	**3.6**	**5.0**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.4**	**3.6**	**8.1**	**36.4**	**14.9**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	**0.02**	**0.02**	**0.26**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW5
				Client sampling date / time	20-Jun-2018 12:30	20-Jun-2018 12:45	20-Jun-2018 13:00	20-Jun-2018 13:15	20-Jun-2018 13:30
Compound	CAS Number	LOR	Unit		ES1817937-001	ES1817937-002	ES1817937-003	ES1817937-004	ES1817937-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**94.6**	**92.7**	**116**	**100**	**109**
Toluene-D8	2037-26-5	2	%		**100**	**85.7**	**91.2**	**99.2**	**94.6**
4-Bromofluorobenzene	460-00-4	2	%		**93.1**	**86.4**	**98.9**	**95.6**	**99.1**

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1826205**	Page	: 1 of 6
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR CHRIS KUCZERA	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: H180253 BORAL KOORAGANG	Date Samples Received	: 05-Sep-2018 15:35
Order number	:	Date Analysis Commenced	: 05-Sep-2018
C-O-C number	: ----	Issue Date	: 11-Sep-2018 16:03
Sampler	: CHRIS KUCZERA		
Site	: ----		
Quote number	: EN/112/18		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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- General Comments
- Analytical Results
- Surrogate Control Limits

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Signatories

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Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP050: The MBAS reported is calculated as LAS, mol wt 342.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW2	----	----	----
			Client sampling date / time	05-Sep-2018 00:00	05-Sep-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES1826205-001	ES1826205-002	--------	--------	--------
				Result	Result	----	----	----
EA005: pH								
pH Value	----	0.01	pH Unit	**9.36**	**10.9**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2890**	**5860**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**1710**	**3070**	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**46**	**49**	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**30.8**	**34.3**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**268**	**363**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.41**	**1.07**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.008**	**0.045**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.013**	**0.093**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.003**	**0.019**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.002**	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.013**	**0.055**	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.376**	**0.765**	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**0.01**	**0.02**	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.009**	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.24**	**0.14**	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.25**	**0.34**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG049F: Dissolved Trivalent Chromium								
Trivalent Chromium	16065-83-1	0.01	mg/L	<0.01	**0.01**	----	----	----
EG050F: Dissolved Hexavalent Chromium								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	----	----	----
				Client sampling date / time	05-Sep-2018 00:00	05-Sep-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES1826205-001	ES1826205-002	--------	--------	--------
					Result	Result	----	----	----
EG050F: Dissolved Hexavalent Chromium - Continued									
Hexavalent Chromium	18540-29-9	0.01	mg/L		**0.01**	**0.08**	----	----	----
EK010-1: Chlorine									
Total Residual Chlorine	----	0.02	mg/L		<0.02	<0.02	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	**0.006**	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.2**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.20**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.09**	**0.52**	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.34**	**2.14**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.43**	**2.66**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**8.6**	**2.1**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**9.0**	**4.8**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	**0.02**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EP050: Anionic Surfactants as MBAS									
Anionic Surfactants as MBAS	----	0.1	mg/L		<0.1	<0.1	----	----	----
EP075(SIM)A: Phenolic Compounds									
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	----	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	----	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	<1.0	----	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	<1.0	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	----	----	----
				Client sampling date / time	05-Sep-2018 00:00	05-Sep-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES1826205-001	ES1826205-002	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Petroleum Hydrocarbons - Continued									
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**26.2**	**25.3**	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**48.2**	**50.8**	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**50.1**	**40.0**	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**79.6**	**87.9**	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**94.3**	**81.3**	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**85.0**	**93.9**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**100**	**100**	----	----	----
Toluene-D8	2037-26-5	2	%		**106**	**106**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**96.1**	**96.7**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1829501**	Page	: 1 of 6
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR CHRIS KUCZERA	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: H180253 BORAL KOORAGANG	Date Samples Received	: 05-Oct-2018 15:46
Order number	:	Date Analysis Commenced	: 05-Oct-2018
C-O-C number	: ----	Issue Date	: 12-Oct-2018 14:18
Sampler	: JASON O'BRIEN		
Site	: ----		
Quote number	: EN/112/18		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

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

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

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

- EA015 TDS, result has been confirmed for sample 3 by re-analysis.
- EP050: The MBAS reported is calculated as LAS, mol wt 342.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW1	SW3	SW4	----	----
			Client sampling date / time	05-Oct-2018 00:00	05-Oct-2018 00:00	05-Oct-2018 00:00	----	----
Compound	CAS Number	LOR	Unit	ES1829501-001	ES1829501-002	ES1829501-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.45**	**9.60**	**12.1**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**4540**	**4960**	**6810**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	----	----	**2500**	----	----
Total Dissolved Solids @180°C	----	10	mg/L	**2430**	**2530**	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**26**	**104**	**120**	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**24.4**	**125**	**146**	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**417**	**321**	**712**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.05**	**0.40**	**0.98**	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	**0.002**	----	----
Barium	7440-39-3	0.001	mg/L	**0.011**	**0.025**	**0.260**	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	**0.018**	**0.043**	**0.131**	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.008**	**0.022**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.002**	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.018**	**0.037**	**0.060**	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	**0.002**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Strontium	7440-24-6	0.001	mg/L	**0.591**	**0.529**	**2.11**	----	----
Vanadium	7440-62-2	0.01	mg/L	**0.01**	**0.02**	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.007**	<0.005	<0.005	----	----
Boron	7440-42-8	0.05	mg/L	**0.40**	**0.24**	<0.05	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	**0.07**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EG049F: Dissolved Trivalent Chromium								
Trivalent Chromium	16065-83-1	0.01	mg/L	<0.01	<0.01	**0.01**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW3	SW4	----	----
				Client sampling date / time	05-Oct-2018 00:00	05-Oct-2018 00:00	05-Oct-2018 00:00	----	----
Compound	CAS Number	LOR	Unit		ES1829501-001	ES1829501-002	ES1829501-003	--------	--------
					Result	Result	Result	----	----
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		**0.02**	**0.04**	**0.12**	----	----
EK010-1: Chlorine									
Free Chlorine	----	0.02	mg/L		**0.06**	**0.10**	**0.07**	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	**0.004**	**0.006**	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.2**	**0.2**	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.16**	**0.13**	**0.33**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.09**	**0.59**	**0.59**	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.43**	**0.92**	**2.76**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.52**	**1.51**	**3.35**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.9**	**1.2**	**5.9**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.4**	**2.7**	**9.2**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.05**	**0.04**	**0.03**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EP050: Anionic Surfactants as MBAS									
Anionic Surfactants as MBAS	----	0.1	mg/L		**0.2**	**0.1**	**0.1**	----	----
EP075(SIM)A: Phenolic Compounds									
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	<2.0	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW3	SW4	----	----
				Client sampling date / time	05-Oct-2018 00:00	05-Oct-2018 00:00	05-Oct-2018 00:00	----	----
Compound	CAS Number	LOR	Unit		ES1829501-001	ES1829501-002	ES1829501-003	--------	--------
					Result	Result	Result	----	----
EP080/071: Total Petroleum Hydrocarbons - Continued									
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**28.4**	**25.0**	**15.7**	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**55.2**	**53.9**	**44.0**	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**57.2**	**61.8**	**41.2**	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**76.6**	**85.2**	**88.8**	----	----
Anthracene-d10	1719-06-8	1.0	%		**96.3**	**99.3**	**93.5**	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**94.7**	**89.3**	**97.1**	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**99.1**	**106**	**97.0**	----	----
Toluene-D8	2037-26-5	2	%		**98.5**	**107**	**99.5**	----	----
4-Bromofluorobenzene	460-00-4	2	%		**91.7**	**100**	**93.8**	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1908121**	Page	: 1 of 11
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR CHRIS KUCZERA	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61 2 8784 8555
Project	: H180253 BORAL KOORAGANG	Date Samples Received	: 18-Mar-2019 13:53
Order number	: ----	Date Analysis Commenced	: 18-Mar-2019
C-O-C number	: ----	Issue Date	: 22-Mar-2019 17:53
Sampler	: JASON O'BRIEN		
Site	: ----		
Quote number	: EN/112/18		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

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

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

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

- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EG050G: Poor spike recovery for Hexavalent Chromium due to matrix interferences.
- EP075(SIM) : Poor surrogate recoveries due to matrix effects.
- EP050: The MBAS reported is calculated as LAS, mol wt 342.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW7
				Client sampling date / time	18-Mar-2019 12:00	18-Mar-2019 12:30	18-Mar-2019 13:00	18-Mar-2019 11:30	18-Mar-2019 11:45
Compound	CAS Number	LOR	Unit		ES1908121-001	ES1908121-002	ES1908121-003	ES1908121-004	ES1908121-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.26	10.6	10.1	10.9	10.8
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		4760	9080	8740	6060	9760
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		2500	4680	4790	3340	5370
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		16	<5	74	41	57
EA045: Turbidity									
Turbidity	----	0.1	NTU		15.7	12.9	84.9	33.5	42.9
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		420	15	492	612	597
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.13	3.38	1.03	2.55	1.49
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.011	0.002	0.004	0.002
Barium	7440-39-3	0.001	mg/L		0.012	0.022	0.068	0.107	0.105
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		0.014	0.278	0.066	0.127	0.076
Cobalt	7440-48-4	0.001	mg/L		<0.001	0.031	0.002	0.003	0.003
Copper	7440-50-8	0.001	mg/L		0.007	0.312	0.027	0.079	0.026
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	7439-98-7	0.001	mg/L		0.012	0.167	0.050	0.082	0.054
Nickel	7440-02-0	0.001	mg/L		0.002	0.055	0.004	0.008	0.004
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L		0.693	0.339	1.14	1.47	1.53
Vanadium	7440-62-2	0.01	mg/L		<0.01	0.02	0.02	0.02	0.02
Zinc	7440-66-6	0.005	mg/L		0.007	0.006	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L		0.43	0.17	0.14	<0.05	0.09
Iron	7439-89-6	0.05	mg/L		<0.05	0.36	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG049F: Dissolved Trivalent Chromium									
Trivalent Chromium	16065-83-1	0.01	mg/L		<0.01	0.21	<0.01	<0.01	<0.01
EG050F: Dissolved Hexavalent Chromium									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW7
				Client sampling date / time	18-Mar-2019 12:00	18-Mar-2019 12:30	18-Mar-2019 13:00	18-Mar-2019 11:30	18-Mar-2019 11:45
Compound	CAS Number	LOR	Unit		ES1908121-001	ES1908121-002	ES1908121-003	ES1908121-004	ES1908121-005
					Result	Result	Result	Result	Result
EG050F: Dissolved Hexavalent Chromium - Continued									
Hexavalent Chromium	18540-29-9	0.01	mg/L		**0.02**	**0.07**	**0.08**	**0.14**	**0.09**
EK010: Chlorine									
Chlorine - Total Residual	----	0.2	mg/L		<0.2	<0.2	<0.2	<0.2	<0.2
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	**0.026**	**0.006**	**0.007**	**0.007**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.2**	**0.2**	**3.6**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.15**	**2.78**	**0.28**	**1.04**	**0.36**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.47**	**10.9**	**2.17**	**5.31**	**2.36**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.69**	**1.90**	**3.97**	**7.99**	**5.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**1.16**	**12.8**	**6.14**	**13.3**	**7.37**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.0**	**10.8**	**2.1**	**4.1**	**1.8**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**2.2**	**23.6**	**8.2**	**17.4**	**9.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	**0.05**	**0.14**	**0.09**	**0.11**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP050: Anionic Surfactants as MBAS									
Anionic Surfactants as MBAS	----	0.1	mg/L		**0.1**	**0.6**	**0.2**	**0.3**	**0.1**
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW7
				Client sampling date / time	18-Mar-2019 12:00	18-Mar-2019 12:30	18-Mar-2019 13:00	18-Mar-2019 11:30	18-Mar-2019 11:45
Compound	CAS Number	LOR	Unit		ES1908121-001	ES1908121-002	ES1908121-003	ES1908121-004	ES1908121-005
					Result	Result	Result	Result	Result
EP075(SIM)A: Phenolic Compounds - Continued									
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	**260**	<100	**130**	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	**260**	<50	**130**	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	**210**	<100	**100**	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	**210**	<100	**100**	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**23.8**	**0.0857**	**3.12**	**1.28**	**0.0270**
2-Chlorophenol-D4	93951-73-6	1.0	%		**55.6**	**1.49**	**2.69**	**1.31**	**1.32**
2.4.6-Tribromophenol	118-79-6	1.0	%		**51.2**	**0.0321**	**9.83**	**8.80**	**3.48**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW1	SW2	SW3	SW4	SW7
				Client sampling date / time	18-Mar-2019 12:00	18-Mar-2019 12:30	18-Mar-2019 13:00	18-Mar-2019 11:30	18-Mar-2019 11:45
Compound	CAS Number	LOR	Unit		ES1908121-001	ES1908121-002	ES1908121-003	ES1908121-004	ES1908121-005
					Result	Result	Result	Result	Result
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		68.6	66.1	66.2	64.7	62.3
Anthracene-d10	1719-06-8	1.0	%		86.8	67.8	86.0	64.9	82.5
4-Terphenyl-d14	1718-51-0	1.0	%		80.9	79.7	84.9	77.4	78.8
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		93.3	97.1	96.4	102	103
Toluene-D8	2037-26-5	2	%		84.5	90.5	93.9	98.9	104
4-Bromofluorobenzene	460-00-4	2	%		84.1	89.6	90.3	94.6	98.1

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW8	----	----	----	----
			Client sampling date / time	18-Mar-2019 11:00	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1908121-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**9.43**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**15400**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**10300**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**84**	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**24.3**	----	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**1180**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.29**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.144**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.068**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.003**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.019**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.056**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.004**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**2.90**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**0.02**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.024**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.19**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG049F: Dissolved Trivalent Chromium								
Trivalent Chromium	16065-83-1	0.01	mg/L	<0.01	----	----	----	----
EG050F: Dissolved Hexavalent Chromium								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW8	----	----	----	----
				Client sampling date / time	18-Mar-2019 11:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1908121-006	--------	--------	--------	--------
					Result	----	----	----	----
EG050F: Dissolved Hexavalent Chromium - Continued									
Hexavalent Chromium	18540-29-9	0.01	mg/L		**0.08**	----	----	----	----
EK010: Chlorine									
Chlorine - Total Residual	----	0.2	mg/L		<0.2	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		**0.009**	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.34**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**1.76**	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**8.24**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**10.0**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.7**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**11.7**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EP050: Anionic Surfactants as MBAS									
Anionic Surfactants as MBAS	----	0.1	mg/L		**0.3**	----	----	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		<1.0	----	----	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	----	----	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	----	----	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	----	----	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	----	----	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	----	----	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW8	----	----	----	----
				Client sampling date / time	18-Mar-2019 11:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1908121-006	--------	--------	--------	--------
					Result	----	----	----	----
EP075(SIM)A: Phenolic Compounds - Continued									
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	----	----	----	----
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	----	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ Total Xylenes	----	2	µg/L		<2	----	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**8.20**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**7.18**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**3.24**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW8	----	----	----	----
				Client sampling date / time	18-Mar-2019 11:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1908121-006	--------	--------	--------	--------
					Result	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**59.5**	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**65.6**	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**78.8**	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**105**	----	----	----	----
Toluene-D8	2037-26-5	2	%		**104**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**98.6**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1927908**	Page	: 1 of 7
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR CHRIS KUCZERA	Contact	: Sepan Mahamad
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61 2 8784 8555
Project	: H180253 BORAL KOORAGANG	Date Samples Received	: 02-Sep-2019 10:59
Order number	: ----	Date Analysis Commenced	: 02-Sep-2019
C-O-C number	: ----	Issue Date	: 06-Sep-2019 15:22
Sampler	: ----		
Site	: ----		
Quote number	: EN/112/18 - Compass A		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

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

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

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

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

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

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

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

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

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	BASIN	SWALE	YARD 1	YARD 2	YARD 3
			Client sampling date / time	31-Aug-2019 10:00	31-Aug-2019 10:15	31-Aug-2019 10:30	31-Aug-2019 10:45	31-Aug-2019 11:00
Compound	CAS Number	LOR	Unit	ES1927908-001	ES1927908-002	ES1927908-003	ES1927908-004	ES1927908-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.69	10.0	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	415	716	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	241	367	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	47	103	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	61.3	107	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	6	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	37	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	29	<1	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	29	43	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	41	70	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.38	0.92	3.36	2.48	2.51
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.001	0.006	0.003	0.002
Barium	7440-39-3	0.001	mg/L	0.004	0.007	0.006	0.060	0.156
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.011	0.026	0.067	0.064	0.087
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.006	0.002	0.008
Copper	7440-50-8	0.001	mg/L	0.008	0.013	0.104	0.053	0.047
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.002	<0.001	0.001
Molybdenum	7439-98-7	0.001	mg/L	0.006	0.014	0.033	0.024	0.014
Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.016	0.006	0.007
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium	7440-24-6	0.001	mg/L	0.093	0.147	0.285	0.651	1.64
Vanadium	7440-62-2	0.01	mg/L	<0.01	0.01	0.02	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	0.008	<0.005	<0.005	0.019	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.38	0.12	0.24

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	BASIN	SWALE	YARD 1	YARD 2	YARD 3
			Client sampling date / time	31-Aug-2019 10:00	31-Aug-2019 10:15	31-Aug-2019 10:30	31-Aug-2019 10:45	31-Aug-2019 11:00
Compound	CAS Number	LOR	Unit	ES1927908-001	ES1927908-002	ES1927908-003	ES1927908-004	ES1927908-005
				Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK010: Chlorine								
Chlorine - Total Residual	----	0.2	mg/L	<0.2	<0.2	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.7**	**0.4**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.08**	**0.12**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.16**	**0.36**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.96**	**2.00**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.12**	**2.36**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.5**	**0.9**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.6**	**3.3**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.03**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	BASIN	SWALE	YARD 1	YARD 2	YARD 3
				Client sampling date / time	31-Aug-2019 10:00	31-Aug-2019 10:15	31-Aug-2019 10:30	31-Aug-2019 10:45	31-Aug-2019 11:00
Compound	CAS Number	LOR	Unit		ES1927908-001	ES1927908-002	ES1927908-003	ES1927908-004	ES1927908-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**118**	**101**	----	----	----
Toluene-D8	2037-26-5	2	%		**118**	**92.9**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**100**	**88.6**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	YARD 4	----	----	----	----
				Client sampling date / time	31-Aug-2019 11:45	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1927908-006	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**2.42**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.016**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.072**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.002**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.041**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.023**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.004**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	----	----	----	----
Strontium	7440-24-6	0.001	mg/L		**0.312**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		**0.02**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.20**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128