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Soil and Water Assessment

Kooragang Recycling Facility EIS

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Boral Recycling (NSW/ACT) Pty Ltd

Version: FINAL

Soil and Water Assessment

Kooragang Recycling Facility EIS

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1 INTRODUCTION

1.1 Background

Boral Recycling Pty Ltd ('Boral') proposes to increase the area and stockpile heights at its Kooragang Waste Recycling WRF (the WRF). This will require an expansion to the existing WRF. The proposal is being assessed as State Significant Development (SSD) under Part 4.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). Accordingly, this Soil and Water Assessment has been prepared to support an environmental impact statement (EIS) and development application (DA) for the proposal.

The existing WRF is located on the corner of Cormorant Road and Egret St, Kooragang Island within Lot 12 DP 1032146 (the Site).

Environmental Property Services (EPS) was commissioned by the Applicant to prepare the EIS to accompany the DA. SLR Consulting Australia Pty Ltd (SLR) was subsequently engaged to prepare a Soil and Water Assessment (SWA) as part of the EIS.

This SWA report has been prepared to fulfil the requirements detailed in the Secretary's Environmental Assessment Requirements (SEARs) relating to soil and water issued by the NSW Department of Planning and Environment (DP&E) as detailed in **Table 1**.

1.2 Site Description

The property description of the Site is Lot 12 DP 1032146. The Site is zoned SP1 (Special Activities) under SEPP (Three Ports) 2013. This SEPP has recently been amended so that waste management facilities (among other activities) are permitted with consent.

The location of the Site is shown in **Figure 1**. The Site extent is shown in **Figure 2**.

The Site covers an area of approximately 12.45 ha. It is wholly owned by Boral Cement but is currently occupied by four separate businesses as follows and shown in **Figure 3**:

- 2.1 ha leased to Boral Recycling (i.e. the WRF) (shaded green);
- 0.71 ha leased to Boral Concrete (shaded blue);
- 1.9 ha leased to Origin Energy (shaded yellow); and
- Boral Cement operations make up the remaining 7.74 ha (shaded orange).

In brief, the WRF comprises the following:

- Incoming materials stockpile area;
- Processed materials stockpiles;
- Water management area;
- Weighbridge;
- Office and amenities area; and
- Car park.

Boral holds an Environment Protection Licence (EPL 11968) for waste storage and resource recovery. The proposed DA would require a variation to the existing EPL conditions to revise the waste received at the premises in accordance with the development approval being sought.

1.3 Overview of Proposal

The WRF currently operates under an existing development consent granted by Newcastle City Council in 2003 (DA 01/2716). This consent was for a mobile plant and limited stockpile heights to 5m. Due to the small site area and the onerous limit on stockpile heights, Boral is seeking to submit a development application to permit the following:

- Increased production volumes;
- Increased stockpile heights; and
- Importation of additional waste streams not currently listed in either the EPL or consent including:
    - Building and demolition waste, as defined in Schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act);
    - Asphalt waste;
    - Concrete waste from concrete batching plants;
    - Virgin excavated natural material (VENM);
    - Excavated natural material (ENM);
    - Plasterboard and ceramics;
    - Soil (meeting CT1 thresholds for General Solid Waste in Table 1 of the waste classification guidelines);
    - Tiles and masonry;
    - Natural quarry products;
    - General or specific exempted waste (meeting all conditions of a resource recovery exemption under clause 51A of the *POEO (Waste) Regulation 2014*);
    - Any waste that is below licensing thresholds in schedule 1 of the POEO Act; and
    - Bricks, tiles and masonry seconds direct from the manufacturer.

Figure 4 shows the proposed expanded layout of the recycling operations (the Expanded WRF) to a total area of approximately 3.45 ha. The proposed expansion intends to acquire 5250m^2 of land which is currently leased by Origin Energy with an additional 5200m^2 of land proposed for the expansion being the drainage strip located to the south of the Origin lease, adjacent to the main entrance to the Boral Cement facility. The drainage land is intended to be used as a stockpiling area and as a result will be partially filled and will require the installation of an alternative drainage regime to safely convey runoff from the existing site as well as increased amounts of runoff that will be generated by the proposed development. It is noted that the final Expanded WRF footprint is likely to be less than 3.45 ha in order to incorporate management measures as detailed in this report.

Figure 5 shows the Expanded WRF and the proposed operations footprint's for each of the other three businesses.

Figure 1 Site Locality Plan

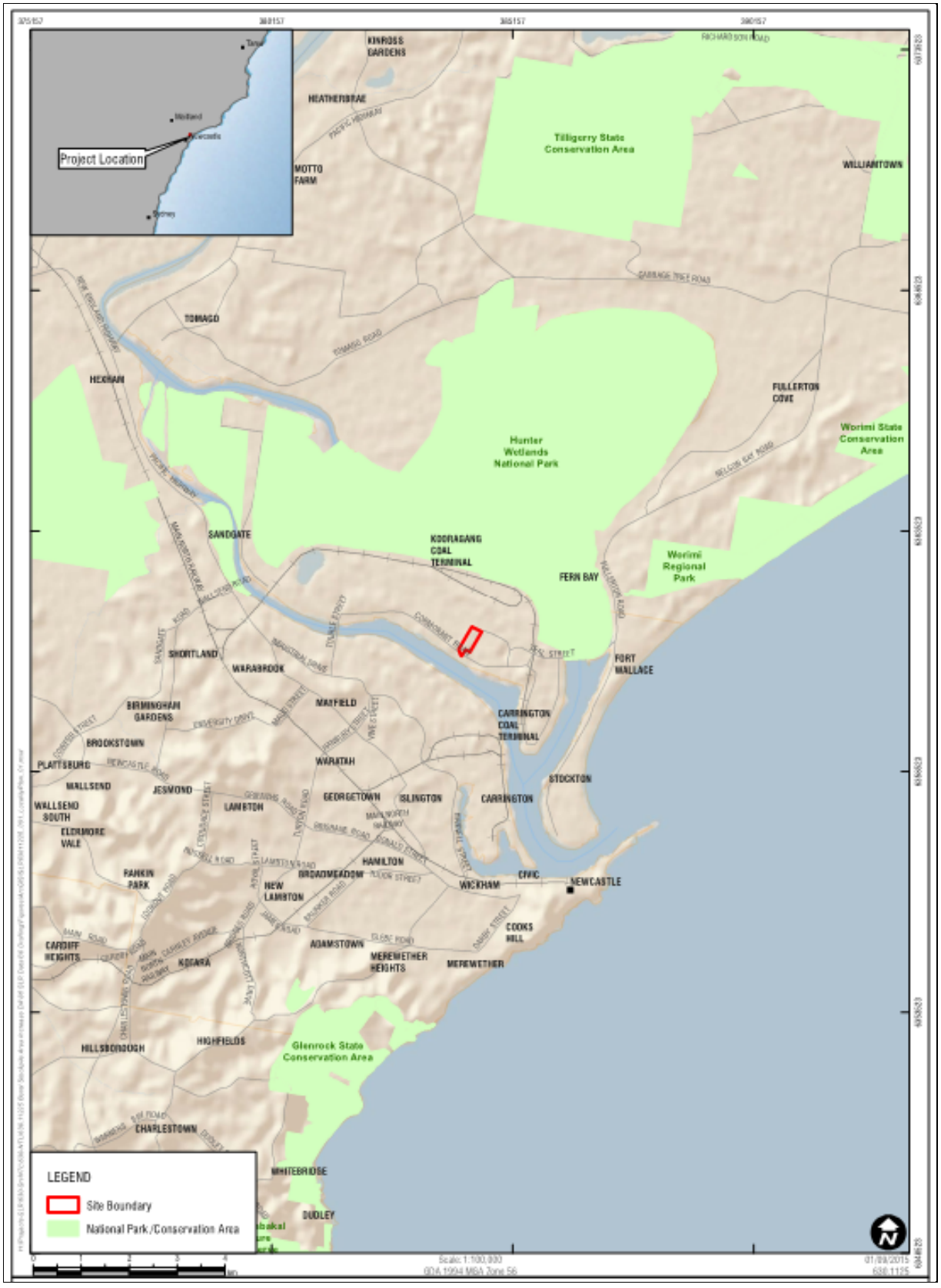


Figure 2 Site Extent

Figure 3 Existing Operations

Figure 4 Proposed WRF Expansion

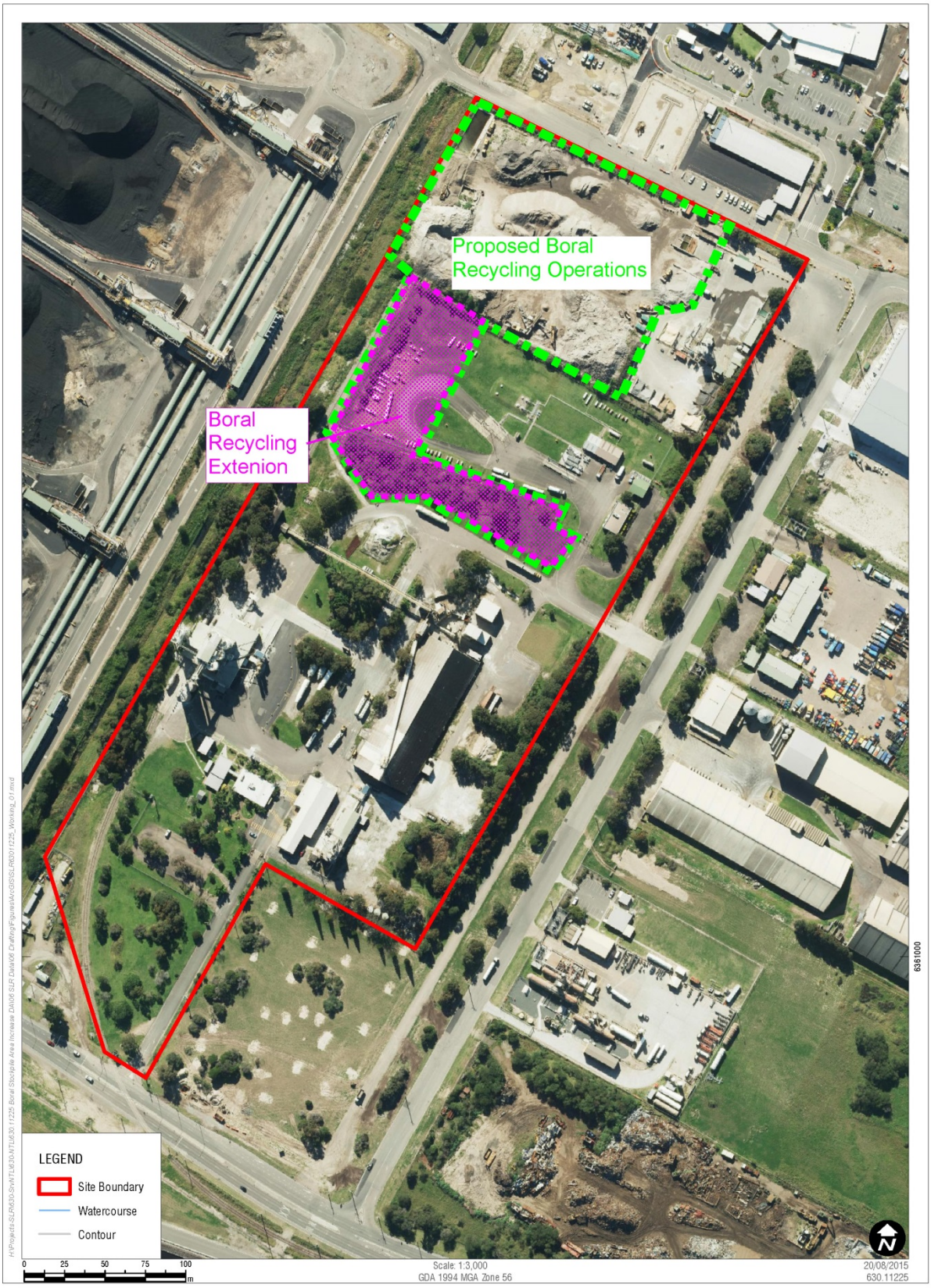


Figure 5 Proposed Operations

1.4 Soil and Water Assessment Scope of Works

This SWA focussed on:

- assessment of potential soil and water impacts associated with the Proposal;
- assessment of soil and water impacts associated with the ongoing operation of the existing WRF; and
- development of appropriate measures to mitigate the potential impacts associated with the Proposal and ongoing operation of the existing WRF.

The SWA scope of works included:

- Site walkover;
- Liaison with the Port of Newcastle (who own land parcels adjacent to the Site and associated stormwater infrastructure) in relation to their expectations for stormwater management;
- Literature review of relevant legislation, policies and guidelines and relevant Boral documentation;
- Surface Water Assessment including:
    - Review of existing stormwater management system and control measures within the WRF;
    - Review of the existing stormwater management system and control measures within other areas of the Site potentially affected by the Proposal;
    - Development of appropriate options to mitigate potential surface water quality and quantity impacts;
    - Hydrological and hydraulic modelling to assess potential surface water discharge impacts during a range of design events and conceptually design mitigation measures to meet regulator requirements;
- Water balance modelling including:
    - Development of a daily time step water balance model;
    - Assessment of proposed mitigation options in relation to their effect on water security; and
    - Water balance for a dry, median and wet years.
- Groundwater Assessment including:
    - Desktop assessment of groundwater quality within the Site and surrounding area;
    - Desktop assessment to assess the presence of any local Groundwater Dependant Ecosystems (GDE's);
    - Installation of two (2) groundwater monitoring wells (monitoring wells R1 and C2);
    - Groundwater sampling at groundwater monitoring wells R1 and C2 and gauging of groundwater levels at monitoring wells R1, C1 and C2; and
    - Review of previous groundwater quality and level data for groundwater monitoring well C1.
- Assessment of soil and water impacts associated with the Proposal and ongoing operation of the WRF and development of appropriate mitigation and management measures.

1.5 Planning Context

The following relevant legislation, policies and guidelines were considered as part of this SWA:

- Water Management Act (2000) and Water Act (1912);
- Greater Metropolitan Region Unregulated River Water Sources (2011);
- Protection of the Environment Operations Act (1997)
- Managing Urban Stormwater: Soils & Construction (NSW Government, 2004)
- State Environmental Planning Policy (Exempt and Complying Development Codes) 2008
- National Water Quality Management Strategy, Department of Environment, Australian Government, 1992
- NSW State Rivers and Estuaries Policy, NSW Government 1993
- Newcastle City Council Stormwater and Water Efficiency for Development - Technical Manual, 2013

These are discussed further in Section **3**.

2 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

The Secretary's Environmental Assessment Requirements (SEARs) for the Proposal, relevant to Soil and Water, and other requirements identified by government agencies are listed in **Table 1**.

Table 1 Secretary's Environmental Assessment Requirements

Government Agency	Paraphrased Requirement	Relevant section of this report
	SOIL and WATER - SEARs	
NSW Department of Planning and Environment (27/5/2015)	A description of local soils, topography, landscapes, drainage, watercourses, riparian lands and groundwater dependent ecosystems	4
	A site water balance, including details on water supply, licence requirements and a description of the measures to minimise the water use	6
	A description of the proposed leachate, stormwater and wastewater management systems including the capacity of onsite detention systems and measures to treat, reuse or dispose of water	5.5 & 5.6
	A description of the proposed erosion and sediment controls during construction and operation	8
	An appraisal of the development against the rules of the relevant Water Sharing Plan (WSP) and legislation	3.1.2
	An assessment of impacts to surface and groundwater resources, soils and flooding;	7
	A description and appraisal of proposed mitigation, management and monitoring measures	8
	SOIL and WATER – EPA REQUIREMENTS	
NSW EPA (12/5/2015)	Adequate assessment of impacts on water quality and site water management	7
	SOIL and WATER – OFFICE OF WATER REQUIREMENTS	
NSW Office of Water (4/5/2015)	Details of water proposed to be taken (including through inflow and seepage) from each surface water source as defined by the relevant water sharing plan	5
	Assessment of any water licensing requirements (including those for ongoing water take following completion of the project)	3 & 4
	The identification of an adequate and secure water supply for the life of the project. Confirmation that water can be sourced from an appropriately authorised and reliable supply. This is to include an assessment of the current market depth where water entitlement is required to be purchased.	6
	A detailed and consolidated site water balance	6
	Assessment of impacts on surface water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land and measures proposed to reduce and mitigate these impacts.	7
	Full technical details and data of all surface and groundwater modelling.	4, 5, 6, 7 & 8
	Proposed surface water monitoring activities and methodologies	4
	Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts	7 & 8
	Consideration of relevant policies and guidelines.	3
	SOIL and WATER – PORT OF NEWCASTLE REQUIREMENTS	
Port of Newcastle (15/5/2015)	All material from stockpiles (existing and proposed) should be contained on site; and appropriate erosion and sedimentation controls be designed and implemented.	8

Government Agency	Paraphrased Requirement	Relevant section of this report
	Surface water should be managed on-site through the design and implementation of appropriate stormwater management controls. Any discharge of Stormwater into the North-South drain on Lot 16 or Egret Street should meet ANZECC water quality guideline standards, particularly for TSS and metals.	5

3 RELEVANT LEGISLATION, POLICY, GUIDELINES AND LICENCES

3.1 Legislation

3.1.1 Water Management Act 2000 and Water Act 2012

The *Water Act 1912* and *Water Management Act 2000* (WM Act 2000) contain provisions for the licensing of water capture and use. If any dams are proposed as part of the water management infrastructure, consideration must be given to whether the storages onsite need to be licensed. If the storages are not within the harvestable right of the property, or are not specifically exempt storages, it is likely that they would need to be licensed.

The WRF is located within an area covered by a water sharing plan. Therefore volumetric licensing applies.

The proposal is an SSD project and is therefore exempt from requiring water use approvals, water management works approvals and controlled activity approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

3.1.2 Water Sharing Plan

The proposal is located within the area covered by the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2014 (the Water Sharing Plan). This Plan includes rules for protecting the environment, extractions, managing licence holders' water accounts, and water trading in the plan area.

As a means of achieving the objectives of the Water Sharing Plan, total daily extraction limits are in place to protect the water held under access licences for the purpose of providing water to the environment and protecting flow. Extraction limits and environmental flow protection rules are used to protect, preserve, maintain and enhance the region's water. Planned environmental water provisions are in place to achieve this and relate to water that is committed by management plans for fundamental ecosystem health or other specified environmental purposes, and that cannot to the extent committed be taken or used for any other purpose. Adaptive environmental water conditions may be imposed on the whole or part of an access licence as another way to ensure the environmental water supply is protected.

Rainfall runoff from the wider Site is currently collected in a concrete storage dam and drainage areas and is reused on-site for dust mitigation and wheel washing, with some runoff infiltrating to ground. The Proposal will involve the creation of new infiltration basins to replicate this regime.

An existing licensed bore GW200456 (licence 20BL168957) is installed onsite (within the Boral Cement Operations). A NSW Office of Water database search indicates that water is extracted for irrigation purposes.

Water is also extracted from the spear point GW053226 (licence 20BL117398) within the WRF for dust suppression purposes. A search of the NSW Office of Water database indicates that the licence of this spear point has lapsed. As such Boral will apply for this spear point licence to be re-activated.

Water is not extracted from any other water sources onsite.

3.2 Policies and Guidelines

The following relevant policies and guidelines were considered as part of this SWA:

- Newcastle City Council Stormwater Technical Manual (NCC, 2013)
- Managing Urban Stormwater: Soils & Construction (NSW Government, 2004);

- Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000)
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC, 2004);
- NSW Aquifer Interference Policy (NOW, 2012); and
- NSW Groundwater Dependent Ecosystems Policy (NSW Department of Land and Water Conservation, 2001).

3.2.1 Newcastle City Council Stormwater and Water Efficient for Development Technical Manual

The technical manual supports the Newcastle Development Control Plan (DCP) 2012, particularly Sections 7.06 Stormwater Management, 7.07 Water Efficiency and 7.02 Landscape, Open Space and Visual Amenity. The manual provides detailed text, instructions and best practice guidelines on the management of stormwater runoff from all public and private property within the City of Newcastle.

The principles and design criteria of the manual have been adopted when assessing the performance and suitability of stormwater management in relation to the Proposal and developing mitigation measures as part of this SWA.

3.2.2 Managing Urban Stormwater: Soils and Construction

In NSW, the most relevant and comprehensive guidelines for the design of stormwater controls at the Site are contained within the Landcom document, 'Managing Urban Stormwater: Soils and Construction', Vol. 1, 4th ed. (Landcom, 2004) commonly known as the 'Blue Book'. The Blue Book is utilised as guidance for broader industries and contains prescriptive guidelines for what should be included in an Erosion and Sediment Control Plan (ESCP) and a Soil and Water Management Plan (SWMP). Managing Urban Stormwater: Soils & Construction – Volume 2B, Waste Landfills (DECC, 2008), although not directly applicable to a recycling facility has been considered during the preparation of this SWA given that stormwater runoff onsite will come into contact with waste materials.

The principles of surface water and sediment control, have been adopted when assessing the performance and suitability of the onsite basins and in developing the proposed management and mitigation measures.

3.2.3 NSW Water Quality and River Flow Objectives

The NSW Water Quality Objectives are the agreed environmental values and long-term goals for NSW's surface waters. They set out:

- the community's values and uses for our rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help us assess whether the current condition of our waterways supports those values and uses.

Water Quality Objectives have been agreed for Fresh and Estuarine surface waters and Marine Waters.

The Objectives are consistent with the agreed national framework for assessing water quality set out in the ANZECC (2000) guidelines. The Water Quality Objectives provide environmental values for NSW waters and the ANZECC 2000 Guidelines provide the technical guidance to assess the water quality needed to protect those values.

The River Flow Objectives are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

The water quality objectives and river flow objectives have been considered within this SWA.

3.2.4 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) provides a national approach to improving water quality in Australia's waterways. Development has progressed since 1992, with the Australian Government working in cooperation with state and territory governments to produce the Strategy. The Strategy incorporates a number of key guidelines concerning management and monitoring of water including the following:

- Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000); and
- Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000).

Direction for the application of the guidelines is provided in the following document:

- Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC, 2006).

These guidelines provide an agreed framework to assess water quality in terms of whether the water is suitable for a range of environmental values (including human uses).

The ANZECC (2000) guidelines for protection of downstream ecosystems have been considered in assessing the water quality impacts of current and future discharges to the Hunter River and its tributaries.

3.2.5 NSW State Rivers and Estuaries Policy

The NSW State Rivers and Estuaries Policy, originally published in 1993, contains State-wide objectives for the protection and enhancement of watercourses. Though the institutional arrangements and legislation have changed since then, the overarching objectives remain valid. The overall objectives of the policy are “to manage the rivers and estuaries of NSW in ways which slow, halt or reverse the overall rate of degradation in their systems, ensure the long-term sustainability of their essential biophysical functions, and maintain the beneficial use of these resources” (NSW Water Resources Council, 1993).

The proposed stormwater management associated with the Proposal should be consistent with the policy objectives. This assessment demonstrates there is no significant degradation of the Hunter River as a result of the Proposal.

3.2.6 State Water Management Outcomes Plan (WM Act)

The WM Act includes the State Water Management Outcomes Plan, a statutory document which sets the overarching policy, targets and strategic outcomes of the WM Act. This document expired in 2007, however, the content of the document remains an important reference with regard to water management objectives for proposed developments.

3.2.7 Guidelines for Controlled Activities – Riparian Corridors (WM Act)

The WM Act includes guidelines for Controlled Activities – Riparian Corridors which outline the required buffer zones required to be maintained between watercourses and proposed developments including Core Riparian Zone, a Vegetated Buffer and an Asset Protection Zone. The required size of these buffer zones depends upon the conservation significance of the stream, with larger buffer zones required for more significant streams.

The North-South Drain adjacent to the Site is the only water body within close proximity to the Site. This assessment demonstrates that the Proposal is unlikely to pose a detrimental impact to the North-South Drain.

3.2.8 NSW Aquifer Interference Policy (WM Act)

The NSW Aquifer Interference Policy was released in September 2012. It sets out the requirements for assessing the impacts of aquifer interference activities on water resources. It explains the role and requirements of the Minister administering the *Water Management Act 2000* in the water licensing and assessment processes for aquifer interference activities under the *Water Management Act 2000* and other relevant legislative frameworks.

No deep excavations are proposed as part of the Proposal and the proposed stormwater storage / infiltration facilities have been designed to ensure groundwater is not intercepted.

3.2.9 NSW Groundwater Dependent Ecosystems Policy

The NSW Groundwater Dependent Ecosystem Policy was created in 2002. This policy explains the various types of groundwater dependent ecosystems (GDEs) found in NSW and promotes the management of these systems during planning processes. Five principles provide guidance on how to protect and manage these natural systems using a range of documented tools. The *Water Management Act 2000* provides the legislative framework for implementing the policy.

The Proposal will be managed to prevent adverse impacts to all identified GDEs.

3.3 Environment Protection Licences

Boral Recycling currently holds an Environment Protection Licence (EPL 11968) for waste storage and resource recovery.

Boral Cement currently holds an Environment Protection Licence (EPL 1094) for cement or lime works and handling.

Origin Energy holds an Environment Protection Licence (EPL 20081) for chemical storage.

No Environment Protection Licence exists for Boral Concrete's operations at the Site.

3.3.1 Licensed Discharge Points

Based upon the Site's Environment Protection Licences (EPL 1094, EPL 11968 and EPL 20081), it is understood that there are currently no licensed discharge points at the Site.

3.3.2 Limits

No concentration or volumetric limits apply for EPL 1094, EPL 11968 or EPL 20081 in relation to the discharge to waters. Both EPL 1094 and EPL 11968 state that:

> *Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997*

3.4 Port of Newcastle Requirements

Egret Street (Lot 2, DP 1195449) and the North South Drain (Lot 16 DP 1119752) are privately owned by the Port of Newcastle (PON), including the stormwater infrastructure assets within these parcels of land.

SLR consulted the PON in relation to stormwater management. The PON advised that the design of stormwater infrastructure onsite was to be based generally on the principles outlined in the Newcastle City Council Stormwater Technical Manual. In addition, PON requested that the following aspects be considered:

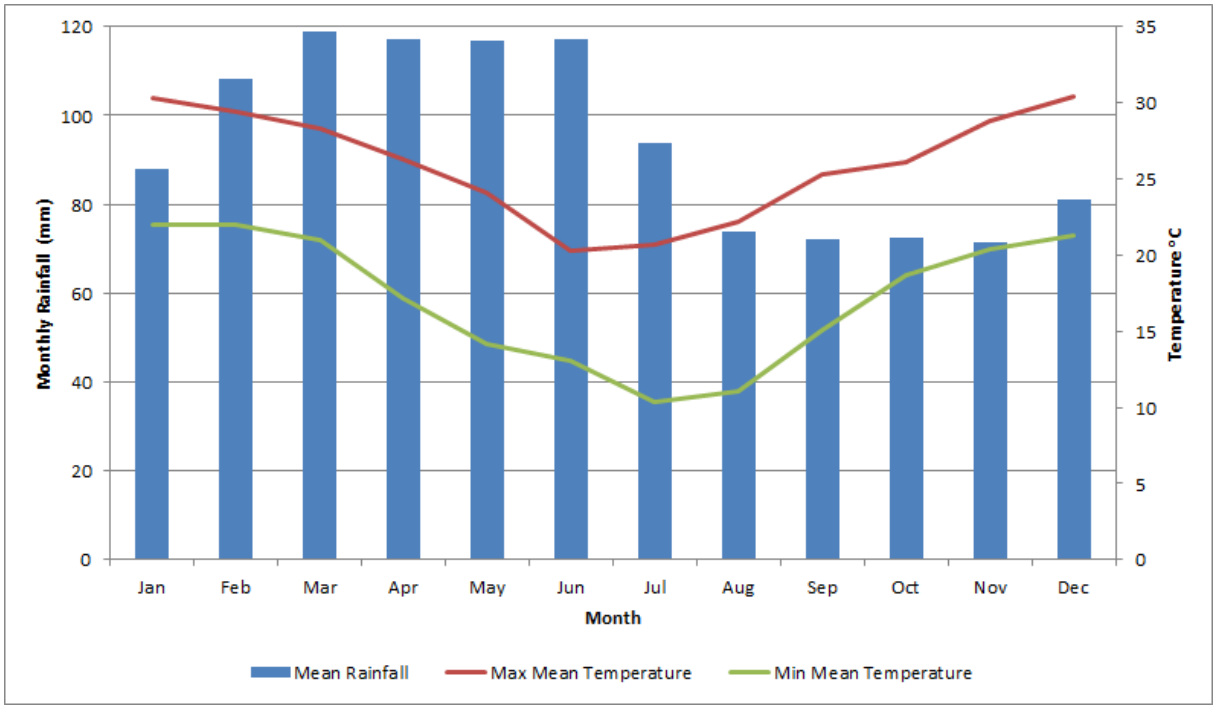
- Any connections to the Egret Street stormwater system is to be confirmed. The allowable discharge to this pipe network for minor storm events is to match the existing system capacity. Accordingly, a hydraulic grade line analysis shall be provided as part of the assessment process;
- The existing north south open drain should be considered as an alternative for additional stormwater drainage connection for both minor (up to 20 Average Recurrence Interval (ARI) events) and major (100 ARI event). Should this alternative be considered the analysis, connection and flow path arrangements are to be provided for approval as part of the assessment process;
- The connection to PON stormwater drainage infrastructure may require an easement or licence to secure access, maintenance and occupation of Boral infrastructure on PON land. If this is required PON will liaise directly with Boral through the EIS assessment process; and
- Any proposed stormwater detention system must be designed and constructed in a manner that ensures it is sustainable over the life of the development.

4 EXISTING SOIL AND WATER ENVIRONMENT

4.1 Climate

Newcastle has a borderline oceanic/humid subtropical climate like much of central and northern New South Wales. Summers tend to be warm and winters are generally mild. Precipitation is heaviest in spring. A summary of the mean rainfall and temperature statistics for the local area, obtained from the Bureau of Meteorology climate station at Newcastle Nobbys Signal Station AWS (Site Number 61055), is provided in **Figure 6**.

Figure 6 Local climate statistics



4.2 Landform

Topographic survey information for the site is presented in **Appendix A**.

4.3 Regional Geology and Hydrogeology

The Site is recorded as being partially located on an area of man-made fill, comprising spoil and slag, deposited in reclamation of the south-eastern section of Kooragang Island over the last 70 years. The fill may be discontinuous beneath the site (Aecom, 2012).

Where present, the fill is recorded to be underlain by a mixture of silt, clay and estuarine sediments that form the natural deposits of Kooragang Island (Aecom, 2012).

The nearest major surface water body is the Hunter River, which is located approximately 175 m south from the southern boundary of the Site. Regional groundwater flow is expected to be in a southerly direction towards the Hunter River.

4.4 Soils

4.4.1 Local soils

Soil lithology has been recorded during a limited soil and groundwater investigation by Aecom (2012) and during SLR's July 2015 well installation program. Borehole logs for the SLR 2015 well installation program are provided in **Appendix B**.

The soil lithology was observed to comprise layers of sand, sandy clay, clayey sand, organic silty clay.

Hydrocarbon odours were observed within some soils beneath the groundwater level during the SLR (2015) well installation program.

Sampling conducted to ascertain the waste classification of drilling spoil indicated that the drilling spoil could be disposed of as General Solid Waste, however, toluene, heavy metals, total recoverable hydrocarbons and PAHs were detected in the drilling spoil samples (as is typical across many areas of Kooragang Island). The effect of these analytes on the quality of the groundwater are discussed in Section **4.5.5**).

4.4.2 Acid sulphate soils

Acid Sulphate Soils (ASS) maps 003 and 004 from the Newcastle Local Environmental Plan (2012) show that the Site is not located within any areas mapped as having ASS. The ASS maps are provided in **Appendix C**.

4.5 Groundwater

4.5.1 Licensed bores

Based upon a NOW bore search, there are currently eight licensed bores within 500 m of the Site. Details for the eight bores identified in the search, including five monitoring bores, one bore used for irrigation and one bore used for industrial purposes is provided in **Table 2**. No information was available for bore GW202982 including coordinate data. As such, this bore could not be mapped, however, from the NOW records the bore appears to be approximately 300m to the east of the site.

One (1) existing licensed bore (GW200456 licence no. 20BL168957) is shown in the NOW records to be installed onsite. Based upon documentation provided by NOW (provided in **Appendix D**) it is understood that:

- the water is extracted from the bore for irrigation purposes by Boral Cement;
- the bore is 10.5 m deep; and
- the yield is 6 L/s.

It is noted that a spear point (GW053226 licence no. 20BL117398) is also located on the Recycling WRF. Groundwater is abstracted for water dust suppression and process purposes. As the license for this spear point has lapsed Boral will apply for this spear point licence to be re-activated.

The locations of the local groundwater bores (as shown on the NOW records) are displayed in **Figure 7**.

4.5.2 Groundwater monitoring wells

SLR installed two new groundwater monitoring wells at the Site for the purpose of assessing groundwater levels and groundwater quality at (and upgradient of) the drainage feature.

A groundwater monitoring well installed as part of a previous investigation (Aecom, 2012) was also used for measuring groundwater elevations. The monitoring well locations are shown in **Figure 7**.

Table 2 Licensed Bore Details

Bore Reference	Licence	Licence Status	Type	Completion Date	Northing	Easting	Authorised Purpose	Intended Purpose	Depth	Standing Water Level
GW053226	20BL117398	Lapsed	Spear	1981	6361236	384293	Industrial	Industrial	4.6 m	2.0 m
GW200456	20BL168957	Active	Bore	2003	6361165	384217	Industrial	Irrigation	10.5 m	2.0 m
GW292796	20BL173347	Active	Bore	2012	6360917	384119	Monitoring	Monitoring	5.4 m	Unknown
GW202657	20BL173444	Active	Monitoring Well	1996	6361582	384871	Monitoring	Monitoring	8.2 m	1.4 m
GW202658	20BL173444	Active	Monitoring Well	1996	6361582	384877	Monitoring	Monitoring	2.2 m	Unknown
GW202655	20BL173444	Active	Monitoring Well	1996	6361781	384453	Monitoring	Monitoring	11.3 m	0.6 m
GW202656	20BL173444	Active	Monitoring Well	1996	6361782	384453	Monitoring	Monitoring	3.3 m	0.6 m
GW202982 [#1]	-	-	-	-	-	-	-	-	-	-

#1 Due to no Easting and Northing data being available for Bore GW202982 mapping the location of this bore was not possible.

Figure 7 Local groundwater bores

4.5.3 Groundwater use

Groundwater is currently extracted from a spear point located within the WRF (refer to **Figure 7**). The extracted groundwater is used to top up the concrete storage dam during dry periods. As detailed in Section **4.5.1**, water from the storage dam, which is a mixture of site runoff water and spear point water, is reused onsite for dust suppression and wheel washing.

4.5.4 Groundwater levels and yield

The groundwater elevation was recorded to be relatively flat across the Site, ranging between 2.53 m AHD at monitoring well R1 on the northern boundary of the WRF and 2.62 m AHD at monitoring well C1 adjacent to the offices on the Boral Cement Works. The groundwater elevation at monitoring well C2 near to the existing central drainage feature was 2.69 m AHD. Groundwater elevations are shown on **Figure 7**.

Two water bearing zones separated by a low permeability unit of clay were encountered within the vicinity of monitoring well C1 (refer to **Figure 7**) as part of the previous Aecom (2012) investigation. An unconfined shallow perched groundwater table (2.6 to 2.8 m below ground level) was observed within an upper sand unit and a deeper confined aquifer within a lower sand unit (4.5 to 5.5 m below ground level).

Although it is expected that regional groundwater flow is southerly towards the Hunter River (Aecom, 2012), due to the presence of perched shallow groundwater onsite, local groundwater flow direction was unable to be determined based upon the three (C1, C2 and R1) monitoring wells which are likely to be influenced by perched groundwater. However, it is likely that local groundwater flow is in a southerly direction towards the Hunter River.

During the groundwater sampling program conducted by SLR in July 2015, the groundwater recharge rate was observed to be high in both monitoring wells. As detailed in Section **4.5.1**, the yield in bore GW200456 is reported to be 6 L/s. The high recharge rate is attributable to the sandy soils onsite.

4.5.5 Groundwater quality

SLR undertook in-situ testing and groundwater quality sampling at monitoring wells C2 and R1 on the 23rd July 2015 for:

- pH; Temperature and Conductivity
- Benzene, Toluene, Ethylbenzene, Xylene (BTEX);
- Total Recoverable Hydrocarbons (TRH);
- Total Petroleum Hydrocarbons (TPH);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Nutrients (total nitrogen, total phosphorus, nitrate, nitrite, total oxidised nitrogen, total Kjeldahl nitrogen);
- Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury).

The groundwater sampling results and details of the monitoring conducted are presented in **Appendix E** and are representative of groundwater quality across many areas of Kooragang Island. The sampling results have been compared against:

- Ecological Groundwater Investigation Levels (EGILs) to assess potential impacts to the receiving environment; and
- Drinking Water Investigation Levels (DWILs) to provide a preliminary indication of health issues related to reusing groundwater onsite for dust suppression and wheel wash activities.

The marine waters EGILs are based upon the Hunter River water quality objectives (OEH, 2006) and ANZECC (2000) marine water trigger levels.

The fresh waters EGILs are based upon the ANZECC (2000) fresh water trigger levels.

The DWILs are based upon the health values of the National Water Quality Management Strategy Australian Drinking Water Guidelines (NHRMC, 2011)

Groundwater had a relatively neutral pH (6.9 to 7.2) and was brackish (1500 to 4900 uS/cm).

PAH levels above the reporting limits were recorded in both monitoring wells with results of 84 µg/L and 45 µg/L in wells R1 and C2 respectively. Low levels of TRH (TRH fraction C10-C16) were also recorded above the reporting limits with results of 140 µg/L and 93 µg/L in wells R1 and C2 respectively. Other fractions of TRH were below the reporting limits and the concentration of all TRH fractions were below the limit of reporting in both monitoring wells for the silica gel clean-up test. No EGILs exist for PAH or TRH however given their presence in the groundwater, the use of groundwater to top up the concrete storage facility may pose a risk to site operatives and visitors through inhalation of the dust suppression water aerosols. Section 8.2.5 further discusses a targeted investigation and risk assessment into groundwater quality.

Heavy metal concentrations were generally below the adopted EGILs for fresh and marine waters in both monitoring wells with the exception of zinc which exceeded the EGIL for fresh and marine waters at monitoring well R1 and C2.

Total nitrogen and total phosphorus were elevated in both monitoring wells R1 and C2 in relation to the EGILs for marine waters.

No DWILs were exceeded.

4.5.6 Groundwater Dependant Ecosystems

SLR conducted a desktop review of the subject site to explore the potential presence of any groundwater dependent ecosystems (GDEs), and to assess the likelihood of any adverse impacts to such ecosystems by the proposed development. Analysis of vegetation characteristics on the subject site was also undertaken by SLR during a site survey on 30 October 2014.

GDEs are defined as “ecosystems which have their species composition and their ecological processes determined by groundwater” in the *NSW State Groundwater Dependent Ecosystem Policy* (Department of Land and Water Conservation, 2002). The Policy defines the following types of GDEs in NSW:

- Terrestrial Vegetation;
- Base flows in streams;
- Aquifer and cave ecosystems;
- Wetlands.

Of the above listed types of GDEs, it is likely that only wetland and terrestrial vegetation GDE types occur on Kooragang Island. There are extensive wetland areas located in the low lying parts of the island that have not been built up with artificial materials in the past. Such areas are predominantly in the northwest of the island which has not been developed for industrial purposes - unlike the south eastern parts (including the subject site). Numerous vegetated areas on the island may be dependent on groundwater for survival and could support ‘terrestrial vegetation’ GDEs. The presence of these, again, would likely be in areas which have not been exposed to a history of piling of fill and artificial materials to enhance land for building purposes.

The Site itself is a highly modified environment, which, like much of Kooragang Island, is built up from fill and waste materials - meaning that the substrate no longer remains in its natural state. The site occurs on land classified as 'Disturbed Terrain' by the NSW Department of Land & Water Conservation (mapped in 1979). Given this, alterations to groundwater flows in the area are likely to be significant and are interrupted by previous excavations and filling activities.

Furthermore, a search of potential GDEs in the lower Hunter area using the Bureau of Meteorology - *Atlas of Groundwater Dependant Ecosystems* (conducted on 27th July 2015) reveals that there are no known GDEs (wetland or terrestrial) occurring on the Boral site or adjacent lands (refer to **Appendix F**).

The Site is predominantly devoid of native vegetation, apart from numerous small patches of *Eucalyptus* species, *Acacia* species and other natives within the drainage swales, the central drainage feature and non-developed areas (on site boundaries). Most areas are dominated by exotic plant species, particularly in the ground layer. Based on the field inspection of the site, the vegetation appears to be partly reliant on surface water and runoff from the Site (flowing into drainage lines and water retention areas). No vegetation that is commonly associated with groundwater seepages or springs (such as Pouched Coral Fern and Saw-sedge) was observed on the Site. Furthermore, the groundwater elevations onsite are at a minimum of 1 m below ground level within vegetated areas such as the central drainage feature. This suggests that there is a low potential for groundwater interaction (with existing plant root systems) and vegetation is unlikely to be supported by subsurface groundwater (permanent or intermittent).

The only surface water observed on the subject site during the October 2014 inspection was in a small pool near the machinery wash zone area and also within the Boral Cement infiltration dam. Both features would collect water from Boral Cement and would not form part of any wetland area. Other drainage features were dry at the time of the site survey. The substrate at the base of these features appeared to be very sandy and showed no evidence of moisture or seepage.

4.6 Surface Water

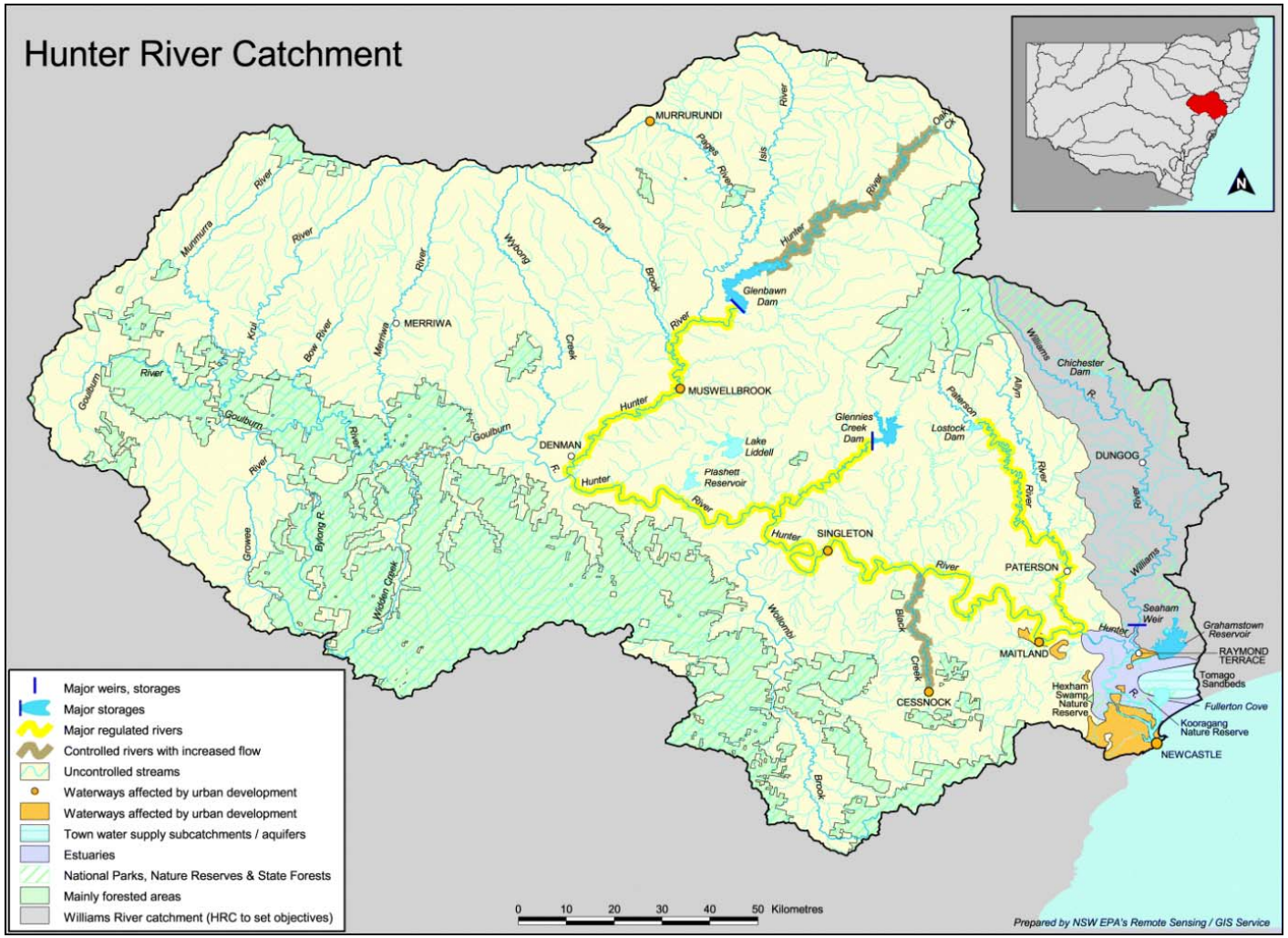
4.6.1 Hydrology

The Site is located within the Hunter Catchment which covers an area of approximately 21,367 km^2. The Hunter River catchment is shown in **Figure 8**.

The location of the Hunter River estuary protected wetlands including a Ramsar wetland is shown in **Figure 9**. The protected estuary wetlands are not down gradient of the WRF.

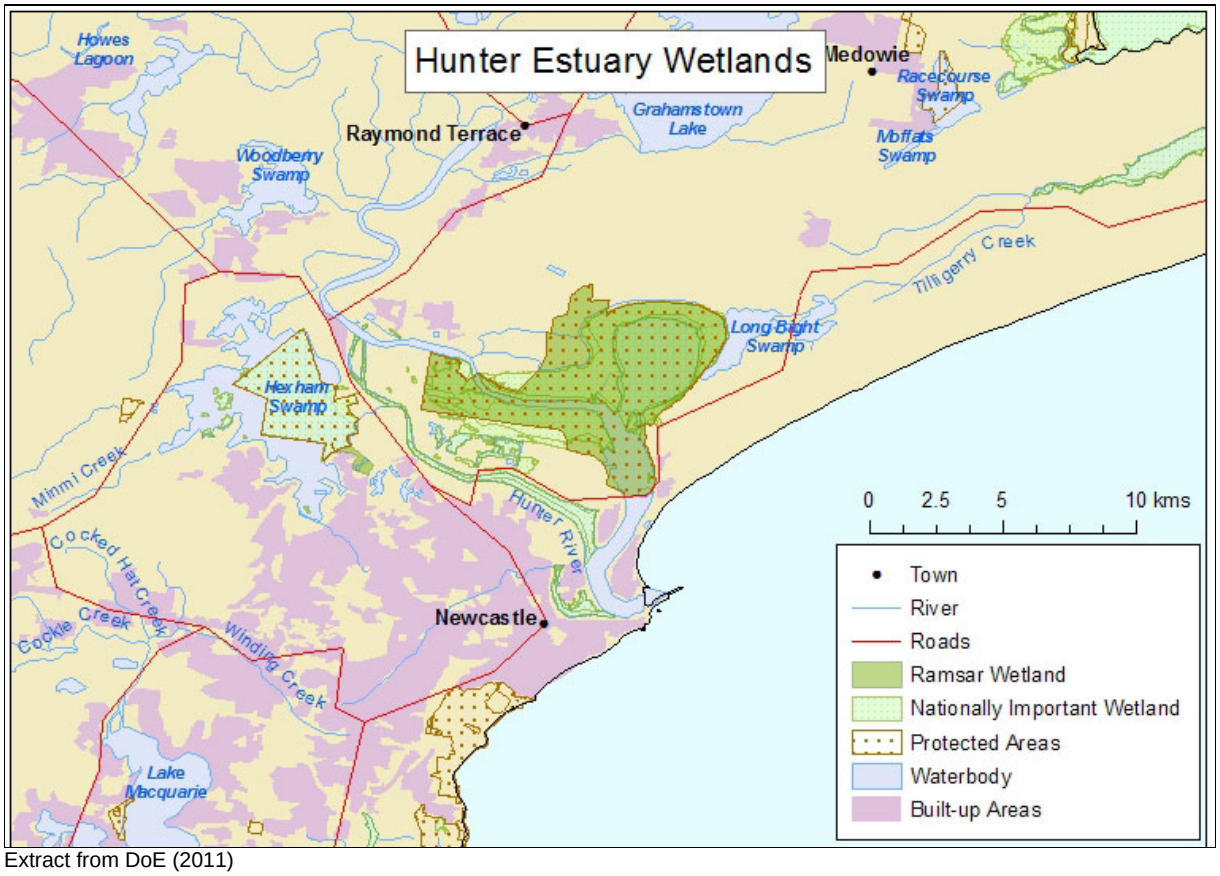
The south-east corner of the Site is located approximately 140 m from the southern arm of the Hunter River which flows south easterly towards the estuary. A drain runs from north to south (known as the North-South Drain), parallel to the western boundary of the Site, on the western side of the railway embankment (refer to **Figure 10**). Onsite stormwater management is discussed in Section **4.7**.

Figure 8 Hunter River Catchment



Extracted from OEH (2006)

Figure 9 Hunter Estuary Wetlands



Extract from DoE (2011)

4.6.2 Regional water quality and river flow objectives

The site drains to the Southern Arm of the Hunter River which is designated as a *waterway affected by urban development* zone by the NSW Office of Environment and Heritage (OEH), refer to **Figure 8**.

OEH has provided Water Quality Objectives (WQOs) and River Flow Objectives (RFOs) depending on the catchment zone. The WQOs for *waterways affected by urban development* include protection of the following environmental values:

- Aquatic ecosystems;
- Visual amenity;
- Secondary recreation; and
- Primary contact recreation.

Meeting water quality trigger levels suitable for local aquatic ecosystems is generally the basis for protecting the other environmental values, which are the uses people have for water (OEH, 2006).

The *waterway affected by urban development* aquatic ecosystem trigger levels for the Hunter River estuary (OEH, 2006) are outlined below. A detailed description of the water quality objectives and trigger levels for the other environmental values is provided in OEH (2006).

Table 3 Hunter River water quality objectives (OEH, 2006)

Parameter	Numerical criteria (trigger value)
Total phosphorus	30 µg/L
Total nitrogen	300 µg/L
Chlorophyll-a	4 µg/L
Turbidity	0.5 to 10 NTU
Electrical Conductivity	Not Applicable
Dissolved oxygen	80 to 100%
pH	7.0 to 8.5
Temperature	As detailed in ANZECC 2000 guidelines, Table 3.3.1
Chemical contaminants or toxicants	As detailed in ANZECC 2000 guidelines, Chapter 3.4 and Table 3.4.1

The OEH (2006) Hunter River RFOs for *waterways affected by urban development* include:

- Maintain wetland and floodplain inundation – *to maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems;*
- Maintain natural drying in temporary waterways (and wetlands) – mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.
- Maintain natural flow variability – *to maintain or mimic natural flow variability in all streams*
- Maintain natural rates of change in water levels – *to maintain rates of rise and fall of river heights within natural bounds*; and
- Minimise effects of weirs and other structures – *minimise the impact of instream structures*.

4.6.3 Hunter River water quality

The Hunter River estuary is an important site for migratory shorebirds and home to a range of fish and crustaceans. The Lower Hunter region is part of a transition zone for many plant and animal species between the sub-tropical influences of the north and the cooler conditions of the south (DoE, 2015).

Agricultural activities, mining and urban development is impacting on the Hunter River. Water quality is being affected by continued urban development, urban and rural pollution and riverbank erosion.

SLR contacted NOW to obtain water quality data for the Hunter River estuary. The nearest monitoring location was at Morpeth (Station 21010138) approximately 40 km upstream of the Site. Given the distance upstream and amount of development between the monitoring location and the Site, the water quality data provided is not considered appropriate for the purposes of this assessment.

4.6.4 Onsite storage - water quality

Sampling is conducted on a monthly basis for pH and electrical conductivity in the concrete storage dam (refer to **Figure 10**). Water is currently extracted from the concrete storage dam and reused for dust suppression and to top up the wheel wash water. A summary of three (3) years of monthly data (36 samples in total) collected between July 2012 and June 2015 is provided in **Table 4** below.

Table 4 Onsite storage water quality monitoring summary

Parameter	pH	Electrical Conductivity (µS/cm)
Minimum	6.70	1,569
Mean	7.87	10,263

Parameter	pH	Electrical Conductivity (µS/cm)
Maximum	9.24	16,840
10 Percentile	7.08	4,965
50 Percentile	7.68	11,250
90 Percentile	8.81	15,075

The water quality results presented in **Table 4** should be read in the context that the concrete storage dam has never overflowed offsite to date and will continue to be managed to prevent any future overflows. As such, the likelihood of water from the concrete storage dam discharging from the site is considered to be low.

The results indicate that the water is brackish and the pH is sometimes elevated in relation to the pH criteria for the Hunter River estuary (refer to **Table 3**).

The 90th percentile pH value (8.81) is outside of the Managing Urban Stormwater Harvesting and Reuse (DEC, 2006) pH criteria for public health risk management (6.5-8.5) for a controlled public access industrial site.

4.6.5 Flooding

A flood information certificate obtained from Newcastle City Council (No. 2014/227 which is provided in **Appendix G**) indicates that the Site is not affected by the 1% Annual Exceedance Probability (1 in 100 year ARI event) for ocean flooding and Hunter River flooding.

The boundary of the Site is entirely above the Probable Maximum Flood (PMF) level for ocean flooding (3.4m AHD) therefore it is considered that the Site would not be impacted by ocean flooding.

The Hunter River PMF level (4.5m AHD) is above ground levels on the fringes of the Site's Egret Street boundary. Flooding is considered to be L1 (H3) hazard category. No part of the site is affected by a floodway or flood storage area.

The flood hazard classification is defined in the *Additional information for the holders of flood information certificates* document provided in **Appendix G**. In summary the L1 (H3) category relates to a site where no on site refuge is required (evacuation to flood free land before flood occurs is available) with peak flood depths ranging between 0.8 and 1.2 m and flood velocities ranging between 0 and 2 m/s.

4.7 Existing Soil and Water Management

4.7.1 Water Management

Stormwater management for the Site is outlined in **Figure 10**. Key stormwater management measures and constraints for the existing WRF are shown in **Figure 11**. A conceptual flow diagram showing how water (including groundwater and stormwater) is sourced, stored, treated and reused within the existing WRF is presented in **Figure 12**.

The existing WRF is predominantly drained towards a sediment trap in the north east corner of the WRF.

During larger rainfall events, stormwater will flood the northern fringes of the WRF which includes a narrow infiltration trench along its fringe. When stormwater ponds up to 4.0 m AHD, it begins to overtop into the concrete storage dam located within the north west corner of the WRF. The collected stormwater is reused for dust suppression and to supply the wheel wash. Additional flood storage is also provided by way of the site levels and the WRF perimeter bunding up to a level of approximately 4.4 m AHD as shown in **Figure 11**. At this point, stormwater would tend to overflow the WRF operations area and flow overland onto the Boral Concrete site and subsequently offsite towards Egret Street. The likelihood of this occurring is assessed in Section **5**. At present, groundwater is used to top up the concrete storage facility as required during dryer periods, refer to **Figure 12**.

The southern and central portions of the Site including a portion of the Boral Cement and Origin Leased site drain towards the existing vegetated drainage feature (the Central Drainage Feature) as shown in **Figure 10**. During a significant flood event, overflows from the Drainage Feature would tend to flow onto Egret Street before being drained via the stormwater drainage network towards the Hunter River.

The remainder of the Boral Cement site is either drained to Egret Street via existing stormwater connections, the infiltration dam, an infiltration pit or the access road to Cormorant Road via existing stormwater connections or overland flow, refer to **Figure 10**. The remainder of the Origin Leased site is drained to Egret Street via existing stormwater connections, refer to **Figure 10**.

An area surrounding the Boral Recycling office including the access road towards the weighbridge and the vegetated fringes of the Boral Concrete site drain directly to Egret Street (via overland flow).

The remainder of the Boral Concrete site currently drains to a concrete storage basin.

Figure 10 Existing Stormwater Management

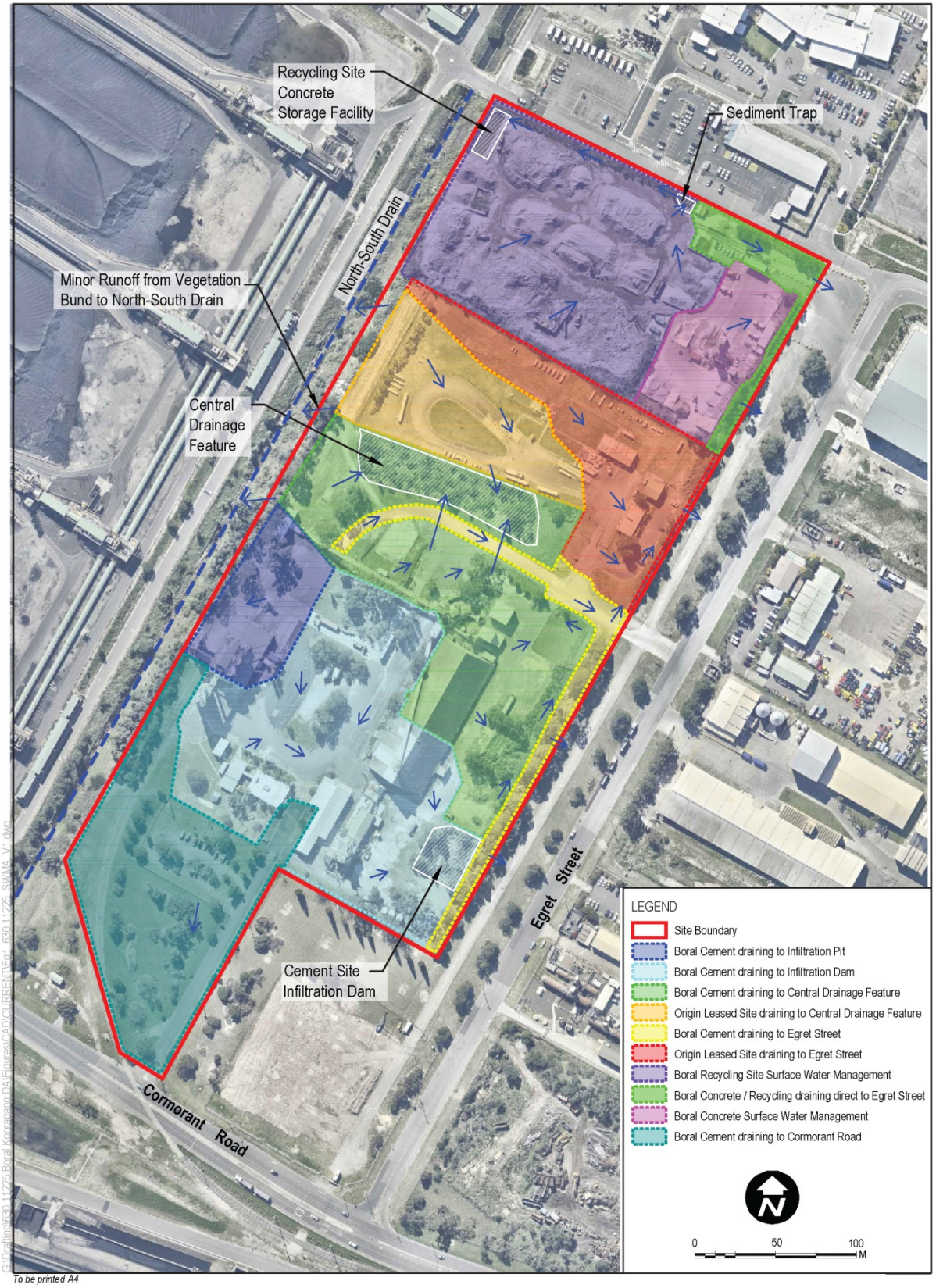
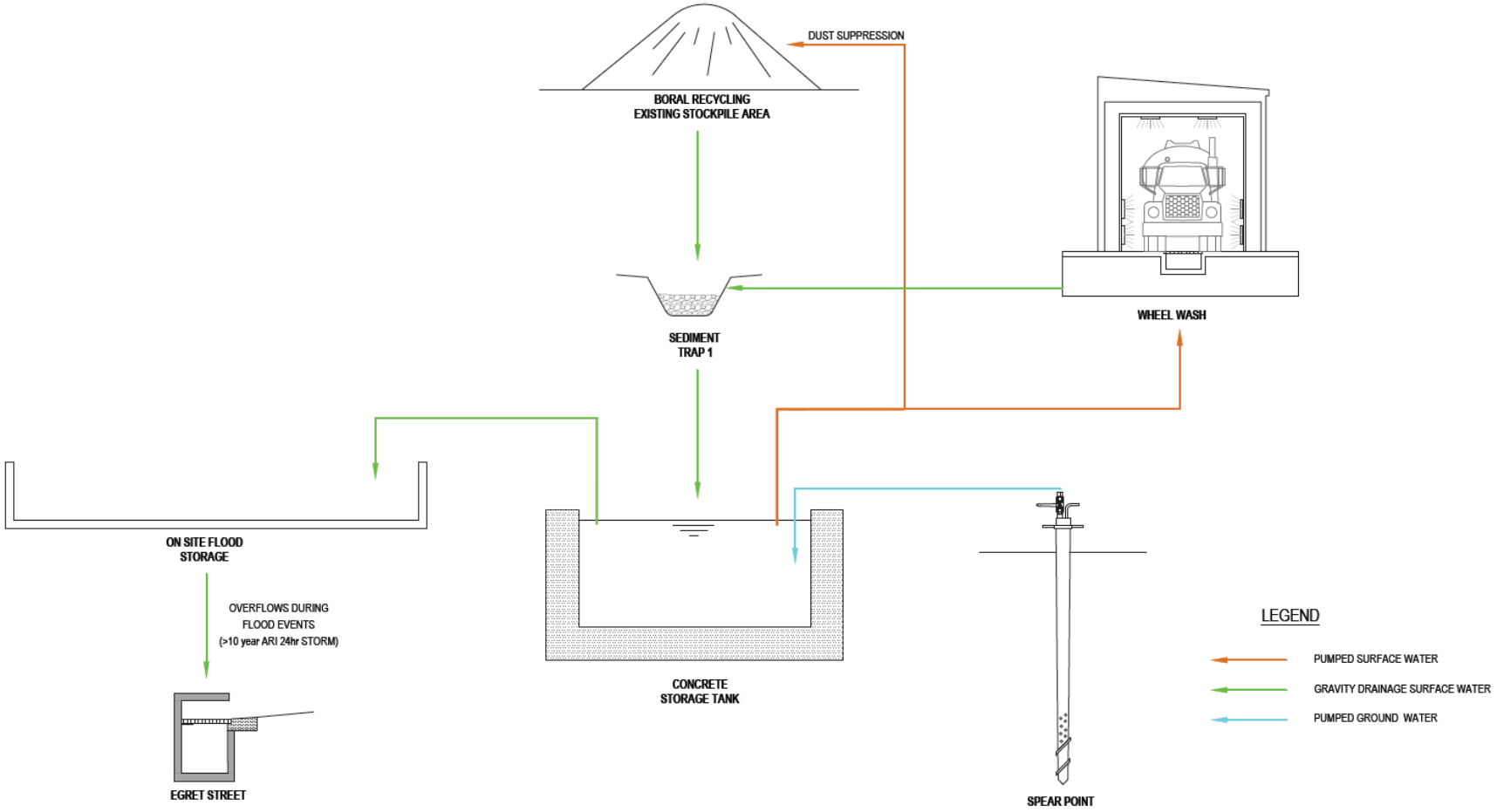


Figure 11 Existing WRF stormwater management constraints

Figure 12 Conceptual flow diagram for existing WRF



4.7.2 Erosion and sediment controls

A vegetated bund has been constructed around the northern, western and southern perimeters of the WRF. A concrete block wall forms part of the eastern boundary. The bunds are approximately 1.5 m high. It is proposed to extend the vegetation bunds around the boundary of the Expanded WRF.

Silt fencing is also provided around the existing WRF sediment trap (refer to **Figure 11**).

4.7.3 Chemical management

The oils, solvents and gas storage and management details for the existing recycling WRF are outlined in the Pollution Incident Response Management Plan (PIRMP) for Kooragang Recycling. Practicable procedures are undertaken to make ensure that unforeseen events, such as spills or leaks do not result in polluted water entering the stormwater system. The management procedures are outlined in **Table 5** below.

Table 5 Kooragang Recycling chemical management summary

Description	Amount Stored	Location of Storage	Current Controls
Oils / Solvents	Packaged goods up to 100 litres	Oil storage shed at workshop	Bunding; PMP; Training; Flammable Cabinet; Spill kits; Inductions; Firefighting equipment; and Security.
Lubricants, Gases	Variable	Maintenance workshop	Fire extinguishers; Concrete floor; Enclosed shed; Containment cages and cabinets.

4.7.4 Wastewater management

The existing WRF wastewater is discharged to an onsite septic tank which is periodically cleaned out by vacuum truck.

5 STORMWATER ASSESSMENT

5.1 Objectives

The key objectives of the stormwater assessment were:

- to develop a conceptual design of stormwater management measures to control the additional runoff generated by the increased stockpile area on the WRF;
- to develop a conceptual design of stormwater management measures to control stormwater runoff from parts of the Boral Cement Works and Origin Leased sites which currently drain to the Central Drainage Feature (which will be filled in as part of the Proposal to generate additional stockpile area for the WRF).

5.2 Constraints

The key constraints for stormwater management onsite are outlined in **Table 6** below.

Table 6 Stormwater constraints

Parameter	Key Constraints
Runoff Quality	• Waste materials will be stored externally onsite. Stormwater runoff which comes into contact with waste materials could potentially convey and discharge pollutants associated with the waste materials to stormwater management systems onsite. • Existing monitoring results from the concrete storage tank indicate that water within this tank is brackish with alkaline pH levels, which at times exceed the adopted water quality objectives (i.e >8.5 pH units). However the water management system at the site is designed to prevent offsite discharges so no water quality monitoring of runoff leaving the site has ever been undertaken. • Stormwater from the Boral Cement site currently undergoes primary sediment treatment prior to draining to the central drainage feature.
Discharge Control	• Stormwater runoff is currently retained within the WRF operations area until water levels reach 4.4 m AHD, at which point water would tend start to flow onto Boral Concrete site and then offsite. • New stormwater controls are required to manage stormwater from the Boral Cement and Origin Leased site which currently drain to the central drainage feature. The purpose of these controls is to retain and treat stormwater runoff from the WRF. Increases in stockpile area and subsequently an increase in runoff may cause discharge rates and discharge frequency to increase without appropriate mitigation measures.

Parameter	Key Constraints
Water Reuse	• Managing Urban Stormwater Soils and Construction, Waste Landfills (DECC, 2008) states that it is generally accepted that runoff which contains sediments is suitable for reuse for dust suppression and wheel wash water following basic treatment (i.e. settlement treatment). However stormwater runoff from areas which may contain pollutants other than sediments is considered to be unacceptable for reuse without further treatment. • Sediment bound pollutants would tend to accumulate in the sediments captured within the WRF treatment and storage systems, however, some dissolved pollutants or pollutants bound to fine (unsettled) sediments may be present within water extracted from the concrete storage facility for reuse as dust suppression and wheel wash water onsite. • The addition of new waste streams will increase the risk of pollutants being present in stormwater runoff and subsequently reused dust suppression and wheel wash water. • Sampling of water in the concrete storage dam indicates that the 90th percentile pH value is outside of the Managing Urban Stormwater Harvesting and Reuse (DEC, 2006) pH criteria for public health risk management (6.5-8.5) for a controlled public access industrial site.
Groundwater	• Infiltration is currently used to manage stormwater runoff across the Site and is therefore considered to be a suitable stormwater disposal method • Infiltrating potentially contaminated stormwater runoff may transfer pollutants to the underlying groundwater if a sufficient filtration zone is not maintained; • The base level of the existing central drainage feature ranges between 4.0 m AHD and 2.9 m AHD

5.3 Stormwater Quantity Design Criteria

Stormwater will be managed to ensure that:

- The Proposal does not cause an increase in the existing peak flow rate or discharge frequency from the Site for events up to and including the 100 year ARI 72 hour event.
- Newcastle City Council's stream erosion index target of 2 is achieved.

To achieve the above design criteria it is proposed that:

- additional stormwater generated from the expanded WRF be captured, treated and reused or allowed to infiltrate into the ground with no overflows occurring for events up to and including the 10 year ARI 24 hour storm event. This will effectively meet Newcastle City Councils stream erosion index target of 2 as discharge events will not occur during the majority of years; (i.e. a discharge will only occur during an event which occurs on average 1 out of 10 years);
- overflows during events in exceedance of 10 year ARI 24 hr event will be controlled to ensure no increase in peak flow rate for events up to and including the 100 year ARI 72 hour event;
- stormwater from the Boral Cement and Origin Leased site which currently drain to the central drainage feature will be infiltrated. This approach replicates how stormwater is currently controlled by the central drainage feature. The new infiltration systems will be designed to prevent overflows up to a 100 year ARI 72 hour event;

- the base of any infiltration basins onsite should be elevated a minimum of 0.5 m above the highest anticipated groundwater level in accordance with best management groundwater practices. This 0.5m buffer level equates to 0.8m above the highest groundwater level recorded during the recent groundwater monitoring event (refer to Section **4.5.4**) which includes an additional 0.3m of cover to account for variability in groundwater fluctuations from the maximum recorded groundwater level.

5.4 Stormwater Quality Design Criteria

Stormwater will be managed to ensure that:

- Newcastle City Council MUSIC modelling pollutant load reduction targets are achieved including:
    - 90% gross pollutant load reduction
    - 80% total suspended solid load reduction;
    - 65% total phosphorus load reduction;
    - 45% total nitrogen load reduction.
- Potentially contaminated stormwater (i.e. runoff from waste storage areas) is retained onsite with offsite discharges only occurring during a significant flood event;
- A minimum of 0.5 m of clearance will be maintained between the base of any new infiltration systems and the underlying standing water level to protect local groundwater quality;
- Primary treatment (i.e. sediment treatment) should be provided up gradient of all infiltration systems to provide pollutant control and ensure infiltration rates are not affected by overloading of coarse sediment into the infiltration systems; and
- All water to be reused at the WRF is to be monitored to determine if it meets the public health risk management criteria (DEC, 2006) and the adopted EGIL criteria to ensure that any environmental risks and health risks to workers are managed appropriately.

To achieve the above criteria it is proposed that:

- Stormwater be retained on the WRF for events up to and including the 10 year ARI 24 hour event to prevent discharges and pollutant loading to the stormwater network and downstream waterways with the exception of a significant flood event. This will effectively meet Newcastle City Council's pollutant load reduction targets as no stormwater discharges will occur during the majority of years (i.e. a discharge will only occur during a single event which occurs on average 1 out of 10 years);
- Boral Cement primary (sediment) treatment measures be retained (or replicated) up gradient of any new infiltration systems serving the Boral Cement site;
- A minimum of primary (sediment) treatment measures be implemented up gradient of any infiltration devices on the Expanded WRF;
- Stormwater water quality is monitored and compared against the public health risk management criteria (DEC, 2006) and the adopted EGIL criteria prior to being reused onsite. If the water quality does exceed this criteria then water of a suitable quality may be pumped in for dilution purposes. Following this dilution the water would then be re-monitored to ensure that the water quality criteria are met. Water exceeding the public health risk management criteria (DEC, 2006) or the adopted EGIL criteria will not be reused onsite.
- The pH of stormwater collected in the WRF storage facility should be adjusted to between 7 and 8.5; and

- The base level of any new infiltration systems shall be raised a minimum of 0.8 m above the maximum groundwater level recorded during SLRs 2015 investigation (i.e. be set at 3.5 m AHD or higher). This is expected to provide an appropriate buffer zone for filtration treatment and seasonal fluctuations based on current best management groundwater practices.

5.5 WRF Stormwater Management

SLR conducted hydrological modelling using the RAFTS model in DRAINS to predict which design storm event would lead to offsite discharges from the WRF for the following scenarios:

- Existing WRF;
- Expanded WRF with no mitigation.

Hydrological modelling in RAFTS was then conducted to develop mitigation measures to meet the stormwater quantity design criteria for the expanded WRF (refer to Section **5.3** and Section **5.4)**.

5.5.1 Model Development

DRAINS performs design and analysis calculations for urban stormwater drainage systems and models the flooding behaviour in rural and urban catchments. The RAFTS model function in DRAINS is a runoff routing model which allows routing to occur at sub-catchment nodes and in reaches.

The hydrological model was developed to simulate the available flood storage within WRF hardstand areas based upon survey data provided by Boral.

The following assumptions and parameters were adopted within the hydrological model.

Table 7 Hydrological Model Assumptions

Parameter	Assumption	
	Existing WRF	***Expanded WRF***
Catchment Area (ha)	2.06	2.81
Impervious Fraction	0.8	0.8
Mannings roughness	0.02	0.02
Impervious Area Initial Loss (mm)	2	2
Pervious Area Initial Loss (mm)	10	10
Impervious Area Continuing Loss (mm/hr)	0	0
Pervious Area Continuing Loss (mm/hr)	2.5	2.5
BX (calibration) parameter	1	1
Concrete storage dam capacity at start of rainfall event (%)	50	50
Weir level for overflows to occur (m AHD)	4.4	4.4

5.5.2 Hydrological Impacts

The hydrological modelling results for the *Existing WRF* and *Expanded WRF* (with no mitigation) are summarised in **Table 8**.

Table 8 Hydrological impact modelling results (no mitigation measures)

Design Rainfall event (ARI)	Scenario	2 year	10 year	20 year	100 year
Peak flow rate (m^3/s)	Existing WRF	0	0.06	0.07	0.17
	Expanded WRF	0.06	0.16	0.20	0.26
Peak water level (mAHD)	Existing WRF	4.40	4.45	4.47	4.50
	Expanded WRF	4.44	4.49	4.51	4.53
Minimum storm duration which overflows occur (hours)	Existing WRF	No overflow	24	18	9
	Expanded WRF	30	9	6	<4.5

The hydrological modelling indicates that with no mitigation measures:

- Currently, stormwater will overtop the available 4.4m AHD storage onsite during events in excess of a 10 year 24 hour rainfall event;
- Expanding the WRF will cause discharge events to occur more frequently with events in exceedance of a 2 year ARI 30 hour event now predicted to discharge offsite;
- Expanding the WRF will marginally increase the peak flow rate being discharged offsite.

The results described above do not meet Newcastle City Council's stream erosion index and post development peak flow rate requirements (described in Section **5.3**). As such, mitigation measures are required to attenuate the peak flow rates from the WRF.

5.5.3 Proposed Mitigation

The following mitigation is proposed:

- Raise ground levels to the west of the weighbridge and seal the block wall to the south west of the weighbridge up to a minimum level of 4.9m AHD (equating to an increase of 0.5m) to effectively create a flood bund which will increase flood storage onsite.
- The vegetated bunds which surround the northern and western boundaries should be maintained at all times to prevent floodwater from draining away to the north or west.
- As per the existing WRF, floodwater retained onsite will drain away slowly via the existing infiltration trench which runs along the northern boundary.
- For primary treatment purposes a sediment trap should be provided on the expanded WRF which drains to a perimeter drain connecting to the concrete storage dam.

The proposed mitigation was incorporated into the *Expanded WRF* hydrological model to develop an *Expanded WRF with mitigation* model.

A comparison of the hydrological modelling results for the *Expanded WRF with mitigation* and the *Existing WRF* are presented in **Table 9**.

Table 9 Residual (with mitigation) hydrological impact modelling results

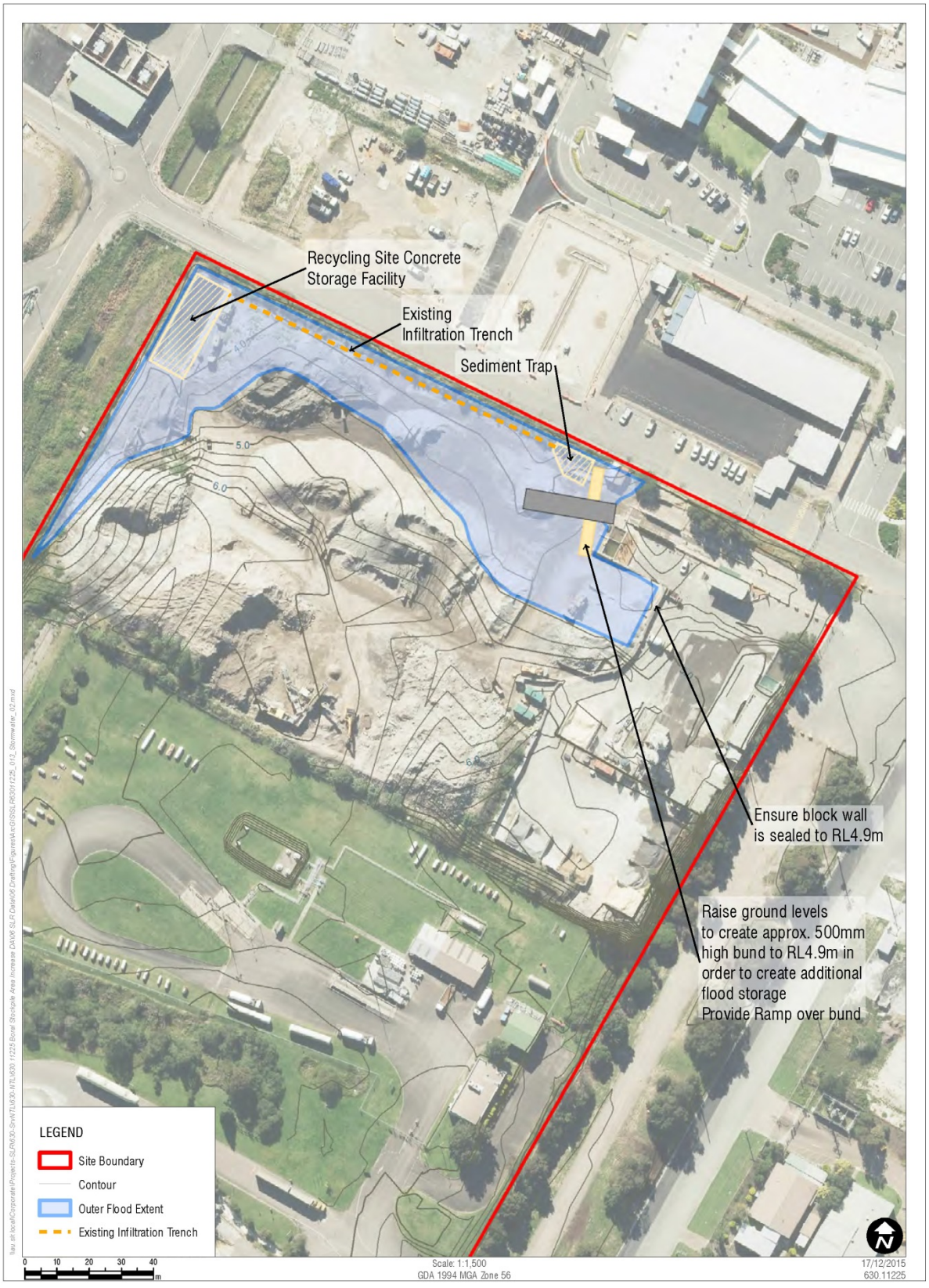
Design Rainfall event (ARI)	Scenario	2 year	10 year	20 year	100 year
Peak flow rate (m^3/s)	Existing WRF	0	0.06	0.07	0.17
	Expanded WRF with mitigation	0	0	0.07	0.13
Peak water level (mAHD)	Existing WRF	4.40	4.45	4.47	4.50
	Expanded WRF with mitigation	4.57	4.89	4.95	4.98
Minimum storm duration which overflows occur (hours)	Existing WRF	No overflow	24	18	9
	Expanded WRF with mitigation	No overflow	No overflow	72	24

The hydrological modelling indicates that:

- With the proposed mitigation implemented, stormwater will overtop the available storage onsite less frequently during events in excess of a 20 year 72 hour rainfall event;
- With the proposed mitigation implemented, the peak discharge rate during significant events (up to and including a 100 year ARI 72 hour event) will be limited to or less than the equivalent existing peak discharge rate;

The results described above meet Newcastle City Council's stream erosion index and post development peak flow rate requirements (described in Section **5.3**). A conceptual plan of the proposed mitigation for the Expanded WRF is presented in **Figure 13**.

Figure 13 Proposed Expanded WRF Stormwater Management



5.6 Boral Cement Works and Origin Stormwater Management

It is proposed to infiltrate runoff onsite from the parts of the Boral Cement and Origin Leased site which currently drain to the Central Drainage Feature (refer to **Figure 10**).

It is recommended that two infiltration basins are provided in locations shown in **Figure 14**.

Calculations were undertaken to size the infiltration basins to capture and infiltrate runoff for events up to and including the 100 year ARI 72 hour event from the contributing catchments as summarised in **Table 10**.

Table 10 Catchment Assumptions

Infiltration Basin	Catchment Area (ha)	Adopted Volumetric Runoff Coefficient
1	0.74	0.74
2	1.67	0.75

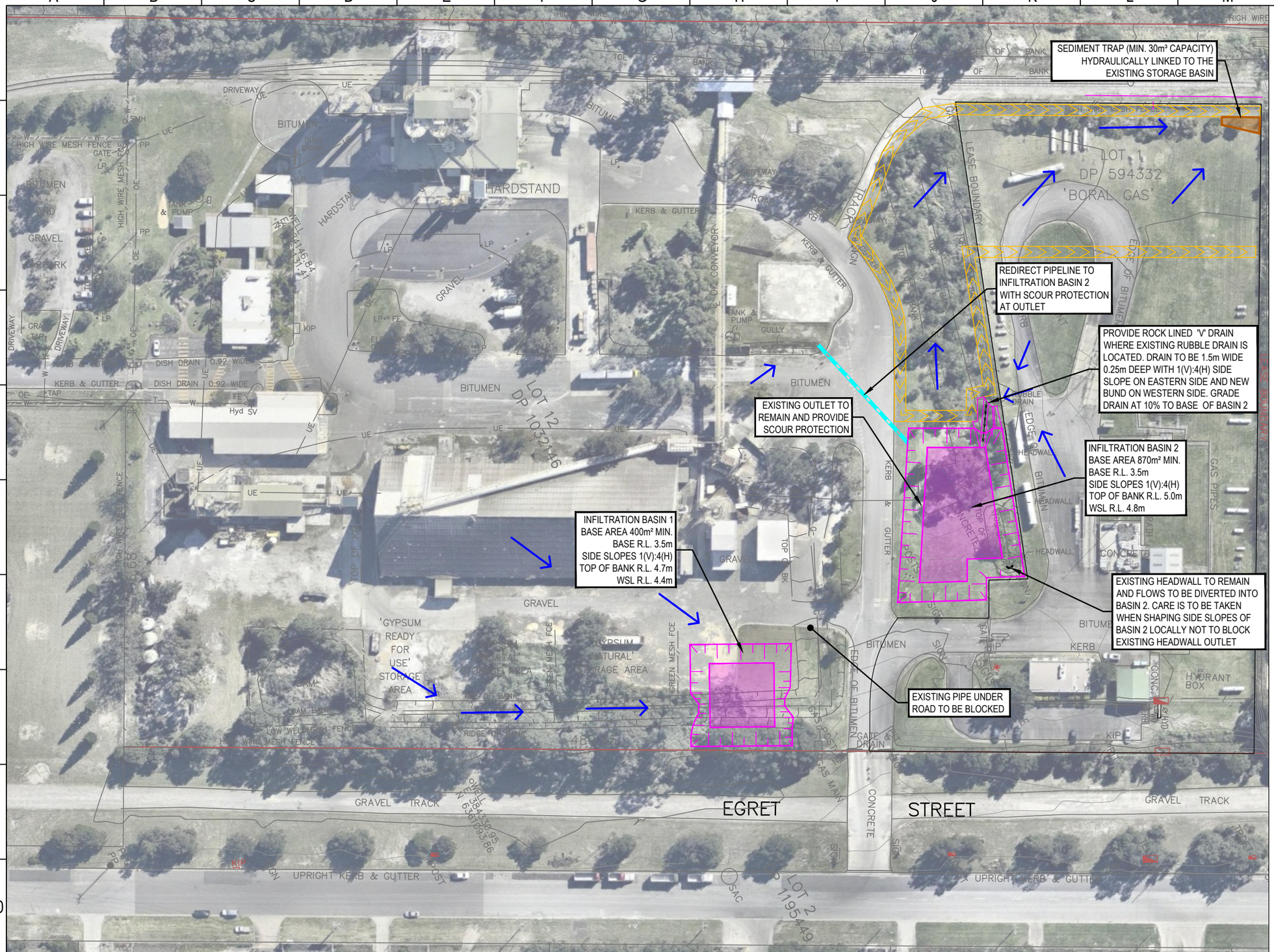
Based upon observations during the installation of the monitoring wells by SLR and the available soil lithology information, the saturated hydraulic conductivity beneath all infiltration systems was assumed to be equivalent to a sandy clay. Saturated hydraulic conductivity of sandy clay typically ranges between 36 and 180 mm/hr (Engineers Australia, 2006). The median of this range was adopted for design purposes (108 mm /hr).

Given the sandy soils onsite, infiltration basins were sized using the Design Storm Method as documented in the Western Australia Stormwater Management Manual (WA DoW, 2007). The method used to size the infiltration basins is documented in **Appendix H**.

The infiltration basin design requirements are summarised in **Table 11** below. A conceptual plan of the proposed mitigation is provided in in **Figure 14**.

Table 11 Infiltration basin design requirements

Infiltration Basin	Base Area (m^2)	Max Water Depth (m)	Bank slope (V/H)
1	415	0.9	1:4
2	870	1.3	1:4



LEGEND

- SURFACE FLOW PATH
- NEW PIPELINE
- 1.5m HIGH BUND

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CLIENT: BORAL
PROJECT: BORAL STOCKPILE
DRAWING TITLE: **PROPOSED BORAL CEMENT STORMWATER MANAGEMENT**
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\\au.slr.local\Corporate\Projects-SLR\630-SrvNTL\630-NTL\630.11225 Boral Stockpile Area Increase DA\06 SLR Data\06 Drafting\Figures\CAD\Current\630.11225-FIG 14 (INFILTRATION

6 WATER DEMAND, SUPPLY AND REUSE

6.1 Site Water Balance Model

The model used to represent the water balance for the facility is GoldSim Version 11.0.6 (GoldSim Technology Group LLC). This software is a graphical, object oriented system simulation software for completing either static or dynamic systems. Simulation, in this context, is defined as a process of creating a model of a system in order to identify and understand the factors that control the system performance or predict the future behaviour of the system.

The GoldSim water balance model (hereafter referred to as "the model") simulates daily changes in the volumes of the sediment basins in response to inflows (rainfall) and outflows (evaporation and usage). The model makes use of operating conditions relevant to site water storage management and captures as accurately as possible the Site's hydrologic cycle.

6.1.1 Surface Water Management System

The existing WRF water management system is outlined in Section **4.7.1** and conceptually presented in **Figure 10**.

The proposed development will generate an increased water demand for stockpile dust suppression and additional runoff from the larger stockpile area.

Two water balance models were developed in GoldSim, for the existing development and proposed development respectively, to assess the potential impact of the proposed development on the WRF's water security.

6.1.2 Model Representation and Accuracy

The following simplifications were incorporated into both models to idealise the WRF water storage management system:

- A 10% allowance for sedimentation within the concrete storage dam was applied as a constant reduction of the storage volume rather than sediment build up over the course of the simulation period. This simplification was made due to the WRF not having a strict sediment removal schedule which could be modelled accurately and took into account the presence of sediment control measures up gradient of the concrete storage facility;

- The total volume available for the storage of water in the concrete storage dam (incorporating the assumption above) was assumed to be 1,350 m^3; and

- Sensitivity tests indicate that the water balance results are highly sensitive to water cart water usage. With no accurate data on the days the water cart is used to rely upon, the results of the water balance should be considered indicative only but suitable for the purposes of this assessment.

6.1.3 Rainfall Runoff

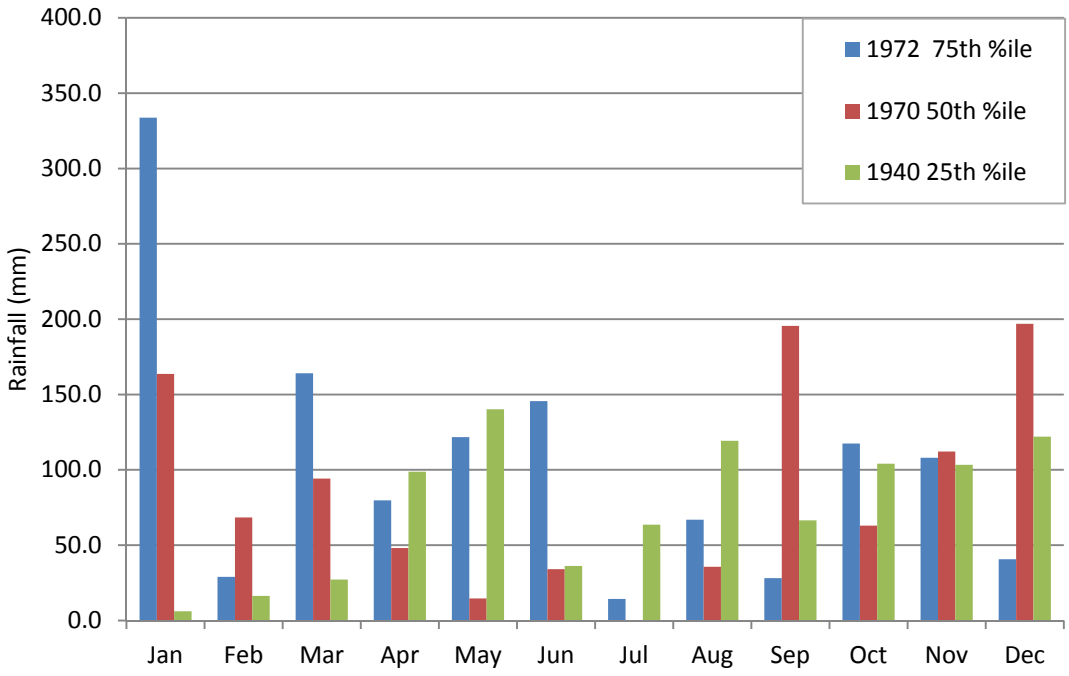
Rainfall data was collected from the Newcastle Nobbys Signal Station AWS meteorological station (Site Number 61055) located approximately 5.3 km from the recycling facility. The meteorological station has an extensive set of records ranging from 1862 to present, which is satisfactory for statistical analysis. From the data set, three years (1940, 1970 and 1972) were chosen to represent the 25^{th} (dry year), 50^{th} (median year) and 75^{th} (wet year) percentiles respectively. These values are summarised below in **Table 12**.

Table 12 Summary of Rainfall data input in to the Water Balance Model

Rainfall Year	Annual Precipitation (mm)
25th percentile (1940) - Dry Year	903
50th percentile (1970) – Median Year	1026
75th percentile (1972) – Wet Year	1249

Further analysis of rainfall data reveals that "*Wet*" years are dictated by short episodes of intense rainfall over several days rather than a general increase spread over the course of the year. To visualise this concept, a monthly comparison of rainfall data from 1940 (25th %ile – Dry Year), 1970 (50th %ile – Median Year) and 1972 (75th %ile – Wet Year) is shown below in **Figure 15**.

Figure 15 Comparison of monthly rainfall data



The hydraulic parameters used in the water balance model are initial rainfall loss and runoff coefficients. These parameters are used due to their link to the volumetric requirements of a daily time step water balance. These values have been conservatively estimated based on relevant guidelines and SLR's experience with similar water balance investigations. The hydraulic parameters which were used in the model are shown below in **Table 13**.

Table 13 Summary of hydraulic parameters

Parameter	Value
Hardstand Initial Volume Loss	5 mm
Vegetated Initial Volume Loss	30 mm
Hardstand Volumetric Runoff Coefficient	0.75
Vegetated Bund Volumetric Runoff Coefficient	0.9

6.1.4 Additional Make-Up Water

The WRF has access to a supplementary potable water supply (i.e. town water) in the event that no water is available for reuse in the concrete storage dam.

6.1.5 Evaporation

The raw mean daily evaporation rates by month are available from the Williamtown RAAF meteorological station (site number 61078). This data was adjusted by a pan co-efficient of 0.8 to account for differences in the measuring site conditions compared to the project site conditions. The adjusted mean daily evaporation rates from this meteorological station which were used in the model are shown in **Table 14** below.

Table 14 Summary of Mean Daily Evaporation Rates

Month	Mean Daily Evaporation (mm)
January	5.52
February	4.96
March	3.92
April	3.04
May	2.16
June	2.00
July	2.08
August	2.88
September	3.76
October	4.48
November	5.04
December	5.76

6.1.6 Water Usage

Water collected in the concrete storage dam is used for dust suppression (by water cart and fixed spray) and in the wheel wash. Existing daily water demands (refer to **Table 15**) for the fixed spray and wheel wash are relatively constant, however the water cart daily water demand will vary depending on climatic conditions (rainfall and wind conditions). The existing fixed spray and water cart water usages were proportionally increased to account for the stockpile area increase in the expanded WRF. The water cart was assumed to operate at the adopted daily water usage when no rainfall falls on that day and when the rainfall over the preceding two days is less than 5 mm.

The daily water usage values used in the model are shown in **Table 15**. These values have been obtained from information provided by Boral.

Table 15 Summary of Daily Water Usage

Water Demand	Existing Daily Water Usage (KL/day)	Predicted Expanded WRF Daily Water Usage (KL/day)
Water cart (dust suppression)	80.0[1]	109.0[1]
Fixed Spray (dust suppression)	5.0	6.8
Wheel wash	0.5	0.5

[1]The water cart was assumed to operate at the adopted daily water usage when no rainfall falls on that day and when the rainfall over the preceding two days is less than 5 mm. The water cart was assumed to use no water during other periods.

6.2 Site Water Balance Results

The modelling results for the existing WRF and the proposed expanded WRF (including the extended stockpile area) are summarised in **Table 16** below.

Table 16 Summary of Water Balance Results for the Existing and Proposed Development

Year	Total Water Demand (ML)	Stormwater runoff (ML)	Overflows from storage facility (ML)	Make-up water demand (ML)	% Demand Met by Runoff	Number of days Basin is Empty
Existing WRF						
Dry (25th percentile)	17.41	8.16	0.04	9.66	45	148
Median (50th percentile)	13.56	8.54	0.77	6.79	50	118
Wet (75th percentile)	12.53	11.10	3.01	4.19	66	85
Proposed Expanded WRF						
Dry (25th percentile)	23.67	11.12	0.62	13.78	41	157
Median (50th percentile)	18.41	11.62	1.86	9.64	47	126
Wet (75th percentile)	16.99	15.12	5.28	6.95	59	108

Results in **Table 16** show that the Proposal will lead to between approximately 40 and 65% additional makeup water being required to meet the expanded WRF water demands (i.e. potable town water supply or other source of water) compared to the existing WRF.

In order to test whether increasing the storage facility by 50% will have a significant impact on the need for make-up water, further analysis of the Proposed Expanded WRF model (median rainfall year) was undertaken incorporating a 50% increase in the capacity of the concrete storage dam. The results indicate that the additional storage will have minimal impact (approx. 2% decrease) on the make-up water demand. This indicates that a much larger storage facility would be required to provide a meaningful benefit in terms of reducing make-up water demand. Due to space constraints, this is unlikely to be feasible.

7 SOIL AND WATER IMPACT ASSESSMENT

7.1 Potential Impacts

The key parts of this Proposal which have the potential to impact on the soil and water environment and the potential consequence of those impacts are outlined in **Table 17** below. The construction phase impacts are assessed in Section **7.2**. The operational phase impacts are assessed in Section **7.3**.

Table 17 Potential Proposal Soil and Water Impacts

Activity / Source of Potential Impact	Potential Impact	Key Potential Consequences
Stockpiling and earthworks during construction and operational phases.	Mobilisation and erosion of soils leading to sediment loading to the stormwater network.	Deposition of suspended solids in waterways which can smother aquatic habitats.
	Disturbance of potentially contaminated soils onsite.	Health risk to workers.
	Mobilisation of soil contaminants in stormwater.	Contaminants conveyed in stormwater can deplete dissolved oxygen and increase toxicity levels, causing degradation of ecological health of receiving waterways.
Increase in stockpile area during the construction and operational phases.	Increases in peak discharge rate	Worsen local overland flooding with associated impacts to adjacent landholders.
	Increases in discharge frequency and volume	Increase frequency of local overland flooding with associated impacts to adjacent landholders. Changes to waterway morphology and degradation of aquatic habitats.
	Increased potable water usage to meet increased dust suppression demand.	Increased pressure on town water supply.
Infiltration of potentially pollutant laden stormwater during construction and operational phases.	Infiltration of stormwater contaminants can increase toxicity levels in the underlying soil and groundwater.	Infiltration of stormwater contaminants can increase toxicity levels in the underlying soil and groundwater.
Storage and use of lubricants, oil and chemicals during construction and operational phases.	Spillage of hazardous substances Offsite discharge of contaminants conveyed by stormwater.	Increase toxicity levels in the underlying soil and groundwater which may impact on local groundwater users and the health of any GDEs. Contaminants conveyed in stormwater can deplete dissolved oxygen and increase toxicity levels, causing degradation of ecological health of receiving waterways
Storage of waste materials onsite.	Offsite discharge of contaminants in stormwater.	Contaminants conveyed in stormwater can deplete dissolved oxygen and increase toxicity levels, causing degradation of ecological health of receiving waterways.

Activity / Source of Potential Impact	Potential Impact	Key Potential Consequences
Reuse of sediment captured in the stormwater treatment system as part of the recycling process during operational phase.	Pollutants may accumulate in stormwater treatment areas leading to elevated levels of pollutants in sediments stored in these areas. Reuse of these sediments in the recycling process could contaminate the recycling materials.	Transport of potentially contaminated material offsite.
Use of groundwater to top up the water in the concrete storage facility during operational phase.	Groundwater could potentially be contaminated and increase toxicity levels in dust suppression and wheel wash water. Increase toxicity levels in recycling materials.	Health risk to workers. Transport of potentially contaminated material offsite.
	Drawdown of groundwater levels locally.	Impact on adjacent licensed groundwater users and the health of any GDEs.
Reuse of stormwater captured in the concrete storage facility during operation phase for dust suppression	Stormwater could potentially contain elevated levels of pollutants which may be ingested by workers onsite or transferred to recycling materials.	Health risk to workers Transport of potentially contaminated material offsite

7.2 Construction Phase

7.2.1 Stormwater quantity

During the construction phase, the existing Central Drainage Feature will be filled in and a new stockpile area will constructed within the WRF expansion. There is potential for the stormwater discharge volumes and rates to the stormwater network on Egret Street to increase. It is noted that given the short duration of the construction phase, stormwater quantity impacts pose less of a risk to down gradient receptors that the operational phase.

In order to manage the potential impacts:

- the works will be staged to reduce the likelihood of stormwater quantity impacts occurring;
- During construction, temporary stormwater control measures will be implemented in line with best practice construction techniques to prevent uncontrolled discharges offsite; and
- It is recommended that the construction phase stormwater management techniques be outlined and documented within an Erosion and Sediment Control Plan (ESCP).

The proposed mitigation measures are discussed further in Section **8.1**.

It is considered that the construction works will not significantly impact on stormwater discharge volumes and rates.

7.2.2 Stormwater quality

Vegetation removal, earthworks, stockpiling of spoil and construction materials, construction of the infiltration basins and vegetation bunds, oil and chemical spills could all affect stormwater quality during construction as a result of pollutant laden runoff discharging offsite to the Egret St stormwater network.

In order to manage the potential impacts:

- Oils, solvents and lubricants will continue to be stored and managed in accordance with the sites Pollution Incident Response Management Plan (PIRMP) as detailed in Section **4.7.3**;

- Best practice erosion and sediment control measures will be implemented during the construction phase;
- The erosion and sediment control measures will be outlined and documented within an Erosion and Sediment Control Plan (ESCP).

The proposed mitigation measures are discussed further in Section **8.1**.

It is considered that the construction works will not significantly impact on the quality of stormwater flows within Egret Street.

7.2.3 Groundwater

No groundwater dewatering will occur during the construction phase.

Oils, solvents and lubricant spills during the construction phase could potentially impact on groundwater quality. Oils, solvents and lubricants will continue to be stored and managed in accordance with the sites Pollution Incident Response Management Plan (PIRMP) as detailed in Section **4.7.3**.

It is considered that the construction works will not significantly impact on groundwater.

7.2.4 Contaminated soil

The Site is recorded to partially be sited on an area of man-made fill, comprising spoil and slag, deposited in reclamation of the south-eastern section of Kooragang Island over the last 70 years. Hydrocarbon odours were observed during the drilling of monitoring wells onsite and toluene, PAH's, heavy metals and total recoverable hydrocarbons were detected during waste classification sampling of the drilling spoil.

Activities which may disturb or expose potentially contaminated soils have the potential to pose a health risk to workers during the construction phase and potentially lead to environmental impacts as a result of mobilisation of soil contaminants by stormwater runoff or improper disposal of contaminated soils.

Further investigation is required to better delineate and assess the human health risks posed by disturbance of the existing soils onsite. The findings of the investigation will enable an appropriate contamination management plan to be developed (if required) for the construction phase.

Further details on the proposed mitigation measures to manage the potential risks are provided in Section **8.1.2**.

7.3 Operational Phase

7.3.1 Stormwater quantity

The Proposal will increase the stockpile area onsite which could potentially increase peak flow rates and runoff volumes being discharged offsite.

The Proposal will incorporate additional stormwater storage systems and infiltration systems onsite to meet the following design criteria:

- All stormwater generated from the existing and expanded WRF is to be retained onsite (i.e. no offsite discharge) for events up to and including the 10 year 24 hour storm event;
- Limit the peak post-development offsite discharge rate to the peak pre-development offsite discharge rate for events up to and including the 100 year ARI 72 hour rainfall event for the entire site;

- Contain stormwater from areas which currently drain to the Central Drainage Feature onsite for events up to and including the 100 year ARI 72 hour rainfall event.

Further details of the proposed mitigation measures are provided in Section **8.2.1**.

WRF stormwater

Hydrological modelling results (refer to Section **5.5.3**) indicate that with the proposed mitigation measures in place the peak offsite discharge rates will not increase for events up to and including the 100 year ARI 72 hour event.

Discharge volumes could potentially increase during events in exceedance of a 10 year ARI event. In the context of the Hunter River catchment, this is unlikely to cause any significant impacts to ecology within the Hunter River.

Boral Cement and Origin stormwater

As stormwater runoff from parts of the Boral Cement and Origin Leased site which currently drains to the Central Drainage Feature will be captured and retained onsite for events up to and including the 100 year ARI event, no significant impacts in terms of stormwater discharges to Egret St are likely to occur.

Other areas onsite

The Boral Concrete site and parts of the Boral Cement and Origin Leased site which are unaffected by the Proposal will continue to operate as they do now. Therefore, it is considered that the Proposal will not impact on discharge rates and volumes within these parts of the Site.

7.3.2 Regional and local flooding

The Proposal is located outside the ocean flooding extent and the Hunter River flood extent for the 100 year ARI event.

The Proposal will increase the stockpile area onsite which could potentially increase peak flow rates being discharged offsite. This could potentially increase overland flow rates during a flood event in adjacent and down gradient properties.

The Proposal will incorporate additional flood storage and infiltration systems to manage stormwater onsite (as detailed in Section **8.2.1**). Modelling (refer to Section **5.5.3**) indicates that with these mitigation measures in place, the Proposal will not increase peak flow rates for events up to and including the 100 year ARI 72 hour event and the frequency of discharge events is likely to be reduced.

It is therefore considered that the Proposal will not cause a significant impact to flood behaviour or overland flow rates on adjacent or downstream properties.

7.3.3 Stormwater quality

Waste materials will be stored externally onsite. Stormwater runoff which comes into contact with waste materials could potentially convey and discharge pollutants associated with the waste materials to stormwater management systems onsite and to the stormwater network and / or local water bodies down gradient of the Site.

By filling the existing Central Drainage Feature, there is potential for increased discharges to Egret Street from the Boral Cement and Origin Leased site and subsequently an increase in pollutant loading. The two infiltration basins proposed will accommodate the stormwater flows from the Boral Cement and Origin Energy sites, thereby mitigating the potential for increased discharged to Egret Street.

WRF management

The Proposal will incorporate raising ground levels to the west of the weighbridge and sealing of the block wall to the south west of the weighbridge up to a minimum level of 4.9 m AHD to effectively create a flood bund which will increase flood storage onsite. Additionally the vegetated bunds which surround the northern and western boundaries will be maintained to prevent floodwater from draining away to the north or west. Floodwater retained onsite will drain away slowly via the existing infiltration trench which runs along the northern boundary.

Modelling indicates that the proposed stormwater control measures will prevent offsite discharges from occurring from the Expanded WRF for events up to and including the 20 year ARI 72 hour event, an improvement (i.e. less frequent discharges) on the existing WRF. Pollutants conveyed in stormwater runoff will therefore only be discharged offsite in significant flood events. Due to the relatively short duration and volume of discharge which would occur during this type of significant flood event, pollutant loading to the stormwater network is likely to be relatively minor and is unlikely to significantly impact on the water quality of downstream waters.

The proposed WRF stormwater management approach will achieve Newcastle City Councils stormwater pollutant reduction targets, refer to Section **5.4**.

Boral Cement / Origin Leased site management

The Proposal will incorporate two new infiltration basins to manage stormwater from areas of the Boral Cement and Origin Leased site which currently drains to the Central Drainage Feature as detailed in Section **4.7.1**. The infiltration basins have been designed to contain stormwater runoff from their contributing catchments for events up to and including the 100 year ARI event, therefore, pollutant loading to the Egret St stormwater network (from areas of the Boral Cement and Origin Leased site which currently drain to the central drainage feature) would only occur on very rare occasions during significant flood events which exceed this design criteria.

Due to the relatively short duration and volume of discharge which would occur during this type of major flood event, pollutant loading to the stormwater network is likely to be relatively minor and is unlikely to significantly impact on the water quality of downstream waters.

Other areas onsite

The Boral Concrete site and parts of the Boral Cement and Origin Leased site which are unaffected by the Proposal will continue to operate as they do now, therefore the Proposal is unlikely to impact stormwater quality from these parts of the Site.

Summary

The Proposal is therefore considered to provide adequate control measures to prevent any significant impacts in terms of pollutant loading to the stormwater network in Egret Street and subsequently the Hunter River.

7.3.4 Water reuse quality

As a result of the settlement treatment, sediment bound pollutants would tend to accumulate in the sediments captured within the WRF sediment trap, infiltration trench and concrete storage facility, however, some dissolved pollutants or pollutants bound to fine (unsettled) sediments may be present within water extracted from the concrete storage facility for reuse as dust suppression and wheel wash water onsite. The pH of the water sampled from the WRF concrete storage dam has also on occasions had a high alkalinity with the 90 percentile pH reported to be outside the public health risk management criteria (DEC, 2006). For these reasons, the water could potentially be unsuitable for water reuse onsite.

It is therefore recommended that any water proposed to be reused onsite be monitored prior to reuse and compared against the public health risk management criteria (DEC, 2006) and the adopted EGIL criteria. If the water quality does exceed this criteria then water of a suitable quality may be pumped in for dilution purposes. Following this dilution the water shall then be re-monitored to determine if the water quality criteria are met. Water exceeding the public health risk management criteria (DEC, 2006) or the adopted EGIL criteria will not be reused onsite.

With these control measures in place, the reuse of stormwater for dust suppression and wheel wash water will pose a low risk to the environment and worker health.

7.3.5 Potable water usage

The water balance results in **Table 16** indicate that the Expanded WRF will require approximately 40 to 65% more make-up water (i.e. water supplied by sources other than runoff) than the existing WRF.

As groundwater is unlikely to be a suitable water source going forward (subject to the findings of an additional investigation, refer to Section **8.2.5**), potable water from the town water supply is likely to be the only alternative water source available to the WRF.

Therefore the Proposal is likely to significantly increase the WRF's potable water usage.

7.3.6 Contamination and Spills

Unforeseen events such as chemical spills or leaks have the potential to contaminate soil, groundwater and surface waters.

All operations are conducted on compacted road base. Oils, solvents and lubricants will continue to be stored and managed in accordance with the sites Pollution Incident Response Management Plan (PIRMP) as detailed in Section **4.7.3**.

The existing management procedures will be adopted for the Expanded WRF, which will also be surfaced with compacted road base.

It is proposed to retain stormwater on the Expanded WRF with no releases for events up to and including the 10 year ARI event. Therefore pollutants associated with a major spill and/or leak are unlikely to be conveyed offsite by stormwater.

The Proposal therefore poses a low risk to the soil and water environment in terms of contamination as a result of a spill or leak.

7.3.7 Sediment quality

Stormwater borne pollutants will tend to accumulate in sediment which is collected in the WRF sediment traps and stormwater storage facilities.

Material being stored and processed onsite could potentially be contaminated by recycling sediment which accumulates in the sediment traps and the concrete storage facilities.

It is recommended that sediment which collects in the sediment traps and concrete storage facilities is appropriately tested under the waste classification guidelines prior to being recycled or disposed of at an appropriate waste management WRF.

The reuse of sediment will thereby pose a low risk in terms of contaminating material to be recycled and subsequently the soil and water environment.

7.3.8 Groundwater quality

Previous investigations and groundwater monitoring conducted by SLR as part of this assessment indicates that groundwater is brackish with low levels of PAH present. Nitrogen and zinc concentrations were elevated above the ecological investigation levels for marine waters (ANZECC, 2000) in both SLR wells. Zinc was elevated above the ecological investigation level for freshwaters (ANZECC, 2000) in both SLR wells and phosphorus was elevated above the long term irrigation guideline (ANZECC, 2000).

The risk associated with oil and chemicals spills and leaks in discussed in Section **7.1**.

Infiltration is currently used to manage stormwater across the Site. Use of the existing infiltration systems as well as the new infiltration systems proposed will act as mitigation measures for the Proposal (refer to Section **5.5** and **5.6**).

Groundwater quality could potentially be impacted by pollutants, conveyed in stormwater runoff which infiltrate to the underlying groundwater. As detailed in Section **5.4**, the new infiltration systems have been designed with sufficient buffer between the base of newly proposed infiltration surface and the underlying groundwater level so that adequate filtration treatment may occur prior to groundwater being intercepted.

Material being stored and processed onsite could potentially be contaminated by using groundwater for dust suppression. The reuse of potentially contaminated groundwater may also pose a risk to site operatives and visitors through inhalation of the dust suppression water aerosols.

Further details of the proposed management and mitigation measures are provided in Section **8.2.5**. In any case, groundwater quality is considered to be poor and unsuitable for most uses.

7.3.9 Groundwater levels and abstraction

No groundwater dewatering is proposed to be undertaken as part of the Proposal.

If groundwater abstraction for the purpose of water reuse is deemed appropriate by the findings of a groundwater investigation (refer to Section **8.2.5**), groundwater could potentially continue to be used to top up the concrete storage facility during extended dry periods (provided that the groundwater bore licenses are active at the time of groundwater abstraction). Further details of the proposed management and mitigation measures are provided in Section **8.2.5**. In any case, groundwater quality is considered to be poor and unsuitable for most uses.

As the license for this spear point has lapsed Boral will apply for this spear point licence to be re-activated.

Water balance results indicate that 9.64 ML/yr of water will need to be sourced from water sources other than stormwater runoff (i.e. groundwater or town water supply) during a median year or approximately 0.6 L/s when applied across the whole year. This is approximately 2.85 ML/yr greater than what is predicted for the existing site operations during a median year and when applied across the whole year equates to an 0.09 L/s increase compared to the existing WRF operation.

Given the relatively low abstraction rate and high local groundwater recharge rates the Proposal is unlikely to pose a significant impact to groundwater levels.

With the exception of the licenced irrigation bore on the Boral Cement site (GW200456), the only known licenced groundwater bores close to the Site are monitoring bores. Therefore there are no known local groundwater users that are likely to be affected by the Proposal.

7.3.10 Groundwater dependant ecosystems (GDEs)

Due to the reasons discussed in Section **4.7** as well as the depth of groundwater, altered substrate and absence of characteristic vegetation on the Site, it is unlikely that GDEs are present within the Site. Consequently, the proposal is not likely to impose adverse impacts on GDEs, as per Principle 5 of the *NSW State Groundwater Dependent Ecosystem Policy* (Department of Land and Water Conservation (2002).

8 MANAGEMENT AND MITIGATION MEASURES

8.1 Construction

8.1.1 Erosion and sediment control

An Erosion and Sediment Control Plan (ESCP) will be developed in accordance with Managing Urban Stormwater, Soils and Construction, Volume 1, (NSW Government, 2004) prior to the commencement of construction works onsite.

It is also recommended that:

- the two proposed infiltration basins and sediment trap are installed prior to commencement of works in the WRF expansion area; and
- under no circumstance should runoff from disturbed surfaces of the WRF be diverted to the proposed infiltration basins during construction. This will ensure the infiltration system does not clog up.

8.1.2 Contaminated soil management

It is recommended that a targeted contaminated soil investigation be undertaken in potential disturbance areas prior to the commencement of any activities which may disturb the underlying soils.

The findings of the contaminated soil investigation should be used to develop (if required) a contamination management plan to:

- manage the health risks to workers onsite during the construction works; and
- ensure that potentially contaminated soils are managed / disposed of appropriately.

Mitigation measures for managing contaminants in stormwater will also be incorporated within the ESCP, refer to Section **8.1.1**.

8.2 Operation

8.2.1 Stormwater management measures

The Proposal will incorporate:

- Two new infiltration basins designed for a 100 year ARI event as shown in **Figure 14** which will capture and infiltrate runoff from the existing contributing portions of the Boral Cement and Origin Leased Site;
- Raising the ground levels to the west of the weighbridge and sealing the block wall to the south west of the weighbridge up to a minimum level of 4.9 m AHD to effectively create a flood bund which will increase flood storage onsite.
- The vegetation bunds which surround the northern and western boundaries should be maintained at all times to prevent floodwater from draining away to the north or west.
- Construction of a sediment trap on the expanded WRF.

A conceptual plan of the proposed stormwater management measures is presented in **Figure 13** and **Figure 14**.

8.2.2 Dust suppression water quality

It is recommended that any water proposed to be reused onsite be monitored prior to reuse and compared against the public health risk management criteria (DEC, 2006) and the adopted EGIL criteria prior. If the water quality does exceed this criteria then water of a suitable quality may be pumped in for dilution purposes. Following this dilution the water shall then be re-monitored to ensure that the water quality criteria are met. Water exceeding the public health risk management criteria (DEC, 2006) or the adopted EGIL criteria will not be reused onsite.

It is recommended that water collected in the concrete storage facility is dosed or diluted to adjust the pH to between 6.5 and 8.5.

8.2.3 Contamination and Spills

All operations are conducted on compacted road base. Oils, solvents and lubricants will continue to be stored and managed in accordance with the sites Pollution Incident Response Management Plan (PIRMP) as detailed in Section **4.7.3**.

The existing management procedures will be adopted for the Expanded WRF, which will also be surfaced with compacted road base.

8.2.4 Sediment quality

It is recommended that sediment which collects in the sediment traps and concrete storage facilities is appropriately tested under the waste classification guidelines prior to being recycled or disposed of at an appropriate waste management WRF.

8.2.5 Groundwater quality

Pre-treatment measures, such as the sediment trap, will be provided for managing runoff from the WRF Expansion prior to stormwater draining to the existing concrete storage facility. Any pre-treatment measures currently implemented on the Boral Cement site will also be maintained or replicated as required.

No groundwater dewatering activities are proposed to be undertaken as part of the Proposal.

As the use of potentially contaminated groundwater to top up the concrete storage dam may pose a risk to site operatives and visitors through inhalation of the dust suppression water vapour it is recommended that a targeted investigation and risk assessment process into the quality of the groundwater abstracted should be undertaken by a suitable qualified consultant. The investigation should consider (but not be limited to) groundwater quality at the abstraction point, water quality in the concrete storage facility, the potential for temporal variations in water quality, ongoing health risks and cumulative health risks associated with long term exposure. Groundwater abstraction, for onsite water reuse purposes, should only recommence if the findings of the investigation deem it appropriate for groundwater abstraction to recommence.

8.2.6 Groundwater levels and abstraction

No groundwater dewatering activities are proposed to be undertaken as part of the Proposal.

The proposed management and mitigation measures outlined in **Section 8.2.5** are considered to adequately mitigate groundwater quality impacts. In any case, groundwater quality is considered to be poor and unsuitable for most uses.

9 CONCLUSIONS AND RECOMMENDATIONS

The Proposal will result in an expansion of the existing WRF to occupy a total area of approximately 3.45 ha. The proposed expansion intends to acquire 5250m2 of land which is currently leased by Origin Energy with an additional 5200m2 of land proposed for the expansion being the drainage strip located to the south of the Origin lease, adjacent to the main entrance to the site. The drainage land is intended to be used as a stockpiling area and as a result will be partially filled and will require the installation of an alternative drainage regime to safely convey runoff from the existing site as well as increased amounts of runoff that will be generated by the proposed development.

The key parts of the Proposal which have the potential to impact on the soil and water environment during the construction and operational phase are as follows:

- Stockpiling and earthworks during construction and operational phases.
- Increase in stockpile area during the construction and operational phases.
- Infiltration of potentially pollutant laden stormwater during construction and operational phases.
- Storage and use of lubricants, oil and chemicals during construction and operational phases.
- Storage of waste materials onsite.
- Reuse of sediment captured in the stormwater treatment system as part of the recycling process during operational phase.
- Use of groundwater to top up the water in the concrete storage facility during operational phase.
- Reuse of stormwater captured in the concrete storage facility during operation phase for dust suppression.

Management and mitigation measures to be implemented during the construction and operational phase include:

- Development and implementation of an Erosion and Sediment Control Plan (ESCP) in accordance with Managing Urban Stormwater, Soils and Construction, Volume 1, (NSW Government, 2004) prior to the commencement of construction works onsite.
- Staging of the works to reduce the likelihood of stormwater quantity impacts occurring.
- During construction, temporary stormwater control measures will be implemented in line with best practice construction techniques to prevent uncontrolled discharges offsite.
- Oils, solvents and lubricants will continue to be stored and managed in accordance with the sites Pollution Incident Response Management Plan (PIRMP)
- In order to:
    a) retain onsite all stormwater generated from the existing and expanded WRF for events up to and including the 10 year 24 hour storm event,
    b) limit the peak post-development offsite discharge rate to the peak pre-development offsite discharge rate for events up to and including the 100 year ARI 72 hour rainfall event for the entire Site, and
    c) contain stormwater from areas which currently drain to the Central Drainage Feature onsite for events up to and including the 100 year ARI 72 hour rainfall event

  the Proposal includes additional stormwater mitigation measures as follows:

    - Two new infiltration basins designed for a 100 year ARI event which will capture and infiltrate runoff from the existing contributing portions of the Boral Cement and Origin Leased Site;

- Raising the ground levels to the west of the weighbridge and sealing the block wall to the south west of the weighbridge up to a minimum level of 4.9 m AHD to effectively create a flood bund which will increase flood storage onsite.
- The vegetation bunds which surround the northern and western boundaries should be maintained at all times to prevent floodwater from draining away to the north or west.
- Construction of a sediment trap on the expanded WRF.

In addition to mitigating potential stormwater quantity impacts these features will also mitigate any potential impacts on stormwater quality.

- It is recommended that a targeted contaminated soil investigation will be undertaken in potential disturbance areas prior to the commencement of any activities which may disturb the underlying soils. The findings of the contaminated soil investigation would be used to develop (if required) a contamination management plan to:
  - manage the health risks to workers onsite during the construction works; and
  - ensure that potentially contaminated soils are managed / disposed of appropriately.
- It is recommended that any water proposed to be reused onsite be monitored prior to reuse and compared against the public health risk management criteria (DEC, 2006) and the adopted EGIL criteria. Water exceeding the public health risk management criteria (DEC, 2006) or the adopted EGIL criteria will not be reused onsite.
- It is recommended that water collected in the concrete storage facility is dosed to adjust the pH to between 6.5 and 8.5.
- It is recommended that sediment which collects in the sediment traps and concrete storage facilities is appropriately tested under the waste classification guidelines prior to being recycled or disposed of at an appropriate waste management WRF.
- As the use of potentially contaminated groundwater to top up the concrete storage facility may pose a risk to site operatives and visitors through inhalation of the dust suppression water aerosols it is recommended that:
  - Site operatives immediately cease using groundwater to top up the Boral Recycling WRF concrete storage facility and any other storage facilities for the purpose of water reuse; and
  - A targeted investigation and risk assessment process into the quality of the groundwater abstracted should be undertaken by a suitable qualified consultant. The investigation should consider (but not be limited to) groundwater quality at the abstraction point, water quality in the concrete storage facility, the potential for temporal variations in water quality, ongoing health risks and cumulative health risks associated with long term exposure. Groundwater abstraction, for onsite water reuse purposes, should only recommence if the findings of the investigation deem it appropriate for groundwater abstraction to recommence.

It should be noted that the final Expanded WRF footprint is likely to be less than 3.45 ha in order to incorporate the aforementioned mitigation measures.

10 REFERENCES

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Site Topographic Survey

SITE NORTH

CORMORANT ROAD

CHANNEL

LOT 11
DP 1032146
HUNTER WATER CORPORATION

LOT 2 DP 594332 PUBLIC WORKS

RAILWAY LINE

HEADWALL

RUBBLE DRAIN

SILOS

RUBBLE PIT

BUILDING A

CLINKER SHED

DRIVEWAY

POZZOMENT

SILO

SILO

SUB STN

MILLET SLAG

BUILDING B

TAP

GRASS

DM

CONTROL VALVE LOCK

BOOM

FUEL DEPOT

BITUMEN AND GRAVEL CARPARK

BUILDING C

ADMINISTRATION

LOT 12
DP 1032146

℄ OF CONVEYOR

TOP OF BANK

TOE OF BANK

FILTER

KERB & GUTTER

DISH DRAIN 0.92 WIDE

KERB & GUTTER

DISH DRAIN 0.92 WIDE

FE

Hyd SV

BUILDING E

ORIGIN ENERGY

STACK

BUILDING F

SLAG DRYER

STACK

FILTERS

HW

CLINKER SHED

LOT 71
DP 1119950

'GYPSUM CHEMICAL' STORAGE AREA

'GYPSUM NATURAL' STORAGE AREA

BOOM

DAM

DM

BUILDINGS

GATE

TOP OF BANK

TOE OF BANK

EGRET STREET

LEGEND

KIP DENOTES KERB INLET PIT
SIP DENOTES SURFACE INLET PIT
DIP DENOTES DRAINAGE INLET PIT
DM DENOTES DUST MONITORING STATION
HW DENOTES HEADWALL

REVISIONS						
3	DP NUMBER CHANGED	PAM	MAK	PEP	09/12/13
2	CHANGE DRAWING SCALE TO 1:750	PAM	MAK	PEP	06/12/13
1	ISSUE TO CLIENT	PAM	MAK	PEP	06/12/13
No	REVISION	SVY	DFT	CHK	DATE

Monteath & Powys Pty Ltd
ACN 000 861 110
SURVEYING
PLANNING
ENGINEERING DESIGN
PROJECT MANAGEMENT
125 Bull Street Newcastle NSW 2300
PO Box 726 Newcastle NSW 2300
T 61 2 4926 1388 F 61 2 4929 3475
E survey@monteathpowys.com.au
W www.monteathpowys.com.au

Surveyed	Drafted	Checked
PAM	MAK	PEP

REGISTERED SURVEYOR

Scale @A1 : 1:750
@A3 : 1:1500

DO NOT SCALE

Original Size A1

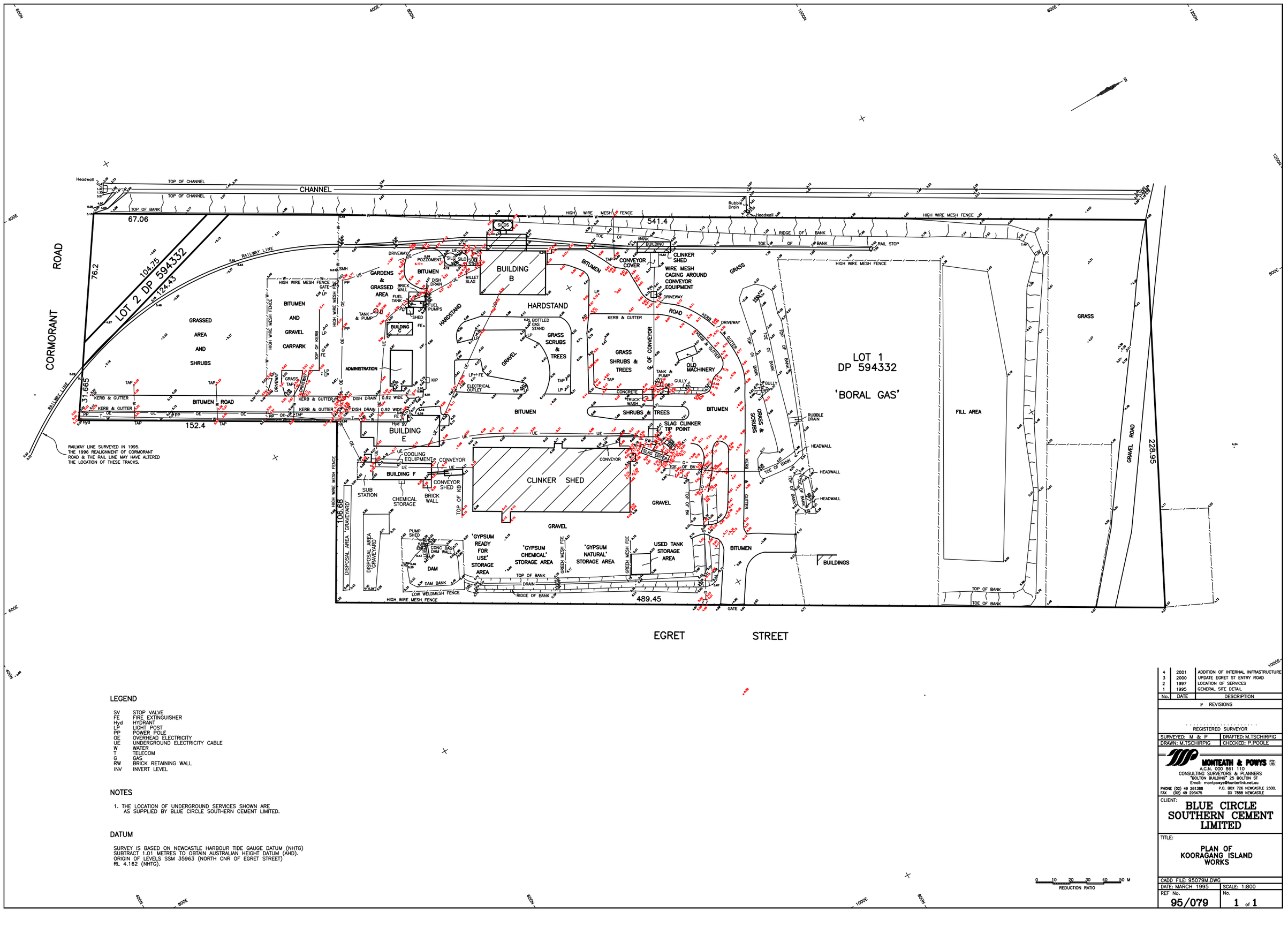
Client: BORAL CEMENT

Title: PLAN SHOWING STORMWATER DRAINAGE STRUCTURES, SMOKE STACKS & DUST MONITORING STATIONS BORAL CEMENT SITE, KOORAGANG ISLAND

CAD File: 95079R_03 | Ref No: 95/079 | Date: 06/12/2013

Sheet No. 1/1

Revision 3



LEGEND

SV	STOP VALVE
FE	FIRE EXTINGUISHER
Hyd	HYDRANT
LP	LIGHT POST
PP	POWER POLE
OE	OVERHEAD ELECTRICITY
UE	UNDERGROUND ELECTRICITY CABLE
W	WATER
T	TELECOM
G	GAS
RW	BRICK RETAINING WALL
INV	INVERT LEVEL

NOTES

1. THE LOCATION OF UNDERGROUND SERVICES SHOWN ARE AS SUPPLIED BY BLUE CIRCLE SOUTHERN CEMENT LIMITED.

DATUM

SURVEY IS BASED ON NEWCASTLE HARBOUR TIDE GAUGE DATUM (NHTG) SUBTRACT 1.01 METRES TO OBTAIN AUSTRALIAN HEIGHT DATUM (AHD). ORIGIN OF LEVELS SSM 35963 (NORTH CNR OF EGRET STREET) RL 4.162 (NHTG).

No.	DATE	DESCRIPTION
4	2001	ADDITION OF INTERNAL INFRASTRUCTURE
3	2000	UPDATE EGRET ST ENTRY ROAD
2	1997	LOCATION OF SERVICES
1	1995	GENERAL SITE DETAIL

REVISIONS

REGISTERED SURVEYOR

SURVEYED: M & P	DRAFTED: M.TSCHIRPIG
DRAWN: M.TSCHIRPIG	CHECKED: P.POOLE

MONTEATH & POWYS PTY LTD
A.C.N. 000 861 110
CONSULTING SURVEYORS & PLANNERS
"BOLTON BUILDING" 25 BOLTON ST
Email: montpowys@hunterlink.net.au
PHONE (02) 49 261388 P.O. BOX 726 NEWCASTLE 2300.
FAX (02) 49 293475 DX 7888 NEWCASTLE

CLIENT:
BLUE CIRCLE SOUTHERN CEMENT LIMITED

TITLE:
PLAN OF KOORAGANG ISLAND WORKS

CADD FILE: 95079M.DWG	
DATE: MARCH 1995	SCALE: 1:800
REF No. 95/079	No. 1 of 1

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" 143.005

29°26'25" 384.13

LOT 4
DP 1015754

29.72
119°49'35"

BASIN

RECYCLING STOCKPILES
(GROUND LEVEL ONLY)

LEASE BOUNDARY

EDGE OF BITUMEN

CONCRETE

WEIGH BRIDGE

BUILDING

SEPTIC TANK

BITUMEN

GATE

POST

BLOCK WALL

TANK

SILO ON CONCRETE

WASH DOWN BAY

PIPE INV.2.84

PIPE INV.2.86

PIPE INV.2.93

SIGN

TREES

TPOST

SAC

WELL

HYDRANT

METAL SHED

LIGHT RODS

GAS PIPES

RAIL

ELEC

STORMW

GRAVEL TRACK

UPRIGHT KERB & GUTTER

GAS POST

GAS MAIN

CONCRETE DRIVEWAY

DITUMEN DRIVEWAY

GATE & DRAIN

PIT
INV.3.32

ø0.25 PIPE
INV.3.34

TRACK

KERB

BITUMEN

ø0.35 PIPE

PIT
INV.4.50

ø0.3 PIPE

SIGN

WELL
E 384146.84
N 6361131.41

WELL
E 384330.95
N 6361093.86

PEG
PP

KIP

SCRUB

STOCKPILES
FOR CEMENT PLANT

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

Borehole Logs

SLR Consulting

BOREHOLE NUMBER C2

CLIENT Boral **PROJECT NAME** Kooragang

PROJECT NUMBER 630.11225 **PROJECT LOCATION** Egret St, Kooragang Island

DATE STARTED 8-7-15 **COMPLETED** 8-7-15 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Epoca **SLOPE** 90° **BEARING** -90°

EQUIPMENT Geoprobe **HOLE LOCATION** Boral Cement

HOLE SIZE 125 mm **LOGGED BY** WL **CHECKED BY** CM

NOTES

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL	TOPSOIL with grass		
						SW-SC	SAND with Clay, fine to medium grained, slightly moist, grey, occasional weathered sandstone gravel. No odour.		
				0.5		CLS	Sandy CLAY, soft, low plasticity, moist, mottled red, brown, grey, occasional weathered sandstone gravel. No odour.		
				1.0					
				1.5					
						OL	Silty CLAY, dark grey / black, soft, low plasticity, moist. No odour.		
				2.0		SW	SAND, fine to medium grained, well graded, increasing from moist to wet with depth, grey, contains fine shell fragments. No odour.		
				2.5					
				3.0					
				3.5		SW	Same but dark grey. Hydrocarbon odour.		
				4.0					
	▼ Drilling observed water level			4.5			Borehole C2 terminated at 4.5m		Target depth reached
				5.0					

BOREHOLE / TEST PIT 630.11225_BH_LOGS_20150729.GPJ GINT STD AUSTRALIA.GDT 29-7-15

SLR Consulting

BOREHOLE NUMBER R1

CLIENT Boral **PROJECT NAME** Kooragang

PROJECT NUMBER 630.11225 **PROJECT LOCATION** Egret St, Kooragang Island

DATE STARTED 8-7-15 **COMPLETED** 8-7-15 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Epoca **SLOPE** 90° **BEARING** -90°

EQUIPMENT Geoprobe **HOLE LOCATION** Boral Recyling

HOLE SIZE 125 mm **LOGGED BY** WL **CHECKED BY** CM

NOTES

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Drilling observed water level			0.5		FILL	FILL, gravelly sand, with occasional concrete, dry, brown. No odour.		
				1.0					
				1.5		SW	SAND, fine to medium grained, well graded, increasing wetness with depth, grey, contains fine shell fragments. Hydrocarbon odour		
				2.0					
				2.5					
				3.0					
				3.5		OL	Silty CLAY, black / dark grey, soft, low plasticity, saturated. Hydocarbon odour.		
				4.0			Borehole R1 terminated at 4m		Target depth reached
				4.5					
				5.0					

Acid Sulphate Soils Maps

Newcastle Local Environmental Plan 2012

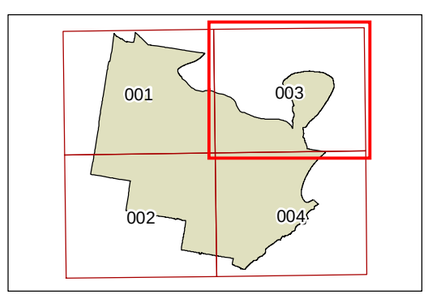
Acid Sulfate Soils Map - Sheet ASS_003

Acid Sulfate Soils

- 1 Class 1
- 2 Class 2
- 3 Class 3
- 4 Class 4
- 5 Class 5

Cadastre

Base data 01/08/2007 © Land and Property Information (LPI)
Addendum data 13/03/2014 © City of Newcastle



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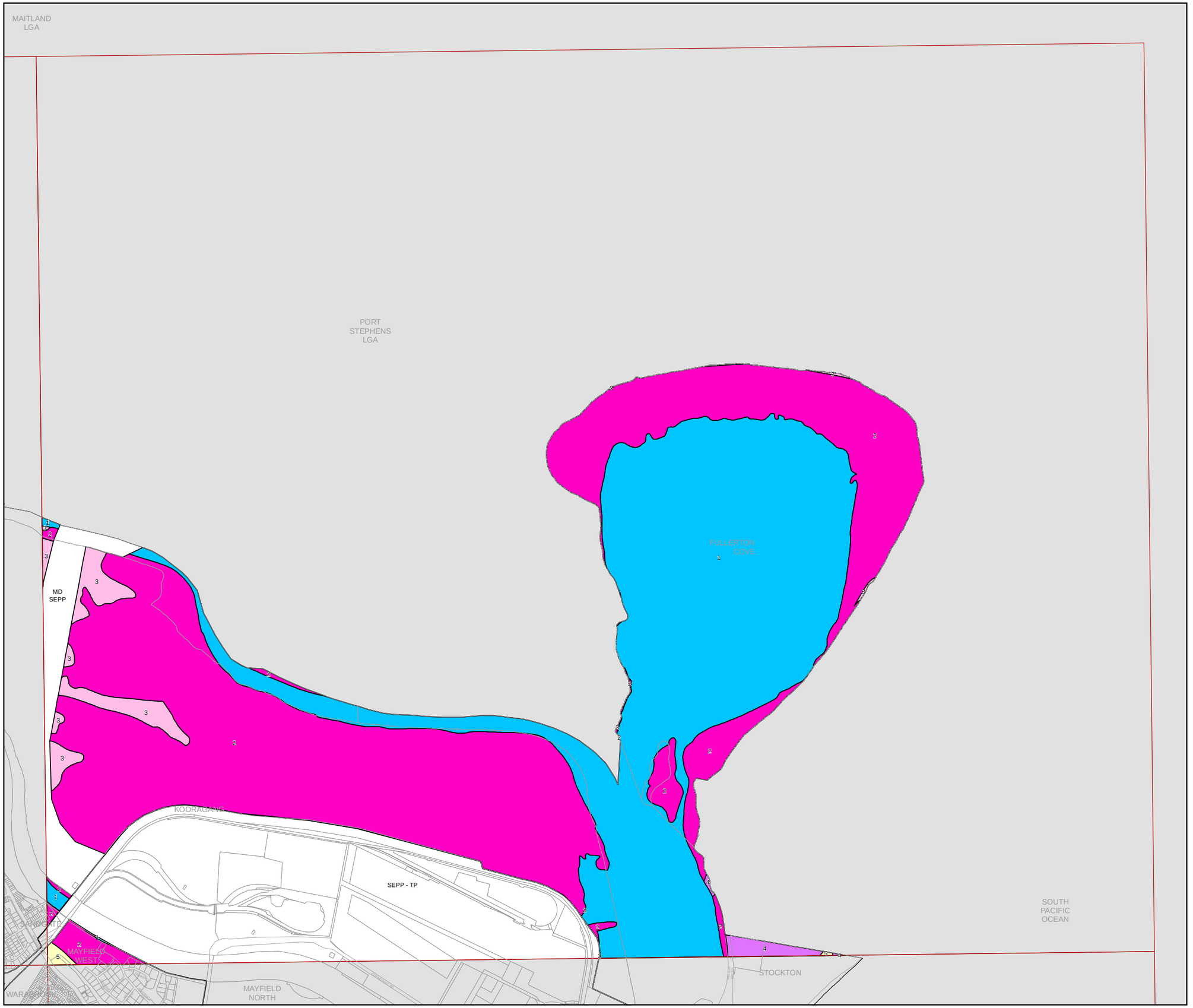
Projection: GDA 1994
MGA Zone 56

Map Identification Number: 5900_COM_ASS_003_040_20140509



Newcastle Local Environmental Plan 2012

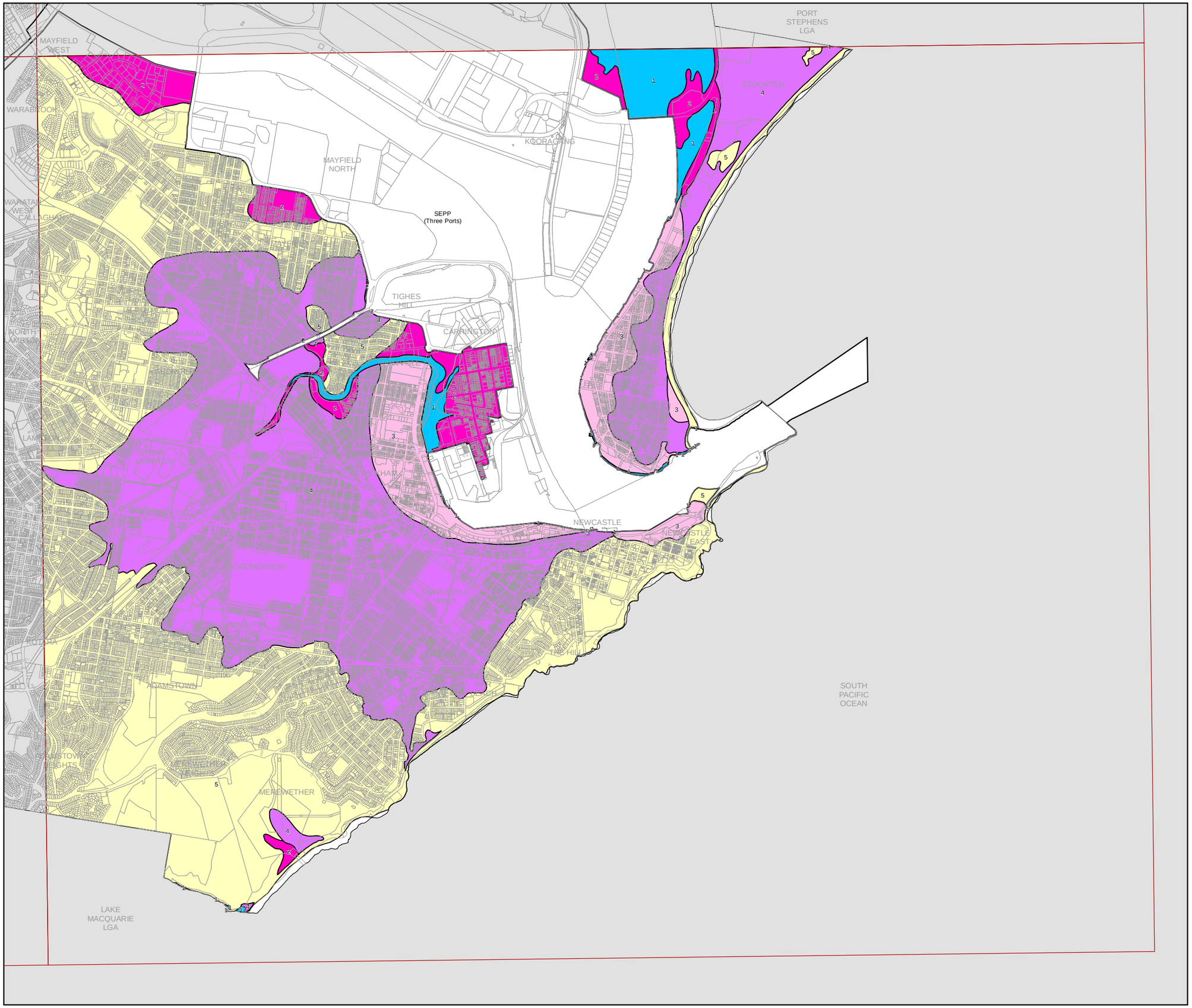
Acid Sulfate Soils Map - Sheet ASS_004

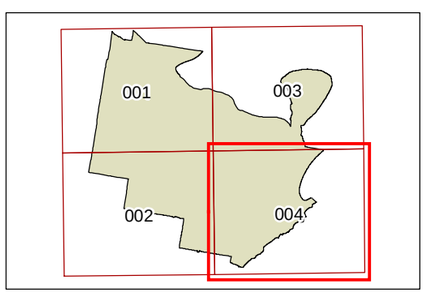
Acid Sulfate Soils

- 1 Class 1
- 2 Class 2
- 3 Class 3
- 4 Class 4
- 5 Class 5

Cadastre

Base data 01/08/2007 © Land and Property Information (LPI)
Addendum data 13/03/2014 © City of Newcastle





N

0 400 800 1,200 Metres

Scale:1:40,000 @ A3

Projection: GDA 1994
MGA Zone 56

Map Identification Number: 5900_COM_ASS_004_040_20140509

GW200456 Bore Log

Date/Time : 17-Jun-2015 9:57 AM
User : NELNIZ
Report : RMGW001D.QRP
Executable : Y:\SOE-NON-MSI\Water-Apps\centura-prod32\Ground.exe
Exe Date : 03-Jun-2014
System : Groundwater
Database : Edbp

Department of Primary Industries
NSW Office of Water

NSW OFFICE OF WATER
Work Summary

GW200456

Licence : 20BL168957
Licence Status Active
Authorised Purpose(s) INDUSTRIAL (LOW SECURITY)
Intended Purpose(s) IRRIGATION

Work Type : Bore
Work Status :
Construct. Method : Auger - Hollow Flight
Owner Type :

Commenced Date :
Completion Date : 30-Sep-2003
Final Depth : 10.50 m
Drilled Depth : 10.50 m

Contractor Name :
Driller : 1772 STEWART, Peter James
Assistant Driller's Name :

Property : - N/A
GWMA : -
GW Zone : -

Standing Water Level : 2.00 m
Salinity :
Yield : 6.00 L/s cumulative

Site Details

Site Chosen By
Client Driller

	County	Parish	Portion/Lot DP
Form A :	NORTHUMBERLAND	NEWCASTLE	12/1032146
Licensed :	NORTHUMBERLAND	NEWCASTLE	12 1032146

Region : 20 - HUNTER
River Basin :
Area / District :

CMA Map :
Grid Zone : **Scale :**

Elevation :
Elevation Source :

Northing : 6361165 **Latitude (S) :** 32° 52' 54"
Easting : 384217 **Longitude (E) :** 151° 45' 44"

GS Map : **MGA Zone :** 56 **Coordinate Source :** Map Interpretation

Construction

Negative depths indicate Above Ground Level;
H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	10.50	180			Auger - Hollow Flight
1	1	Casing	PVC Class 9	0.00	10.50	60	55		Glued; Seated on Bottom; Cap
1	1	Opening	Slots - Vertical	9.30	10.50	60			PVC Class 9; Casing - Drilled Holes; SL: 1.2mm; A: 1.2mm
1		Annulus	Waterworn/Rounded	9.80	10.50				Graded; GS: 3.5-5mm; 20m³

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
6.50	10.50	4.00		2.00		6.00		1.50	

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	5.00	5.00	sand (grey)	Sand	
5.00	7.00	2.00	mud (grey with shells)	Mud	
7.00	10.50	3.50	sand (amber)	Sand	

Remarks

Updated coordinates as per existing Eastings and Northings.

***** End of GW200456 *****

***** End of Report *****

Groundwater Investigation July 2015 Report

24 September 2015

630.11225_L1_20150924.docx

Boral Property Group
Clunies Ross Street
Prospect
NSW 2148

Attention: Kate Jackson

Dear Kate

Groundwater Investigation July 2015
Kooragang Recycling Facility

1 Introduction

SLR Consulting Australia (SLR) were engaged by Boral Property Group (Boral) to undertake a groundwater investigation at Boral's Kooragang Island facility on the corner of Cormorant Road and Egret St, Kooragang Island within Lot 12 DP 1032146 (the Site) in July 2015. The site extent is shown in **Figure 1**.

The groundwater investigation was undertaken to support a Soil and Water Assessment being carried out by SLR to support an Environmental Impact Statement (EIS) in relation to the Boral Recycling Pty Ltd proposal to increase the area and stockpile heights at its Kooragang Waste Recycling Facility (the WRF).

The specific objectives of the groundwater investigation were:

- to obtain data to inform the Soil and Water Assessment being conducted by SLR in relation to establishing baseline groundwater levels and groundwater quality at the Site;
- to identify potential contaminants in groundwater which may affect the reuse of groundwater onsite.

SLR Consulting Australia Pty Ltd 2 Lincoln Street Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9428 8100 F: 61 2 9427 8200 E: sydney@slrconsulting.com www.slrconsulting.com
ABN 29 001 584 612

Figure 1 Site Extent

2 Analytical Schedule

In-situ testing was conducted for conductivity, temperature, pH, redox potential and dissolved oxygen.

Groundwater quality sampling was conducted at monitoring wells C2 and R1 for:

- Benzene, Toluene, Ethylbenzene, Xylene (BTEX);
- Total Recoverable Hydrocarbons (TRH);
- Total Petroleum Hydrocarbons (TPH);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Nutrients (total nitrogen, total phosphorus, nitrate, nitrite, total oxidised nitrogen, total Kjeldahl nitrogen); and
- Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury).

3 Methodology

3.1 Well installation

Two groundwater monitoring wells (R1 and C2) were installed by Epoca Environmental on the 8th July 2015 using hollow stem auger drilling methods under the supervision of a competent environmental engineer.

Drill cuttings and excavated soil from the borehole were temporarily placed on the ground adjacent to the hole. The drill cuttings were examined to determine the lithology and inspected for any evidence (visual or olfactory) of contamination.

The monitoring well was developed by an SLR Consultant one week after installation.

Prior to drilling a 'Dial Before You Dig' (DBYD) search was performed on the site to determine underground service locations. An underground service location survey was conducted by a specialist service locating contractor under the supervision of Boral personnel for the proposed drilling locations. The final selected drilling location was clear of services.

The coordinates and top of casing elevation for the groundwater monitoring wells were surveyed after installation.

The monitoring well locations are shown in **Figure 2**.

Figure 2 Groundwater monitoring well and local bore locations

3.2 Field Observations and Lithology

Borehole logs for the SLR July 2015 well installation program are provided in **Attachment 1.**

The soil lithology was observed to comprise layers of sand, sandy clay, clayey sand and organic silty clay.

Hydrocarbon odours were noted within some soils beneath the groundwater level.

3.3 Groundwater sampling methodology

Groundwater sampling was conducted at monitoring wells R1 and C2 (refer to **Figure 2**) in accordance with the SLRs standard operating procedure (refer to **Attachment 2**) on 23rd July 2015. Groundwater level gauging was conducted at monitoring well C1, refer to **Figure 2**, on 23rd July 2015.

Low flow groundwater equipment was used to micro-purge and collect groundwater samples.

The depth and thickness of hydrocarbon product (if present) and depth to groundwater was recorded in each well prior to the commencement of purging and sampling using an oil/water interface probe.

Field parameters including Electrical Conductivity (EC), pH, Dissolved Oxygen (DO), Redox Potential, and Temperature (T^oC) were measured during purging. The sampling of groundwater commenced once the water quality parameters had stabilised.

Samples were collected and stored in suitably preserved laboratory supplied bottles, packaged in chilled coolers and delivered on the day of sampling, under chain of custody protocol to SGS, a NATA certified laboratory.

Disposable tubing and bladders were used for the low flow sampling. Samples for metals analysis were filtered using 0.45 μm membrane inline filters into laboratory-supplied plastic containers.

All re-usable sampling equipment was decontaminated using Decon 90 (a phosphate free detergent), and rinsed between each sample. The respective holding times were not exceeded.

The samples collected were analysed for a range of contaminants as outlined in the analytical schedule (refer to Section **2**).

Field data and relevant documentation is provided in **Table 5** and **Attachment 3**.

4 Quality assurance and quality control

4.1 Field QAQC

Field methodologies were consistent with SLR's standard quality assurance (QA) and quality control (QC) protocols. This ensured that cross contamination was prevented and the integrity, accuracy and precision of data were maintained. The QAQC protocols used in the fieldwork conducted for this investigation are outlined in **Table 1.**

Table 1 Field QAQC Protocols

Protocol	Description
Sampling Team	Experienced and professionally qualified environmental consultants undertook fieldwork in general accordance with relevant water quality sampling guidelines and standards.
Chain of Custody Forms	All samples were logged and transferred under appropriately completed Chain of Custody (COC) forms.
Preservation	All samples were transferred to the laboratory in appropriately preserved and chilled containers.
Decontamination	All sampling equipment was decontaminated using Decon 90 (a phosphate free detergent) and rinsed between each sample.

Protocol	Description
Trip Blank and Trip Spike	Transport blanks were carried during the transportation of samples to the laboratories. One trip blank and one trip spike was submitted for BTEX analysis.
Blind Sample Replicates	One field duplicate water sample was analysed and subjected to the same set of analysis as the primary sample.

4.2 Laboratory QAQC

The samples were submitted to SGS (primary samples and duplicates), which is a NATA registered for the specified tests. **Table 2** outlines the validation criteria, qualifications to the data and the QAQC procedures used for the laboratory testing program.

Table 2 Laboratory QAQC

Protocol	Description
Holding times	Holding times are the maximum permissible elapsed time in days from the collection of the sample to its extraction and/or analysis.
Method Blanks	A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process.
Laboratory Duplicates	Laboratory duplicates are field samples that are split in the laboratory and subsequently analysed a number of times in the same batch. These sub samples are selected by the laboratory to assess the accuracy and precision of the analytical method.
Laboratory Control Standard	A laboratory control standard is a standard reference material used in preparing primary standards. The concentration should be equivalent to a mid-range standard to confirm the primary calibration. Laboratory control samples are performed on a frequency of 1 per 20 samples or at least one per analytical run.
Matrix Spikes/Matrix Spike Duplicates (MS/MSD)	MS/MSDs are field samples to which predetermined stock solution of known concentration has been added. The samples are then analysed for recovery of the known addition. Recoveries should be within the stated laboratory control limits of 70% to 130%.
Surrogate Spikes	Surrogate spikes provide a means of checking for every analysis that no gross errors have occurred at any stage of the procedure leading to significant analyte loss. Recoveries should be within the stated laboratory control limits of 70% to 130%.

4.3 Data Evaluation

The results of internal laboratory QA/QC procedures are provided within the SGS Statement of QA/QC Performance (**Attachment 4**). Quality control validation data have been tabulated and are presented in **Table 3.**

Table 3 Data Validation

QA/QC requirement	Completed	Comments
Appropriate sample handling undertaken	Yes	Samples were stored in chilled eskies onsite and during transport via courier to the laboratory. A Chain of Custody (CoC) form was completed, signed and sent with the samples. The laboratory confirmed receipt of all samples and specified the condition on delivery and the scheduled analysis. All samples were received intact and chilled.
Decontamination of field sampling equipment undertaken	Yes	Nitrile gloves were used. Non-dedicated equipment was decontaminated using phosphate free detergent (Decon 90) and rinsed with clean water between each sample event to reduce the potential for cross contamination.
Samples delivered to laboratory within sample holding times and with correct preservative	Yes	All samples were delivered correctly preserved and analysed within the holding time used for assessment purposes.
All analyses NATA accredited	Yes	SGS is NATA accredited for the analysis undertaken

QA/QC requirement	Completed	Comments
Required number of sample duplicates and blanks taken	Yes	1:10 duplicate samples collected, Laboratory duplicates and triplicates, control samples, method blanks and matrix spikes undertaken as per NEPM (1999), as amended 2013, requirements
Sample duplicates reported RPD's within the acceptable limits	Yes	All duplicate samples were within the acceptable RPD range.
Trip Blank results were below LOR and Trip Spike recoveries were within acceptable limits	Yes	All Trip Blank results were below LOR and all Trip Spike results were within 40-130% recovery.
Laboratory QA/QC samples were within acceptable limits	Yes	All SGS laboratory QA/QC samples were within the acceptable limits.
Laboratory limits of reporting within assessment criteria	Majority	Laboratory limits of reporting (LLOR) used during laboratory analysis were within the assessment criteria for all analytes except Phosphorus (for the Marine Waters EGIL) and Benzo(a)pyrene for the DWIL. The LLOR for phosphorus was above the MW guideline criteria, however, all total phosphorus results exceeded the criteria. The assessment was therefore not affected. The LLOR for benzo(a)pyrene was below the DWIL. As a wide range of PAHs were detected, further investigation into the health impacts associated with groundwater use for dust suppression will be required in any case. Therefore, the high LLOR for benzo(a)pyrene does not impact on this assessment.

4.4 Quality Control Results

The following criteria were adopted when assessing Relative Percentage Difference (RPD):

- It is recommended that the Relative Percentage Difference (RPD) is <30-50%.
- For the purposes of this assessment, replicate data with concentrations above 20 times the LOR should have a RPD <30% and replicate data with concentrations greater than 10 times the LOR should have a RPD <50%. For example, the LOR for arsenic is 1 ug/L, so replicate data with concentrations >10 ug/L should have RPDs <30% and data with concentrations <10 ug/L should have RPDs <50%.
- Replicate data with concentrations less than 10 times the LOR may have an unlimited RPD.
- Where one laboratory concentration is below the LOR and one is above, a value equal to the detection limit is substituted for the non-detect sample.

The RPD analysis results and the trip blank and trip spike results are tabulated in **Table 4**. All RPD results met the adopted criteria.

Based on the review of field observations and laboratory QA/QC procedures and results, SLR considers that the sampling and laboratory procedures used were appropriate and the results reliable for the purposes of this assessment.

Table 4 QAQC Sampling Results and RPD Analysis

		Sample Type	Primary	Duplicate	RPD	Trip Blank	Trip Spike
		Sample Name	SE141751.001	SE141751.003		SE141751.004	SE141751.005
		Description	R1	Dup 01		Trip Blank	Trip Spike
		Location	Boral Recycling	Boral Recycling		N.A.	N.A.
		Sample Date	23-7-2015	23-7-2015		22-7-2015	22-7-2015
		Matrix	Water	Water		Water	Water
Analyte Name	**Units**	**Reporting Limit**	**Result**	**Result**		**Result**	**Result**
Benzene	µg/L	0.5	<0.5	<0.5	<LOR	<0.5	[97%]
Toluene	µg/L	0.5	<0.5	<0.5	<LOR	<0.5	[100%]
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<LOR	<0.5	[101%]
m/p-xylene	µg/L	1	<1	<1	<LOR	<1	[100%]
o-xylene	µg/L	0.5	<0.5	<0.5	<LOR	<0.5	[99%]
Total Xylenes	µg/L	1.5	<1.5	<1.5	<LOR	<1.5	N.A.
Total BTEX	µg/L	3	<3	<3	<LOR	<3	N.A.
Naphthalene	µg/L	0.5	<0.5	<0.5	<LOR	<0.5	57
Dibromofluoromethane (Surrogate)	%	0	126	122	2.1	111	102
d4-1,2-dichloroethane (Surrogate)	%	0	127	116	5.9	113	104
d8-toluene (Surrogate)	%	0	90	87	2.2	104	103
Bromofluorobenzene (Surrogate)	%	0	87	92	-3.8	82	110
TRH C6-C9	µg/L	40	<40	<40	<LOR	N.A.	N.A.
Benzene (F0)	µg/L	0.5	<0.5	<0.5	<LOR	N.A.	N.A.
TRH C6-C10	µg/L	50	<50	<50	<LOR	N.A.	N.A.
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<LOR	N.A.	N.A.
Dibromofluoromethane (Surrogate)	%	0	126	122	2.1	N.A.	N.A.
d4-1,2-dichloroethane (Surrogate)	%	0	127	116	5.9	N.A.	N.A.
d8-toluene (Surrogate)	%	0	90	87	2.2	N.A.	N.A.
Bromofluorobenzene (Surrogate)	%	0	87	92	-3.8	N.A.	N.A.
TRH C10-C14	µg/L	50	66	69	-3.0	N.A.	N.A.
TRH C15-C28	µg/L	200	<200	240	-12.5	N.A.	N.A.
TRH C29-C36	µg/L	200	<200	<200	<LOR	N.A.	N.A.
TRH C37-C40	µg/L	200	<200	<200	<LOR	N.A.	N.A.
TRH >C10-C16 (F2)	µg/L	60	140	160	-9.1	N.A.	N.A.
TRH >C16-C34 (F3)	µg/L	500	<500	<500	<LOR	N.A.	N.A.
TRH >C34-C40 (F4)	µg/L	500	<500	<500	<LOR	N.A.	N.A.
TRH C10-C36	µg/L	450	<450	<450	<LOR	N.A.	N.A.
TRH C10-C40	µg/L	650	<650	<650	<LOR	N.A.	N.A.
TRH C10-C14-Silica	µg/L	50	<50	<50	<LOR	N.A.	N.A.
TRH C15-C28-Silica	µg/L	200	<200	<200	<LOR	N.A.	N.A.
TRH C29-C36-Silica	µg/L	200	<200	<200	<LOR	N.A.	N.A.
TRH C37-C40-Silica	µg/L	200	<200	<200	<LOR	N.A.	N.A.
TRH >C10-C16-Silica	µg/L	60	<60	<60	<LOR	N.A.	N.A.
TRH >C16-C34-Silica	µg/L	500	<500	<500	<LOR	N.A.	N.A.
TRH >C34-C40-Silica	µg/L	500	<500	<500	<LOR	N.A.	N.A.
TRH Sum C10-C36-Silica	µg/L	450	<450	<450	<LOR	N.A.	N.A.
TRH Sum C10-C40-Silica	µg/L	650	<650	<650	<LOR	N.A.	N.A.
Naphthalene	µg/L	0.1	19	14	19.2	N.A.	N.A.
2-methylnaphthalene	µg/L	0.1	3.7	3.2	9.4	N.A.	N.A.
1-methylnaphthalene	µg/L	0.1	6.9	7.7	-7.4	N.A.	N.A.
Acenaphthylene	µg/L	0.1	<0.1	0.1	0.0	N.A.	N.A.
Acenaphthene	µg/L	0.1	20	20	0.0	N.A.	N.A.
Fluorene	µg/L	0.1	9.4	9.3	0.7	N.A.	N.A.
Phenanthrene	µg/L	0.1	11	11	0.0	N.A.	N.A.
Anthracene	µg/L	0.1	2.8	2.8	0.0	N.A.	N.A.
Fluoranthene	µg/L	0.1	6.7	7.0	-2.9	N.A.	N.A.
Pyrene	µg/L	0.1	3.4	3.3	2.0	N.A.	N.A.
Benzo(a)anthracene	µg/L	0.1	0.2	0.2	0.0	N.A.	N.A.
Chrysene	µg/L	0.1	0.2	0.2	0.0	N.A.	N.A.
Benzo(b&j)fluoranthene	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Benzo(k)fluoranthene	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Benzo(a)pyrene	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Indeno(1,2,3-cd)pyrene	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Dibenzo(a&h)anthracene	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Benzo(ghi)perylene	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Total PAH (18)	µg/L	1	84	79	4.0	N.A.	N.A.
d5-nitrobenzene (Surrogate)	%	0	50	52	-2.6	N.A.	N.A.
2-fluorobiphenyl (Surrogate)	%	0	50	52	-2.6	N.A.	N.A.
d14-p-terphenyl (Surrogate)	%	0	76	70	5.4	N.A.	N.A.
Nitrate Nitrogen, NO3-N	mg/L	0.005	<0.025	<0.025	<LOR	N.A.	N.A.
Nitrite Nitrogen, NO2 as N	mg/L	0.005	0.013	0.013	0.0	N.A.	N.A.
Total Oxidised Nitrogen, NOx-N	mg/L	0.005	0.013	0.013	0.0	N.A.	N.A.
Total Kjeldahl Nitrogen	mg/L	0.05	0.42	0.63	-28.6	N.A.	N.A.
Total Nitrogen (calc)	mg/L	0.05	0.43	0.65	-29.1	N.A.	N.A.
Total Phosphorus (Kjeldahl Digestion)	mg/L	0.05	0.16	0.16	0.0	N.A.	N.A.
Arsenic, As	µg/L	1	2	2	0.0	N.A.	N.A.
Cadmium, Cd	µg/L	0.1	<0.1	<0.1	<LOR	N.A.	N.A.
Chromium, Cr	µg/L	1	<1	<1	<LOR	N.A.	N.A.
Copper, Cu	µg/L	1	<1	<1	<LOR	N.A.	N.A.
Lead, Pb	µg/L	1	<1	<1	<LOR	N.A.	N.A.
Nickel, Ni	µg/L	1	2	2	0.0	N.A.	N.A.
Zinc, Zn	µg/L	5	15	12	14.3	N.A.	N.A.
Mercury	mg/L	0.0001	<0.0001	<0.0001	<LOR	N.A.	N.A.

Notes

<LOR	Both samples were below the LOR
Highlighted Cell	Result does not meet the adopted analysis criteria

5 Assessment Levels

The water quality sampling results were compared to:

- Ecological Groundwater Investigation Levels (EGILs) to assess potential impacts to the receiving environment; and
- Drinking Water Investigation Levels (DWILs) to provide a preliminary indication of health issues related to reusing groundwater onsite for dust suppression and wheel wash activities.

The marine waters EGILs are based upon the Hunter River water quality objectives (OEH, 2006) and ANZECC (2000) marine water trigger levels.

The fresh waters EGILs are based upon the ANZECC (2000) fresh water trigger levels.

The DWILs are based upon the health values of the National Water Quality Management Strategy Australian Drinking Water Guidelines (NHRMC, 2011).

6 Groundwater Monitoring Results

The groundwater field test results, compared to the adopted assessment levels (refer to Section **5**), are presented in **Table 5**

The groundwater sampling results, compared to the adopted assessment levels (refer to Section **5**), are presented in **Table 6**.

Table 5 Groundwater field test results

Monitoring Well	C1	C2	R1
Location	**Boral Cement**	**Boral Cement**	**Boral Recycling**
Date	23-07-2015	23-07-2015	23-07-2015
Easting	384146	384349	384372
Northing	6361131	6361236	6361485
Depth to Water	2.47	3.42	1.48
TOC Elevation	5.087	6.113	4.013
GW Elevation	2.617	2.693	2.533
Conductivity (uS/cm)	-	1543	4872
Temperature ^{O}C	-	19.7	16.7
pH	-	6.9	7.21
Redox Potential (mV)	-	44.5	19.6
Dissolved Oxygen (mg/L)	-	0.13	0.12
Observations	-	Slight hydrocarbon odour	Slight hydrocarbon odour
Comments	Not Sampled	-	-

[A] Hunter River estuary water quality objectives (OEH, 2006)

Laboratory results and documentation is provided within **Attachment 4**.

Table 6 Groundwater Sampling Results

		Ecological Groundwater Investigation Levels		Drinking Water Investigation Levels	Sample Name	SE141751.001	SE141751.002	SE141751.003
					Description	R1	C2	Dup 01
					Location	Boral Recycling	Boral Cement	Boral Recycling
					Sample Date	23-7-2015	23-7-2015	23-7-2015
					Matrix	Water	Water	Water
Analyte Name	**Units**	**Fresh Waters [A]**	**Marine Waters [A]**	**Drinking Water [I]**	**Reporting Limit**	**Result**	**Result**	**Result**
Benzene	µg/L	950	500[C]	1	0.5	<0.5	<0.5	<0.5
Toluene	µg/L	-	-	800	0.5	<0.5	<0.5	<0.5
Ethylbenzene	µg/L	-	-	300	0.5	<0.5	<0.5	<0.5
m/p-xylene	µg/L	200	-	-	1	<1	<1	<1
o-xylene	µg/L	350	-	-	0.5	<0.5	<0.5	<0.5
Total Xylenes	µg/L	-	-	600	1.5	<1.5	<1.5	<1.5
Total BTEX	µg/L	-	-	-	3	<3	<3	<3
Naphthalene	µg/L	16	50[C]	-	0.5	<0.5	<0.5	<0.5
Dibromofluoromethane (Surrogate)	%	-	-	-	0	126	118	122
d4-1,2-dichloroethane (Surrogate)	%	-	-	-	0	127	117	116
d8-toluene (Surrogate)	%	-	-	-	0	90	102	87
Bromofluorobenzene (Surrogate)	%	-	-	-	0	87	83	92
TRH C6-C9	µg/L	-	-	-	40	<40	<40	<40
Benzene (F0)	µg/L	950	500[C]	1	0.5	<0.5	<0.5	<0.5
TRH C6-C10	µg/L	-	-	-	50	<50	<50	<50
TRH C6-C10 minus BTEX (F1)	µg/L	-	-	-	50	<50	<50	<50
Dibromofluoromethane (Surrogate)	%	-	-	-	0	126	118	122
d4-1,2-dichloroethane (Surrogate)	%	-	-	-	0	127	117	116
d8-toluene (Surrogate)	%	-	-	-	0	90	102	87
Bromofluorobenzene (Surrogate)	%	-	-	-	0	87	83	92
TRH C10-C14	µg/L	-	-	-	50	66	<50	69
TRH C15-C28	µg/L	-	-	-	200	<200	260	240
TRH C29-C36	µg/L	-	-	-	200	<200	<200	<200
TRH C37-C40	µg/L	-	-	-	200	<200	<200	<200
TRH >C10-C16 (F2)	µg/L	-	-	-	60	140	93	160
TRH >C16-C34 (F3)	µg/L	-	-	-	500	<500	<500	<500
TRH >C34-C40 (F4)	µg/L	-	-	-	500	<500	<500	<500
TRH C10-C36	µg/L	-	-	-	450	<450	<450	<450
TRH C10-C40	µg/L	-	-	-	650	<650	<650	<650
TRH C10-C14-Silica	µg/L	-	-	-	50	<50	<50	<50
TRH C15-C28-Silica	µg/L	-	-	-	200	<200	<200	<200
TRH C29-C36-Silica	µg/L	-	-	-	200	<200	<200	<200
TRH C37-C40-Silica	µg/L	-	-	-	200	<200	<200	<200
TRH >C10-C16-Silica	µg/L	-	-	-	60	<60	<60	<60
TRH >C16-C34-Silica	µg/L	-	-	-	500	<500	<500	<500
TRH >C34-C40-Silica	µg/L	-	-	-	500	<500	<500	<500
TRH Sum C10-C36-Silica	µg/L	-	-	-	450	<450	<450	<450
TRH Sum C10-C40-Silica	µg/L	-	-	-	650	<650	<650	<650
Naphthalene	µg/L	-	50[C]	-	0.1	19	0.2	14
2-methylnaphthalene	µg/L	-	-	-	0.1	3.7	<0.1	3.2
1-methylnaphthalene	µg/L	-	-	-	0.1	6.9	<0.1	7.7
Acenaphthylene	µg/L	-	-	-	0.1	<0.1	1.2	0.1
Acenaphthene	µg/L	-	-	-	0.1	20	27	20
Fluorene	µg/L	-	-	-	0.1	9.4	0.4	9.3
Phenanthrene	µg/L	-	-	-	0.1	11	0.7	11
Anthracene	µg/L	-	-	-	0.1	2.8	0.4	2.8
Fluoranthene	µg/L	-	-	-	0.1	6.7	9.7	7.0
Pyrene	µg/L	-	-	-	0.1	3.4	5.0	3.3
Benzo(a)anthracene	µg/L	-	-		0.1	0.2	0.2	0.2
Chrysene	µg/L	-	-	-	0.1	0.2	0.2	0.2
Benzo(b&j)fluoranthene	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	µg/L	-	-	0.01	0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1
Dibenzo(a&h)anthracene	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	µg/L	-	-	-	0.1	<0.1	<0.1	<0.1
Total PAH (18)	µg/L	-	-	-	1	84	45	79
d5-nitrobenzene (Surrogate)	%	-	-	-	0	50	56	52
2-fluorobiphenyl (Surrogate)	%	-	-	-	0	50	50	52
d14-p-terphenyl (Surrogate)	%	-	-	-	0	76	68	70
Nitrate Nitrogen, NO3-N	mg/L	-	-	50	0.005	<0.025	<0.01	<0.025
Nitrite Nitrogen, NO2 as N	mg/L	-	-	3	0.005	0.013	<0.005	0.013
Total Oxidised Nitrogen, NOx-N	mg/L	-	0.015[G]	-	0.005	0.013	0.009	0.013
Total Kjeldahl Nitrogen	mg/L	-	-	-	0.05	0.42	0.84	0.63
Total Nitrogen (calc)	mg/L	-	0.3[H]	-	0.05	0.43	0.85	0.65
Total Phosphorus (Kjeldahl Digestion)	mg/L	-	0.03[H]	-	0.05	0.16	0.44	0.16
Arsenic, As	µg/L	13[E]	-	10	1	2	<1	2
Cadmium, Cd	µg/L	0.2	0.2[D]	2	0.1	<0.1	<0.1	<0.1
Chromium, Cr	µg/L	1[F]	4.4[F]	50[F]	1	<1	<1	<1
Copper, Cu	µg/L	1.4	1.3	2000	1	<1	<1	<1
Lead, Pb	µg/L	3.4	4.4	10	1	<1	<1	<1
Nickel, Ni	µg/L	11	7	20	1	2	2	2
Zinc, Zn	µg/L	8[C]	15	-	5	15	26	12
Mercury	mg/L	0.06[D]	0.1	1	0.0001	<0.0001	<0.0001	<0.0001

[A] Investigation levels apply to typical slightly-moderately disturbed systems. Refer to ANZECC & ARMCANZ (2000) for further guidance

[C] Figure may not protect key species from chronic toxicity, refer to ANZECC & ARMCANZ (2000) for further guidance

[D] Chemical for which possible bioaccumulation and secondary poisoning effects should be considered, refer to ANZECC & ARMCANZ (2000

[E] Relates to As (V)

[F] Relates to Cr (VI)

[G] Trigger value for Estuaries. Refer to ANZECC & ARMCANZ (2000) for further guidance

[H] Hunter River estuary water quality objectives (OEH, 2006)

7 Conclusions and Recommendations

Groundwater had a relatively neutral pH (6.9 to 7.2) and was brackish (1500 to 4900 uS/cm).

Low levels of PAH and TRH (TRH fraction C10-C16) were recorded in both monitoring wells. The concentration of all TPH fractions was below the limit of reporting in both monitoring wells.

Heavy metal concentrations were generally below the adopted EGILs for fresh and marine waters in both monitoring wells with the exception of zinc which exceeded the EGIL for fresh and marine waters at monitoring wells R1 and C2.

Total nitrogen and total phosphorus were elevated in both monitoring wells R1 and C2 in relation to the EGILs for marine waters.

No DWILs were exceeded, however, the LLOR for benzo(a)pyrene was higher than the DWIL.

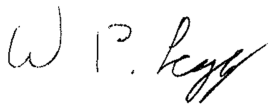
Given the presence of PAHs in groundwater, the use of groundwater to top up the concrete storage facility may pose a risk to site operatives and visitors through inhalation of the dust suppression water aerosols. Therefore it is recommended that

- Site operatives immediately cease to use groundwater to top up the Boral Recycling WRF concrete storage facility and any other storage facilities for the purpose of water reuse; and
- groundwater abstraction for onsite water reuse purposes should only recommence if a targeted investigation and risk assessment process is undertaken and the findings of this investigation deem it appropriate for groundwater abstraction to recommence.

Further recommendations in relation to the proposed development of the recycling facility have been provided in SLR Consulting's Soil and Water Assessment.

It is concluded that the objectives of the groundwater investigation have been met.

Yours sincerely



WILL LEGG
Senior Consultant

Attachment 1

Report 630.11225

Borehole Logs

SLR Consulting

BOREHOLE NUMBER C2

CLIENT Boral **PROJECT NAME** Kooragang

PROJECT NUMBER 630.11225 **PROJECT LOCATION** Egret St, Kooragang Island

DATE STARTED 8-7-15 **COMPLETED** 8-7-15 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Epoca **SLOPE** 90° **BEARING** -90°

EQUIPMENT Geoprobe **HOLE LOCATION** Boral Cement

HOLE SIZE 125 mm **LOGGED BY** WL **CHECKED BY** CM

NOTES

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL	TOPSOIL with grass		
						SW-SC	SAND with Clay, fine to medium grained, slightly moist, grey, occasional weathered sandstone gravel. No odour.		
				0.5		CLS	Sandy CLAY, soft, low plasticity, moist, mottled red, brown, grey, occasional weathered sandstone gravel. No odour.		
				1.0					
				1.5					
						OL	Silty CLAY, dark grey / black, soft, low plasticity, moist. No odour.		
				2.0		SW	SAND, fine to medium grained, well graded, increasing from moist to wet with depth, grey, contains fine shell fragments. No odour.		
				2.5					
				3.0					
				3.5		SW	Same but dark grey. Hydrocarbon odour.		
				4.0					
	▼ Drilling observed water level			4.5			Borehole C2 terminated at 4.5m		Target depth reached
				5.0					

BOREHOLE / TEST PIT 630.11225_BH_LOGS_20150729.GPJ GINT STD AUSTRALIA.GDT 29-7-15

SLR Consulting

BOREHOLE NUMBER R1

CLIENT Boral **PROJECT NAME** Kooragang

PROJECT NUMBER 630.11225 **PROJECT LOCATION** Egret St, Kooragang Island

DATE STARTED 8-7-15 **COMPLETED** 8-7-15 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Epoca **SLOPE** 90° **BEARING** -90°

EQUIPMENT Geoprobe **HOLE LOCATION** Boral Recyling

HOLE SIZE 125 mm **LOGGED BY** WL **CHECKED BY** CM

NOTES

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Drilling observed water level			0.5		FILL	FILL, gravelly sand, with occasional concrete, dry, brown. No odour.		
				1.0					
				1.5		SW	SAND, fine to medium grained, well graded, increasing wetness with depth, grey, contains fine shell fragments. Hydrocarbon odour		
				2.0					
				2.5					
				3.0					
				3.5		OL	Silty CLAY, black / dark grey, soft, low plasticity, saturated. Hydocarbon odour.		
				4.0			Borehole R1 terminated at 4m		Target depth reached
				4.5					
				5.0					

Attachment 2

Report 630.11225
Standard Operation Procedures

Land and Water Quality - Groundwater Collection using the micro purge method

1 PURPOSE

The purpose of this document is to specify procedures for micropurge groundwater sampling.

2 REFERENCES

- AS/NZS 5667.11:1998 Water quality – Sampling of groundwaters;
- Geoscience Australia Record 2009/27, Groundwater Sampling and Analysis-A field guide
- Department of Environment and Heritage Protection (2009) Monitoring and Sampling Manual 2009, Version 2 (Queensland);
- Victorian Environmental Protection Authority (2000) Groundwater Sampling Guidelines;

3 FORMS

- Field Activity Log
- Groundwater Monitoring Event field measurement form
- Sampling and analysis schedule;
- Chain-of-Custody form;
- Examples of field instrument maintenance and calibration record sheets.

4 EQUIPMENT REQUIREMENTS

Sampling Equipment

- Groundwater level meter (dipper)
- Micropurge Groundwater Sampling Equipment including:
  - 12V Compressor (normally attached to a car battery while engine is running);
  - Pressure regulator;
  - Wire cable use for anchoring the pump;
  - Submersible water pump; and
  - Flow cell
- *In situ* water quality monitoring equipment (water quality meter);
- LDPE air and water tubing;
- Bladder(s);
- 0.45 micron field filter (either a syringe or inline filter);
- Sample container(s) with appropriate preservation method for desired analysis (as specified / provided by analytical laboratory);
- Field filtration equipment;
- Iced sample carrier container;
- 10L Buckets;
- Deionised water;

Land and Water Quality - Groundwater Collection using the micro purge method

- Tap water contained in 20 L plastic tank;
- Decontamination agent (e.g. Decon 90);
- Marker pens;
- General field tools (Allen keys, hammer, screw drivers, scissors)
- Camera;
- GPS;
- Cleaning brush;
- Disposable towels

Safety Equipment

- Nitrile Gloves;
- Safety glasses;
- Steel capped boots or gumboots;
- Hard hat (if required);
- High visibility clothing;
- Witches hats (if working in car parks or roadways)

5 PROCEDURE

5.1 Preparation

- Ensure that the micropurge equipment is clean and functional before taking the equipment to the field. A certificate of calibration must be retained in a project document file. A copy of the certificate must be presented as an appendix in a relevant report. A sufficient amount of water must be prepared for both deionised water and tap water for each well. As a standard requirement (i.e. groundwater sampling from 4 groundwater monitoring wells), 40 L of deionised water and 40 L of tap water are required.

5.2 Assembly of sampling equipment

- The groundwater level and the well depth are measured at the point marked at the top of the PVC casing using the interface probe (the probe must be lowered gently to the base of the well, to avoid damage). Record the measurements on the Groundwater Monitoring Event – Water Quality Parameters form.
- Calculate the depth to the middle of the water column. This is where the pump should be positioned to sample groundwater unless project manager states otherwise.
- Dismantle the pump and ensure that a new bladder is fitted inside;
- Assemble the pump. A pump can be disassembled to fit a disposable bladder. When it is assembled/disassembled, ensure that parts are fitted in line (refer to grooves engraved in each part);
- Fit the cable to the hook attached to the top of the pump. Ensure to fit a bolt or a coupler inwards to minimise the risk of jamming the well with the pump;
- Fit the tubing to the pump;
- Lower the pump into the monitoring well;

Land and Water Quality - Groundwater Collection using the micro purge method

- Position the dip meter above the pump and gently lower down the pump and the dipmeter simultaneously using the dipmeter to establish the sampling location inside the well (remember to allow for the length of pump below the dipmeter when measuring the sampling depth);
- Secure the cable base and cut the tubing at 2-3 m from the top of the well;
- Fit the ground end of the 3/8" tubing to the pressure regulator;
- Fit the ground end of the 1/4" tubing to the flow cell;
- Place the flow cell discharge point inside the 10 L bucket;
- Connect the pressure regulator to the air compressor;
- Connect the electrical cables of the compressor to the car battery;
- Turn engine ignition on;
- Switch the compressor power on;
- Adjust the pressure gauge to 50 psi; and
- Adjust the cycle per minute (CPM) to 1 CPM or 2 CPM (or optimum flow rate depending on parameter stabilisation, and minimising draw down in the well, calculated using the water level meter) using control keys;

5.3 Sample Collection

- Label and tag sample containers;
- Collect the water sample through the flow cell and into the bucket;
- Place the water quality meter into the flow cell to measure the water quality of the sample (i.e. pH, Electrical Conductivity or Total Dissolved Solids, Redox Potential, Dissolved Oxygen and temperature). Field conditions are described and field data recorded in a sampling form (Groundwater Monitoring Field Record Form; see Section 4).
- Purging should continue until three consecutive stabilised readings have been measured. The parameters may be considered stable when three consecutive readings (obtained several minutes apart) are within:
  - ±10% for dissolved oxygen;
  - ±10% for temperature;
  - ±3% for electrical conductivity;
  - ±0.1 for pH; and
  - ±10 mV for redox potential.
- Where field filtration is required (dissolved metal analysis) either
  - connect an inline filter to the water tube and pump directly into the sample container; or
  - pump water into an unpreserved decontaminated container, abstract water from the unpreserved container with the field filter syringe and fill the sample bottles;
- Where no filter is required, discharge water at a low flow rate into the sample container directly from the water tubing. If pump rate needs to be high (leading to short bursts of flow), discharge water into an unpreserved sample bottle and decant into the various sample bottles;
- Sample bottles/vials being submitted for volatiles analysis (e.g. BTEX, C6-C10, VOC, methane) should be filled first, then semi –volatiles (e.g. PAH, pesticides), then inorganics / physical properties (e.g. metals, TDS).

Land and Water Quality - Groundwater Collection using the micro purge method

- Repeat this operation to fill the sample containers entirely. Do not overflow the bottle;
- Secure the bottle cap tightly. Do not allow more than 5 mm head space between the water surface and the cap, as water chemistry may be changed during the transportation due to interaction with the atmospheric air (no headspace is allowed for organic analysis due to possible loss of analyte);
- Record sample container details on the chain of custody;
- Place the samples in an iced shipping container (the samples should be cooled to 4^0C as soon as possible);
- Dismantle and clean the pump and flow cell using Decon 90;
- Clean the interface probe using Decon 90 or equivalent (unless manufacturer instructions state otherwise). This should involve cleaning of the probe and wetted portion of the reel only with a cleaning brush;
- Dispose of the tubing and bladder (refer to Section 6);
- Dispose of purge water (refer to Section 6);

Note:

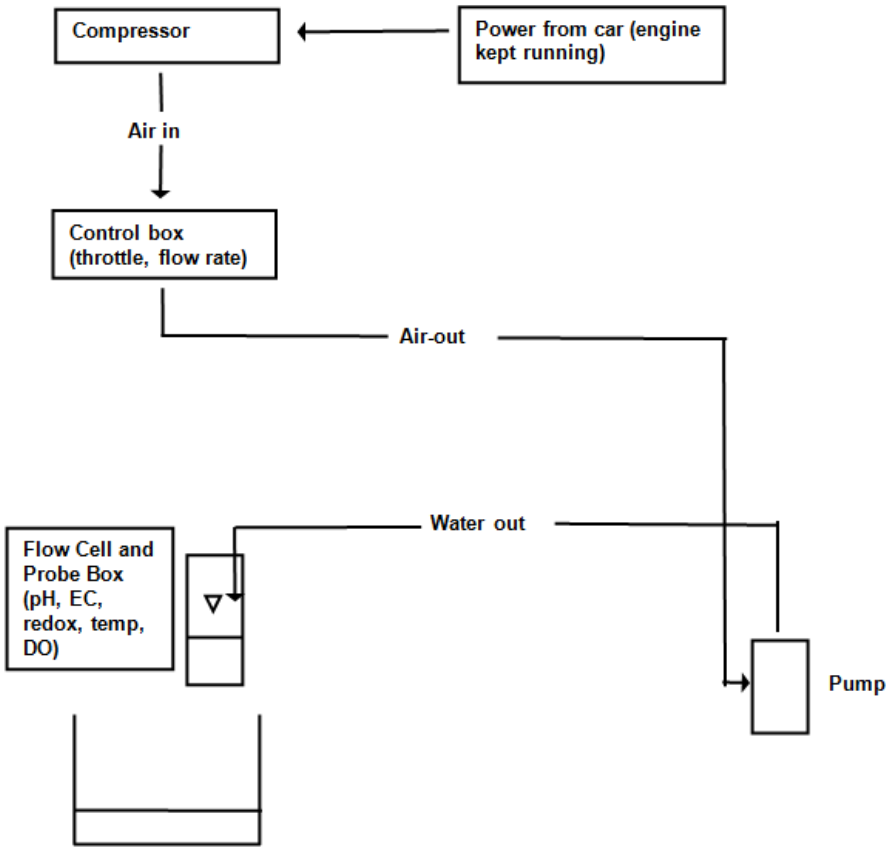
Where multiple wells are to be sampled, new tubing and bladders should be used for each well.

Whenever the sampling event does not proceed as planned, any abnormality encountered and corrective action taken should be recorded in the Field Activity Log.

A schematic diagram of the Mircopurge Groundwater Sampling Method is shown in Figure 1.

Land and Water Quality - Groundwater Collection using the micro purge method

Figure 1 Schematic Diagram of Micropurge Sampling Method



5.4 Sample handling and delivery

- Complete the Chain-of-Custody form and ship the samples to the laboratory as soon as possible to minimise sample holding time.
- Receive a copy of a sample receipt notification.
- Try to deliver samples to laboratory with at least half of the holding time remaining. This ensures the laboratory has adequate time to log and prepare the sample;
- Always review the Sample Receipt Notification. This is done to check that the samples have been logged for the correct analysis, note any damage to sample containers etc. This can then be followed up with immediate clarification if required.

6 PERSONAL AND ENVIRONMENTAL HEALTH & SAFETY

- Cross reference back to the site/project specific safety documentation;
- Always ensure the minimum PPE requirements are adhered to;
- Ensure appropriate disposal of field consumables (tubing, bladders, nitrile gloves and towels) either at:
  - a general waste disposal bin onsite (if available); or

Land and Water Quality - Groundwater Collection using the micro purge method

  - a general waste disposal bin at the SLR office;
  - where disposal to general waste is considered to be inappropriate due to site specific hazardous water contamination issues, consumables should be disposed of at an appropriate hazardous waste disposal site (landfill). Consult with project manager prior to disposing offsite.

- Liaise with the client or site staff to agree on an appropriate location to dispose of purge water (directly to ground, wastewater container for disposal offsite, wastewater system). Where purge water is to be discharged offsite, arrange for the collection of the wastewater container by an appropriate liquid waste handling contractor.

The following health and safety issues and environmental risks should be considered when groundwater sampling:

- Exposure to weather conditions;
- Manual handling;
- Lone working hazards;
- Electrical hazards (car battery);
- Contact (dermal or ingestion) with water;
- Contact with sample preservatives;

Attachment 3

Report 630.11225
Field documentation

Groundwater Sampling by Low Flow Purging Record Form

1.1 PROJECT INFORMATION

JOB NO: 630.11225 DATE: 23/7/15

CLIENT: Boral SITE LOCATION: Recycling Site

PROJECT MANAGER: Will Legg FIELD CONSULTANT: W. L.

MONITORING WELL NAME/NUMBER: R1

1.1.1 FIELD INFORMATION

FIELD CONDITIONS:

WEATHER (TEMPERATURE, CLOUD COVER/PRECIPITATION):

1.2 GROUNDWATER WELL DATA

Information recorded on site

Diameter of standpipe (mm)	
Standpipe stick up (m)	
Time	12.46
Depth to water (mbRP)	1.48
Total depth of well (mbRP)	9.70
Thickness of sediment on base of well (m)	

Information from file

Surveyed reference point	
Depth of well (from log)	
Standard flow rate (L/min)	
Depth of pump intake (mbRP)	
Length of hose (m)	
Volume in hose (m^3)	

Interface probe used	Yes / No
Depth to product (mbRP)	Y
Depth to water (mbRP)	1.48
Thickness of product (m)	Not detected

Note: Standard reference point is at the top of PVC standpipe

mbRP: metres below top of reference point

Unit hose volume: 0.1 L/m for 12 mm diameter hose

1.3 PURGING RECORD

Depth to water after placement of pump (mbRP) 1.48

Time	Volume Purged (L)	Conductivity (mS/cm or S/cm)	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Depth to water (mbRP)	Appearance (colour, turbidity, odour etc)
1.10	0							
1.12	2	4630 uS/cm	17°C	7.18	39.5	0.24	1.48	Slight hydrocarbon odour No
1.16	3.5	4749	16.8	7.18	28.7	0.19	1.48	Brown, Med T.
1.18	6.5	4807	16.8	7.19	27.4	0.17	1.50	No odour, Brown, LT
1.20	7	4815	16.79	7.19	23.8	0.16	1.50	"
1.22	8.5	4845	16.8	7.20	20.6	0.14	1.50	"
1.24	10	4872	16.7	7.21	19.6	0.12	1.50	"
Total volume purged (L)					Flow rate (L/min)			

Depth to water at end of purging (mbRP) 1.50

Purging and sampling method Low flow

SAMPLING RECORD

Time Sampled: 1.25 Sample ID: R1 + DUP01

Sample Appearance: Colour: Light brown Odour: I

Turbidity: (Low) / Medium / High Hydrocarbon sheen? No

Sample Container and Preservation:

Samples filtered for metals?: (Yes) / No Duplicate Samples Taken?: Yes DUP01

Groundwater Sampling by Low Flow Purging Record Form

1.1 PROJECT INFORMATION

JOB NO: 630.11225 DATE: 23/7/15

CLIENT: Boral SITE LOCATION: Boral Cement

PROJECT MANAGER: W.L. FIELD CONSULTANT: W.L.

MONITORING WELL NAME/NUMBER: C2

1.1.1 FIELD INFORMATION

FIELD CONDITIONS: Grass, Standpipe

WEATHER (TEMPERATURE, CLOUD COVER/PRECIPITATION):

1.2 GROUNDWATER WELL DATA

Information recorded on site

Diameter of standpipe (mm)	50mm
Standpipe stick up (m)	72cm
Time	2.58
Depth to water (mbRP)	3.42
Total depth of well (mbRP)	5.26
Thickness of sediment on base of well (m)	

Information from file

Surveyed reference point	
Depth of well (from log)	
Standard flow rate (L/min)	
Depth of pump intake (mbRP)	
Length of hose (m)	
Volume in hose (m^3)	

Interface probe used	(Yes) / No
Depth to product (mbRP)	—
Depth to water (mbRP)	3.42
Thickness of product (m)	—

Note: Standard reference point is at the top of PVC standpipe

mbRP: metres below top of reference point

Unit hose volume: 0.1 L/m for 12 mm diameter hose

1.3 PURGING RECORD

Depth to water after placement of pump (mbRP) 3.43

Time	Volume Purged (L)	Conductivity (mS/cm or S/cm)	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Depth to water (mbRP)	Appearance (colour, turbidity, odour etc)
3.18	2	1532 uS/cm	19.4	6.90	-40.6	0.12	3.43	Light brown, MT Slight hydrocarbon odour
3.21	3	1536	19.6	6.90	-42.9	0.09	3.43	Same but LT
3.23	4	1543	19.7	6.90	-44.5	0.13	3.43	"
Total volume purged (L)			4		Flow rate (L/min)			

Depth to water at end of purging (mbRP) 3.43

Purging and sampling method Low flow

SAMPLING RECORD

Time Sampled: 3.25 Sample ID: C2

Sample Appearance: Colour: Light brown Odour: Slight hydrocarbon odour

Turbidity (Low) / Medium / High Hydrocarbon sheen? No

Sample Container and Preservation:

Samples filtered for metals? (Yes) / No Duplicate Samples Taken?: No

Groundwater Sampling by Low Flow Purging Record Form

1.1 PROJECT INFORMATION

JOB NO: 630.11225 DATE: 23/7/15

CLIENT: Boral SITE LOCATION: Cement Silo (Old MW)

PROJECT MANAGER: _____ FIELD CONSULTANT: _____

MONITORING WELL NAME/NUMBER: C1 (Old MW on Cement Silo)

1.1.1 FIELD INFORMATION

FIELD CONDITIONS: _____

WEATHER (TEMPERATURE, CLOUD COVER/PRECIPITATION): _____

1.2 GROUNDWATER WELL DATA

Information recorded on site

Diameter of standpipe (mm)	
Standpipe stick up (m)	NA - Flush
Time	4:00
Depth to water (mbRP)	2.47
Total depth of well (mbRP)	
Thickness of sediment on base of well (m)	

Information from file

Surveyed reference point	
Depth of well (from log)	
Standard flow rate (L/min)	
Depth of pump intake (mbRP)	
Length of hose (m)	
Volume in hose (m^3)	

Interface probe used	Yes / No
Depth to product (mbRP)	
Depth to water (mbRP)	
Thickness of product (m)	

Note: Standard reference point is at the top of PVC standpipe

mbRP: metres below top of reference point

Unit hose volume: 0.1 L/m for 12 mm diameter hose

1.3 PURGING RECORD

Depth to water after placement of pump (mbRP)

Time	Volume Purged (L)	Conductivity (mS/cm or S/cm)	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Depth to water (mbRP)	Appearance (colour, turbidity, odour etc)
Total volume purged (L)					Flow rate (L/min)			

Depth to water at end of purging (mbRP) _____

Purging and sampling method _____

SAMPLING RECORD

Time Sampled: _____ **Sample ID:** _____

Sample Appearance: **Colour:** _____ **Odour:** _____

Turbidity: Low / Medium / High **Hydrocarbon sheen?** _____

Sample Container and Preservation: _____

Samples filtered for metals?: Yes / No _____ **Duplicate Samples Taken?:** _____

CHAIN OF CUSTODY & ANALYSIS REQUEST

Lab ID Number: _____ *(please quote on all correspondence)*

SGS Environmental Services Sydney
Unit 16, 33 Maddox Street
Alexandria NSW 2015
Telephone No: (02) 85940400
Facsimile No: (02) 85940499

Email: au.samplereceipt.sydney@sgs.com

Company Name:	SLR Consulting	Project Name/No:	630.11225
Address:	2 Lincoln St, Lane Cove, NSW, 2066	Purchase Order No:	
		Results Required Date:	5 day turn around
		Telephone:	0409226875 Fax:
Contact Name:	Will Legg	Email Results to:	wlegg@slrconsulting.com
Laboratory Quotation No:	ENVI-30J3VM		_____@_____ _____@_____

SGS ID	Client Sample ID	Sampling Date/Time (field record sheet number)	Tick as Appropriate: Solid Sample	Liquid Sample	Gas/Air Sample	PRESERVATIVE	NO. OF ITEMS	ANALYSIS REQUESTED. SPECIFY & TICK AS APPROPRIATE: PAH	8 Heavy Metals	TRH + Silica Gel Cleanup	BTEX	Napthalene	TN, Total P, NOx	Notes/Guidelines/LOR/ Special instructions
1	R1	**23/7/15**		x				X	X	X	X	X	X	**Hydrocarbon impacted**
2	C2	**23/7/15**		x				X	X	X	X	X	X	**Hydrocarbon impacted**
3	Dup 01	**23/7/15**		x				X	X	X	X	X	X	**Hydrocarbon impacted**
Trip Blank	4	22/7/15		x							x			
Trip Spike	5	22/7/15		x							x			

SGS Alexandria Environmental

SE141751 COC
Received: 24 – Jul – 2015

Relinquished By: Will Legg	Date/Time: 9.30am 24/7/2015	Received By: Priscilla T	Date/Time: 24/07/15 @ 11:00
Relinquished By: W. Phipps	Date/Time:	Received By:	Date/Time:
Samples Intact: *Yes* / ~~No~~	Temperature: ~~Ambient~~ / Chilled / ~~NA~~ Ice	Sample Security Sealed: *Yes / No*	
Comments / Subcontracting details: *i.e. samples subcontracted to SGS Cairns due to TAT requested*			Quarantine: *Yes / No* Hazards: *e.g. may contain Asbestos*

SAMPLE RECEIPT ADVICE

SE141751

CLIENT DETAILS

Contact	Will Legg
Client	SLR CONSULTING AUSTRALIA PTY LTD
Address	Lego Building, 2 Lincoln Street (PO Box 176 NSW LANECOVE 1595) NSW 2066
Telephone	02 9427 8100
Facsimile	02 9427 8200
Email	wlegg@slrconsulting.com
Project	**630.11225**
Order Number	(Not specified)
Samples	5

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
Samples Received	Fri 24/7/2015
Report Due	Fri 31/7/2015
SGS Reference	**SE141751**

SUBMISSION DETAILS

This is to confirm that 5 samples were received on Friday 24/7/2015. Results are expected to be ready by Friday 31/7/2015. Please quote SGS reference SE141751 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	5 Waters	Type of documentation received	COC
Date documentation received	24/7/2015	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	5.6°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	Ice	Samples clearly labelled	Yes
Complete documentation received	Yes		

Samples will be held for one month for water samples and two months for soil samples from date of report, unless otherwise instructed.

COMMENTS

SAMPLE RECEIPT ADVICE

SE141751

CLIENT DETAILS

Client SLR CONSULTING AUSTRALIA PTY LTD

Project 630.11225

SUMMARY OF ANALYSIS

No.	Sample ID	Anions by Ion Chromatography in Water	Nitrite in Water	PAH (Polynuclear Aromatic Hydrocarbons) in Water	TKN Kjeldahl Digestion by Discrete Analyser	TRH (Total Recoverable Hydrocarbons) in Water	TRH Silica Gel (Total Recoverable	VOCs in Water	Volatile Petroleum Hydrocarbons in Water
001	R1	1	2	22	2	9	9	12	8
002	C2	1	2	22	2	9	9	12	8
003	Dup 01	1	2	22	2	9	9	12	8
004	Trip Blank	-	-	-	-	-	-	12	-
005	Trip Spike	-	-	-	-	-	-	12	-

CONTINUED OVERLEAF

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SAMPLE RECEIPT ADVICE

SE141751

CLIENT DETAILS

Client SLR CONSULTING AUSTRALIA PTY LTD

Project 630.11225

SUMMARY OF ANALYSIS

No.	Sample ID	Mercury (dissolved) in Water	Total Phosphorus by Kjeldahl Digestion DA in	Trace Metals (Dissolved) in Water by ICPMS
001	R1	1	1	7
002	C2	1	1	7
003	Dup 01	1	1	7

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

ANALYTICAL REPORT

WORLD RECOGNISED ACCREDITATION

CLIENT DETAILS

Contact	Will Legg
Client	SLR CONSULTING AUSTRALIA PTY LTD
Address	Lego Building, 2 Lincoln Street (PO Box 176 NSW LANECOVE 1595) NSW 2066
Telephone	02 9427 8100
Facsimile	02 9427 8200
Email	wlegg@slrconsulting.com
Project	**630.11225**
Order Number	(Not specified)
Samples	5
Date Received	24/7/2015

LABORATORY DETAILS

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SGS Reference	**SE141751 R0**
Report Number	0000116846
Date Reported	31/7/2015
Date Started	28/7/2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

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Senior Organic Chemist

Dong Liang
Metals/Inorganics Team Leader

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Senior Chemist

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Chemist / 2IC Inorganics

VOCs in Water [AN433/AN434] Tested: 28/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003	Trip Blank WATER - 22/7/2015 SE141751.004	Trip Spike WATER - 22/7/2015 SE141751.005
Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	[97%]
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	[100%]
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	[101%]
m/p-xylene	µg/L	1	<1	<1	<1	<1	[100%]
o-xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	[99%]
Total Xylenes	µg/L	1.5	<1.5	<1.5	<1.5	<1.5	-
Total BTEX	µg/L	3	<3	<3	<3	<3	-
Naphthalene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	**57**

Volatile Petroleum Hydrocarbons in Water [AN433/AN434/AN410] Tested: 28/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
TRH C6-C9	µg/L	40	<40	<40	<40
Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5
TRH C6-C10	µg/L	50	<50	<50	<50
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water [AN403] Tested: 28/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
TRH C10-C14	µg/L	50	**66**	<50	**69**
TRH C15-C28	µg/L	200	<200	**260**	**240**
TRH C29-C36	µg/L	200	<200	<200	<200
TRH C37-C40	µg/L	200	<200	<200	<200
TRH >C10-C16 (F2)	µg/L	60	**140**	**93**	**160**
TRH >C16-C34 (F3)	µg/L	500	<500	<500	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500	<500
TRH C10-C36	µg/L	450	<450	<450	<450
TRH C10-C40	µg/L	650	<650	<650	<650

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water [AN403] Tested: 28/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
TRH C10-C14-Silica	µg/L	50	<50	<50	<50
TRH C15-C28-Silica	µg/L	200	<200	<200	<200
TRH C29-C36-Silica	µg/L	200	<200	<200	<200
TRH C37-C40-Silica	µg/L	200	<200	<200	<200
TRH >C10-C16-Silica	µg/L	60	<60	<60	<60
TRH >C16-C34-Silica	µg/L	500	<500	<500	<500
TRH >C34-C40-Silica	µg/L	500	<500	<500	<500
TRH Sum C10-C36-Silica	µg/L	450	<450	<450	<450
TRH Sum C10-C40-Silica	µg/L	650	<650	<650	<650

PAH (Polynuclear Aromatic Hydrocarbons) in Water [AN420] Tested: 28/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Naphthalene	µg/L	0.1	**19**	**0.2**	**14**
2-methylnaphthalene	µg/L	0.1	**3.7**	<0.1	**3.2**
1-methylnaphthalene	µg/L	0.1	**6.9**	<0.1	**7.7**
Acenaphthylene	µg/L	0.1	<0.1	**1.2**	**0.1**
Acenaphthene	µg/L	0.1	**20**	**27**	**20**
Fluorene	µg/L	0.1	**9.4**	**0.4**	**9.3**
Phenanthrene	µg/L	0.1	**11**	**0.7**	**11**
Anthracene	µg/L	0.1	**2.8**	**0.4**	**2.8**
Fluoranthene	µg/L	0.1	**6.7**	**9.7**	**7.0**
Pyrene	µg/L	0.1	**3.4**	**5.0**	**3.3**
Benzo(a)anthracene	µg/L	0.1	**0.2**	**0.2**	**0.2**
Chrysene	µg/L	0.1	**0.2**	**0.2**	**0.2**
Benzo(b&j)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	µg/L	0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	µg/L	0.1	<0.1	<0.1	<0.1
Dibenzo(a&h)anthracene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	µg/L	0.1	<0.1	<0.1	<0.1
Total PAH (18)	µg/L	1	**84**	**45**	**79**

Anions by Ion Chromatography in Water [ME-AU-ENVAN245] Tested: 27/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Nitrate Nitrogen, NO3-N	mg/L	0.005	<0.025↑	<0.010↑	<0.025↑

Nitrite in Water [AN277/WC250.312] Tested: 29/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Nitrite Nitrogen, NO2 as N	mg/L	0.005	**0.013**	<0.005	**0.013**
Total Oxidised Nitrogen, NOx-N	mg/L	0.005	**0.013**	**0.009**	**0.013**

TKN Kjeldahl Digestion by Discrete Analyser [AN281/AN292] Tested: 30/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Total Kjeldahl Nitrogen	mg/L	0.05	**0.42**	**0.84**	**0.63**
Total Nitrogen (calc)	mg/L	0.05	**0.43**	**0.85**	**0.65**

Total Phosphorus by Kjeldahl Digestion DA in Water [AN279/AN293] Tested: 30/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Total Phosphorus (Kjeldahl Digestion)	mg/L	0.05	**0.16**	**0.44**	**0.16**

Trace Metals (Dissolved) in Water by ICPMS [AN318] Tested: 27/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Arsenic, As	µg/L	1	**2**	<1	**2**
Cadmium, Cd	µg/L	0.1	<0.1	<0.1	<0.1
Chromium, Cr	µg/L	1	<1	<1	<1
Copper, Cu	µg/L	1	<1	<1	<1
Lead, Pb	µg/L	1	<1	<1	<1
Nickel, Ni	µg/L	1	**2**	**2**	**2**
Zinc, Zn	µg/L	5	**15**	**26**	**12**

Mercury (dissolved) in Water [AN311/AN312] Tested: 30/7/2015

PARAMETER	UOM	LOR	R1 WATER - 23/7/2015 SE141751.001	C2 WATER - 23/7/2015 SE141751.002	Dup 01 WATER - 23/7/2015 SE141751.003
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001

METHOD	METHODOLOGY SUMMARY
AN020	Unpreserved water sample is filtered through a 0.45µm membrane filter and acidified with nitric acid similar to APHA3030B.
AN083	Separatory funnels are used for aqueous samples and extracted by transferring an appropriate volume (mass) of liquid into a separatory funnel and adding 3 serial aliquots of dichloromethane. Samples receive a single extraction at pH 7 to recover base / neutral analytes and two extractions at pH < 2 to recover acidic analytes. QC samples are prepared by spiking organic free water with target analytes and extracting as per samples.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN277/WC250.312	Nitrite ions, when reacted with a reagent containing sulphanilamide and N-(1-naphthyl)-ethylenediamine dihydrochloride produce a highly coloured azo dye that is measured photometrically at 540nm.
AN279/AN293	The sample is digested with Sulphuric acid, K2SO4 and CuSO4. All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.
AN281	An unfiltered water or soil sample is first digested in a block digestor with sulfuric acid, K2SO4 and CuSO4. The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.
AN311/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36. Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents . The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN433/AN434/AN410	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.
AN433/AN434	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		
^	Performed by outside laboratory.				

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/ Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE141751 R0

CLIENT DETAILS

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Project	**630.11225**
Order Number	(Not specified)
Samples	5

LABORATORY DETAILS

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SGS Reference	SE141751 R0
Report Number	0000116847
Date Reported	31 Jul 2015

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS Environmental Services' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met (within the SGS Alexandria Environmental laboratory).

SAMPLE SUMMARY

Sample counts by matrix	5 Waters	Type of documentation received	COC
Date documentation received	24/7/2015	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	5.6°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	Ice	Samples clearly labelled	Yes
Complete documentation received	Yes		

HOLDING TIME SUMMARY

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SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Anions by Ion Chromatography in Water

Method: ME-AU-ENVAN245

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081766	23 Jul 2015	24 Jul 2015	20 Aug 2015	27 Jul 2015	20 Aug 2015	29 Jul 2015
C2	SE141751.002	LB081766	23 Jul 2015	24 Jul 2015	20 Aug 2015	27 Jul 2015	20 Aug 2015	29 Jul 2015
Dup 01	SE141751.003	LB081766	23 Jul 2015	24 Jul 2015	20 Aug 2015	27 Jul 2015	20 Aug 2015	29 Jul 2015

Mercury (dissolved) in Water

Method: ME-(AU)-[ENV]AN311/AN312

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB082019	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015
C2	SE141751.002	LB082019	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015
Dup 01	SE141751.003	LB082019	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015

Nitrite in Water

Method: ME-(AU)-[ENV]AN277/WC250.312

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081937	23 Jul 2015	24 Jul 2015	20 Aug 2015	29 Jul 2015	20 Aug 2015	29 Jul 2015
C2	SE141751.002	LB081937	23 Jul 2015	24 Jul 2015	20 Aug 2015	29 Jul 2015	20 Aug 2015	29 Jul 2015
Dup 01	SE141751.003	LB081937	23 Jul 2015	24 Jul 2015	20 Aug 2015	29 Jul 2015	20 Aug 2015	29 Jul 2015

PAH (Polynuclear Aromatic Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	29 Jul 2015
C2	SE141751.002	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	29 Jul 2015
Dup 01	SE141751.003	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	29 Jul 2015

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281/AN292

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081986	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015
C2	SE141751.002	LB081986	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015
Dup 01	SE141751.003	LB081986	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081987	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015
C2	SE141751.002	LB081987	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015
Dup 01	SE141751.003	LB081987	23 Jul 2015	24 Jul 2015	20 Aug 2015	30 Jul 2015	20 Aug 2015	30 Jul 2015

Trace Metals (Dissolved) in Water by ICPMS

Method: ME-(AU)-[ENV]AN318

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081742	23 Jul 2015	24 Jul 2015	19 Jan 2016	27 Jul 2015	19 Jan 2016	28 Jul 2015
C2	SE141751.002	LB081742	23 Jul 2015	24 Jul 2015	19 Jan 2016	27 Jul 2015	19 Jan 2016	28 Jul 2015
Dup 01	SE141751.003	LB081742	23 Jul 2015	24 Jul 2015	19 Jan 2016	27 Jul 2015	19 Jan 2016	28 Jul 2015

TRH (Total Recoverable Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015
C2	SE141751.002	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015
Dup 01	SE141751.003	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water

Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015
C2	SE141751.002	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015
Dup 01	SE141751.003	LB081793	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015

VOCs in Water

Method: ME-(AU)-[ENV]AN433/AN434

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081838	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015
C2	SE141751.002	LB081838	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015
Dup 01	SE141751.003	LB081838	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015
Trip Blank	SE141751.004	LB081838	22 Jul 2015	24 Jul 2015	29 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015
Trip Spike	SE141751.005	LB081838	22 Jul 2015	24 Jul 2015	29 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015

Volatile Petroleum Hydrocarbons in Water

Method: ME-(AU)-[ENV]AN433/AN434/AN410

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
R1	SE141751.001	LB081838	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015
C2	SE141751.002	LB081838	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015
Dup 01	SE141751.003	LB081838	23 Jul 2015	24 Jul 2015	30 Jul 2015	28 Jul 2015	06 Sep 2015	30 Jul 2015

HOLDING TIME SUMMARY

SE141751 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Volatile Petroleum Hydrocarbons in Water (continued)

Method: ME-(AU)-[ENV]AN433/AN434/AN410

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
Trip Blank	SE141751.004	LB081838	22 Jul 2015	24 Jul 2015	29 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015
Trip Spike	SE141751.005	LB081838	22 Jul 2015	24 Jul 2015	29 Jul 2015	28 Jul 2015	06 Sep 2015	31 Jul 2015

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
2-fluorobiphenyl (Surrogate)	R1	SE141751.001	%	40 - 130%	50
	C2	SE141751.002	%	40 - 130%	50
	Dup 01	SE141751.003	%	40 - 130%	52
d14-p-terphenyl (Surrogate)	R1	SE141751.001	%	40 - 130%	76
	C2	SE141751.002	%	40 - 130%	68
	Dup 01	SE141751.003	%	40 - 130%	70
d5-nitrobenzene (Surrogate)	R1	SE141751.001	%	40 - 130%	50
	C2	SE141751.002	%	40 - 130%	56
	Dup 01	SE141751.003	%	40 - 130%	52

VOCs in Water

Method: ME-(AU)-[ENV]AN433/AN434

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	R1	SE141751.001	%	40 - 130%	87
	C2	SE141751.002	%	40 - 130%	83
	Dup 01	SE141751.003	%	40 - 130%	92
	Trip Blank	SE141751.004	%	40 - 130%	82
	Trip Spike	SE141751.005	%	40 - 130%	110
d4-1,2-dichloroethane (Surrogate)	R1	SE141751.001	%	40 - 130%	127
	C2	SE141751.002	%	40 - 130%	117
	Dup 01	SE141751.003	%	40 - 130%	116
	Trip Blank	SE141751.004	%	40 - 130%	113
	Trip Spike	SE141751.005	%	40 - 130%	104
d8-toluene (Surrogate)	R1	SE141751.001	%	40 - 130%	90
	C2	SE141751.002	%	40 - 130%	102
	Dup 01	SE141751.003	%	40 - 130%	87
	Trip Blank	SE141751.004	%	40 - 130%	104
	Trip Spike	SE141751.005	%	40 - 130%	103
Dibromofluoromethane (Surrogate)	R1	SE141751.001	%	40 - 130%	126
	C2	SE141751.002	%	40 - 130%	118
	Dup 01	SE141751.003	%	40 - 130%	122
	Trip Blank	SE141751.004	%	40 - 130%	111
	Trip Spike	SE141751.005	%	40 - 130%	102

Volatile Petroleum Hydrocarbons in Water

Method: ME-(AU)-[ENV]AN433/AN434/AN410

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	R1	SE141751.001	%	40 - 130%	87
	C2	SE141751.002	%	40 - 130%	83
	Dup 01	SE141751.003	%	40 - 130%	92
d4-1,2-dichloroethane (Surrogate)	R1	SE141751.001	%	60 - 130%	127
	C2	SE141751.002	%	60 - 130%	117
	Dup 01	SE141751.003	%	60 - 130%	116
d8-toluene (Surrogate)	R1	SE141751.001	%	40 - 130%	90
	C2	SE141751.002	%	40 - 130%	102
	Dup 01	SE141751.003	%	40 - 130%	87
Dibromofluoromethane (Surrogate)	R1	SE141751.001	%	40 - 130%	126
	C2	SE141751.002	%	40 - 130%	118
	Dup 01	SE141751.003	%	40 - 130%	122

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Anions by Ion Chromatography in Water

Method: ME-AU-ENVAN245

Sample Number	Parameter	Units	LOR	Result
LB081766.001	Nitrate Nitrogen, NO3-N	mg/L	0.005	<0.005

Mercury (dissolved) in Water

Method: ME-(AU)-[ENV]AN311/AN312

Sample Number	Parameter	Units	LOR	Result
LB082019.001	Mercury	mg/L	0.0001	<0.0001

Nitrite in Water

Method: ME-(AU)-[ENV]AN277/WC250.312

Sample Number	Parameter	Units	LOR	Result
LB081937.001	Nitrite Nitrogen, NO2 as N	mg/L	0.005	<0.005

PAH (Polynuclear Aromatic Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB081793.001		Naphthalene	µg/L	0.1	<0.1
		2-methylnaphthalene	µg/L	0.1	<0.1
		1-methylnaphthalene	µg/L	0.1	<0.1
		Acenaphthylene	µg/L	0.1	<0.1
		Acenaphthene	µg/L	0.1	<0.1
		Fluorene	µg/L	0.1	<0.1
		Phenanthrene	µg/L	0.1	<0.1
		Anthracene	µg/L	0.1	<0.1
		Fluoranthene	µg/L	0.1	<0.1
		Pyrene	µg/L	0.1	<0.1
		Benzo(a)anthracene	µg/L	0.1	<0.1
		Chrysene	µg/L	0.1	<0.1
		Benzo(a)pyrene	µg/L	0.1	<0.1
		Indeno(1,2,3-cd)pyrene	µg/L	0.1	<0.1
		Dibenzo(a&h)anthracene	µg/L	0.1	<0.1
		Benzo(ghi)perylene	µg/L	0.1	<0.1
	Surrogates	d5-nitrobenzene (Surrogate)	%	-	82
		2-fluorobiphenyl (Surrogate)	%	-	72
		d14-p-terphenyl (Surrogate)	%	-	92

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293

Sample Number	Parameter	Units	LOR	Result
LB081987.001	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.05	<0.05

Trace Metals (Dissolved) in Water by ICPMS

Method: ME-(AU)-[ENV]AN318

Sample Number	Parameter	Units	LOR	Result
LB081742.001	Arsenic, As	µg/L	1	<1
	Cadmium, Cd	µg/L	0.1	<0.1
	Chromium, Cr	µg/L	1	<1
	Copper, Cu	µg/L	1	<1
	Lead, Pb	µg/L	1	<1
	Nickel, Ni	µg/L	1	<1
	Zinc, Zn	µg/L	5	<5

TRH (Total Recoverable Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result
LB081793.001	TRH C10-C14	µg/L	50	<50
	TRH C15-C28	µg/L	200	<200
	TRH C29-C36	µg/L	200	<200
	TRH C37-C40	µg/L	200	<200

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water (continued)

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result
LB081793.001	TRH C10-C14-Silica	µg/L	50	<50
	TRH C15-C28-Silica	µg/L	200	<200
	TRH C29-C36-Silica	µg/L	200	<200
	TRH C37-C40-Silica	µg/L	200	<200

VOCs in Water

Method: ME-(AU)-[ENV]AN433/AN434

Sample Number		Parameter	Units	LOR	Result
LB081838.001	Monocyclic Aromatic	Benzene	µg/L	0.5	<0.5
	Hydrocarbons	Toluene	µg/L	0.5	<0.5
		Ethylbenzene	µg/L	0.5	<0.5
		m/p-xylene	µg/L	1	<1
		o-xylene	µg/L	0.5	<0.5
	Polycyclic VOCs	Naphthalene	µg/L	0.5	<0.5
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	104
		d4-1,2-dichloroethane (Surrogate)	%	-	107
		d8-toluene (Surrogate)	%	-	105
		Bromofluorobenzene (Surrogate)	%	-	84

Volatile Petroleum Hydrocarbons in Water

Method: ME-(AU)-[ENV]AN433/AN434/AN410

Sample Number		Parameter	Units	LOR	Result
LB081838.001		TRH C6-C9	µg/L	40	<40
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	104
		d4-1,2-dichloroethane (Surrogate)	%	-	107
		d8-toluene (Surrogate)	%	-	105
		Bromofluorobenzene (Surrogate)	%	-	84

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury (dissolved) in Water

Method: ME-(AU)-[ENV]AN311/AN312

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE141762.004	LB082019.014	Mercury	µg/L	0.0001	-0.02	-0.0268	200	0
SE141889.010	LB082019.027	Mercury	µg/L	0.0001	-0.0112	-0.0146	200	0

Nitrite in Water

Method: ME-(AU)-[ENV]AN277/WC250.312

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE141751.001	LB081937.004	Nitrite Nitrogen, NO2 as N	mg/L	0.005	0.013	0.013	55	1

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281/AN292

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE141751.001	LB081986.004	Total Kjeldahl Nitrogen	mg/L	0.05	0.42	0.5	26	17

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE141751.001	LB081987.004	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.05	0.16	0.1641	27	3

Trace Metals (Dissolved) in Water by ICPMS

Method: ME-(AU)-[ENV]AN318

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE141762.007	LB081742.014	Arsenic, As	µg/L	1	0.373	0.271	200	0
		Cadmium, Cd	µg/L	0.1	0.003	0.002	200	0
		Chromium, Cr	µg/L	1	0.118	0.138	200	0
		Copper, Cu	µg/L	1	0.88	0.751	138	0
		Lead, Pb	µg/L	1	0.114	0.096	200	0
		Nickel, Ni	µg/L	1	3.651	2.88	46	24
		Zinc, Zn	µg/L	5	4.536	2.07	166	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Anions by Ion Chromatography in Water

Method: ME-AU-ENVAN245

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081766.002	Nitrate Nitrogen, NO3-N	mg/L	0.005	1.9	2	80 - 120	96

Nitrite in Water

Method: ME-(AU)-[ENV]AN277/WC250.312

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081937.002	Nitrite Nitrogen, NO2 as N	mg/L	0.005	0.19	0.2	85 - 115	96

PAH (Polynuclear Aromatic Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081793.002		Naphthalene	µg/L	0.1	28	40	60 - 140	70
		Acenaphthylene	µg/L	0.1	27	40	60 - 140	68
		Acenaphthene	µg/L	0.1	30	40	60 - 140	75
		Phenanthrene	µg/L	0.1	33	40	60 - 140	82
		Anthracene	µg/L	0.1	33	40	60 - 140	83
		Fluoranthene	µg/L	0.1	32	40	60 - 140	79
		Pyrene	µg/L	0.1	32	40	60 - 140	80
		Benzo(a)pyrene	µg/L	0.1	34	40	60 - 140	84
	Surrogates	d5-nitrobenzene (Surrogate)	µg/L	-	0.4	0.5	40 - 130	86
		2-fluorobiphenyl (Surrogate)	µg/L	-	0.4	0.5	40 - 130	80
		d14-p-terphenyl (Surrogate)	µg/L	-	0.6	0.5	40 - 130	112

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081987.002	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.05	1.0	1	80 - 120	103

Trace Metals (Dissolved) in Water by ICPMS

Method: ME-(AU)-[ENV]AN318

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081742.002	Arsenic, As	µg/L	1	19	20	80 - 120	93
	Cadmium, Cd	µg/L	0.1	19	20	80 - 120	95
	Chromium, Cr	µg/L	1	19	20	80 - 120	97
	Copper, Cu	µg/L	1	19	20	80 - 120	94
	Lead, Pb	µg/L	1	19	20	80 - 120	96
	Nickel, Ni	µg/L	1	19	20	80 - 120	97
	Zinc, Zn	µg/L	5	18	20	80 - 120	91

TRH (Total Recoverable Hydrocarbons) in Water

Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081793.002		TRH C10-C14	µg/L	50	1100	1200	60 - 140	88
		TRH C15-C28	µg/L	200	1100	1200	60 - 140	96
		TRH C29-C36	µg/L	200	1100	1200	60 - 140	94
	TRH F Bands	TRH >C10-C16 (F2)	µg/L	60	1100	1200	60 - 140	91
		TRH >C16-C34 (F3)	µg/L	500	1100	1200	60 - 140	95
		TRH >C34-C40 (F4)	µg/L	500	590	600	60 - 140	99

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081793.002	TRH C10-C14-Silica	µg/L	50	1100	1200	60 - 140	88
	TRH C15-C28-Silica	µg/L	200	1100	1200	60 - 140	96
	TRH C29-C36-Silica	µg/L	200	1100	1200	60 - 140	94
	TRH >C10-C16-Silica	µg/L	60	1100	1200	60 - 140	91
	TRH >C16-C34-Silica	µg/L	500	1100	1200	60 - 140	95
	TRH >C34-C40-Silica	µg/L	500	590	600	60 - 140	99

VOCs in Water

Method: ME-(AU)-[ENV]AN433/AN434

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081838.002	Monocyclic	Benzene	µg/L	0.5	57	45.45	60 - 140	125
	Aromatic	Toluene	µg/L	0.5	61	45.45	60 - 140	134
		Ethylbenzene	µg/L	0.5	62	45.45	60 - 140	136
		m/p-xylene	µg/L	1	110	90.9	60 - 140	123

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

VOCs in Water (continued)

Method: ME-(AU)-[ENV]AN433/AN434

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081838.002	Monocyclic	o-xylene	µg/L	0.5	61	45.45	60 - 140	134
	Surrogates	Dibromofluoromethane (Surrogate)	µg/L	-	5.0	5	60 - 140	99
		d4-1,2-dichloroethane (Surrogate)	µg/L	-	5.0	5	60 - 140	100
		d8-toluene (Surrogate)	µg/L	-	5.2	5	60 - 140	104
		Bromofluorobenzene (Surrogate)	µg/L	-	5.3	5	60 - 140	106

Volatile Petroleum Hydrocarbons in Water

Method: ME-(AU)-[ENV]AN433/AN434/AN410

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB081838.002		TRH C6-C10	µg/L	50	1000	946.63	60 - 140	107
		TRH C6-C9	µg/L	40	760	818.71	60 - 140	93
	Surrogates	Dibromofluoromethane (Surrogate)	µg/L	-	5.0	5	60 - 140	99
		d4-1,2-dichloroethane (Surrogate)	µg/L	-	5.0	5	60 - 140	100
		d8-toluene (Surrogate)	µg/L	-	5.2	5	60 - 140	104
		Bromofluorobenzene (Surrogate)	µg/L	-	5.3	5	60 - 140	106
	VPH F Bands	TRH C6-C10 minus BTEX (F1)	µg/L	50	660	639.67	60 - 140	103

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury (dissolved) in Water

Method: ME-(AU)-[ENV]AN311/AN312

QC Sample	Sample Number	Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE141735.001	LB082019.004	Mercury	mg/L	0.0001	0.0077	-0.0264	0.008	97

Nitrite in Water

Method: ME-(AU)-[ENV]AN277/WC250.312

QC Sample	Sample Number	Parameter	Units	LOR	Original	Spike	Recovery%
SE141857.008	LB081937.016	Nitrite Nitrogen, NO2 as N	mg/L	0.005	0.003	0.2	94

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281/AN292

QC Sample	Sample Number	Parameter	Units	LOR	Original	Spike	Recovery%
SE141889.008	LB081986.006	Total Kjeldahl Nitrogen	mg/L	0.05	0.112	2.5	97

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293

QC Sample	Sample Number	Parameter	Units	LOR	Original	Spike	Recovery%
SE141889.008	LB081987.008	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.05	-0.0061	1	105

Trace Metals (Dissolved) in Water by ICPMS

Method: ME-(AU)-[ENV]AN318

QC Sample	Sample Number	Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE141751.001	LB081742.004	Arsenic, As	µg/L	1	22	2	20	101
		Cadmium, Cd	µg/L	0.1	19	<0.1	20	95
		Chromium, Cr	µg/L	1	19	<1	20	94
		Copper, Cu	µg/L	1	17	<1	20	85
		Lead, Pb	µg/L	1	18	<1	20	90
		Nickel, Ni	µg/L	1	19	2	20	86
		Zinc, Zn	µg/L	5	32	15	20	83

MATRIX SPIKE DUPLICATES

SE141751 R0

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here:
http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
^	Analysis performed by external laboratory.

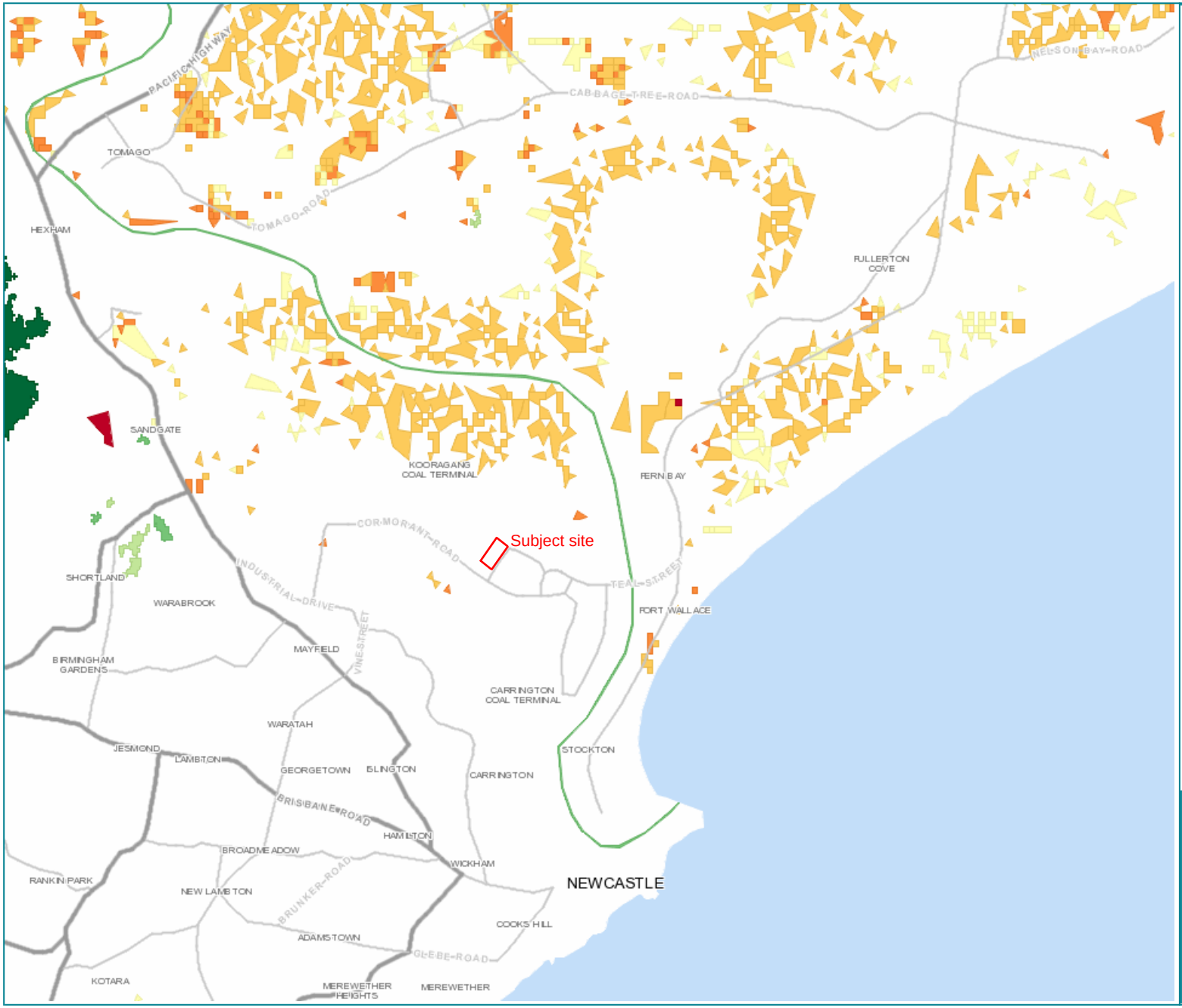
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

Groundwater Dependent Ecosystem Map Report

Australian Government
Bureau of Meteorology

Groundwater Dependent Ecosystem Map Report



N

newest

GDE, Reliant on surface expression of groundwater (rivers, springs, wetlands)

- Identified in previous study: fieldwork
- Identified in previous study: desktop
- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction

GDE, Reliant on subsurface groundwater (vegetation)

- Identified in previous study: fieldwork
- Identified in previous study: desktop
- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction
- No Ecosystems analysed

GDE, Subterranean (Cave & Aquifers)

- Identified in previous study: fieldwork
- Identified in previous study: desktop
- No Ecosystems analysed

1:110,358

Metres 2,000 4,000 6,000 8,000

Data source - Data are assumed to be correct as supplied from Commonwealth, State and Territory data suppliers or referenced projects.

Disclaimer - Use of the information and data contained within this document is at your sole risk. Neither the Bureau nor its agents make any warranties or representations regarding the quality, accuracy, merchantability or fitness for purpose of any material in this document.

Date: 27 July, 2015

Flood Information Certificate and Additional Information

26 September 2014

The City of Newcastle
PO Box 489, Newcastle
NSW 2300 Australia
Phone 02 4974 2000
Facsimile 02 4974 2222
Email mail@ncc.nsw.gov.au
www.newcastle.nsw.gov.au

To: SLR Consulting
Of: 10 Kings Road
NEW LAMBTON NSW 2305

Dear Sir/Madam

Request for information regarding Complying Development Criteria

Flood Information Certificate No:	2014/227
Property:	LOT: 12 DP: 1032146
	100 Cormorant Road Kooragang

Thank you for your recent enquiry regarding flood behaviour at the above property. This letter confirms the property is located in a flood prone area.

The pertinent features of the flood behaviour are estimated as follows:

Ocean Flooding

Is any part of the site affected by a floodway?	No
Is any part of the site affected by a flood storage area?	No
Estimated 1% Annual Exceedence Probability event level: (equivalent to the "*Defined Flood Level*" in the Building Code of Australia)	Not Affected
Highest Property Hazard Category	N/A
Estimated Probable Maximum Flood Level	3.4m AHD
Highest Life Hazard Category	L1 (H3)

Hunter River Flooding

Is any part of the site affected by a floodway?	No
Is any part of the site affected by a flood storage area?	No
Estimated 1% Annual Exceedence Probability event level: (equivalent to the "*Defined Flood Level*" in the Building Code of Australia)	Not Affected
Highest Property Hazard Category	N/A
Estimated Probable Maximum Flood Level	4.5m AHD
Highest Life Hazard Category	L1 (H3)

The flood study from which the above information is derived is part of a Newcastle City Wide Floodplain Management Plan. The above advice may change in the future, however the advice is based on the best information held by Council at the time of issue of this certificate.

The above ocean flood level estimates include a sea level rise relative to 1990 mean sea levels of 90cm by 2100, as used in the Newcastle City-wide Floodplain Risk Management Study and Plan (June 2012).

The Newcastle Development Control Plan 2012 addresses the issues of flood management for new development. You can view the development control plan at www.newcastle.nsw.gov.au. In summary, the following requirements apply for all future development applications on the site.

Development in a floodway is not generally allowable due to likely redistribution of flood water.	Not Applicable
Filling of a flood storage area by more than 20% is not generally allowable due to redistribution of flood water.	Not Applicable
Minimum floor level for occupiable rooms in a new development on this site is: (equivalent to the "*Flood Hazard Level*" in the Building Code of Australia)	Not Applicable
Is onsite flood refuge required?	No

Complying Development Criteria

1.	Is the land identified as a Flood Control Lot?	Yes
2.	Is any part of the land identified as being:	
	a) a flood storage area, or	No
	b) a floodway area, or	No
	c) a flow path, or	No
	d) a high hazard area, or	No
	e) a high risk area	No

Based on the information contained within the above table the lot meets the "*development standards for flood control lots*", to the extent specified within the relevant subclause 3.36C(2) or 3A.38(2) of *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*.

For an additional fee, Council can also assess the suitability of a proposal for development of the lot against the other relevant development standards for flood control lots, as specified in clause 3.36C or 3A.38 of *State Environmental Planning Policy (Exempt and Complying Development Codes) 2008*. To obtain the assessment please select Box 4. b) (ii) on the flood information application form, submit plans and other relevant documentation for the proposal and pay the required fee. Please also include a copy of this certificate with the application.

Council holds information concerning floor levels of existing structures on the site (Please see Attachment 1). If the building has been altered this level may have changed or may only be relevant to part of the floor level on the site. You may need to undertake a survey to clarify this information.

Please note that the information contained in this certificate may alter in the future. The applicant should at all times ensure the currency of this information.

Should you require any further clarification please contact A Peddie on 4974 2788.

A Peddie

Alastair Peddie MIEAust, CPEng
Senior Development Officer (Engineering)
Development & Building Services

Attachment 1: Existing Floor Levels

Additional information for the holders of Flood Information Certificates

This information explains the terms used in Newcastle City Council's Flood Information Certificates and provides some basic information on Councils requirements for future development of flood prone land.

Compliance with these requirements in the Development Control Plan does not guarantee approval, however, in most cases, the flood issues can be resolved by adhering to these guidelines.

Newcastle City-wide Floodplain Risk Management Plan 2012
Newcastle Development Control Plan

FLOOD CERTIFICATE NOTES

GENERAL:

- The information presented in the Certificate relates to the Newcastle City-wide Floodplain Risk Management Plan and the Newcastle Development Control Plan, which have been developed in accordance with the principles of the NSW Government's Flood Prone Land Policy.
- Council's flood information is compiled from a composite of data. The variability of rainfall itself is a major factor in the uncertainty of flood information and accordingly, this certificate is only an estimate of real flood characteristics. Any particular flood is likely to be different to the conditions described in this certificate.
- Council acknowledges that its flood information is incomplete and varies in accuracy, however it is the best available to Council at the time of issue.
- Where information is presently not known, it is denoted by "unknown"
- From time to time, on going research and studies will replace or add to Council's flood information. Accordingly, the information in this certificate is not warranted after the day of issue.
- Should you disagree with Council's assessment of the flood behaviour, you may conduct your own investigations or enquires and submit them to Council for consideration. Where revision of this assessment is warranted, Council is committed to making such amendments to its information.

EXPLANATIONS FOR TERMS USED IN THE FLOOD INFORMATION CERTIFICATE

Is any part of the site affected by a Floodway?

Generally, where a property is affected by a floodway, we will provide you with additional information on where we believe the floodway to be by way of a map. In some circumstances it may be possible to redirect a floodway subject to appropriate engineering advice. You should start by discussing the matter with a development officer from Council.

A ***Floodway*** is a pathway taken by major discharges of floodwaters, the obstruction or partial obstruction of which would cause a significant redistribution of floodwaters, or a significant increase in flood levels. Floodways are often aligned with natural channels and are usually characterised by deep and relatively fast flowing water.

The Newcastle DCP 2012 states:

> *"No building or structure is to be erected and no land is to be filled by way of the deposition of any material within any area identified as a floodway except for:*
>
> > *Minor alterations to ground levels for roads, parking, below ground structures and landscaping, provided that the fundamental flow patterns are not significantly altered.*
>
> *Where dividing fences across floodways are unavoidable, they are to be constructed only of open type fencing that will not restrict the flow of flood waters and be resistant to blockage. New development shall be designed to avoid fences in floodways."*

Is any part of the site affected by a flood storage area?

Where a property is wholly affected by flood storage area, we will answer "yes" to this question on the Flood Information Certificate. Where a property is partly affected, we will provide additional information by way of a map.

Flood storage area is an area where flood water accumulates and the displacement of that floodwater will cause a significant redistribution of floodwaters, or a significant increase in

flood levels, or a significant increase in downstream flood frequency. Flood storage areas are often aligned with floodplains and are usually characterised by deep and slow moving floodwater.

The Newcastle DCP 2012 states:

> *"Not more than 20% of the area of any development site in a flood storage area is to be filled. The remaining 80% can generally be developed allowing for underfloor storage of floodwater by the use of suspended floor techniques such as pier and beam construction.*
>
> *Where it is proposed to fill development sites, the fill is not to impede the flow of ordinary drainage from neighbouring properties, including overland flow."*

1% Annual Exceedence Probability (AEP) event level:

The 1% AEP event is the basic benchmark for Council's development controls. It is a flood event that has a 1 in 100 chance of being exceeded in any one year. Conceptually, it is similar to a "1 in 100 year" event, except that the term 1 in 100 years conveys the notion that the event is definitely going to happen in a 100 year time frame, and will only occur once in that time frame. In fact, a 1 in 100 year event has a 67% probability of occurring once in any nominate hundred year period.

Levels are reduced to the Australian Height Datum. This means that the quoted levels are heights above sea level. They can be compared to ground levels determined by a surveyor using the same datum to ascertain the likely flood depth.

In general, the minimum requirement for development of flood prone land is to set floor levels above the **Flood planning level (FPL)**. The flood planning level is the peak flood level for the flood planning event (usually the 1% AEP flood) **plus** the appropriate freeboard (usually, but not always 500mm, depending on the circumstances) to account for uncertainty, wave action and model error.

The Newcastle DCP 2012 states:

> *"Floor levels of all occupiable rooms of all buildings are not to be set lower than the FPL."*
>
> *"Garage floor levels are to be set no lower than the 1% AEP flood event. However it is recognised that in some circumstances this may be impractical due to vehicular access constraints. In these cases, garage floor levels should be as high as practicable."*
>
> *"Basement garages may be acceptable where all potential water entry points are at or above the probable maximum flood (PMF), excepting that vehicular entry points can be at the FPL. In these cases, explicit points of refuge should be accessible from the carpark in accordance with the provisions for risk to life set out below."*
>
> *"Electrical fixtures such as power points, light fittings and switches are to be sited above the FPL unless they are on a separate circuit (with earth leakage protection) to the rest of the building."*
>
> *"Where parts of the building are proposed to be below the flood planning level, they are to be constructed of water-resistant materials. "*

Highest Property Hazard Category:

Property hazards describe the danger that flood waters might pose to the property of persons affected by flooding. Generally, the descriptions are:

- **P1** Parked or moving cars remain stable
- **P2** Parked or moving heavy vehicles remain stable
- **P3** Suitable for light construction (eg timber frame, masonry and brick veneer)

P4 Suitable for heavy construction (eg steel frame, and concrete)

P5 Hydraulically unsuitable for normal building construction

They are determined by direct correlation to the Hydraulic Behaviour Threshold (P1 relates to a Hydraulic Behaviour Threshold of H1) as determined at the flood-planning event, usually the 1% AEP flood. The Hydraulic behaviour thresholds used in the determination of these hazards are shown in the figure N1.

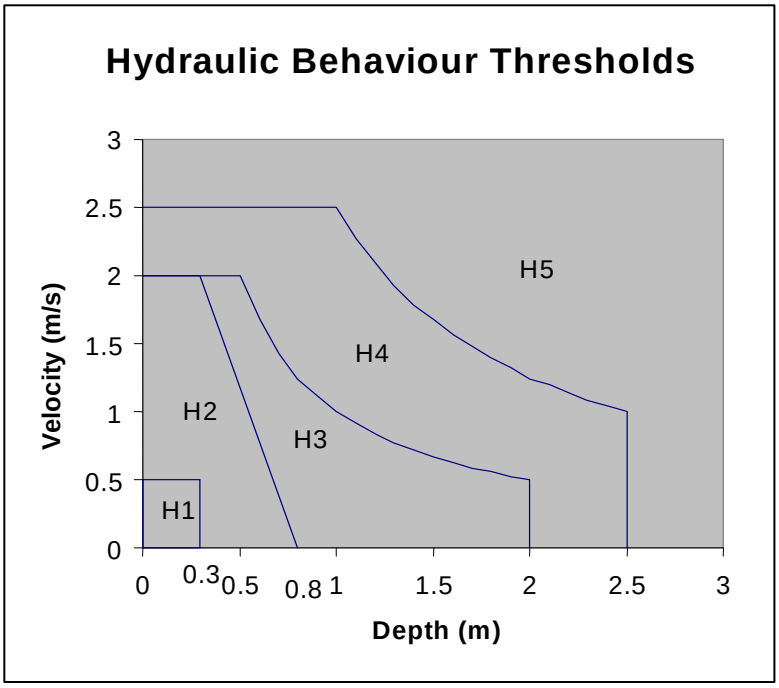


Figure N1 – Hydraulic Behaviour Thresholds

For the purposes of the flood information quoted here, the property hazard relates to the ground level as understood by Council at the time the information was collected. The property hazard cannot be used to determine the ground level of the site.

Property hazards can be reduced by filling a site, or raising floor levels as appropriate provided that the work is compatible with the applicable (if any) floodway or flood storage area.

In general, the minimum requirement for managing property risk is to set floor levels to the Flood planning level. The flood planning level is the level (usually expressed as a reduced level above the Australian Height Datum (AHD).

The Newcastle DCP 2012 states:

> "Areas where cars, vans and trailers etc are parked, displayed or stored are not to be located in areas subject to property hazard of P2 or higher. Containers, bins, hoppers and other large floatable objects also are not to be stored in these areas. Heavy vehicle parking areas are not to be located in areas subject to property hazard P3 or higher."
>
> "Timber framed, light steel construction, cavity brickwork and other conventional domestic building materials are generally not suitable forms of construction where the property hazard is P4 or higher. Where property hazard is P4, the structure shall be certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters."
>
> "Property hazards of P5 are generally unsuitable for any type of building construction and building is discouraged from these areas. Where building is necessary, the

structure is to be certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters."

Highest life Hazard Category:

Life hazards describe the danger that flood waters might pose to the lives of persons affected by flooding. Generally, the descriptions are:

Table N1 Life hazard descriptions

	HAZARD CLASSIFICATION				
HAZARD FACTOR	**L1**	**L2**	**L3**	**L4**	**L5**
Effective Warning	Y	N	N	N	N
Effictive capacity to allow evacuation to flood free land	**Y**	**Y**	**N**	**N**	**N**
Rate of rise of flood waters	Slow	Flash	Flash	Flash	Flash
Duration of Flooding	Too long for refuge enclosed by floodwaters to be appropriate.	Short enough for occupation during the entire flood to be appropriate	Short enough for occupation during the entire flood to be appropriate	Short enough for flood free refuge enclosed by floodwaters to be appropriate	Short enough for flood free refuge enclosed by floodwaters to be appropriate
Escape route	An obvious rising escape route to flood free land outside of the entire flood is available	An obvious rising escape route to flood free land outside of the entire flood is available	There is be no obvious rising escape route to flood free land outside of the entire flood.	There is be no obvious rising escape route to flood free land outside of the entire flood. An obvious rising escape route to flood free land outside of the entire flood is available	There is be no obvious rising escape route to flood free land outside of the entire flood.
Nature of enclsing floodwaters	Flood free land outside of the enture flood can be reached before the flooding affects the site itself	Reaching flood free land outside of the entire flood requires evacuation through enclosing floodwaters, and these flood waters are suitable for wading or heavy vehicles at all times	Enclosing flodwaters are suitable for waiding and for medical emegrency evacuation by waiding or heavy vehichle at all times	Enclosing floodwaters are not suitable for waiding or heavy vehicles, and require heavy construction for structural stability of buildings (eg steel frame and concrete)	No form of normal building construction would be feasible to ensure structural satbility in enclosing floodwaters
Evacuation need:	Required to flood free land otuside of the entire flood	Required to flood free land otuside of the entire flood	Not Required	Required to a suitable flood free refuge within the enclosed flood waters	Normally not possible (therefore normally unsuitable for development)
Evacuation problems	Still need to ensure that any proposed development in these areas will not cause additional burden on emergency response services	Still need to ensure that any proposed development in these areas will not cause additional burden on emergency response services	Nil (for abled bodied adults)	Evacuation shall be self directed and fail safe.	Enclosing flood waters are so hazardous that evacuation by normal means to flood free land outside the entire flood would not be contemplated. The structural stability of an an on-site refuge cannot be assured by normally available building types, and therefore a refuge enclosed by floodwaters cannot (normally) be provided

Life hazards are used to manage risks to life and accordingly, are determined by considering the hydraulic behaviour threshold (see figure N1) at the Probable Maximum Flood (PMF).

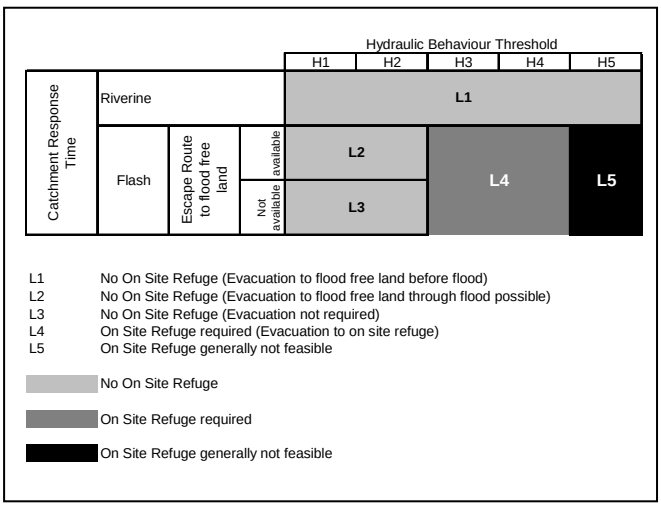


Figure N2 – Life Hazard determination

Figure N2 shows how the life hazard categories are determined in accordance with the methodology of the Newcastle City-wide Floodplain Risk Management Plan.

The Newcastle DCP 2012 states:

> "On site refuge is to be provided for all development where the life hazard category is L4 or higher unless the proposed development is less than 40m from the perimeter of the PMF extent and the higher ground is accessible. "
>
> "The minimum on-site refuge level is to be the level of the PMF. On site refuges are to be designed to cater for the number of people reasonably expected to be on the development site and are to be provided with emergency lighting."
>
> "On site refuges are to be of a construction type able to withstand the effects of flooding. Design certification by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF) is required. "

The requirement for on site refuge (where applicable) will generally be satisfied by a two storey building form. However, for residential properties, an attic access ladder and suitable small platform will usually also suffice.

In most cases where on site refuge is required, the duration of the peak flood event is short and accordingly, it is not expected to have to utilise flood refuge areas for long periods of time, especially when their use the chance of them being used is generally less than 1% in any given year. Accordingly, comfort factors are not of large concern to owners, occupiers or Council in determining the suitability of flood refuges.

Infiltration Basin Sizing Method

The infiltration basins were sized based upon the *Sizing Storage Volume (Design Storm Method)* as detailed in the Stormwater Management Manual for Western Australia, Structural Controls (WA Department of Water, 2007). The method is summarised below:

$$\text{Inflow Volume} = \frac{CiAD}{1000}$$

Where:

C = runoff coefficient

i = probabilistic rainfall intensity (mm/hr)

A = contributing area connected to the infiltration system (m^2)

D = storm duration (hours)

$$\text{Outflow Volume} = \frac{\left[A_{inf} + \left(\frac{Pd}{2}\right)\right] U k_h D}{1000}$$

Where:

k_h = point saturated hydraulic conductivity (mm/hr)

A_{inf} = infiltration area (m^2)

P = perimeter length of the infiltration area (m)

d = depth of the infiltration system (m)

U = point soil hydraulic conductivity moderating factor

D = storm duration (hours)

Approximation of the required storage volume of an infiltration system can be computed as follows:

Required Storage = Inflow Volume – Outflow Volume