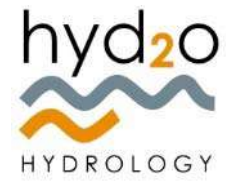


Appendix D

Local Water Management Strategy (Hyd2o)



Rivermark Area 4 Stage 1

Local Water Management Strategy

October 2025



Client: **HESPERIA**

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Hyd2o recognise site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe.

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Executive Summary

Hyd2o was commissioned by Hesperia to prepare this Local Water Management Strategy (LWMS) to support the proposed Rivermark Area 4 Stage 1 Local Structure Plan (LSP) within the existing Midland Brick site in Viveash.

The Area 4 Stage 1 LSP area is approximately 14 ha in size and located approximately 20 km north east of the Perth central business district within the City of Swan. The proposed urban development, subject to a future subdivision application, will consist of residential lots, roads, and public open space areas creating public amenity and connectivity to the Swan River and Blackadder Creek tributary. Area 4 Stage 2 located to the sites east is subject to future planning and a separate local structure plan.

This LWMS presents stormwater management for Area Stage 1 in the context of the whole of the Midland Brick site including outside of the LSP area to provide a comprehensive overall assessment of the existing water management system and its performance and how this will be modified to improve water sensitive urban design outcomes as a result of the proposed land use change.

Understanding key hydrological considerations has informed the development of the LWMS. The Midland Brick site has been a brickworks since 1946 with operations and brick sales currently operating. The LSP area is generally characterised as having low permeability soils with good clearance to regional groundwater. It currently is part of a larger existing stormwater network which operates via a pumped system to transfer water from Midland Brick to the Blackadder Creek Tributary, with larger events flowing to the Swan River.

The environmental considerations and values of the Swan River, Blackadder Creek tributary and Eveline Reserve have guided the hydrological design for the LSP area.

This document has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008) and its overarching District Water Management Strategy (DWMS) (Hyd2o, 2020a). Key agencies ultimately involved with its implementation including the City of Swan, (CoS), Department of Biodiversity, Conservation, and Attractions (DBCA) and Department of Water and Environmental Regulation (DWER), have been widely consulted during project planning to date.

Implementation of the strategy will be undertaken in accordance with Better Urban Water Management through the development and implementation of Urban Water Management Plans for individual stages of development within the LSP area.

The Better Urban Water Management LWMS checklist is included as Appendix A.

Local Water Management Strategy Summary

Water Use Sustainability	
Water Efficiency	- Promotion of 6 star building standards (water efficient fixtures and fittings). - Use of water-wise plantings in POS and landscape rehabilitation areas. - Maximise infiltration of residential stormwater runoff.
Water Supply	- Construction: Temporary DWER groundwater licence and use of brickworks stormwater - Lots: Water Corporation IWSS and rainwater tanks (optional). - POS: Groundwater irrigation. - Retained industrial outside of LSP area to continue with Water Corporation IWSS and stormwater harvesting via Clay Basin/Swale storage for dust suppression.
Wastewater	Water Corporation reticulated sewerage.
Stormwater	
Design & Management Principles	- Habitable development levels have suitable clearance above the 1% AEP flood level of the Swan River (5.7-6.0 mAHD) and Blackadder Creek (5.46 mAHD downstream of Muriel St). - Water quality to be managed through biofiltration treatment of runoff generated by first 15mm of rainfall prior to discharge to Swan River or Blackadder Creek tributary. - For catchments draining toward Swan River, stormwater flows in excess of 15mm to flow to Swan River via existing outlets. - For catchments draining toward the Blackadder Creek Tributary, maintain the overall water balance and peak flows at Muriel St, and maintain water levels adjacent to the Threatened Ecological Community within existing levels to maintain existing hydrology. - For the remaining industrial area and its upstream external catchment, continue to provide an outflow path and support operation consistent with existing practice.
Lot Scale Measures	- Soakwells sized to retain and infiltrate first 15 mm rainfall on lots within sand fill. - Rainwater tanks (optional). - Water-wise landscaping to retain stormwater and minimise runoff
Street Scale Measures	- Biofiltration as specified in POS and road reserves, with additional local scale areas identified at UWMP scale as/if required. - Piped drainage, with opportunities for localised swales and/or underground storage within wider road reserves to be reviewed at UWMP stage. - GPT's as required.

Estate Scale Measures	• Provision of regional floodplain setback from the Swan River as per DWER (2019), and rehabilitation of Swan River foreshore area. • Water quality treatment area for treatment of runoff from first 15mm rainfall via biofiltration. Estimated modelled area and volume required for Area 4 Stage 1 of 0.073 ha and 327 m³, based on a depth of 0.45m. • Flood management storage areas within POS areas to attenuate flows in accordance with agency requirements. • Post development groundwater, surface water, and system performance monitoring and annual reporting.
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Groundwater

Fill & Subsoil	• Use of imported fill to raise the site to proposed development levels, above the 1% AEP level of the Swan River, and improve the Swan River foreshore interface. • Subsoil to be implemented to control perched water levels within the imported fill.
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Acid Sulphate Soils	▪ Development area of the site has no known risk of ASS. Acid sulphate soils will however be investigated as a separate process if required.
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Implementation

Process	• Predevelopment groundwater and surface water monitoring program complete and no further monitoring required. • Environmental Water Requirements study to be undertaken (if required) prior to development of future development areas flowing to Blackadder Creek Tributary in consultation with DBCA to ensure maximum benefit in improvements to creek system. • Future stages of planning consistent with BUWM including preparation of UWMP's. • Staging of stormwater changes to be detailed in the relevant UWMP's and implemented to ensure key hydrological performance criteria for the receiving environment are maintained during the transitional process.
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1. Introduction

Hyd2o was commissioned by Hesperia to prepare this Local Water Management Strategy (LWMS) to support the proposed Rivermark Area 4 Stage 1 Local Structure Plan (LSP) for land within the existing Midland Brick site in Viveash.

The LSP area is approximately 14 ha in size and located approximately 20 km north east of the Perth central business district within the City of Swan (Figure 1). The proposed urban development, subject to a future subdivision application, will consist of residential lots, roads, and public open space areas creating public amenity and connectivity to the Swan River and Blackadder Creek tributary. Area 4 Stage 2 located to the sites east is subject to future planning and a separate local structure plan.

This LWMS presents stormwater management for Area 4 Stage 1 in the context of the whole of the Midland Brick site including outside of the LSP area to provide a comprehensive overall assessment of the existing water management system and its performance and how this will be modified to improve water sensitive urban design outcomes as a result of the proposed land use change.

This LWMS provides a total water cycle management approach to development. It has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008) and the overarching District Water Management Strategy (DWMS) (Hyd2o, 2020a).

The document provides the outcomes of detailed site specific analysis relating to groundwater and surface water and provides a clear vision in terms of adopting best management practices to achieve water sensitive design.

A copy of the Better Urban Water Management (WAPC, 2008) LWMS Checklist for Developers is included as Appendix A to assist the Department of Water and Environmental Regulation (DWER) and City of Swan in review of this document.

Key stakeholders involved with its implementation of this strategy including the City of Swan, (CoS), Department of Biodiversity, Conservation, and Attractions (DBCA) and Department of Water and Environmental Regulation (DWER), have been widely consulted during the planning process for the Rivermark development.

1.1 Planning Background

This LSP area is zoned General Industrial, Private Clubs & Institutions under the City of Swan Local Planning Scheme 17 and Urban and Rural under the Metropolitan Region Scheme.

The urban water management planning process is shown in Table 1. This LWMS supports the proposed development of the LSP area of the Midland Brick site to urban development.

Table 1: Integrated Planning and Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Documents
MRS Amendment	MRS Amendment	Midland Brick District Water Management Strategy (Hyd2o, 2020a)
Local Structure Plan/TPS Amendment	Local Structure Plan/ Local Scheme Amendment	Rivermark Area 4 Stage 1 Local Water Management Strategy THIS DOCUMENT
Subdivision	Subdivision Application	Urban Water Management Plan FUTURE PREPARATION

1.2 Key Documents and Previous Studies

This LWMS uses the following key documents to define its principles, criteria, objectives, and implementation responsibilities:

- Midland Brick District Water Management Strategy (Hyd2o, 2020a)
- Rivermark Area 3 Local Water Management Strategy (Hyd2o, 2024a)
- Stormwater Management Manual for WA (DWER, 2022)
- Decision Process for Stormwater Management in WA (DWER, 2017)
- Planning for Land Use, Development and Permitting Affecting the Swan Canning Development Control Area (Department of Parks and Wildlife/Swan River Trust, 2016a)
- Planning for Stormwater Management Affecting the Swan Canning Development Control Area (Department of Parks and Wildlife/Swan River Trust, 2016b)
- Handbook of Stormwater Drainage Design, City of Swan (2012)
- Swan Canning Water Quality Improvement Plan (Swan River Trust 2009)
- Better Urban Water Management (WAPC, 2008)

2. Proposed Development

The proposed Structure Plan for the Area 4 Stage 1 LSP area is shown in Figure 2, providing a unique opportunity for urban infill in close proximity to the Midland town centre and Swan River.

The Area 4 Stage 1 LSP covers approximately 14 ha. Area 4 Stage 2 is located to the sites east and is subject to future planning and a separate local structure plan.

The overall development concept consists of replacing existing industrial hardstand with residential lots, roads, and public open space, adjacent to existing developed areas of Viveash, a rehabilitated Jack Williamson Oval, Swan River and the Blackadder Creek Tributary.

From a stormwater management perspective, the development will seek to provide considerable improvements in local stormwater management and interaction with its adjacent watercourses and seek to improve existing water quality outcomes as the area transitions to urban from its current industrial use.

3. Existing Environment

3.1 Site Conditions

The 14 ha site is located in the suburb of Viveash in the City of Swan.

The Midland Brick site in which Area 4 Stage 1 is located in is bound to the north by Reid Hwy, to the west by the Swan River, to the south and east by existing urban development and Eveline Reserve (Figure 1). It has been used for brick making purposes since 1946 and is currently operational and operates under a DWER Part V Licence.

Topography across the LSP area varies between 3 mAHD and 13 mAHD. The area has been modified for industrial use to have large flat areas at approximately 5 mAHD for brick storage, falling to 3 mAHD in areas immediately adjacent to the Swan River. Elevated areas exist toward the southern and western boundaries of the LSP area.

Figure 3 shows an aerial photograph with existing land use and topography. The Swan River foreshore adjacent to the site comprises a relatively steep vegetated bank and is fenced on the top boundary.

3.2 Geotechnical

According to the Perth Metropolitan Region 1:50 000 Environmental Geology Series Perth Sheet 2034 II and Part of 2034 III and 2134 III, the LSP area is characterised by Pebbly Silt (Mgs1) (Gozzard, 1986). The Pebbly Silt is described as strong brown silt with common, fine to occasionally coarse-grained, sub-rounded laterite quartz, heavily weather granite pebble, some fine to medium grained quartz sand of alluvial origin.

A geotechnical investigation for the wider Midland Brick site was undertaken by Douglas Partners in June 2019. The geotechnical report is included as Appendix B. This investigation included excavation of 11 test pits and 8 cone penetration tests. A dynamic cone penetrometer (DCP) test was also undertaken at each test pit location.

Test locations within the Area 4 Stage 1 LSP area are shown on Figure 4. The encountered ground conditions at the test locations generally comprised uncontrolled fill, generally clayey although some granular fill was also encountered, overlying variable, though generally clayey, natural soils. The typical soil profile as described by Douglas Partners (2019) is as follows:

- **Clayey Fill (Sandy Clay, Clayey Sand, Gravelly Clay, Clayey Gravel, Clay, Bricks and Sand with Clay)** – generally stiff to hard, encountered at all test pit locations, generally forming most of the encountered fill depth. Loose silty or clayey gravel, inferred as possible fill, was encountered between depths of 1.5 m and 4.0 m at test location 7. Firm to very stiff clay fill was encountered to a depth of approximately 5.5 m at test location 6. The clayey fill generally contained brick fragments and/or bricks, and occasionally fragments of plastic, rubber, wood, wire, fabric, carpet and concrete.
- **Granular Fill (Sand, Gravelly Sand, Sandy Gravel)** – generally medium dense to very dense, granular fill, generally encountered from the surface to depths of less than 0.5 m. Granular fill (i.e. fill with no clay content) was encountered at test pit locations 11, 12, 13, 15, 16 and 17 and cone penetration locations 2 and 3. A granular fill layer was encountered at test location 13, underlying clayey fill from a depth of approximately

0.4 m to the termination depth of the test pit at 1.6 m. The fill generally contained brick fragments and/or unbroken bricks. Inferred granular fill or disturbed ground was encountered to a depth of approximately 9.8 m at test location 3, with loose silty sand being encountered between depths of approximately 3.0 m and 8.0 m.

- **Natural Soils** – generally clayey soils from the Guildford Formation, including:
 - o **Clayey Sand** – hard / very dense orange-brown mottled red-brown and grey, fine to medium grained clayey sand, encountered underlying the fill from a depth of 0.75 m at test location 11. Sand with sand clay was encountered from the surface at test location 5.
 - o **Clay** – stiff to hard clay, encountered underlying the fill from a depth of approximately 0.75 m at test location 14 and cone penetration test locations 1, 3, and 6.
 - o **Sand and Silty Sand** – generally medium dense to dense, orange-brown fine to medium grained sand, sometimes with clay, encountered underlying the clayey sand at test pit location 11 and cone penetration test location 5

Groundwater was not observed in any test pit locations on 24 June 2019 however groundwater was measured within some of the cone penetration test locations at levels ranging between -1.3 mAH and 2.9 mAH (interpolated levels only, not surveyed).

Douglas Partners (2019) concluded that from a geotechnical perspective, the site is considered suitable for the proposed redevelopment. It was considered that an equivalent site classification of Class S would likely apply to most of the proposed residential area following placement of a 1.2 m thick layer of compacted, non-reactive granular fill. In order to achieve a site classification of Class A, it would be necessary to remove the full depth of uncontrolled fill and replace with a layer of controlled, non-reactive granular fill of at least 1.8 m.

Further test pits were undertaken in the western area of the site by Douglas Partners in 2024. Locations are shown on Figure 4 with test pit logs included in Appendix B.

3.2.1 Acid Sulphate Soils

Acid Sulphate Soil (ASS) is the common name given to naturally occurring soil and sediment containing iron sulfides. These naturally occurring iron sulfides are generally found in a layer of waterlogged soil or sediment and are benign in their natural state.

When disturbed and exposed to air, however, they oxidise and produce sulfuric acid, iron precipitates, and concentrations of dissolved heavy metals such as aluminium, iron and arsenic. Release of acid and metals as a result of the disturbance of ASS can cause significant harm to the environment and infrastructure.

WAPC's Bulletin 64 (WAPC, 2003) ASS risk mapping for the site indicates that in a small area immediately adjacent to the Swan River the site is classified as having a moderate to high ASS disturbance risk less than 3 m from the surface.

The remainder of the site is classified as no known risk (Figure 4).

3.2.2 Contaminated Sites

Contaminated site investigations have been undertaken over part of the Midland Brick site due to localised areas of elevated petroleum hydrocarbon concentrations in soil and water in several isolated areas. Remediation will be required for residential land use in these areas and are likely to include the excavation and treatment of affected soils and groundwater remediation. These areas will be remediated prior to any subdivision application being made, consistent with Contaminated Sites Act (2003) processes.

3.3 Wetlands and Waterway Assessment

The site is located adjacent to the Swan River and associated Swan River Regional Park. The Swan River is classified as a conservation category wetland as shown in Figure 5.

The foreshore area adjacent to the site is largely occupied by the Midland Brick brickworks site with industrial development abutting the banks of the river. The banks are relative steep and vegetated, and act as a bund to protect the site from flooding during major events in the Swan River. It is not clear if the bunds were constructed for such purposes or represent a remnant outcome of site excavation over time (or combination of both).

On the western side of the site there is an established foreshore reserve adjacent to the Swan River.

A foreshore area assessment has been undertaken by Emerge Associates including an assessment of biophysical characteristics for the portion of the site adjacent to the Swan River. This assessment was used to inform the establishment of the Foreshore Reserve in the LSP, and will guide future planning of that area.

3.4 Threatened Ecological Community (TEC)

With respect to the Blackadder Creek tributary area adjacent to the wider Area 4 boundary, Emerge Associates have advised the presence of a Threatened Ecological Community (TEC) *Eucalyptus Calophylla - Xanthorrhoea Preissii* Woodlands and Shrublands, Swan Coastal Plain (SCP3c) in the vegetated area south of the clay shed, and along areas of the Blackadder Creek Tributary downstream of the site and Eveline Rd.

The location of the TEC is shown on Figure 5.

Maintaining the ecological and hydrological requirements of the TEC and the associated vegetation in the Eveline Reserve area is a key factor considered in the development of the sites overall future stormwater management system.

This is further discussed in Section 6.4.

3.5 Surface Water

3.5.1 Swan River & Blackadder Creek Tributary Flood Levels

The Swan River 1% Annual Exceedance Probability (AEP) levels adjacent to Midland Brick range from 5.7 mAHD near the downstream boundary to 6.0 mAHD at the northern boundary (Figure 6 and Table 2). These levels have been recently updated by DWER based on an updated flood study of the Swan River (BMT WBM Pty Ltd, 2017). These levels supersede previous estimates and are approximately 1m lower than those of the previous 1985 flood study.

The Midland Brick site is predominately located outside the 1% AEP floodplain of the Swan River with only a minor area (outside the LSP area) classified as floodway and flood fringe.

The time of concentration for peak flows in the River is very different to that of the local catchment and not coincident. This suggests non-attenuated rather than attenuated flows from the Midland Brick site during major events to be beneficial from a flood management perspective.

Development that is located in the floodway and is considered obstructive to major flows is not permitted, and no new buildings are considered acceptable within the floodway. Proposed development that is located outside of the floodway is considered acceptable with respect to major flooding. However, a minimum habitable floor level of 0.5 m above the appropriate 1 % AEP flood level is recommended to ensure adequate flood protection.

With respect to Blackadder Creek, the 1% AEP level is also shown in Figure 6 and Table 2. The 1% AEP level value at the confluence of the Blackadder Creek Tributary and Blackadder Creek downstream of the site is 5.46 mAHd.

Table 2: Watercourse Flood Levels

Watercourse	Location	1% AEP Flood Level (mAHd)
Swan River	Downstream near Bernley Drive and Colyton St intersection	5.7 mAHd
Swan River	Upstream of Midland Brick near Reid Hwy	6.0 mAHd
Blackadder Creek	At confluence of Blackadder Creek Tributary	5.46 mAHd

3.5.2 Existing Stormwater Management for Midland Brick site

The Midland Brick site has no specific Environmental Protection Act licence conditions for water control, however objectives for stormwater management are detailed in Boral (2011) and Hyd2o (2022) as follows:

- All industrial surface runoff water is to be treated in an appropriate manner prior to discharge to the Swan River.
- Maximise the storage and reuse of industrial surface runoff water for dust suppression and industrial purposes on site.
- Freshwater runoff may be discharged from site without further treatment if it is segregated from other site water management.

Figure 6 details a map of the key existing stormwater infrastructure and system of the Midland Brick site in the proximity of Area 4 Stage 1, with plates of key locations shown in Appendix C. Plans showing the wider Midland Brick site stormwater management system

reproduced from the DWMS and other reports are contained in Appendix D. The function of the existing Midland Brick stormwater management system is summarised as follows:

- Area 4 lies between two watercourses which receive its stormwater runoff, the Swan River to the north and a tributary of Blackadder Creek to the south.
- Due to clay soils onsite infiltration is limited and stormwater is managed through offsite discharge. The current stormwater system on site comprises of various storage ponds for attenuation and settlement of stormwater and a series of outlets to the Swan River and Blackadder Creek tributary. In general terms, for the majority of the site minor event flows are discharged to the Blackadder Creek tributary, while more major events have an outlet and are permitted to flow to the Swan River.
- The majority of stormwater from the site flows to an existing sump located abutting Kiln 8 (herein called the main site pump), where it is then pumped to southern storage ponds in the south west corner of the Midland Brick site. Hyd2o understand this pumped system was installed in approximately 2000 to divert flows from the site to the Blackadder Creek Tributary and prior to this flows from the site discharged to the Swan River. Pump capacities as reported in SKM (2003) are 170 l/s for the main electric pump and 125 l/s for the diesel pump.
- The original northern storage ponds within Midland Brick were decommissioned to support the early stages of development and relocated as the southern storage ponds. These are currently being decommissioned and relocated to within the southern region of Area 4 Stage 2 to facilitate urban development of Area 3 (Hyd2o, 2024d).
- Following relocation, water will continue to discharge from the pond area to the Blackadder Creek Tributary at the existing southern outlet location.
- Flows from the Clay Shed roof area currently represent a separate stormwater system which discharge into a storage area to the south of the Clay Shed and then into the top of the Blackadder Creek tributary.

The total catchment draining to the Swan River and Blackadder Creek Tributary in this area is estimated to be 116.6 ha. Subcatchments are shown in Appendix D, with external site catchments shown on Figure 6. These were mapped based on site inspections, Boral (2011) and available pipe survey data. The external local authority catchment of approximately 16 ha associated with Great Northern Hwy, Richardson Rd, and Leslie Rd drains into and is managed within the Midland Brick site.

With respect to the Clay Basin, the total catchment draining to basin is estimated to be 31.7 ha, with an estimated equivalent impervious area (EIA) of 19.5 ha during major events. The external local authority catchment contributing flow to the Clay Basin is 10.7 ha (EIA 6.4 ha) and is estimated to contribute 33% of the runoff which currently flows to this storage.

3.5.3 Modelling of Existing System

Stormwater modelling for the existing system using XP-Storm has been reported in detail in a range of various documents prepared by Hyd2o including the following:

- Midland Brick, Middle Swan District Water Management Strategy (Hyd2o, 2020a)

- Midland Brick, Middle Swan Brickworks Kiln 10 Hardstand Expansion Stormwater Management: Updated Report (Hyd2o, 2020b).
- Midland Brick, Middle Swan Local Water Management Strategy Bridging Document, (Hyd2o, 2020c).
- Midland Brick, Middle Swan Brickworks: Southern Replacement Storage Design (Hyd2o (2020d)
- Midland Brick, Middle Swan Brickworks: Masonry Site Stormwater Management, (Hyd2o, 2020e)
- Cranwood Crescent Viveash Stages 1a & 1b Urban Water Management Plan (Hyd2o, 2020f)
- Cranwood Crescent Viveash Stage 2 Urban Water Management Plan (Hyd2o, 2022)
- Rivermark Area 3 Local Water Management Strategy (Hyd2o, 2024a)
- Rivermark Area 3 Local Water Management Strategy Addendum (Hyd2o, 2024b)
- Blackadder Creek Tributary Performance Assessment, (Hyd2o, 2024c)
- Midland Brick Middle Swan Brickworks: Southern Storage Relocation Design (Hyd2o, 2024d)

Key modelling outcomes and extracts from these studies used to inform this LWMS are contained in Appendix D, with design flows at key locations within the Midland Brick site summarised in Table 3.

Table 3: Existing Midland Brick Site Stormwater Management Flow Summary

Location	Flows (m ³ /s)		
	63% AEP	20% AEP	1% AEP
Clay Basin	0.05	0.06	0.07
Swan River Outflow	-	0.08	0.27
Blackadder Creek Tributary at Southern Outlet	0.20	0.21	0.26
Clay Shed Flow	0.33	0.53	1.02
Flow in Blackadder Creek Tributary at Eveline St	0.19	0.24	0.27
Blackadder Creek Tributary at Muriel St culvert	0.28	0.45	0.67

3.5.4 Predevelopment Surface Water Quality

Hyd2o undertook a pre development surface water quality monitoring program over the wider Midland Brick site from September 2019 to September 2020. Sampling locations are

shown in Appendix E. This program was supplemented by data previously collected by Midland Brick as part of broader environmental monitoring within the site over a 15 year period.

Parameters analysed for this LWMS include physical parameters (temperature, electrical conductivity, pH, and turbidity), nutrients, and metals. Surface water quality results are summarised in Table 4 for physical parameters and nutrients compared to ANZECC (2000) guideline trigger values for freshwater lowland river ecosystems and the Swan River Trust's Swan Canning Water Quality Improvement Plan (2009) long term targets.

Full results (including metals) are contained in Appendix E for locations considered relevant to Area 4. Key results are summarised as follows:

- Mean pH at all sites are within the ANZECC guideline range (6.5 – 8) except for the Clay Basin where the mean pH (8.3) was marginally higher than the upper limit.
- Mean EC ($\mu\text{S}/\text{cm}$) at the Swan River downstream site was higher (15455 $\mu\text{S}/\text{cm}$) than at the upstream site (14012 $\mu\text{S}/\text{cm}$). Swan River sites were well outside the ANZECC guideline range (120 - 300 $\mu\text{S}/\text{cm}$) but this is typical of the Upper Swan Catchment of the Swan-Canning River system (DoW, 2009). Mean EC ($\mu\text{S}/\text{cm}$) at the Clay Basin was well below the levels within the Swan River but outside the ANZECC guideline range. Mean EC ($\mu\text{S}/\text{cm}$) at the Main Site Pump and Sump and former Northern Storage Pond 4 site fell within and just outside the ANZECC guideline range respectively.
- Mean TN at Swan River sites were slightly higher downstream (1.31 mg/L) than upstream (1.24 mg/L), and both locations were only marginally above the ANZECC guideline value of 1.2 mg/L and the SCWQIP long term target of 1.0 mg/L. Mean TN at the monitoring locations within the Midland Brick site were all within the ANZECC guideline value and long term SCWQIP target with the exception of the Main Site Sump and Pump.
- Mean TP at Swan River sites were slightly higher downstream (0.09 mg/L) than upstream (0.08 mg/L), and both were slightly above the ANZECC guideline value of 0.065 mg/L but were consistent with the SCWQIP long term target of 0.1 mg/L. Mean TP at the monitoring locations within the Midland Brick site were outside the ANZECC guideline value and long term SCWQIP target with the exception of the Clay Basin.

With respect to metals, mean results were as follows relative to ANZECC guideline values:

- Arsenic was within the 95% protection limit for all sites.
- Cadmium was outside the 80% protection limit for all sites except SW11 (Main Site Sump and Pump) and SW7 (Northern Storage Pond 4) which are within the 90% protection limit.
- Chromium was within the 80% protection limit for all sites with the exception of SW7 (Northern Storage Pond 4). Chromium at SW11 (Main Site Sump and Pump) was also within the 95% protection limit.
- Copper was outside the 80% protection limit at all sites, except SW11 (Main Site Sump and Pump), which was within the 99% protection limit.
- Lead was within the 80% protection limit for all sites. Lead was also within the 95% protection limit at SW7 and within the 99% protection limit at SW11.

- Nickel was within the 95% protection limit for all sites. Nickel was also within the 99% protection limit at SW7 and SW11.
- Zinc was within the 80% protection limit for all sites, except SW7 (Northern Storage Pond 4) which was outside the 80% protection limit. Zinc was also within the 90% protection limit at SW11 (Main Site Sump and Pump).
- Mercury was within the 95% protection limit for all sites, except SW6 (Clay Basin) which fell within the 90% protection limit. Mercury was also within the 99% protection limit at SW7 (Northern Storage Pond 4) and SW11 (Main Site Sump and Pump).

Table 4: Predevelopment Surface Water Quality

Mean of Parameter Values							
Parameter	Swan River Upstrm (SW1/SW8)	Swan River Dnstrm (SW2/SW9)	Clay Basin (SW6)	Main Site Sump & Pump (SW11)	Northern Storage Pond 4 (SW7)	ANZECC	Long term SCWQIP targets
EC (µS/cm)	14012	15455	790	278	302	120-300	-
pH	7.56	7.52	8.31	6.91	6.87	6.5-8.0	-
TN (mg/L)	1.24	1.31	0.72	1.50	0.51	1.2	1.0
Ammonia (mg/L)	0.12	0.13	0.05	0.22	0.03	0.32 – 2.3 (99% - 80%)	-
TP (mg/L)	0.08	0.09	0.03	2.05	0.13	0.065	0.1
FRP (mg/L)	0.02	0.03	0.00	0.02	0.01	0.04	-
Nitrate (mg/L)	0.43	0.48	0.17	0.06	0.07	0.017 – 17 (99% - 80%)	-
Nitrite (mg/L)	0.05	0.06	0.03	0.05	0.25	-	-

3.5.5 Additional Surface Water Monitoring 2021 & 2024

Hyd2o undertook further surface water quality monitoring at selected sites in 2021 and 2024 to reflect water quality during a transitional period following changes to the site, including creation of the southern storages and re-configuration of the Clay Basin.

Sites monitoring during this period included SW3 (Blackadder Tributary at Eveline St), SW6 (Clay Basin) and SW15 (Site Inlet from Great Northern Highway). Sampling locations are shown in Appendix E.

Parameters analysed included those measured in the predevelopment monitoring program (EC, pH, turbidity, nutrients, and metals) with some additional analysis also conducted for total recoverable hydrocarbons (TRH's) at the Clay Basin in 2021.

Surface water quality results are summarised in Table 5 for physical parameters and nutrients compared to ANZECC (2000) guideline trigger values for freshwater lowland river ecosystems and the Swan River Trust's Swan Canning Water Quality Improvement Plan (2009) long term targets.

Full results are contained in Appendix E, including metals and TRH's. Key results are summarised as follows:

- Mean pH at all sites were within the ANZECC guideline range (6.5 – 8).
- Mean EC ($\mu\text{S}/\text{cm}$) at all sites were within the ANZECC guideline range (120 - 300 $\mu\text{S}/\text{cm}$).
- Mean TN at all sites were within the ANZECC guideline value of 1.2 mg/L and the SCWQIP long term target of 1.0 mg/L.
- Mean TP at all sites were within the ANZECC guideline value of 0.065 mg/L and the SCWQIP long term target of 0.1 mg/L, with the exception of SW3 (Blackadder Tributary at Eveline St) which was marginally above ANZECC (0.07 mg/L).

With respect to metals, mean results were as follows relative to ANZECC guideline values:

- Lead, Nickel and Mercury were within the 99% protection limit for all sites.
- Arsenic, Cadmium and Chromium were within the 95% protection limit for all sites.
- Copper ranged from within the 80% to 95% protection limit across the sites.
- Zinc ranged from within the 95% protection limit to outside the 80% protection limit for the external catchment contribution (Site Inlet at Great Northern Highway).

TRH's were below the detectable limit at SW6 (Clay Basin) on all three monitoring occasions.

While water quality generally aligned well with guideline values across the sites, water quality within the Midland Brick site (SW3 and SW6) was better in comparison to that entering the site (SW15).

In particular water quality within the Clay Basin has considerably improved from previous monitoring prior to its redevelopment. Water quality within and entering the Midland Brick site (SW3 and SW6) was notably better than water quality in the Swan River.

Table 5: Surface Water Monitoring 2021 & 2024

Mean of Parameter Values					
Parameter	Blackadder Tributary @ Eveline (SW3)	Clay Basin (SW6)	Site Inlet @ Great Northern Hwy (SW15)	ANZECC	Long term SCWQIP targets
EC (µS/cm)	145	246	300	120-300	-
pH	6.80	7.95	7.45	6.5-8.0	-
TN (mg/L)	1.07	0.52	1.05	1.2	1.0
Ammonia (mg/L)	0.07	0.03	0.01	0.32 – 2.3 (99% - 80%)	-
TP (mg/L)	0.07	0.05	0.05	0.065	0.1
FRP (mg/L)	0.01	0.02	0.01	0.04	-
Nitrate (mg/L)	0.01	0.05	0.50	0.017 – 17 (99% - 80%)	-
Nitrite (mg/L)	0.01	0.01	0.01	-	-

3.6 Groundwater

3.6.1 Groundwater Levels

The Perth Groundwater Map (DWER, online) indicates the superficial aquifer base at the LSP area is approximately -15 mAHD and has a saturated thickness of approximately 16 m.

Groundwater levels in the Perth Groundwater Map are representative of typical end of summer groundwater levels and estimate groundwater levels of less than 1 mAHD for the majority of the Area 4 Stage 1 LSP area, and an approximate 1 mAHD elevation on the eastern edge, with groundwater flow towards the Swan River.

In mid 2023, DWER revised the groundwater information reported on their Perth Groundwater Map to report the Gngangara Jandakot maximum and minimum water table contours for 2019. Advice from DWER indicates these revised contours account for the declines and rises in water tables in recent decades and the impacts of current climate trends. These contours are understood to be based on the contouring of the actual recorded maximum and minimum groundwater levels at DWER bores in 2019. The 2019 maximum contours are shown on Figure 7 and range from 0 to 1 mAHD across the site.

Emerge Associates installed 10 groundwater monitoring bores within the wider Midland Brick site on 20 August, 2018. Lithological logs for the five bores in proximity to LSP area are included as Appendix F.

Water levels in all bores were measured monthly from Sept 2018 to Feb 2019 with further monitoring over 2 winters then undertaken by Hyd2o from September 2019.

The estimated average annual maximum groundwater levels (AAMGL) across the Midland Brick site are shown in Figure 7 based on this data. Hyd2o have calculated the AAMGL by adjusting levels at the bores based on the recorded level in DWER bores MM38 and GD8 referenced to their long term historical data (Table 6). DWER bores MM38 and GD8 long-term hydrographs are provided in Appendix G. The data considered for the calculation is from the year 2000, which is considered representative of current climate conditions

The AAMGL and MGL for each groundwater bore based on this analysis is shown in Table 7. Perching of groundwater appears to be occurring at some bores due to their proximity to existing stormwater storage areas and clayey nature of site soils.

For the Area 4 Stage 1 site, the mapping indicates an AAMGL ranging from 0 to 1 mAHD on the northern boundary adjacent to the Swan River up to approximately 2 mAHD on the southern boundary.

It is important to note this LWMS only uses the terminology AAMGL to represent a valid statistical property of groundwater in the area, and not as a concept as per previous DWER policies. This LWMS presents details of the groundwater's seasonal variation, AAMGL, and MGL all as measures of its seasonal, annual, and interannual behaviour. Simply presenting an MGL is not considered adequate to represent the groundwater characteristics and behaviour of a site.

Table 6: AAMGL and MGL for DWER Bores

Bore	Period of Record	Groundwater Level (mAHD) 21/10/2019	AAMGL 2000-2020 (mAHD)	Correction Factor (m)	MGL (mAHD)	Correction Factor (m)
MM38	1974 – 2020	20.23	20.29	+0.06	20.64	+0.41
GD8	1978-2020	4.01	4.07	+0.06	4.94	+0.94
Correction Factors for Midland Brick Site Bores				+0.06		+0.67

Table 7: AAMGL and MGL for Midland Brick Site Bores

Bore	Natural Surface (mAHD)	AAMGL (mAHD)	MGL (mAHD)	Depth to AAMGL Below Natural Surface (m)
EMW01	5.60	0.67	1.28	4.93
EMW02	9.55	1.26	1.87	8.29
EMW03	10.82	1.42	2.03	9.40
EMW04	9.29	2.14	2.75	7.15
EMW05	10.96	7.38*	7.99	3.58*
EMW06	5.57	4.09	4.70	1.48
EMW07	8.37	6.36	6.97	2.01
EMW08	8.58	3.30	3.91	5.28
EMW09	7.00	1.76	2.37	5.24
EMW10	10.35	5.86	6.47	4.49

- EMW05 calculated AAMGL level above considered to be possibly perched due to comparison which other previously installed and monitored bores in close proximity to this area. Possibly due to stormwater ponding in the area behind the Clay Shed.

3.6.2 Groundwater Quality

Groundwater quality was monitored at the 10 groundwater bores by Emerge in September 2018 and by Hyd2o quarterly from September 2019 to September 2020. Groundwater bore locations are shown in Figure 7 and Appendix E.

Physical parameters (temperature, electrical conductivity, and pH) were measured in situ. Samples were sent to the NATA approved MPL Laboratory for total nitrogen, ammonia, nitrate, nitrite, total phosphorus, filterable reactive phosphorus, and heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, mercury, and zinc).

Groundwater water quality results for the five bores in proximity to Area 4 are outlined in Table 8 compared to ANZECC (2000) guideline trigger values for freshwater lowland river ecosystems. Full results are contained in Appendix E. Results are summarised as follows:

- Mean pH ranged from 5.77, outside the guideline range (6.5 – 8.0), to 6.88, within the ANZECC guideline range.
- Mean EC ranged from 183 $\mu\text{S}/\text{cm}$, within the ANZECC guideline range (120 – 300 $\mu\text{S}/\text{cm}$), to 1896 $\mu\text{S}/\text{cm}$, outside the ANZECC guideline range across the groundwater samples, indicating that the groundwater is fresh to brackish across the bores.
- Mean values for total nitrogen (TN) ranged from 0.63 mg/L to 1.50 mg/L across bores EMW01, EMW03, EMW05 and EMW06, indicating values below and above the ANZECC

guideline value of 1.2 mg/L. Notably the mean TN at EMW07 far exceeded the ANZECC guideline range with a value of 19.05 mg/L.

- Mean total phosphorous (TP) ranged from 0.11 mg/L to 0.60 mg/L across bores EMW01, EMW03, EMW05 and EMW07, above the ANZECC guideline value of 0.065 mg/L. Mean TP at EMW06 fell within the ANZECC guideline range with a value of 0.06 mg/L.

With respect to metals, mean results were as follows relative to ANZECC guideline values:

- Arsenic and Nickel were within the 99% protection limit across the bores.
- Cadmium was within the 95% protection limit at all bores.
- Chromium was within the 95% protection limit for all bores with the exception of EMW07 where it was within the 90% protection limit.
- Copper was within the 99% protection limit at EMW05 while within the 95% protection limit at EMW03 and EMW06. Copper was outside the 80% protection limit at EMW01 and EMW07.
- Lead was within the 99% protection limit across all bores with the exception of EMW01 where lead was within the 80% protection limit.
- Zinc was within the 95% protection limit at EMW03 while within the 90% protection limit at EMW05, EMW06 and EMW07. Zinc was outside the 80% protection limit at EMW01.
- Mercury was within the 99% protection limit at the EMW03, EMW06 and EMW07 while within the 95% protection limit at EMW01 and EMW05.

Table 8: Existing Groundwater Quality

Groundwater Bore	Parameters							
	EC (µS/cm)	pH	TN (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	TP (mg/L)	FRP (mg/L)
ANZECC	120-300	6.5-8.0	1.2	0.32 – 2.3 (99% - 80% protection)	0.017 – 17 (99% - 80% protection)	-	0.065	0.04
EMW01	1420	6.52	1.5	0.14	0.02	0.01	0.42	0.03
EMW03	1896	6.74	1.2	0.03	0.01	0.01	0.60	0.15
EMW05	183	5.77	0.63	0.04	0.21	0.01	0.11	0.01
EMW06	1785	6.88	0.52	0.02	0.09	0.01	0.06	0.01
EMW07	701	5.84	19.05	0.08	15.85	0.01	0.21	0.01

3.7 Constraints and Opportunities

Based on the existing environment, the following key constraints and opportunities are identified to guide the development of the water management strategy:

- The site is predominantly outside the floodplain of the Swan River.
- There is generally good clearance to groundwater across the site.
- Underlying clay soils limit opportunities for stormwater management via infiltration.
- There are existing flow paths to the Blackadder Creek tributary and also the Swan River, with the site discharging to Blackadder Creek during minor events, and to the Swan River during major events.
- Re-development of the site provides opportunities to improve the existing interface and relationship between the site and the Swan River, and also site and the Blackadder Creek tributary.
- Opportunity to coordinate with local catchment groups with respect to revegetation and nearby waterway initiatives.

4. Design Criteria & Objectives

Key design principles and criteria for the Area 4 Stage 1 LSP area are shown in Table 9 and have been established consistent with the key reference documents previously detailed in Section 1.2, and reflect the site constraints and opportunities identified in Section 3.

These principles and criteria are used to formulate the water management strategy for the LSP area to remain within the identified constraints and opportunities of the existing environment.

Table 9: Design Principles & Criteria

Strategy Elements	Method & Approach
Water Use Sustainability	
Water Efficiency	- Water efficiency implementation to be consistent with Building Codes of Australia requirements - Aim for less than 100 kL/person/year water use - Establish "Waterwise" Public Open Space - Maximise infiltration and reuse of stormwater
Water Supply	- Minimise overall use of scheme water for non-drinking purposes - Water Corporation IWSS for lots plus use of rainwater tanks (non mandated) - Use of groundwater for POS irrigation.
Wastewater	Water Corporation reticulated sewerage
Stormwater	
Ecological Protection	- Lot soakwells (15mm event infiltration on site) to be used to maintain the overall required ecological water balance for receiving environments (including TEC areas) post development. - Establishment of biofiltration areas for treatment of first 15mm road runoff and subsoil.
Serviceability	Piped drainage system sized to convey 20% AEP event
Flood Protection	- All development to be outside the floodway of the Swan River. - Establish minimum habitable floor levels at 0.5m above the 1% AEP flood level of the Swan River and Blackadder Creek. - Overland flow paths within road reserves for safe conveyance of flows exceeding pipe drainage system capacity 1% average exceedance probability (AEP) events to be discharged offsite at acceptable rates consistent with downstream ecological and infrastructure constraints.
Groundwater	
Fill Requirement & Subsoil Drainage	Development levels to establish an acceptable clearance to groundwater systems via the use of a combination of subsoil drainage and sand fill above less permeable soils.
Acid Sulphate Soils & Contamination	Management of Acid Sulphate Soils to be handled as a separate process if required consistent with DoE (2004) requirements.

5. Water Use Sustainability

5.1 Water Efficiency Measures

Development of the LSP area will lead to an increased demand of potable water for residential use as irrigation of gardens and POS areas. Water conservation measures will be implemented to reduce scheme water consumption within the development will be consistent with Water Corporation's "Waterwise" land development criteria including:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets, rainwater tanks, waterwise landscaping).
- All houses to be built to 6 star building standards (water efficient fixtures and fittings).
- Use of water wise plantings in POS areas.
- Maximising onsite retention and reuse of stormwater.
- Use of high density residential zoning to reduce garden (ex-house) use of water and minimise fertiliser nutrient inputs.

5.2 Water Supply

The Water Corporation's Integrated Water Supply System (IWSS) will supply potable water to future homes within the LSP area.

Rainwater tanks will not be implemented/mandated at estate scale to supplement the domestic water supply scheme. Residents who wish to supplement scheme water supply with rainwater tanks will be provided for by individual builders during the building application process.

The LSP area is located within the Perth (Superficial-Swan) Groundwater Management Area (GMA), Shire of Swan South groundwater sub area. DWER's online Water Register for Licence and Water Availability Information (Appendix H) indicates that the superficial aquifer is fully allocated within this sub area. The deeper Leederville aquifer is also fully allocated.

With respect to POS irrigation, the developer has a licence for 55,000 kl/yr. The developer also has a Leederville groundwater licence for 75,000 kl/yr at the site valid until July 2030. Water register extracts for these licences are contained in Appendix H

Irrigation of the Jack Williamson oval adjacent to the site is currently contained under the City of Swan's Leederville aquifer licence of 280,755 kL/yr.

Upon handover of POS areas groundwater licences will be handed over to the City of Swan.

Landscape masterplanning is contained as Appendix I. Landscaping will be designed with recognition of the generally low availability of water in the area, with local species incorporated to minimise water use.

Preparation and agency approval of final landscape plans will be undertaken at UMWP stage based on final stormwater design requirements. The UWMP will also include detailed irrigation usage tables demonstrating water use and distribution at local scale.

Note the stormwater areas shown in Appendix I should be considered indicative only, with the final form of this area undertaken at UWMP stage based on refined stormwater modelling and landscape design.

5.3 Wastewater Management

Wastewater will be reticulated sewerage with management by the Water Corporation.

6. Stormwater Management Strategy

Stormwater management at the site has been designed in accordance with Better Urban Water Management (WAPC, 2008), City of Swan's principles for water quality and quantity management, DBCA and DWER requirements, and Stormwater Management Manual for Western Australia (DWER, 2022).

Post development, annual stormwater discharge volumes and peak flows are typically required to be maintained relative to pre development conditions and water quality maintained and/or improved with the aim of maintaining and restoring ecological systems. These principles are the key guiding principles applied to the Blackadder Creek tributary to maintain its existing hydrology.

In the case of flows to the Swan River however, previous discussions with DWER and DBCA have indicated the magnitude of post development flows to the River relative to the existing flows of the Swan River is not a major consideration as the times of concentration of flows from the site and the River are not coincident and therefore larger flows from the site are not considered a flood risk. The key principle for the site with respect to the Swan River will therefore be in relation to smaller more frequently occurring events and ensuring these receive adequate water quality treatment.

An overview of key elements of the wider Area 4 proposed stormwater management system changes are shown in Figure 8, with the aim of providing stormwater quality and quality management, and a staged land use transition. In broad terms the Area 4 system will comprise the following:

- For areas draining to the Blackadder Creek tributary, the stormwater management areas will be required to provide stormwater storage to attenuate flows and maintain existing levels for events up to the 1% AEP. These storage areas will be integrated with landscaped POS for large catchments and contained within wider road reserves for smaller localised catchments.
- For catchments draining to the Swan River, 15mm event biofiltration areas will be provided located outside of designated foreshore buffer areas, with all larger events permitted to discharge to Swan River using rehabilitated existing outlets (due to differences in times of concentration of the River compared to the site catchments).
- For the existing storage area adjacent to the Threatened Ecological Community (TEC) adjacent to the existing clay shed within the site, the principle of maintaining the area of inundation and water levels for various AEP events at or below existing levels has been adopted to protect the TEC.
- For the existing brickworks site and its external contributing catchment, the strategy will be to continue to provide a functioning stormwater management system in accordance with environmental requirements of the site. This will require the continued use of a pumped stormwater management system. Rather than this catchment continue to flow into the southern portion of the Blackadder Creek tributary in low flow events and to the Swan River in major events, this flow is proposed to be ultimately redirected to the upper reaches of the Blackadder Creek tributary to assist in maintaining the overall existing hydrological water balance of the creek system once the Clay Shed roof catchment no longer contributes flow the creek.

Staging of stormwater works will be managed to maintain a functioning stormwater management system for the existing brickworks site and external council drainage system which drains into the site throughout the development transition period. Required works will be presented in future UWMP's.

Reports addressing changes to the Midland Brick site's existing stormwater management system that have already been completed and submitted to agencies, include:

- Midland Brick, Middle Swan Brickworks Kiln 10 Hardstand Expansion Development Application Stormwater Management (Hyd2o, 2019a & 2020b)
- Midland Brick, Middle Swan Local Water Management Strategy Bridging Document, (Hyd2o, 2020c).
- Midland Brick, Middle Swan Brickworks: Southern Replacement Storage Design (Hyd2o (2020d)
- Midland Brick, Middle Swan Brickworks: Masonry Site Stormwater Management, (Hyd2o, 2020e)
- Cranwood Crescent Viveash Stages 1a & 1b Urban Water Management Plan (Hyd2o, 2020f)
- Cranwood Crescent Viveash Stage 2 Urban Water Management Plan (Hyd2o, 2022)
- Rivermark Area 3 Local Water Management Strategy (Hyd2o, 2024a)
- Rivermark Area 3 Local Water Management Strategy Addendum (Hyd2o, 2024b)
- Blackadder Creek Tributary Performance Assessment, (Hyd2o, 2024c)
- Midland Brick Middle Swan Brickworks: Southern Storage Relocation Design (Hyd2o, 2024d)

This LWMS is consistent with these reports.

6.1 Stormwater Event Modelling

Post development stormwater modelling for the site was initially performed using XP-Storm for the DWMS (Hyd2o, 2020a), and is refined in this LWMS based on structure plan refinements. Previous DWMS modelling across the whole Midland Brick site is contained as Appendix J.

Updated post development catchment areas and runoff rates are detailed in Appendix K. Runoff coefficients adopted for modelling purposes for various events and durations were calculated in detail using Hyd2o's CURRV runoff rate estimator based on various individual land use characteristics. Lots are proposed to infiltrate stormwater runoff from constructed impervious surfaces via soakwells sized to retain the 15 mm rainfall event at source.

The proposed stormwater management system post development for Area 4 Stage1 in the context of wider water management planning for Area 4 is shown in Figure 9, showing catchment areas, flows paths, and key infrastructure details based on modelling outcomes using XP-Storm for various AEP events. Table 10 summarises the stormwater management sizing details for individual areas, with more detailed modelling results provided in Appendix L.

Note that the extent of inundation of POS areas shown in Figure 9 for various flood management events are shown to approximate scale. The storage shapes however should be considered indicative only for determination of area requirements and representation of storage areas required in relation to POS areas allocated in the local structure plan.

The final flood attenuation area configuration (side slopes etc), locations, and elevations will be documented in future UWMPs and will be dependent on final earthworks, drainage, and road design levels for the development. Minor refinements to catchment areas shown in this report are considered likely to occur as detailed design proceeds, and stormwater modelling will be updated accordingly during the UWMP process.

The results for individual catchments draining to Area 4 storages are summarised below. Note catchments within Area 4 draining externally (eg Catchment F) have been previously addressed in the Area 3 LWMS the site.

- Catchments A1 and A2 represents the largest overall catchment areas of the site. These areas will drain to two biofiltration swales within the POS adjacent to the foreshore reserve. The total estimated size of the biofilter area for these catchments is 0.14 ha at 0.45m depth (637 m³ volume required). For the initial Area 4 Stage 1 LSP area, 0.07 ha and 327 m³ volume is required. Larger events will discharge to the Swan River via existing outlets and a further 0.2 m depth is estimated to be required in the biofilter area to accommodate the safe conveyance of events up to the 1% AEP. Note these biofilter will also receive subsoil flows from catchments B1 and B2.
- Catchment B1 represents a small catchment adjacent to the vegetated/wetland area north of Eveline Rd. This catchment will flow to a biofilter (nominal width 2.4m, area 200 m², volume 60 m³) within the road reserve, with larger events flowing into the adjacent vegetated/wetland area and the Blackadder Creek Tributary.
- For Catchment B2 a biofilter is proposed to be located within the road reserve with a nominal 1.5m width to provide 55 m³ volume of storage over a 185 m² area for the 15mm event. Flows for larger events will be attenuated in the existing vegetated storage area adjacent to the TEC. The design approach for the existing vegetated storage area is to retain water levels for various events in this area similar (or less) to the existing levels it has based on flow from the Clay Shed roof. This will require a marginally smaller culvert from this area to be installed to that which current exists. The storage area adjacent to the TEC is discussed further in in Section 6.4.

Table 10: Stormwater Management Sizing for Area 4 Catchments

Catchment	A1 (Stages 1 & 2)	A2	B1	B2
Lots (ha)	12.24	3.05	1.43	0.50
POS/TEC (ha)	1.67	0.57	1.12	2.41
Road Reserve (ha)	5.25	1.49	0.64	0.58
Industrial/Commercial (ha)	0.24	3.43	-	-
Total Area (ha)	19.39	8.54	3.18	3.48
Equiv Imp Area (15mm event) ha	3.31	0.94	0.40	0.37
Equiv Imp Area (20% & 1% AEP) ha	10.32	4.82	1.42	1.26
Storage Characteristics				
Side Slopes (v:h)				
Biofilter	0	0	0	-
Flood Storage	-	-	-	Natural
System Component and Design Approach	Biofilter in POS, with overflow to Swan River	Biofilter in POS, with overflow to Swan River	Biofilter in road reserve with outlet to wetland / BAT	Wetland / BAT
				Biofilter in road reserve to existing storage next to TEC
				Existing storage next to TEC Area
Water Quality : 15mm Event (63% AEP results shown for Natural/Wetland Storage Areas)				
Invert (mAHD)	5.95	6.35	8.5	8.40
Flood Rise (m)	0.45	0.45	0.3	0.12
TWL (mAHD)	6.4	6.8	8.8	8.52
Volume (m³)	327 : Stage 1 169 : Stage 2	141	60	226
TWL Area (m²)	727 : Stage 1 376 : Stage 2	313	200	2083
Flood Storage (20% AEP) Event				
Invert (mAHD)				8.40
Flood Rise (m)				0.16
TWL (mAHD)	Outflow to Swan River	Outflow to Swan River	To wetland / BAT	8.56
Volume (m³)				312
TWL Area (m²)				2218
Flood Storage (1% AEP) Event				
Flood Rise (m)				0.18
TWL (mAHD)	Outflow to Swan River	Outflow to Swan River	To adjacent wetland /BAT	8.58
Volume (m³)				357
TWL Area (m²)				2285

6.2 Ecological Protection

This LWMS proposes a treatment train approach to water quality management which includes non- structural as well as structural controls:

- **Non-Structural Controls**

Planning: POS location, lot product and subdivision layout.

Maintenance: regular stormwater system maintenance including POS biofilter area.

Monitoring: Post development program and performance review.

- **Structural Controls**

Catchment Scale Infrastructure: Bioretention in POS and road reserves, living streams.

Local Scale Infrastructure: Soakwells, GPT's.

Landscape: Foreshore reserve establishment and improvements, POS "buffer" around TEC, native plantings.

Measures adopted represent known best management practice as detailed in the Stormwater Management Manual for Western Australia (DWER, 2022). Table 11 details a summary from the Stormwater Management Manual for Western Australia (DWER, 2022) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria.

While DWER (2022) does not provide expected pollutant removal efficiencies for all BMP's, application of a treatment train approach using a combination of the non-structural and structural measures will therefore clearly achieve the design objectives for water quality as detailed in Better Urban Water Management (WAPC, 2008).

Stormwater volumes for ecological protection based on water quality treatment of the 15mm event are provided in Table 10 and Figure 9. The estimated modelled area and volume required for Area 4 Stage 1 is 0.073 ha and 327 m³, based on a depth of 0.45m.

Figure 10 provides a typical cross section showing the biofilter in relation to other key infrastructure and development levels for the area adjacent to the Swan River Foreshore.

Biofiltration systems will be designed at UWMP stage consistent with the Adoption Guidelines for Stormwater Biofiltration Systems (CRC for Water Sensitive Cities, 2015).

Table 11: BMP Water Quality Performance In Relation to Design Criteria

Parameter	Design Criteria via (WAPC, 2008) (required removal as compared to a development with no WSUD)	Structural Controls Nutrient Output Reduction ¹	
		Vegetated Swales/ Bioretention Systems	Detention/ Retention Storages
Total Suspended Solids	80%	60-80%	65-99%
Total Phosphorus	60%	30-50%	40-80%
Total Nitrogen	45%	25-40%	50-70%
Gross Pollutants	70%	-	>90%

1. Typical Performance Efficiencies via DWER (2022)

6.3 TEC Water Level Management Strategy

While not immediately adjacent to Area 4 Stage 1, this section provides results of stormwater modelling of the TEC area near the existing clay sheds adjacent to the wider Area 4 boundary to provide context to the sites development within the framework of the overall water management planning for the wider area. Modelling of the lower TEC area near Muriel St was previous undertaken and reported in the Area 3 LWMS (Hyd2o, 2024a).

As previously described in Section 6, for the existing storage area located adjacent to the Threatened Ecological Community (TEC) within the site, modelling has used the principle of maintaining the area of inundation and water levels for various AEP events similar or below existing levels to protect the TEC.

Areas of inundation post development and inundation heights relative to existing heights are shown in Figure 11. Note that no earthworking of this area is proposed post development and mapping of inundation areas has assumed the existing topography in this area remains unchanged.

It is important to note that currently the TEC area is partially inundated during a 1% AEP event with the existing system with most TEC vegetation located outside the area of inundation. Modelling results shown a marginally lower level and smaller area of inundation post development than existing for major events, which is considered a beneficial outcome for the TEC.

Further modelling of the stormwater design along the whole of the Blackadder Creek Tributary area including TEC areas downstream of Eveline Rd will be refined as more detailed planning progresses for Area 4 Stage 2.

Measures for protection of other aspects of the TEC (such as access control and weed prevention) will be addressed in environmental management plans for Area 4 Stage 2 as a separate process to this LWMS.

6.4 Water Balance Modelling

An existing monthly water balance was established for the Midland Brick site and was used to provide estimates of annual flows and water volume movements across key locations.

Modelling results are presented in Appendix M. These estimates are based on the original water balance model developed and reported in the DWMS (Hyd2o, 2020a), with some refinements based on an improved calibration using Landgate's Map Viewer historical site photographs showing water inundation timeframes in various storages.

The water balance modelling estimated that prior to the recent changes to water management (clay basin changes, and new southern storage construction) on average 172,000 kL/yr of water was lost due to evaporation and other infiltration losses. These losses occurred at the existing open water storages, including approximately 78,000 kL/yr at the Clay Basin alone, and equated to approximately 56 % of the water from the catchments contributing flow within the Midland Brick site.

Based on the proposed post development stormwater management system, the existing system monthly water balance model was refined and used to model the post development case. This model provided estimates of post development annual and seasonal flows and water volume movements at key locations. Modelling results are

summarised in Figure 12 compared to the existing water balance, with more detailed extracts from the model contained in Appendix M.

The total flows considered in the predevelopment water balance model was 306,000 m³/yr, and while a minor difference in the post development flows to the Blackadder Creek Tributary is reported (4,000 m³/yr) this difference is considered within the accuracy of the modelling, and effectively represents a similar pre to post development outcome. At the location of the 4000 m³/yr change, this flow change represents a 3% predevelopment to post development flow difference, which is considerably less than existing interannual flow variability.

The modelling shows that both the annual and monthly seasonal distribution of flow for the Blackadder Creek Tributary at Muriel St post development can be maintained similar to the existing condition.

Further consultation with DBCA and DWER will continue to be undertaken as planning progresses to assess the opportunities this provides to enhance the Blackadder Creek tributary and its environment.

7. Groundwater Management Strategy

7.1 Post Development Groundwater Levels

Development levels within the Area 4 Stage 1 LSP area are not dominated by fill requirements to achieve adequate separation to regional groundwater, given the proximity of groundwater levels to natural surface.

Due to the underlying impermeable soils however, it is envisaged that subsoil drainage will be required within the development to control water rise within imported fill above less permeable soils. Subsoil drainage is a widely used practice across the Swan Coastal Plain.

7.2 Earthworks, Fill and Subsoil Drainage

Development will require the removal of all brick and clay stock, as well as the demolition of any existing structures, pavements and services. Site works will then generally comprise the clearing of existing vegetation (where necessary), stripping of topsoil, earthworking of the existing surface, compaction to areas of existing fill, and importing fill with a top sand layer to facilitate the proposed form of development.

The clayey subgrade surface will be earthworked and shaped, before the sand is placed, to ensure drainage of perched water. Following the subgrade works, a layer of clean sand fill will be imported and placed above the clayey material to achieve the proposed finished levels and desired site classification. The imported material used for sand fill will be a free draining clean sand material with a fines content less than 5% and permeability of greater than 5m/day.

Preliminary earthwork levels prepared by TABEC are detailed in Appendix N on the basis of the following considerations:

- Fill requirement to achieve the required site classification.
- The minimum level required to ensure adequate separation from any perched groundwater within sand fill.
- Interfacing levels with the adjacent development, retained vegetation areas, and existing infrastructure.
- Ensuring finished floor levels for buildings are a minimum 500mm above estimated 1% AEP flood levels of adjacent watercourses.

These earthwork levels have informed the establishment of catchment boundaries for stormwater modelling in Section 6. Catchment boundaries are shown in Appendix N showing the majority of Area 4 Stage 1 draining to the Swan River.

As previously discussed, development levels are generally not dominated by fill requirements to achieve adequate separation to regional groundwater, given the proximity of groundwater levels to natural surface. However, due to the underlying impermeable soils, it is envisaged that subsoil drainage will be required within the development to control the perching of groundwater from rainfall.

Subsoil drainage is proposed to be located within road reserves. All subsoil drainage will have free outfalls and discharge to the biofiltration area for treatment. Ongoing

management of subsoil drainage will be required to ensure its ongoing performance in accordance with design.

Groundwater/subsoil modelling will be performed at the UWMP stage in accordance with the IPWEA (2016) Draft Specification on Separation Distances for Groundwater Controlled Urban Development. This guideline recommends the establishment of development levels on the basis of detailed modelling of subsoil drainage utilising a 30 year daily rainfall record obtained from DWER based on a future median rainfall scenario as outlined in Selection of Future Climate Projections for Western Australia (DoW, 2015).

IPWEA (2016) requires the provision of a minimum 0.3 m of coarse sand in the rear of lots above the 50% AEP phreatic surface for residential lots of size 400-800m², and a 0.15m clearance for lots <400 m². This criteria will be used as the initial basis for establishing fill requirements for the LSP area, in consultation with City of Swan.

Final design lot levels and fill specification are a detailed design issue to be addressed during the preparation of detailed engineering design drawings and preparation of the UWMP and will be ultimately submitted for council approval at that stage.

In situ permeability testing is recommended to be undertaken once the LSP area has been filled to confirm that permeability rates meet those used in design. Testing will be detailed in the UWMP and undertaken by the developer in consultation with the City of Swan.

7.3 Acid Sulphate Soils

Acid sulphate soil mapping has been previously discussed in Section 3.2.1 as ranging from no known risk, to a moderate to high ASS risk in a small area only immediately adjacent to the Swan River and associated with the foreshore.

If disturbance is required, management of ASS will be addressed by a separate study by a suitably qualified environmental consultant. The ASS Management Plan will detail the actions to minimise and mitigate potential adverse environmental effects during the works.

All assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series publications for identification, investigation and management of Acid Sulphate Soils (Department of Environment Regulation, 2015b).

This will be conducted appropriately as a separate process to this LWMS.

8. Urban Water Management Plans

Consistent with processes defined in WAPC (2008), Urban Water Management Plans (UWMPs) will be developed and submitted to support subdivision applications for various stages of development within the Area Stage 1 LSP area.

Preparation of the UWMP will be the responsibility of the developer. UWMPs will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of the City of Swan, DBCA, and DWER.
- Agreed/approved measures to achieve water conservation and efficiencies of water use, including provision of POS irrigation water use distribution details.
- Detailed stormwater management design including the size, location and design of public open space areas, integrating major and minor flood management capability.
- Management of groundwater levels including proposed cut/fill levels.
- Specific structural and non-structural BMPs and treatment trains to be implemented including their function, location, maintenance requirements, expected performance and agreed ongoing management arrangements.
- Management of subdivisional works including development of a strategy for sediment control during construction.
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Specific monitoring and reporting to be undertaken for each UWMP area consistent with the monitoring program defined in the LWMS.
- Contingency plans (where necessary).

Further detail of the integration of stormwater within POS areas and improvements to the Blackadder Creek Tributary area outside of the LSP area will be provided during the development of the relevant water management planning documents covering those specific areas. This will include the refinement of stormwater and tributary modelling, preparation of detailed landscape plans (species selection and treatments), and detailed engineering design drawings.

Staging of stormwater changes will be detailed in the relevant UWMP's and implemented to ensure key hydrological performance criteria in relation to the receiving environment and key design objectives are maintained during the transition process.

9. Monitoring

9.1 Pre Development

Baseline surface and groundwater monitoring of existing conditions commenced in winter 2019 and was completed in winter 2020 as detailed in Chapter 3.

Some additional monitoring was also undertaken in 2021 and 2024 to monitor the performance of the Midland Brick site following the recent changes to its overall system.

No further monitoring is considered to be required to inform development of the site.

9.2 Post Development

The proposed post development monitoring program for Area 4 is summarised in Table 12.

Post development groundwater monitoring is proposed in 4 groundwater monitoring bores as shown in Figure 13 to provide suitable coverage of the site. Locations have been selected based on maintaining existing predevelopment sampling locations where possible.

The following frequency of monitoring is proposed:

- Monthly groundwater level measurements.
- Quarterly groundwater quality measurements.

Groundwater levels will also be measured in DWER bores MM38 and GD8 consistent with pre development monitoring. Groundwater quality will be monitored quarterly (typically January, April, July, October) for physical parameters (pH, electrical conductivity), nutrients (total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus, and filterable reactive phosphorus) and heavy metals.

Surface water samples will be taken in the Swan River upstream and downstream of the LSP area as well as within the Blackadder Creek Tributary at Eveline Rd. Samples will be taken on up to four occasions over each winter monitoring period, when water is flowing, via a collected grab sample. Samples of stormwater outflows will also be taken from each of the stormwater detention and biofilter areas when/if water is present. Visual assessment of these areas will also be undertaken on a quarterly basis via a standardised proforma, to assess performance in relation to design.

All water quality samples will be analysed at a NATA approved laboratory.

Staging requirements of this program in relation to initial Area 4 Stage 1 development area will be determined at UWMP stage in consultation with agencies to determine the preferred sites for initial monitoring and the timing of its commencement.

The monitoring schedule will be undertaken for a three year period consistent with DWER requirements (Department of Water ,2012). An annual report will be prepared summarising the results of the program, with results compared to predevelopment monitoring data. The program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area, or to alter the scope of the program itself. This will require the agreement of all parties.

If required, contingency actions will include a review of all monitoring data to determine the likely cause of any significant changes in water quality, consideration of additional monitoring required to assist a determination, and consideration of remedial actions.

A contingency plan including targets estimated on the basis of predevelopment monitoring is presented in Table 13.

Implementation of the post development monitoring program is the responsibility of the developer. Where any staging aspects require specific additional monitoring to be conducted, this will be appropriately detailed at UWMP stage.

Table 12: Area 4 Post Development Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater level	Water level (m AHD)	4 bores within LSP area and 2 DWER bores	Electrical depth probe or similar	Monthly (12x annually)
Groundwater quality	Physical, nutrients and heavy metals	4 bores within LSP area	Pumped bore sample	Quarterly (4x annually)
Surface water quantity	Flow	1 location Blackadder Creek Tributary	Visual estimate	Quarterly (4 occasions annually)
Surface water quality	Physical, nutrients and heavy metals	1 locations Blackadder Creek Tributary, 2 locations Swan River	Collected grab samples	Maximum four occasions during each annual winter monitoring period
Stormwater quantity (Local)	Flow	6 storages, (including Clay Basin)	Visual estimate	Quarterly (4 occasions annually)
Stormwater quality (Local)	Physical, nutrients and heavy metals	6 storages, (including Clay Basin)	Collected grab samples of outflow	Maximum four occasions during each annual winter monitoring period
System performance	Profroma	All storages, Swan River outlets and Blackadder Creek Tributary	Visual Assessment	Maximum four occasions during each annual winter monitoring period

Table 13: Contingency Planning

Type	Criteria for Assessment	Frequency	Process & Possible Actions
Water Quality	Surface and groundwater quality significantly worse than:	Ongoing assessment following monitoring with annual review	Process 1. Assess spatial extent of occurrence. 2. Determine if due to development or other factors. 3. Perform appropriate action as required (refer below) 4. Record and report any breach and action taken. 5. If necessary, inform residents of any required works. 6. Inform and provide monitoring data to DWER/ City of Swan.
	a) predevelopment water quality; and/or b) typical urban stormwater quality on the Swan Coastal Plain (Martens et al 2005) TN : 1.1 mg/l TP : 0.21 mg/l with reference to ANZECC guidelines ¹		Possible Actions 1. Resample location to determine if it is a false reading. 2. Identify and remove point sources of pollution. 3. Review operational and maintenance practices. 4. Consider alterations to POS areas including landscape regimes and soil amendment. 5. Consider modifications to the stormwater system. 6. Consider initiation of community based projects.

1. ANZECC guidelines to be used as a reference point only. ANZECC guidelines state that guidelines values are not intended to be directly applied to stormwater quality, however are applicable where the stormwater system are regarded as having conservation value. ANZECC guideline values are derived for unmodified or slightly modified ecosystems. ANZECC recommends the values only be applied where site specific values do not exist, or site specific targets cannot be derived.

10. Implementation

Table 14 details the roles, responsibilities and funding to implement the LWMS.

Monitoring outcomes will be used in a continual improvement capacity to review the implemented WSUD within the Area 4 Stage 1 LSP area and inform the planning and design approaches for subsequent stages of development. Monitoring outcomes will also be used to inform continual design and planning improvements in relation to the hydrology of the Blackadder Creek Tributary.

Details of construction and maintenance activities and responsibilities will be appropriately detailed at UWMP stage, and will include further details of specific staging considerations, and the need for ongoing management of subsoil drainage to ensure its ongoing performance in accordance with design.

Table 14: Implementation, Roles and Responsibilities

Implementation Action	Responsibility		
	Developer	DWER / DBCA	City of Swan
Review and approval of this LWMS		✓	✓
Preparation of a UWMP for individual development stages	✓		
Review and approval of UWMP		✓	✓
Construction of stormwater system and maintenance post construction until council handover	✓		
Long term stormwater system operation and maintenance			✓
Conduct post development monitoring program and annual reporting	✓		
Review of monitoring data and annual reports		✓	✓

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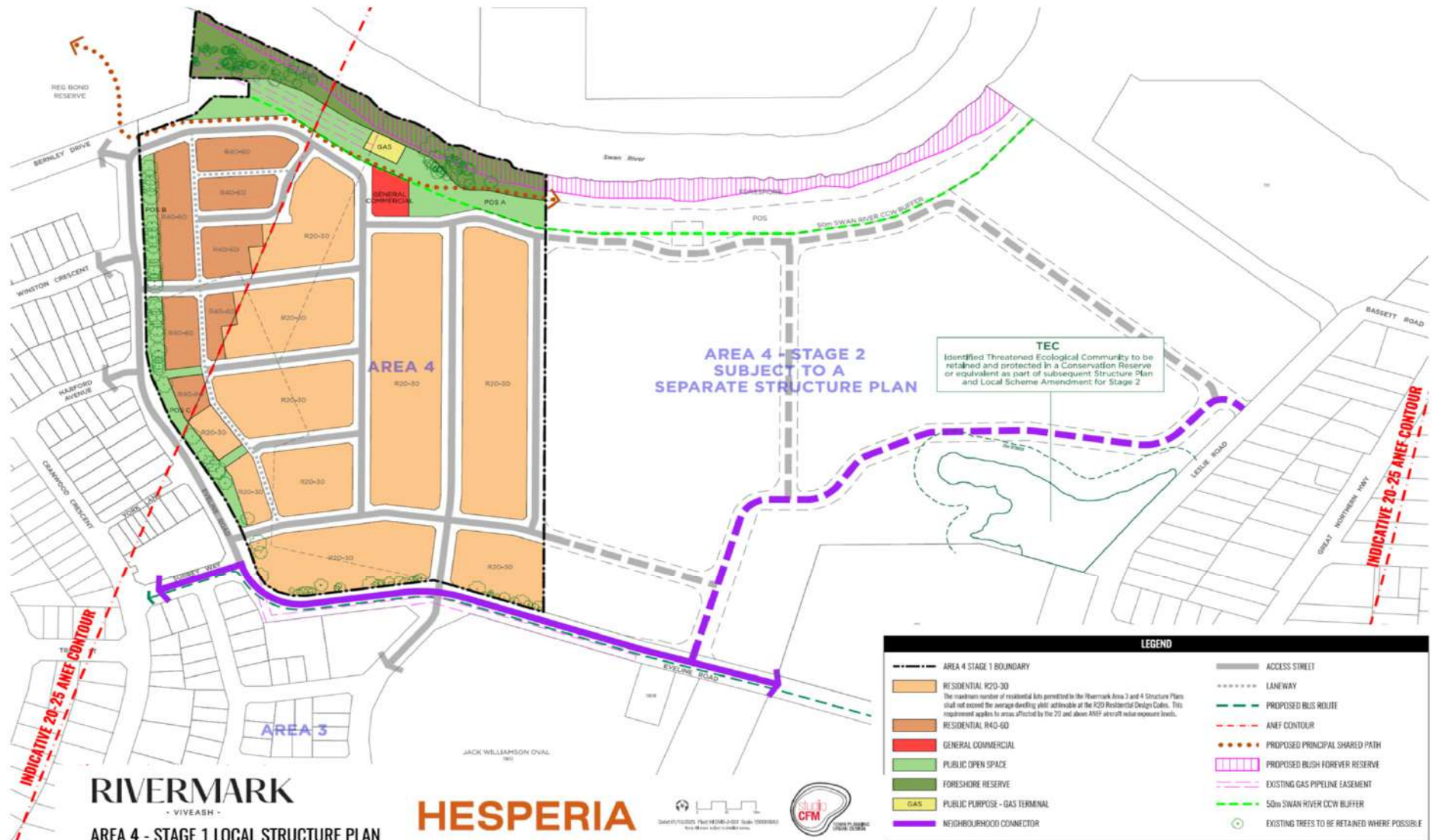
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FIGURES

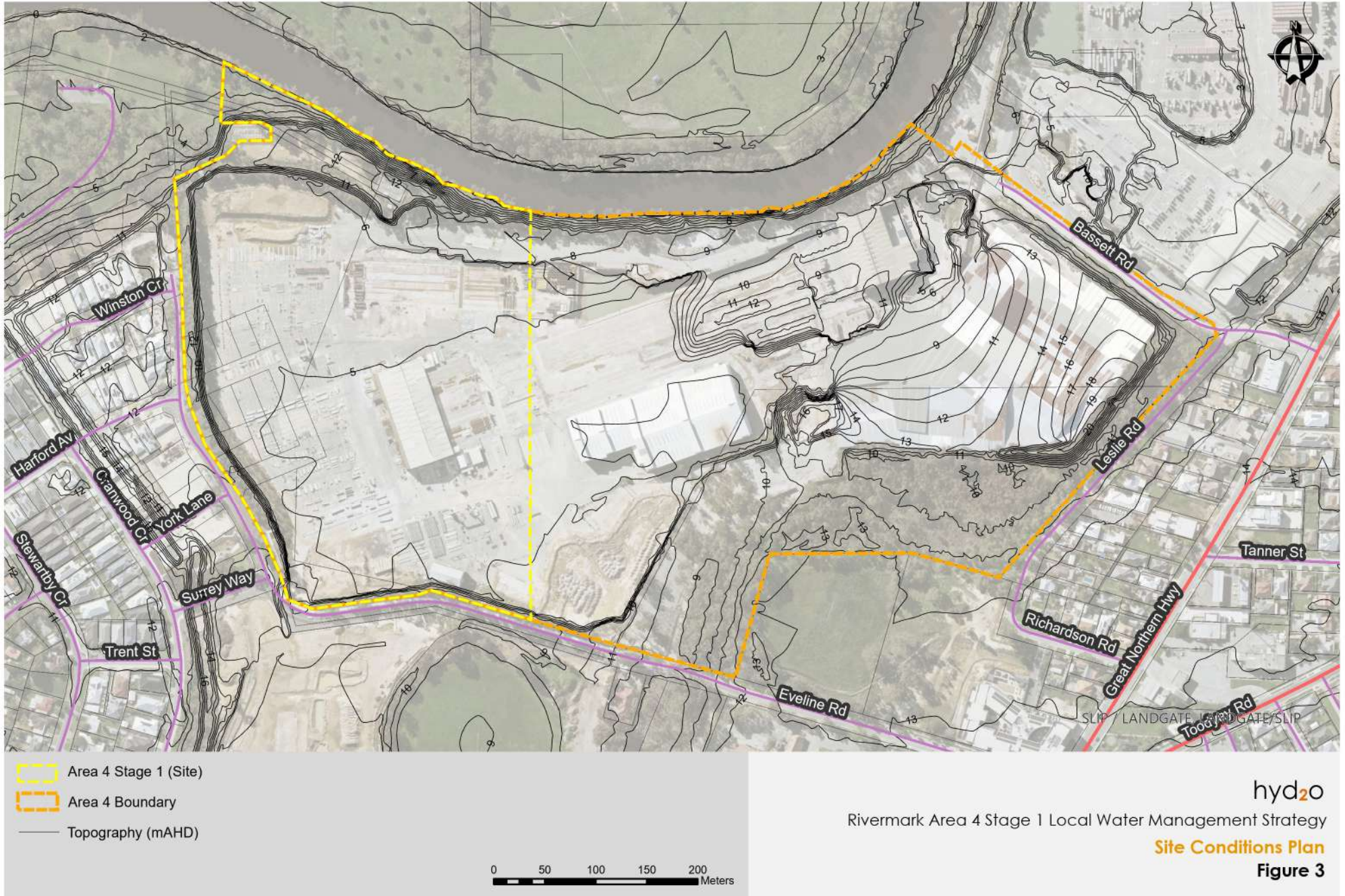


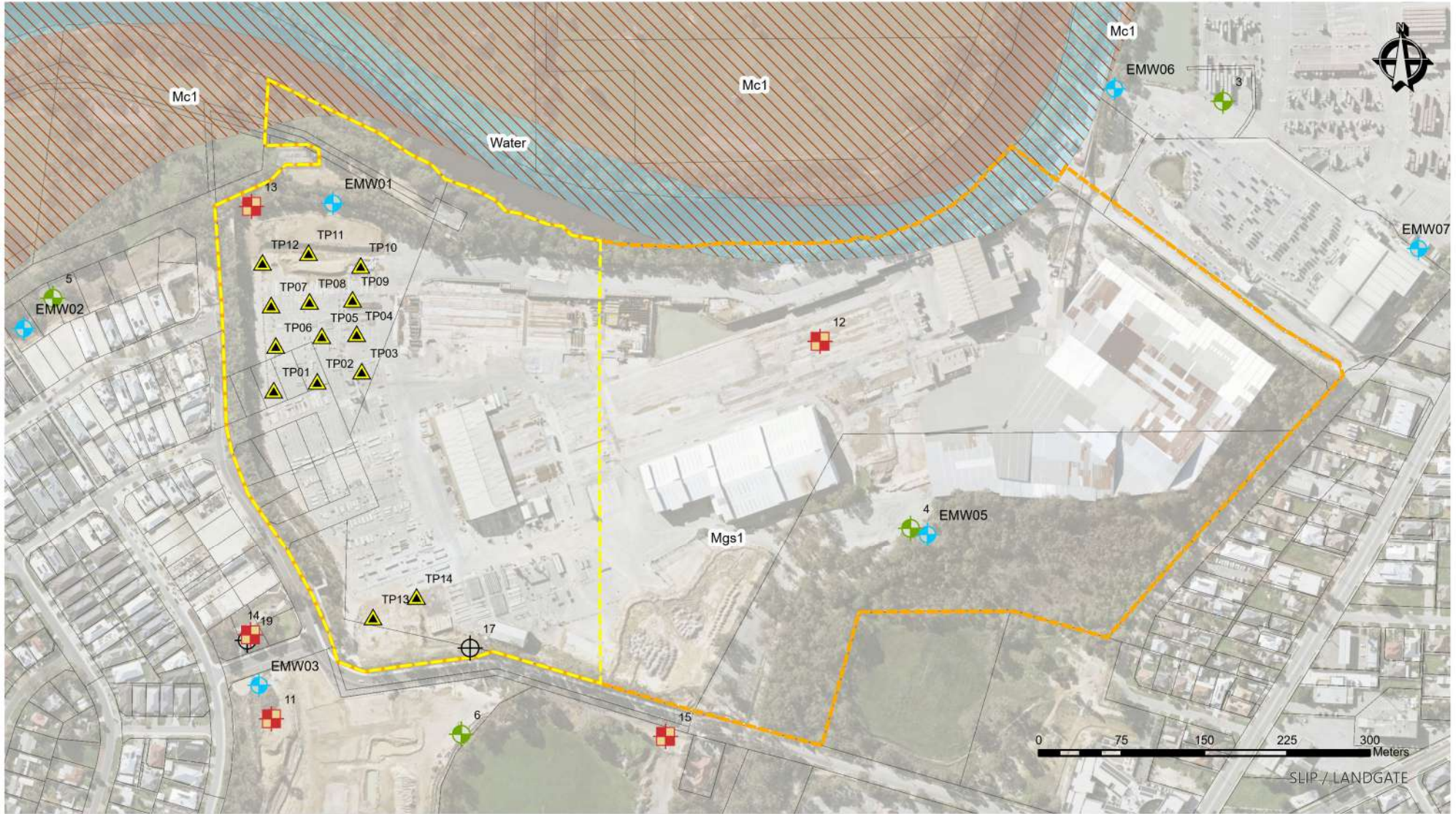
hyd₂o
Rivermark Area 4 Stage 1 Local Water Management Strategy
Location Plan
Figure 1

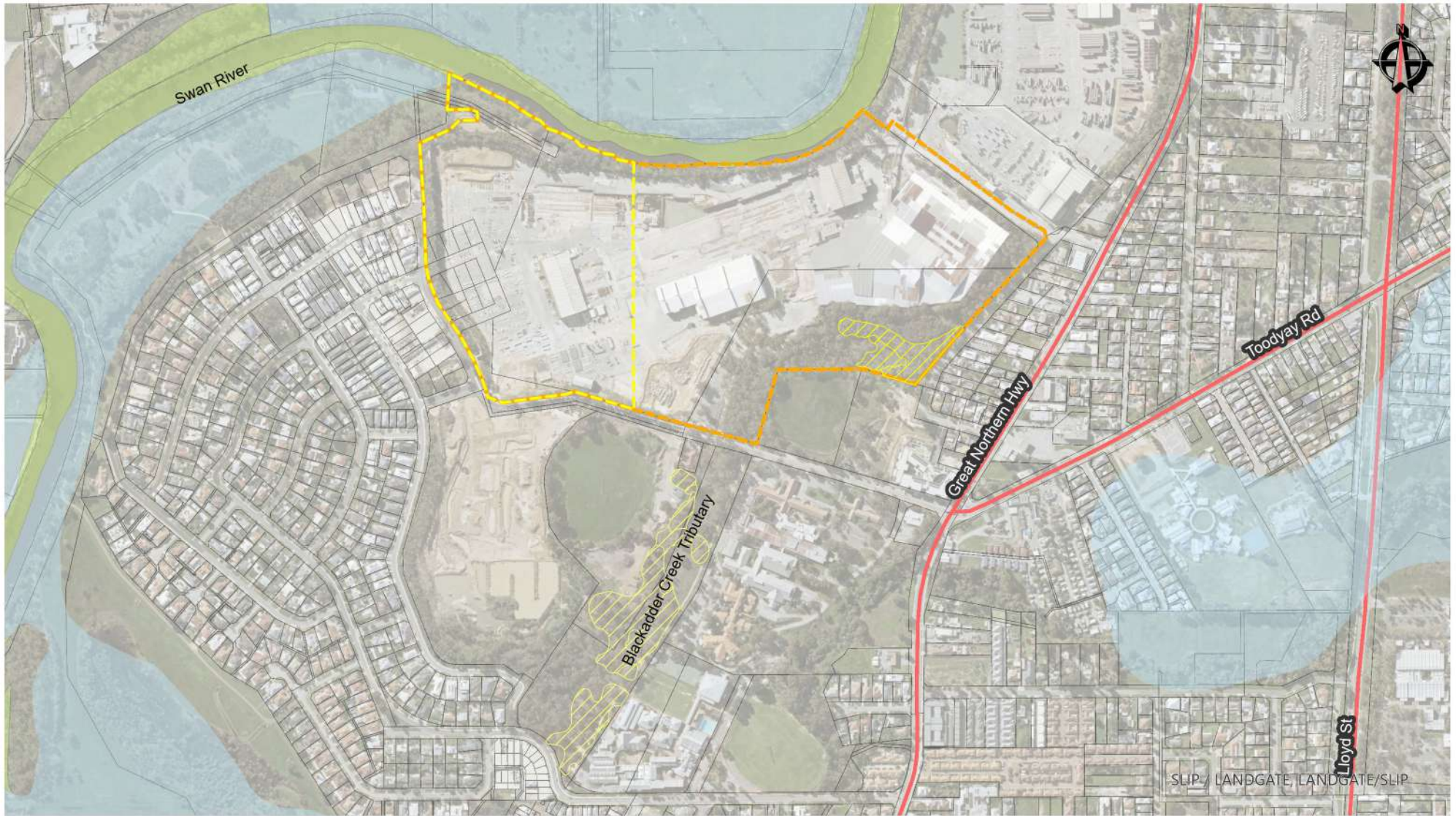


Source: Studio CFM (2025)

hyd₂o
Rivermark Area 4 Stage 1 Local Water Management Strategy
Local Structure Plan
Figure 2







Area 4 Stage 1 (Site)

Area 4 Boundary

SCP Wetlands

Conservation

Multiple Use



Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands,
Swan Coastal Plain TEC

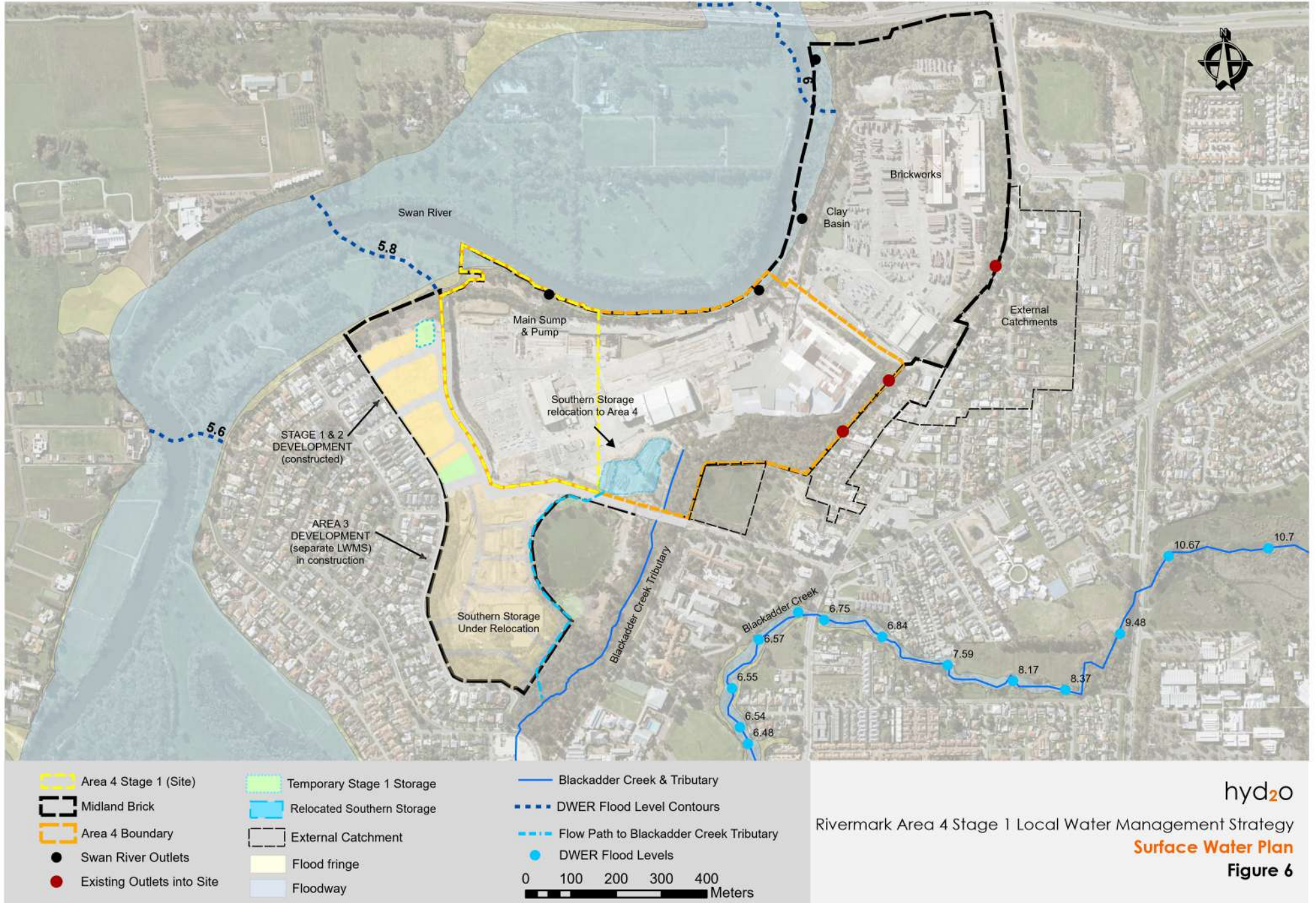
0 80 160 240 320 Meters

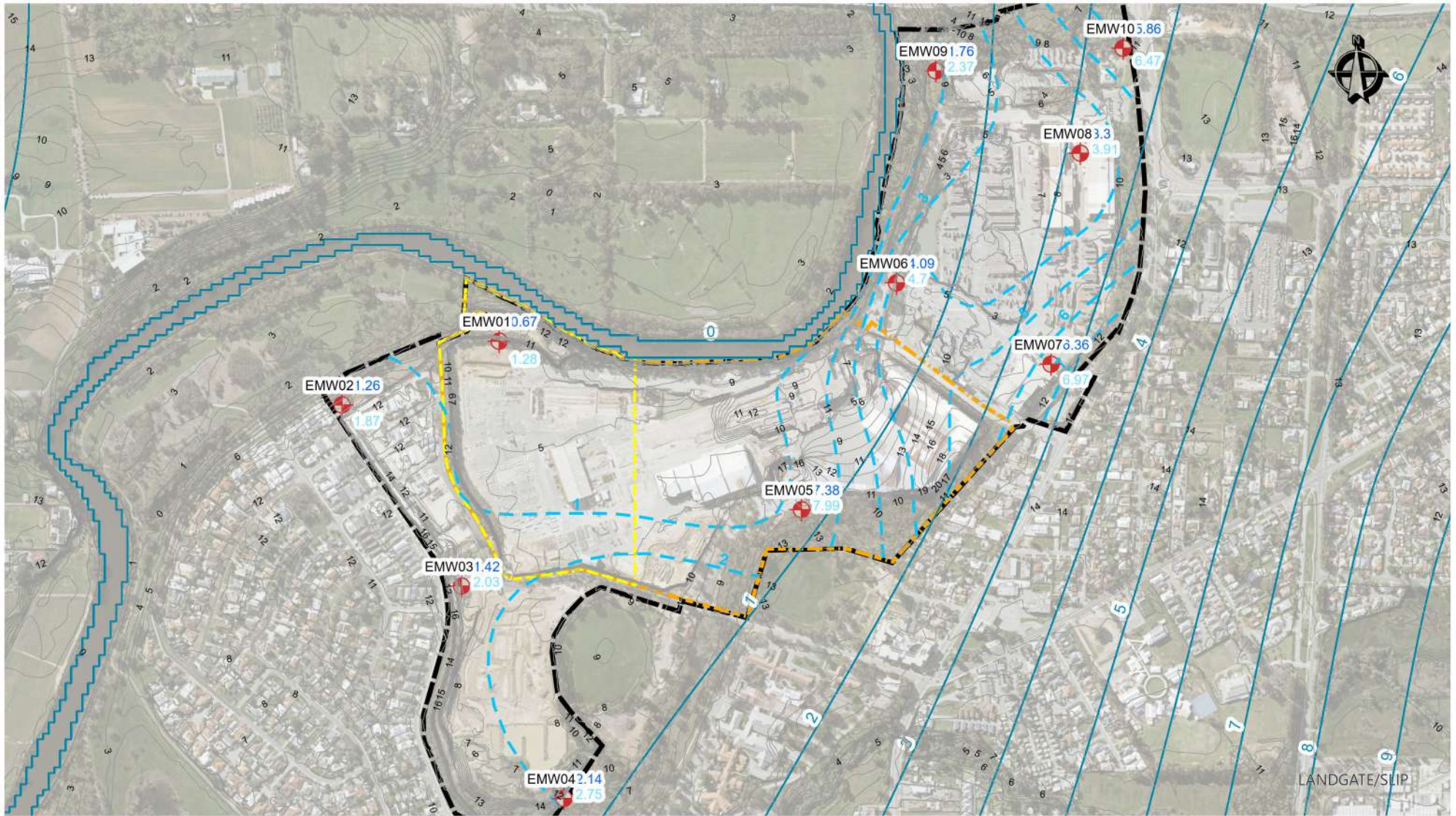
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Rivermark Area 4 Stage 1 Local Water Management Strategy

Environmental Plan

Figure 5





Groundwater Bores



Area 4 Stage 1 (Site)
Area 4 Boundary

AAMGL Contour (mAHd)

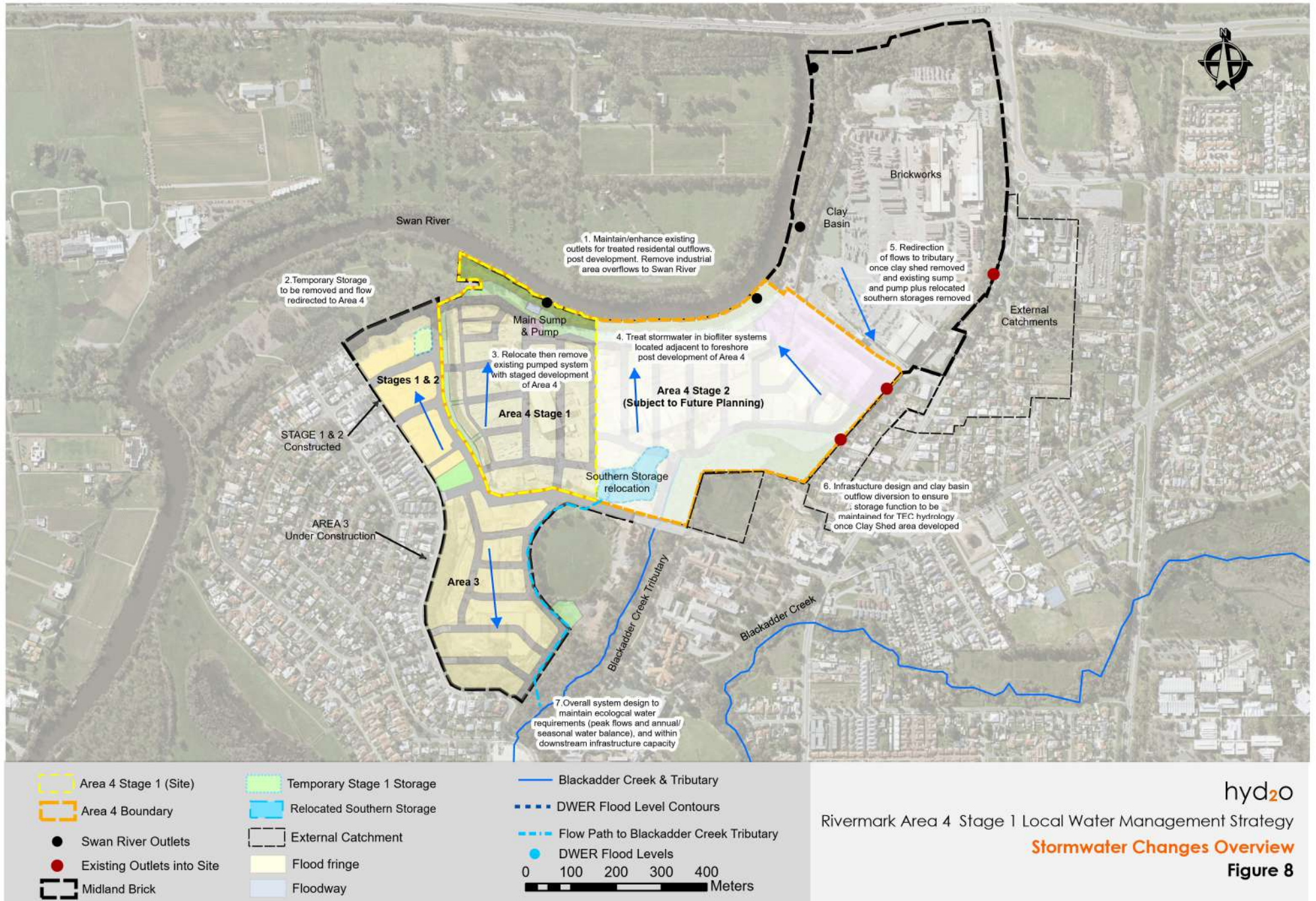
DWER Groundwater Contours Maximum 2019 (mAHd)

0 100 200 300 400 Meters

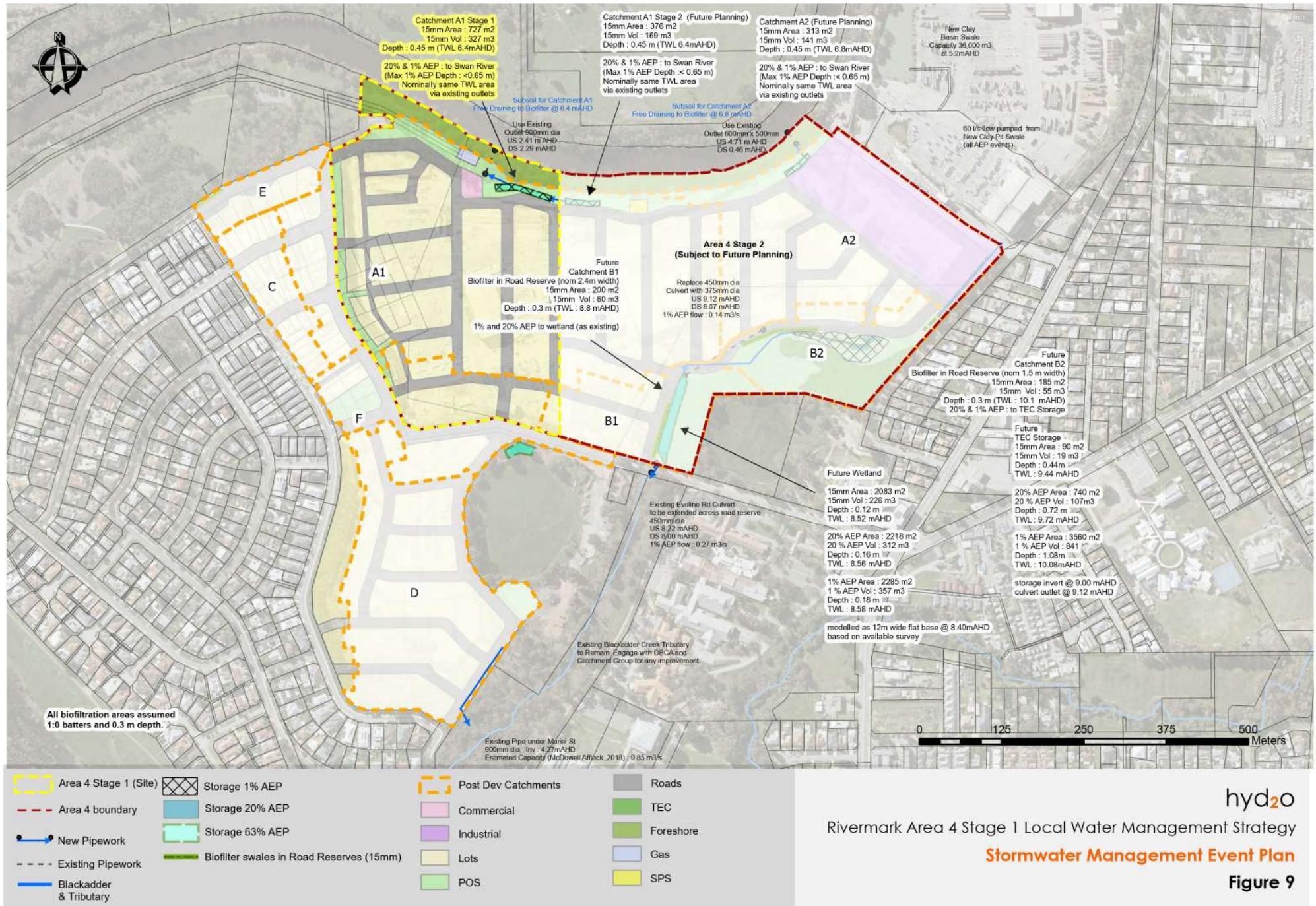
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Rivermark Area 4 Stage 1 Local Water Management Strategy

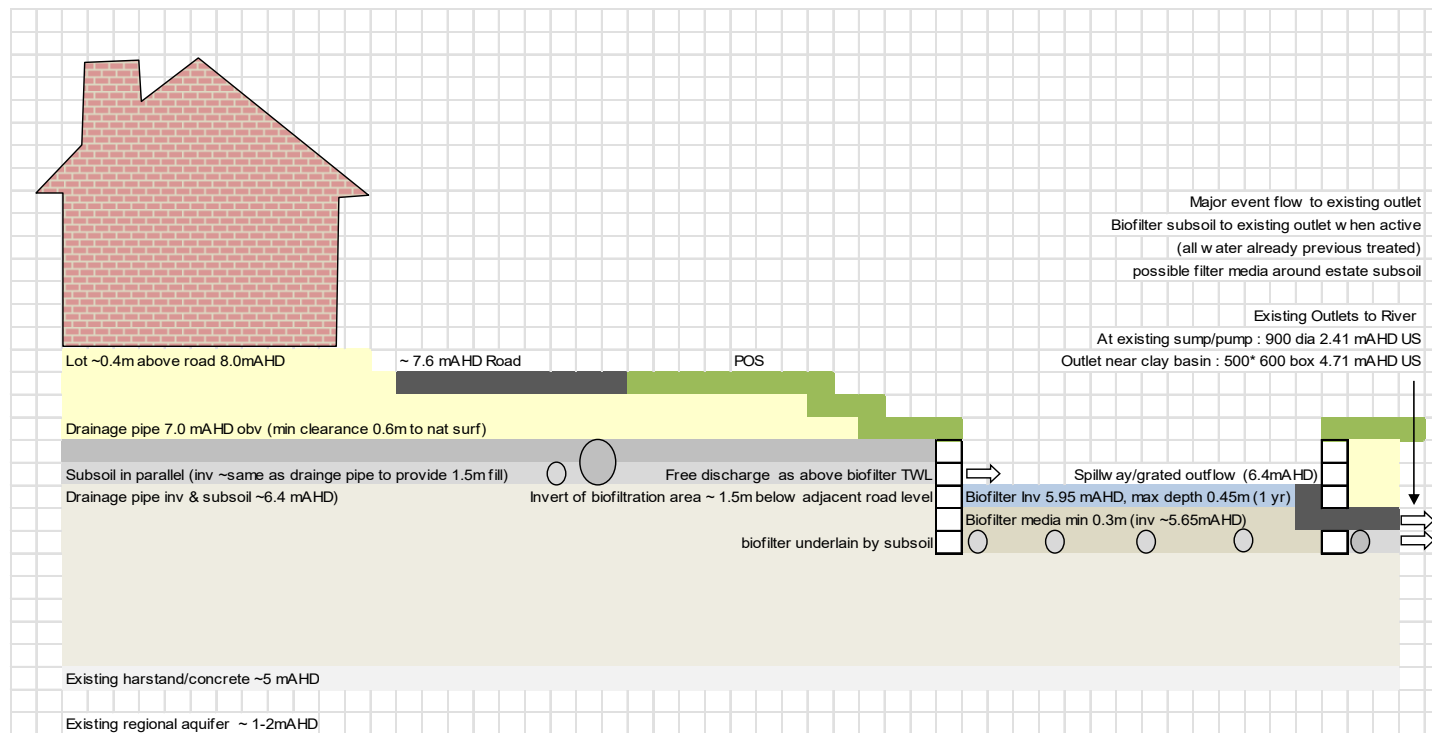
Groundwater Plan

Figure 7



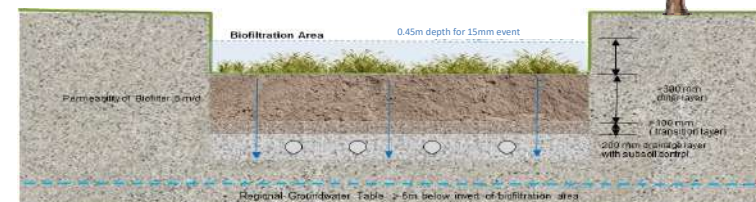
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Rivermark Area 4 Stage 1 Local Water Management Strategy
Stormwater Changes Overview
Figure 8



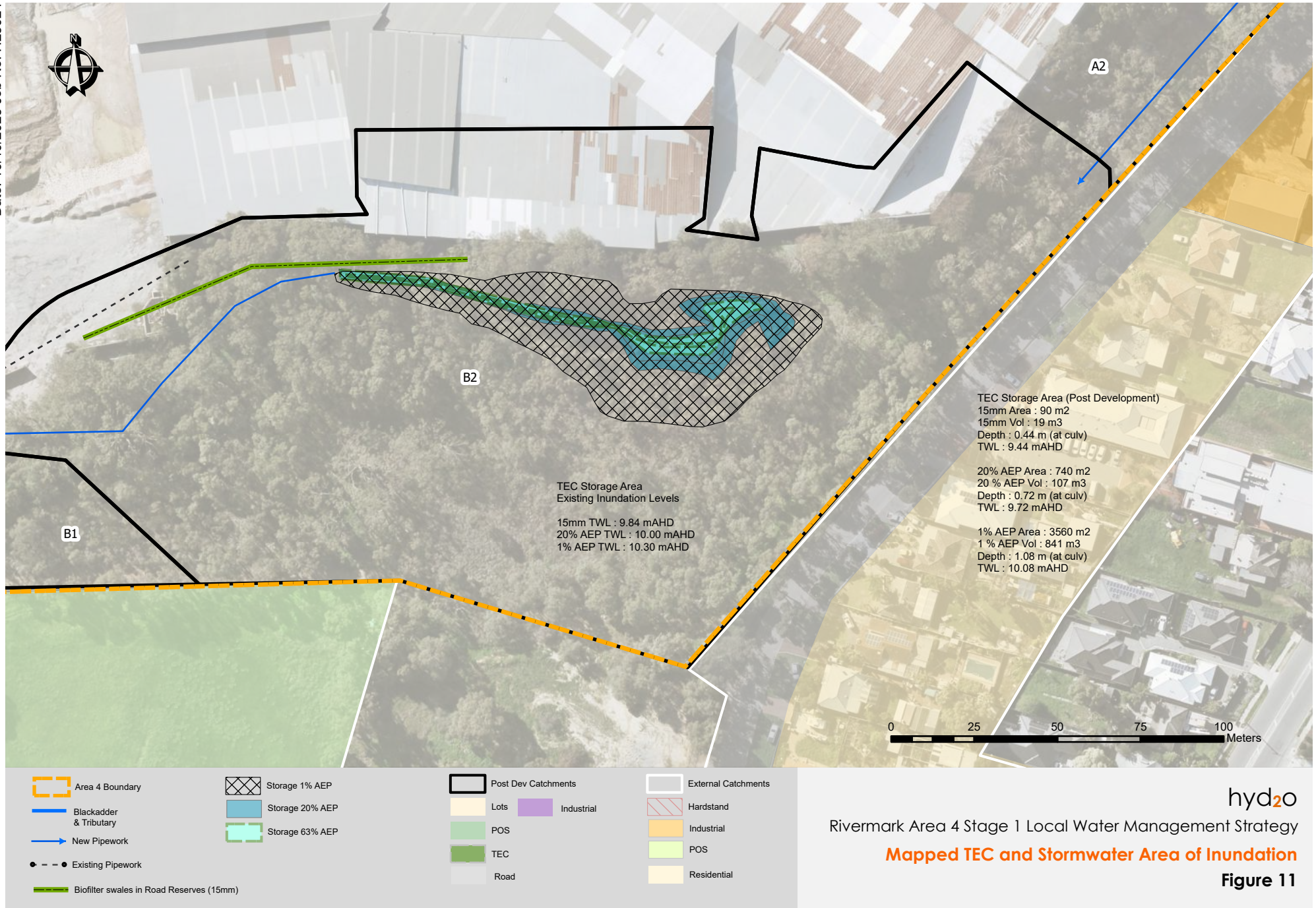


Foreshore POS Level Detail (Western Biofiltration Area)
(indicative levels only subject to detail design)

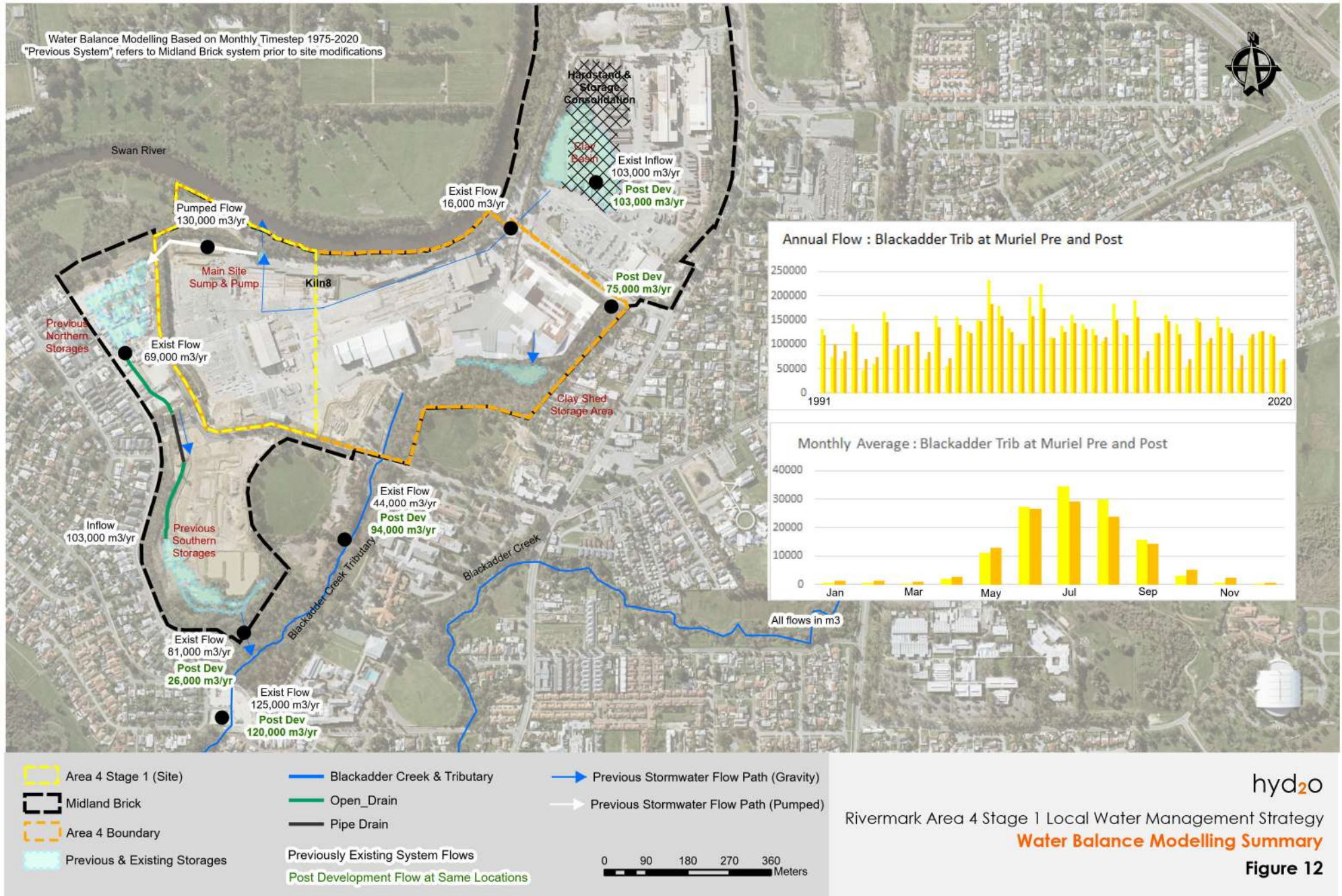
Biofiltration Detail



Not to Scale



hyd2o
 Rivermark Area 4 Stage 1 Local Water Management Strategy
Mapped TEC and Stormwater Area of Inundation
Figure 11





- Midland Brick
- Area 4 Boundary
- Area 4 Stage 1 (Site)
- Groundwater Bores
- Surface Water Sites
- Stormwater Sites
- Blackadder Creek & Tributary

0 125 250 375 500 Meters

hyd2o
Rivermark Area 4 Stage 1 Local Water Management Strategy
Post Development Monitoring
Figure 13

APPENDIX A

Better Urban Water Management Checklist

Better Urban Water Management LWMS Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: design elements and requirements for BMP's and critical control points	☒	Executive Summary
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☒	Chapter 1, Figure 1
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site Context Plan Structure Plan	☒	Section 1.1, Section 2, Figure 2
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☒	Section 5.2, Appendix I
Design criteria			
Agreed design objective and source of objective		☒	Section 4, Table 9
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☒	Section 3, Figures 3-7
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site Condition plan	☒	Section 3.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☒	Section 3.2, Figure 4, Appendix B
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☒	Sections 3.3 & 3.4, Figures 5
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☒	Section 3.5, Figures 6, Appendix C-D
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☒	Section 3.6, Figure 7, Appendices E-G
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☒	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☒	Section 5.2
Wastewater management		☒	Section 5.3
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan Long section of critical points	☒	Section 6.1, Table 10, Figures 8 & 9, Appendix J-L
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☒	Section 6.1, Table 10, Figures 8 & 9, Appendix J-L
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan Typical cross sections	☒	Section 6.1 - 6.4 Tables 10 & 11, Figures 8 - 12

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil plan	☒	Section 7.1 & 7.2, Figure 10, Appendix N
Actions to address acid sulphate soils or contamination		☒	Section 7.3
The next stage - subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design		☒	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☒	Section 9, Figure 13, Table 12 & 13
Implementation			
Developer commitments		☒	Section 10, Table 14
Roles, responsibilities, funding for implementation		☒	Section 10, Table 14
Review		☒	Section 10, Table 14

APPENDIX B

Geotechnical Report



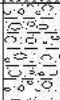
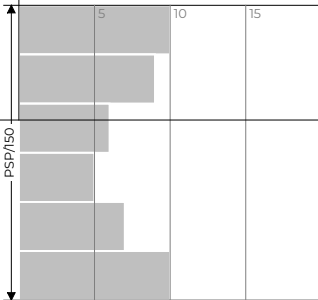
	Test Location Plan Rivermark - Fill Area H4 Viveash, WA	PROJECT: 96584.12 Drawing No: 2 REV: 0
	CLIENT: Capitary No.2 Pty Ltd	DATE: 21/11/2024

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.3 AHD
COORDINATE: E:405549.5, N:6473377.5
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP701
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS					
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)		DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS								
18/11/24 No free groundwater observed.	5	0.04	ASPHALT: black, 10 mm sized nominal aggregate.		FILL			VD	M to D				1										
		0.80	Clayey Sandy GRAVEL (GC): brown; fine to coarse; low plasticity clay; fine to medium sand; possibly fill. Guildford Formation.																	ALV		D	M
		1.10	SAND (SP-SM), with silt: yellow-brown and grey-brown; fine to coarse. Guildford Formation.																	ALV			
Test Pit discontinued at 1.70m depth. (Target depth).																							

NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.1 AHD
COORDINATE: E:405588.8, N:6473385.1
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP702
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ⁽¹⁾ DENSITY. ⁽²⁾	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
18/11/24 No free groundwater observed.	5	0.06	ASPHALT: black, 10 mm sized nominal aggregate.		FILL	VD	M to D				1	PSP150	
	0.30	FILL / Sandy GRAVEL (GP-GM), with silt: yellow-brown; fine to coarse; fine to medium sand; BASECOURSE.	FILL										
	0.70	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of fragments of bricks, trace whole pieces of brick.	FILL										
	0.95	Silty SAND (SM): yellow-brown; fine to medium; low plasticity silt. Guildford Formation.	ALV	MD	M								
		Clayey SAND (SC): yellow-brown mottled grey and red-brown; fine to medium; low plasticity clay. Guildford Formation.	ALV	VSt to H									
			Test Pit discontinued at 1.40m depth. (Target depth).										Refusal 30
		2											
		3											



NOTES: ⁽¹⁾ Soil origin is "probable" unless otherwise stated. ⁽²⁾ Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.3 AHD
COORDINATE: E:405629.3, N:6473393.4
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP703
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS						
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)	DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS										
18/11/24 No free groundwater observed.	5	0.04	ASPHALT: black, 10 mm sized nominal aggregate.		FILL	VD		D to M				1	PP	PSP/5q	5 10 15 Refusal 30									
		0.45	FILL / Sandy GRAVEL (GP-GM), with silt: yellow-brown; fine to coarse; fine to medium sand; BASECOURSE.																					
		0.80	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of whole pieces of brick, with fragments of bricks, plastic wraps observed in fill..		FILL	VD		D to M																
		1.10	Silty SAND (SM): yellow-brown; fine to medium; low plasticity silt. Guildford Formation.																					
		1.10	Clayey SAND (SC): brown mottled grey; fine to medium; low plasticity clay. Guildford Formation.		ALV	VSt		M																
Test Pit discontinued at 1.40m depth. (Target depth).																								
	4																							
	2																							
	3																							



NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

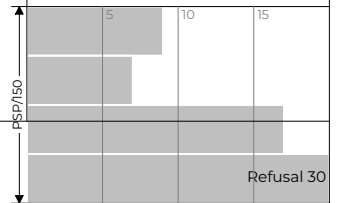
TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.5 AHD
COORDINATE: E:405623.1, N:6473426.7
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP704
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED						SAMPLE			TESTING AND REMARKS				
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*) DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
18/11/24 No free groundwater observed.		0.05	ASPHALT: black, 10 mm sized nominal aggregate.		FILL	VD	M to D				1		
		0.50	FILL / Sandy GRAVEL (GP-GM), with silt: brown; fine to coarse; fine to medium sand; BASECOURSE.										
		1.00	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of whole pieces of brick, scrap metal observed in fill.	ALV	D to VD	M							
		1.60	Silty SAND (SM): brown and yellow-brown; fine to medium; low plasticity silt. Guildford Formation.										
		1.60	Test Pit discontinued at 1.60m depth. (Target depth).										
		2.00											
		3.00											



NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator
METHOD: 450 mm wide toothed bucket test pit
REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

OPERATOR: Urban Resources (Sam) **LOGGED:** GG

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.5 AHD
COORDINATE: E:405594.1, N:6473425.2
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP705
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS	
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)	DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS					
18/11/24 No free groundwater observed.		0.06	ASPHALT: black, 10 mm sized nominal aggregate.		FILL	VD		M to D				1							
		0.25	FILL / Sandy GRAVEL (GP-GM), with silt: brown; fine to coarse; fine to medium sand; BASECOURSE.		FILL														
		0.85	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of whole pieces of brick, with fragments of brick, trace cobbles.		FILL														
	1	Silty SAND (SM), trace gravel: brown mottled pale grey; fine to medium; low plasticity silt. Guildford Formation.	ALV		M														
Test Pit discontinued at 1.40m depth. (Target depth).																			
	4																		
	2																		
	3																		



NOTES: ^(*)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.



NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator
METHOD: 450 mm wide toothed bucket test pit
REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

OPERATOR: Urban Resources (Sam) **LOGGED:** GG

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.4 AHD
COORDINATE: E:405550.7, N:6473417.5
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP706
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)		DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS						
18/11/24 No free groundwater observed.		0.04	ASPHALT: black, 10 mm sized nominal aggregate.		FILL			VD	D to M		sand fraction	D	0.50		PSP/5q						
		0.23	FILL / Sandy GRAVEL (GP-GM), with silt: pale grey; fine to coarse; fine to medium sand; gravel is crushed limestone, BASECOURSE.		FILL																
			FILL / Sandy GRAVEL (GP-GM), with silt, trace cobbles: dark grey; fine to coarse; fine to medium sand.		FILL																
		1.30	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of fragments of brick.		FILL																
	4	1.50	Clayey SAND (SC): grey-brown mottled brown and yellow-brown; fine to medium; low plasticity clay. Guildford Formation.		ALV	H		M						PP	600kPa						
		2	Test Pit discontinued at 1.90m depth. (Target depth).																		
		3																			



NOTES: #Soil origin is "probable" unless otherwise stated. %Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.2 AHD
COORDINATE: E:405548.5, N:6473452.8
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP707
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED													SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*) DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS							
18/11/24 No free groundwater observed.	5	0.07	ASPHALT: black, 10 mm sized nominal aggregate.		FILL	VD	M to D				1	PSP/ISq	5 10 15 Refusal 30							
		0.30	FILL / Sandy GRAVEL (GP-GM), with silt: brown; fine to coarse; fine to medium sand; BASECOURSE.																	
		1	FILL / Sandy BRICK (GP-GM), with silt: pale red-brown; fine to medium sand; mainly consists of fragments of brick, scrap metal, a piece of cloth observed in fill.	FILL																
4	1.50	Clayey SAND (SC): grey mottled brown; fine to medium; low plasticity clay. Guildford Formation.		ALV	H	M						PP	450kPa							
3	Test Pit discontinued at 2.00m depth. (Target depth).																			



NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.3 AHD
COORDINATE: E:405581.8, N:6473455.8
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP708
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

[illegible]

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(†)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.1 AHD
COORDINATE: E:405619.8, N:6473457.4
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP709
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)		DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS						
18/11/24 No free groundwater observed.	5	0.05	ASPHALT: black, 10 mm sized nominal aggregate.																		
		0.40	FILL / Sandy GRAVEL (GP-GM), with silt: grey and brown; fine to coarse; fine to medium sand; BASECOURSE.		FILL		VD		M to D						PSP/sq		5	10	15	Refusal 30	
		0.75	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of fragments of brick, with whole pieces of brick, trace cobbles.		FILL																
		1	Clayey Silty SAND (SC-SM): brown and grey-brown; fine to medium; low plasticity clay; low plasticity silt. Guildford Formation.		ALV		H		M					1	PP	600kPa					
Test Pit discontinued at 1.45m depth. (Target depth).																					
		2																			
		3																			



NOTES: ^(*)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.3 AHD
COORDINATE: E:405630.3, N:6473487.5
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP710
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED													SAMPLE				TESTING AND REMARKS									
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ⁽¹⁾ DENSITY. ⁽²⁾	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS													
18/11/24 No free groundwater observed.	5	0.05	ASPHALT: black, 10 mm sized nominal aggregate.		FILL	VD	M to D																			
		0.40	FILL / Sandy GRAVEL (GP-GM), with silt: red-brown; fine to coarse; fine to medium sand; BASECOURSE.														FILL									
		0.65	FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of fragments of brick, trace cobbles.	FILL	D to VD	M																				
		0.90	Silty SAND (SM): brown; fine to medium; low plasticity silt. Guildford Formation.	ALV																						
		1.00	Silty Sandy GRAVEL (GM): red-brown; fine to coarse; low plasticity silt; fine to medium sand. Guildford Formation.	ALV																						
		4		Clayey Silty SAND (SC-SM): brown mottled grey; fine to medium; low plasticity clay; low plasticity silt. Guildford Formation.	ALV	D to VD	M																			
				Test Pit discontinued at 1.20m depth. (Target depth).																						
		3																								
2																										
1																										

PSP/150

5

10

15

22

Refusal 30

5	10	15	22
			Refusal 30



NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator
METHOD: 450 mm wide toothed bucket test pit
REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

OPERATOR: Urban Resources (Sam) **LOGGED:** GG

Refer to explanatory notes for symbol and abbreviation definitions



TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.2 AHD
COORDINATE: E:405581.3, N:6473501.1
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP711
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)		DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS						
18/11/24 No free groundwater observed.	5	0.10	FILL / Clayey Silty SAND (SC-SM): pale grey; fine to medium; low plasticity clay; low plasticity silt.		FILL			D to M					1								
		FILL																			
		FILL																			
		0.25	FILL / Sandy GRAVEL (GP-GM), with silt: brown; fine to coarse; fine to medium sand; BASECOURSE.																		
			FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of fragments of bricks, trace cobbles, plastic wrap observed in fill.		FILL																
		1.00	Clayey SAND (SC): grey mottled brown; fine to medium; low plasticity clay. Guildford Formation.		ALV			M													
	4		Test Pit discontinued at 1.50m depth. (Target depth).																		
		2																			
		3																			
																					

NOTES: ^(*)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.1 AHD
COORDINATE: E:405542.4, N:6473492.5
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP712
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE			TESTING AND REMARKS		
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*) DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS						
18/11/24 No free groundwater observed.	5	0.05	ASPHALT: black, 10 mm sized nominal aggregate.		FILL								PSP/5q						
		0.24	FILL / Sandy GRAVEL (GP-GM), with silt: brown; fine to coarse; fine to medium sand; BASECOURSE.													5	10	15	Refusal 30
			FILL / Sandy BRICK (GP-GM), with silt: red-brown; fine to medium sand; mainly consists of brick fragments to 0.7 m depth, trace cobbles.		FILL		VD	M to D				1							
	4																		
		1.50	Clayey SAND (SC): grey mottled brown; fine to medium; low plasticity clay. Guildford Formation.		ALV	VSt													
		1.80	Silty SAND (SM): pale grey and brown; fine to medium; low plasticity silt. Guildford Formation.		ALV	(MD)	M												
	3	2																	
Test Pit discontinued at 2.25m depth. (Target depth).																			



NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 6.3 AHD
COORDINATE: E:405635.6, N:6473174.5
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP713
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

[illegible]

NOTES: ^(#) Soil origin is "probable" unless otherwise stated. ^(*) Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

TEST PIT LOG

CLIENT: Capitary No. 2 Pty Ltd
PROJECT: Proposed Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan, WA

SURFACE LEVEL: 5.0 AHD
COORDINATE: E:405674.2, N:6473191.2
DATUM/GRID: MGA2020 Zone 50
DIP/AZIMUTH: 90°/---°

LOCATION ID: TP714
PROJECT No: 96584.12
DATE: 18/11/24
SHEET: 1 of 1

CONDITIONS ENCOUNTERED														SAMPLE				TESTING AND REMARKS			
GROUNDWATER	RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. ^(*)		DENSITY. ^(*)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS						
14/11/24 No free groundwater observed.			FILL / Sandy GRAVEL (GP-GM), with silt: brown and grey-brown; fine to coarse; fine to medium sand.		FILL			VD	D to M						PSP/sq		5	10	15	Refusal 30	
		0.55	FILL / Sandy BRICK (GP-GM), with silt: pink-brown; fine to medium sand; mainly consists of fragments of brick to 0.7 m depth.		FILL																
		1.00	Clayey Silty SAND (SC): yellow-brown; fine to medium; low plasticity clay; low plasticity silt; strongly cemented. Guildford Formation.		ALV		H		M						PP	600kPa					
			Test Pit discontinued at 1.40m depth. (Target depth).																		

NOTES: #Soil origin is "probable" unless otherwise stated. °Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: 9 tonne excavator

OPERATOR: Urban Resources (Sam)

LOGGED: GG

METHOD: 450 mm wide toothed bucket test pit

REMARKS: Surface level surveyed using a differential GPS with a reported accuracy of +/- 0.1 m.

Refer to explanatory notes for symbol and abbreviation definitions



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation

Project Texas
102 Great Northern Highway, Middle Swan, WA

Prepared for
Linc Property Pty Ltd

Project 96584.01
June 2019

Integrated Practical Solutions





Douglas Partners

Geotechnics | Environment | Groundwater

Document History

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		26 JUNE 2019
Reviewer		26 June 2019



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Report on Geotechnical Investigation

Project Texas

102 Great Northern Highway, Middle Swan, WA

1. Introduction

This report presents the results of a geotechnical investigation undertaken for Project Texas at 102 Great Northern Highway, Middle Swan, WA. The investigation was commissioned on 20 June 2019 by Judd Dyer of Linc Property Pty Ltd and was undertaken in accordance with Douglas Partners' proposal PER190248 dated 11 June 2019.

It is understood that the proposed development comprises a residential subdivision development in the western part of the site and an industrial development in the eastern part. Preliminary site formation earthworks design includes cutting below existing surface levels in the western and central parts of the site and filling elsewhere. It is understood that finished levels are proposed to be achieved, following bulk earthworks, by placing approximately 1.2 m of clean granular fill over the existing soils underlying the site in the proposed residential development area (western part of the site) and 0.5 m of clean, granular fill in the industrial (eastern) part of the site.

A desktop study of the site has been previously undertaken by Douglas Partners and is presented in Douglas Partners report 96584.00.R.001.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide preliminary information on:

- the geotechnical suitability of the site for the proposed development;
- the thickness, consistency, strength and density of uncontrolled fill, including in the areas of former clay pits;
- site classification in accordance with AS 2870-2011 following recommended site preparation works;
- the suitability of the encountered existing fill to be left in place below the proposed development, and advice on ground improvement of existing uncontrolled fill if required;
- suitability of encountered uncontrolled fill for reuse as structural fill, and recommendations to improve unsuitable fill to make it suitable for reuse; and
- site preparation, earthworks and ground improvement requirements, if any, required to remediate the existing deep basin in the northern part of the site.

The investigation included the excavation of eleven test pits and the supervision of eight cone penetration tests. The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

2. Site Description

The site is approximately 82 ha in size. It is mostly developed as a brick manufacturing facility, with numerous large industrial buildings scattered across the site, and associated areas of hardstand for storage. There are undeveloped areas around the edges of the site, particularly the western and south western side. A bund of soil has been constructed around the western end of the site. A relatively large water body (approximately 250 m by 175 m maximum dimensions) occupies an inferred former clay pit in the northern part of the site. Most of the site is currently covered with hardstand pavement, apart from the undeveloped fringes which are vegetated.

It is understood that brick making operations have been present on the site since the late nineteenth century. Historical photographs indicate that clay quarrying has been undertaken on parts of the site, notably in the south eastern area and northern part of the site. As previously noted, one relatively deep excavation is partially filled with water in the northern part of the site but the other clay pits have been backfilled.

Douglas Partners has previously undertaken a desktop study of the site. The findings of the desktop study are presented in Douglas Partners report 96584.00.R.001.

3. Field Work Methods

Field work was carried out on 21 June 2019 and comprised:

- Eight cone penetration tests;
- Eleven test pits; and
- A dynamic cone penetrometer (DCP) test at each test pit location.

The cone penetration tests (test locations 1 to 8) were carried out using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 20 mm/sec into the soil by hydraulic thrust from a ballasted 12 tonne tracked rig. Strain gauges in the cone and sleeve measure resistance to penetration and this data allows assessment of the type and condition of the materials penetrated. The cone penetration tests were undertaken to depths of up to approximately 12.9 m, though several tests encountered refusal at shallower depth and three encountered refusal at depths of less than 1 m.

Test pits at test locations 9 to 16 were excavated using a 5 tonne excavator with a 450 mm wide toothed bucket to depths of up to 2.8 m. Several test pits encountered refusal at shallower depths due to slow digging. The pits in the side of the western bund (test locations 17 to 19) were excavated using the same excavator to a depth of 0.4 m and 0.5 m respectively.

Ground conditions were logged in general accordance with AS1726-2017 by a suitably experienced geotechnical engineer from Douglas Partners. Soil samples were recovered for subsequent geotechnical laboratory testing. Laboratory testing had not commenced at time of issue of this report due to timing constraints.

Dynamic cone penetrometer testing was carried out in accordance with AS 1289.6.3.2, adjacent to each test pit, to assess the in situ density of the shallow soils. The results of these penetrometer tests are presented on the test pit log sheets in Appendix B.

Test locations were determined with reference to existing site features, and are presented on Drawing 1 in Appendix A. Surface elevations at each test location were interpolated from publicly available LiDAR data.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing carried out on 21 June 2019 are presented in Appendix B, with notes defining descriptive terms and classification methods provided in Appendix A.

The encountered ground conditions at the test locations generally comprised uncontrolled fill, generally clayey although some granular fill was also encountered, overlying variable, though generally clayey, natural soils.

A summary of the general ground conditions encountered at the test locations is given below:

- **Clayey Fill (Sandy Clay, Clayey Sand, Gravelly Clay, Clayey Gravel, Clay, Bricks and Sand with Clay)** – generally stiff to hard, encountered at all test pit locations, generally forming most of the encountered fill depth. Loose silty or clayey gravel, inferred as possible fill, was encountered between depths of 1.5 m and 4.0 m at test location 7. Firm to very stiff clay fill was encountered to a depth of approximately 5.5 m at test location 6. The clayey fill generally contained brick fragments and/or bricks, and occasionally fragments of plastic, rubber, wood, wire, fabric, carpet and concrete.
- **Granular Fill (Sand, Gravelly Sand, Sandy Gravel)** – generally medium dense to very dense, granular fill, generally encountered from the surface to depths of less than 0.5 m. Granular fill (i.e. fill with no clay content) was encountered at test pit locations 11, 12, 13, 15, 16 and 17 and cone penetration locations 2 and 3. A granular fill layer was encountered at test location 13, underlying clayey fill from a depth of approximately 0.4 m to the termination depth of the test pit at 1.6 m. The fill generally contained brick fragments and/or unbroken bricks.

Inferred granular fill or disturbed ground was encountered to a depth of approximately 9.8 m at test location 3, with loose silty sand being encountered between depths of approximately 3.0 m and 8.0 m.

- **Natural Soils** – generally clayey soils from the Guildford Formation, including:
 - o **Clayey Sand** – hard / very dense orange-brown mottled red-brown and grey, fine to medium grained clayey sand, encountered underlying the fill from a depth of 0.75 m at test location 11. Sand with sand clay was encountered from the surface at test location 5.
 - o **Clay** – stiff to hard clay, encountered underlying the fill from a depth of approximately 0.75 m at test location 14 and cone penetration test locations 1, 3, and 6.

- o **Sand and Silty Sand** – generally medium dense to dense, orange-brown fine to medium grained sand, sometimes with clay, encountered underlying the clayey sand at test pit location 11 and cone penetration test location 5.

4.2 Groundwater

Free groundwater was not observed in test pit locations undertaken on 24 June 2019.

Groundwater was measured within some of the cone penetration test locations, as summarised in Table 1 below, and are indicated on the logs in Appendix B. Some of the cone penetration test holes collapsed prior to dipping for groundwater, precluding measurement of groundwater levels.

Table 1: Summary of Groundwater Observations

Test Location	Surface Level ^[1] (m AHD)	Groundwater Depth (m)	Groundwater Level (RL m AHD)
1	5.9	7.2	-1.3
3	5.8	2.9	2.9
5	9.2	9.1	0.1
6	9.2	8.0	1.2
7	8.3	9.9	1.6

Notes: [1]: Interpolated from publicly available LiDAR data

The Perth Groundwater Atlas (2004) indicates that the level of the regional superficial aquifer beneath the site was at approximately RL 2 m AHD in May 2003 in the north eastern corner of the site but generally below RL 1 m AHD, which is from approximately 3 m to more than 10 m below the estimated current surface elevation of the site. Desktop information and our general experience in the area indicates that perched groundwater may be present at higher elevations (see Douglas Partners report 96584.00.R.001).

It should be noted that groundwater levels are affected by climatic conditions and soil permeability, and will therefore vary with time.

5. Proposed Development

It is understood that the proposed development comprises a residential subdivision development in the western part of the site and an industrial development in the eastern part. Preliminary site formation earthworks design includes cutting below existing surface levels in the western and central parts of the site and filling elsewhere. It is understood that finished levels will be achieved, following bulk earthworks, by placing approximately 1.2 m of clean granular fill over the existing soils in the proposed residential development area (western part of the site) and 0.5 m of clean, granular fill in the industrial (eastern) part of the site.

6. Comments

6.1 Site Suitability

Results of the investigation indicate that the site is generally underlain by generally clayey fill overlying clayey natural soils. Granular fill and natural sand (with some clay content) are present in some locations.

The fill is generally stiff to hard, or medium dense to very dense. Loose inferred fill and disturbed ground was encountered to a depth of approximately 8 m at test location 3, adjacent to the existing large pit in the northern part of the site. Loose and firm soils, interpreted to be possible fill, were identified to depths of between 4 m and 5.5 m at test locations 6 and 7. The fill across the site generally contains brick fragments or bricks, and occasionally contains traces of other materials such as wood, fabric, wire, plastic, rubber and concrete.

It is considered that, from a geotechnical perspective, the site is considered suitable for the proposed redevelopment, as evidenced by existing facilities on the site. The following should be considered:

- The site is underlain by variable, uncontrolled fill of generally unknown thickness. Much of the fill is clayey in nature and commonly contains brick fragments and bricks. In current encountered condition, the fill appears to generally form a suitable foundation material without the requirement of full depth removal of the fill, although partial removal to a given depth to ensure a minimum thickness of engineered ground beneath proposed founding levels should be considered to reduce geotechnical risk, as discussed in Section 6.2. Removal, screening/crushing and replacement of the uncontrolled fill such that a layer of controlled fill with a thickness of at least 1.2 m below the proposed layer of imported sand is suggested at this stage of the study. Following removal of the 1.2 m layer of uncontrolled fill, the exposed surface should be heavily compacted by an impact roller or similar. Given the size of the site, the duration of industrial activity and the limited extent of current investigation, it is considered likely that some areas of unsuitable fill that do not form a suitable foundation layer and require removal, deep ground improvement or soil reinforcement may be encountered.
- The site classification of the site in accordance with AS 2870-2011 in existing condition is considered to be "Class P" due to presence of uncontrolled filling. The site classification of the natural clayey soils underlying the site is indicated to be "Class M" by previous investigations and corroborates Douglas Partners' general experience in the Midland area. Laboratory testing on the clayey fill to further define site classification was outside the scope of this report owing to timing requirements. The following equivalent site classifications are considered likely appropriate following proposed earthworks:
 - o An equivalent site classification of "Class S" is considered to be likely suitable for the residential development in the western part of the site, following placement of 1.2 m of imported clean, granular fill as described in Section 5 and suitable preparation of the existing soils.
 - o An equivalent site classification of either "Class S" or "Class M" is considered to be likely suitable for the industrial development in the eastern part of the site, following placement of 0.5 m of imported clean, granular fill as described in Section 5 and suitable preparation of existing soils. Increasing the proposed thickness of granular fill to at least, say, 0.8 m would reduce the risk of areas of the site being "Class M" in finished condition. Additionally, AS2870-2011 requires placement of at least 0.8 m of

non-reactive, structural fill to change the site classification from that applying to the previous condition.

- o To achieve a site classification of “Class A”, all of the existing fill would need to be removed and replaced by at least 1.8 m of compacted granular fill.
- It is considered that the encountered fill, including the fill in the bund around the western part of the site, could generally be reused as fill elsewhere on the site. Given the abundance of bricks and brick fragments, fill excavated from within the site should be fed through a crusher, or screened and the oversized particles crushed, to reduce the size of the bricks and brick fragments (and over oversized particles such as concrete, to be less than 50 mm in size. However, as discussed above, the presence of unsuitable fill material in some locations may be anticipated and close supervision and testing of fill material excavated on the site will be necessary prior to its reuse elsewhere within the development.
- Remediation of the existing basin in the northern part of the site may require dewatering, removal of soft deposits from within the inundated area, excavation of loose fill and over-steepened slopes (if present) around the basin, and backfilling in a controlled, engineered manner. It is recommended that clayey fill is used to backfill the basin to create ground conditions similar to the natural ground and avoid creation of a ‘swimming pool’ effect.
- Desktop information (see Douglas Partners report 96584.00.R.001) indicates that shallow groundwater may be present in some western areas of the site, particularly adjacent to the Swan River, and perched groundwater is anticipated to form, at least during the wet months of the year, on the surface of clayey soils (i.e. Guildford Formation and some of the uncontrolled fill).

6.2 Suitability of the Existing Fill to be Left in Place

The encountered existing fill was generally clayey in nature, with granular fill present in some locations, generally as a thick surface layer. The encountered fill was generally in a stiff to hard, or medium denser or denser condition at the test locations.

Based on the encountered fill, and the current land use of the site as an active industrial development, it is considered that some ground improvement provisions are required to ensure that a minimum thickness of controlled soils exists beneath founding levels.

The degree of ground improvement provisions will be proportionate to the level of project risk considered acceptable for the proposed structures. The following alternative scenarios may be considered to address geotechnical risks:

- To fully mitigate the geotechnical risk associated with the existing uncontrolled fill, undertake full depth excavation, screening/crushing and replacement of the uncontrolled fill;
or alternatively, with potentially some residual risk;
- Partial excavation and reinstatement of the uncontrolled fill to form a controlled, engineer foundation layer, as follows:
 - o Excavation of the uncontrolled fill to a depth of 1.2 m. The suggested depth can possibly be adjusted (say to 1.0 m) depending on detailed investigation results and compaction details;
 - o Heavy compaction of the uncontrolled fill left in place using an impact roller or possibly heavy (18 tonne) roller (compaction details subject to findings of detailed investigation and may differ across the site depending on uncontrolled fill thickness);
 - o Treatment of the excavated controlled fill by screening and crushing as described in Section 6.4; and
 - o Replacement of the excavated uncontrolled fill in an engineering manner.

The above methodology for partial excavation of the uncontrolled fill is considered a reasonable level of mitigation to address most of the geotechnical risks associated with the uncontrolled fill material. The proposed compacted sand layer could then be constructed above the improved uncontrolled fill platform. It is possible that soil reinforcement (e.g. geogrids) may be required within the foundation layer to reduce differential settlements in areas of poor filling, where encountered, if this approach is adopted.

Notwithstanding the above, given the large size of the site, the duration of industrial developments within the site and the limited scope of investigations undertaken at this stage, it may be anticipated that areas of unsuitable fill may be encountered during redevelopment of the site. Areas of the site requiring full depth fill replacement, deep ground improvement or exclusion from development of the site cannot be precluded at this stage of the study. Detailed investigations should be undertaken during design development to address this matter. Earthworks should be supervised during construction, particularly exposures of fill, so that unsuitable material, if present, can be identified and removed.

6.3 Site Classification

The site is generally underlain by generally clayey, with some sandy, uncontrolled fill to various, and generally unknown, depths.

The site classification of the site in its current condition is “Class P” in accordance AS2870-2011 because of the presence of uncontrolled fill.

The encountered fill was generally in a medium dense or denser or stiff to hard condition, except at test location 3, located adjacent to the existing flooded excavation (see Section 6.5 for a discussion of this area).

It is understood that it is proposed to place a layer of compacted, granular fill over the site to achieve finished levels. The proposed thickness of the granular fill layer is understood to be approximately 1.2 m for the proposed residential development in the western part of the site and 0.5 m for the industrial eastern part of the site.

At this stage, soil reactivity testing has not been undertaken on samples of existing clayey uncontrolled fill.

However, based on Douglas Partners experience, it is anticipated that an equivalent site classification of “Class S” will likely apply to most of the proposed residential area, following placement of a 1.2 m thick layer of compacted, non-reactive, granular fill and following some provisions regarding site preparation as discussed in previous sections to ensure a minimum thickness of controlled founding materials beneath proposed founding levels.

In the proposed industrial area, where a reduced thickness of 0.5 m of compacted granular fill is proposed, a site classification of either “Class S” or Class M” may apply the zones within the area, depending on the reactivity of the existing uncontrolled fill and following site preparation as discussed in previous sections. Increasing the thickness of the proposed fill layer to, say, 0.8 m would reduce the risk of a “Class M” site in finished condition. It should be noted that, in strict accordance to AS-2870-2011, a controlled fill layer thickness of at least 0.8 m is required to change the site classification from the existing condition prior to filling.

Existing information suggests that the natural clayey soils underlying the site may have a site classification of “Class M”. Therefore, if required, a site classification of “Class M” should be assumed for footings founded in natural clayey soils.

In order to achieve a site classification of “Class A”, which assumes no surface movement, it would be necessary to remove the full depth of uncontrolled fill and replace with a layer of controlled, non-reactive granular at least 1.8 m thick. Although the encountered existing fill is generally stiff to hard, the potential variability in the fill material and the possibility of creep within the fill material precludes the application of a site classification of “Class A” unless the uncontrolled fill is removed.

Loose sandy soils were encountered at test locations 3 and 7. The density of loose sand underlying the site would need to be increased to medium dense or denser to achieve the site classifications given above.

It should be noted that AS 2870-2011 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. It also applies to light industrial and commercial buildings if they are similar in size, loading and superstructure flexibility to those designs included in AS 2870-2011.

6.4 Geotechnical Suitability for Re-Use of Uncontrolled Fill

The encountered uncontrolled fill was generally clayey in nature, though granular fill was encountered in some locations, mostly as a thin surface layer. Two pits excavated into the bund located around the western end of the site also encountered clayey fill.

Occurrence of brick fragments and bricks within the fill was frequent. A trace of other materials, such as rubber, wood, fabric, wire and carpet was encountered at some locations.

It is considered that existing fill excavated from the site could be generally suitable for reuse as fill below the proposed surface layer of granular, non-reactive fill, provided that the material is put through a crusher to reduce oversized particles such as bricks and concrete to be less than 50 mm in size, or screened if the soil is suitable for screening. Following screening, oversized fragments such as bricks and concrete could be crushed and remixed with the fill material.

Notwithstanding the above, as discussed in Section 6.2, it is possible that fill that is not suitable for reuse will be encountered. Close supervision and frequent testing of fill material excavated from the site will be required prior to reuse as fill elsewhere on the site.

It should be noted that this geotechnical study does not assess whether unacceptable levels of contaminants (including asbestos) exist within the fill material as this was outside the scope of the geotechnical investigation. Such levels, if they occur, may limit or prevent the use of this material.

6.5 Remediation of the Flooded Excavation

A deep excavation, partially filled with water, is located in the northern part of the site in an area indicated by historical aerial maps to have been part of a former clay pit. The depth of the pit and ground conditions within the inundated area were not known to Douglas Partners at the time of writing this report.

Test locations around the basin by Douglas Partners and others encountered clayey fill on the northern side of the basin and deep granular fill on the southern side. Test location 3 encountered inferred fill or disturbed ground to a depth of approximately 9.8 m at test location 3, with loose silty sand encountered between depths of approximately 1.5 m and 8 m. It is possible that the encountered loose granular soil is material that has been pushed into the former clay pit to form the existing ground elevation at the test location.

Remediation of the basin and backfilling to design surface levels may require the following:

- Dewatering of the basin;
- Removal of anticipated soft deposits from within the inundated area, which will likely require removal from site;
- Excavation of loose material where present around the edges of the basin, such as at test location three, and to make the area within the basin safe for workers to enter;
- Backfilling of the basin to the required elevation in a controlled manner. It is suggested that clayey fill excavated from elsewhere on the site is used to backfill the basin to avoid creating a 'swimming pool' effect that may occur if granular fill is used; and
- Finish the site to design levels with the proposed layer of granular, non-reactive fill.

7. References

1. Australian Standard AS2870-2011, 'Residential Slabs and Footings', April 2011, Standards Australia
2. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
3. Australian Standard AS 1289.6.3.2-1999, Soil Strength and Consolidation Tests- Determination of the Penetration Resistance of a Soil – Dynamic Cone Penetrometer Test.
4. Australian Standard AS 1726-2017, Geotechnical Site Investigation.
5. Australian Standard AS 3798-2007, Guidelines on Earthworks for Commercial and Residential Developments.
6. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004

8. Limitations

Douglas Partners (DP) has prepared this report for this project at in accordance with DP's proposal dated 11 June 2019 and acceptance received from Linc Property Pty Ltd dated 20 June 2019. The work was carried out under a Professional Services Agreement, with amended terms and conditions. This report is provided for the exclusive use of Linc Property Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Drawing

About this Report

Douglas Partners



Introduction

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

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

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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



Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Cone Penetration Tests Douglas Partners



Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

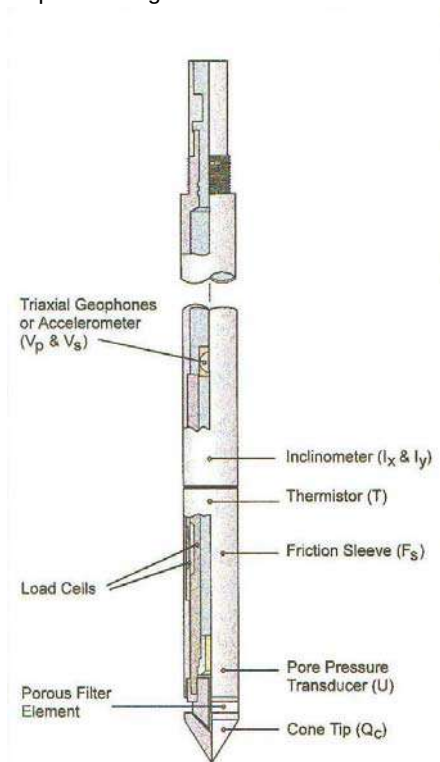


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.



Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c , f_s , i & z)
Piezococone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Q_t) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

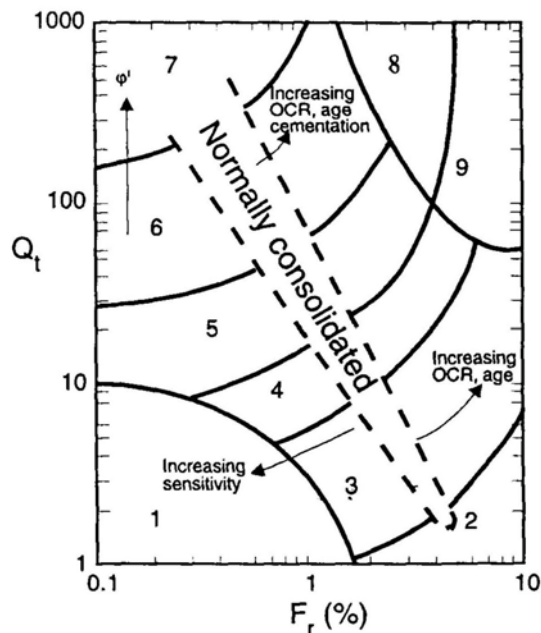


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0 . Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

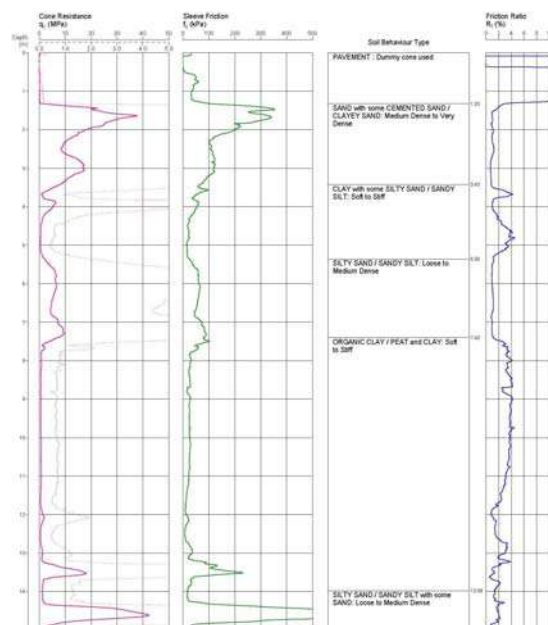


Figure 4: Sample Cone Plot



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

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

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

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

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;

- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).

Symbols & Abbreviations

Douglas Partners



Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General



Asphalt



Road base



Concrete



Filling

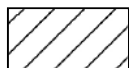
Soils



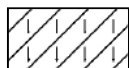
Topsoil



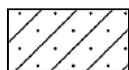
Peat



Clay



Silty clay



Sandy clay



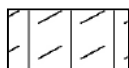
Gravelly clay



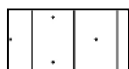
Shaly clay



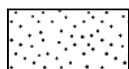
Silt



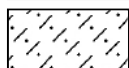
Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



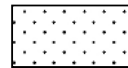
Boulder conglomerate



Conglomerate



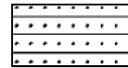
Conglomeratic sandstone



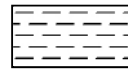
Sandstone



Siltstone



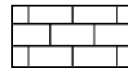
Laminite



Mudstone, claystone, shale

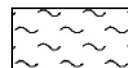


Coal

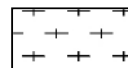


Limestone

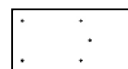
Metamorphic Rocks



Slate, phyllite, schist

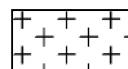


Gneiss

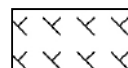


Quartzite

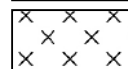
Igneous Rocks



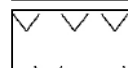
Granite



Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry



Appendix B

Results of Field Work

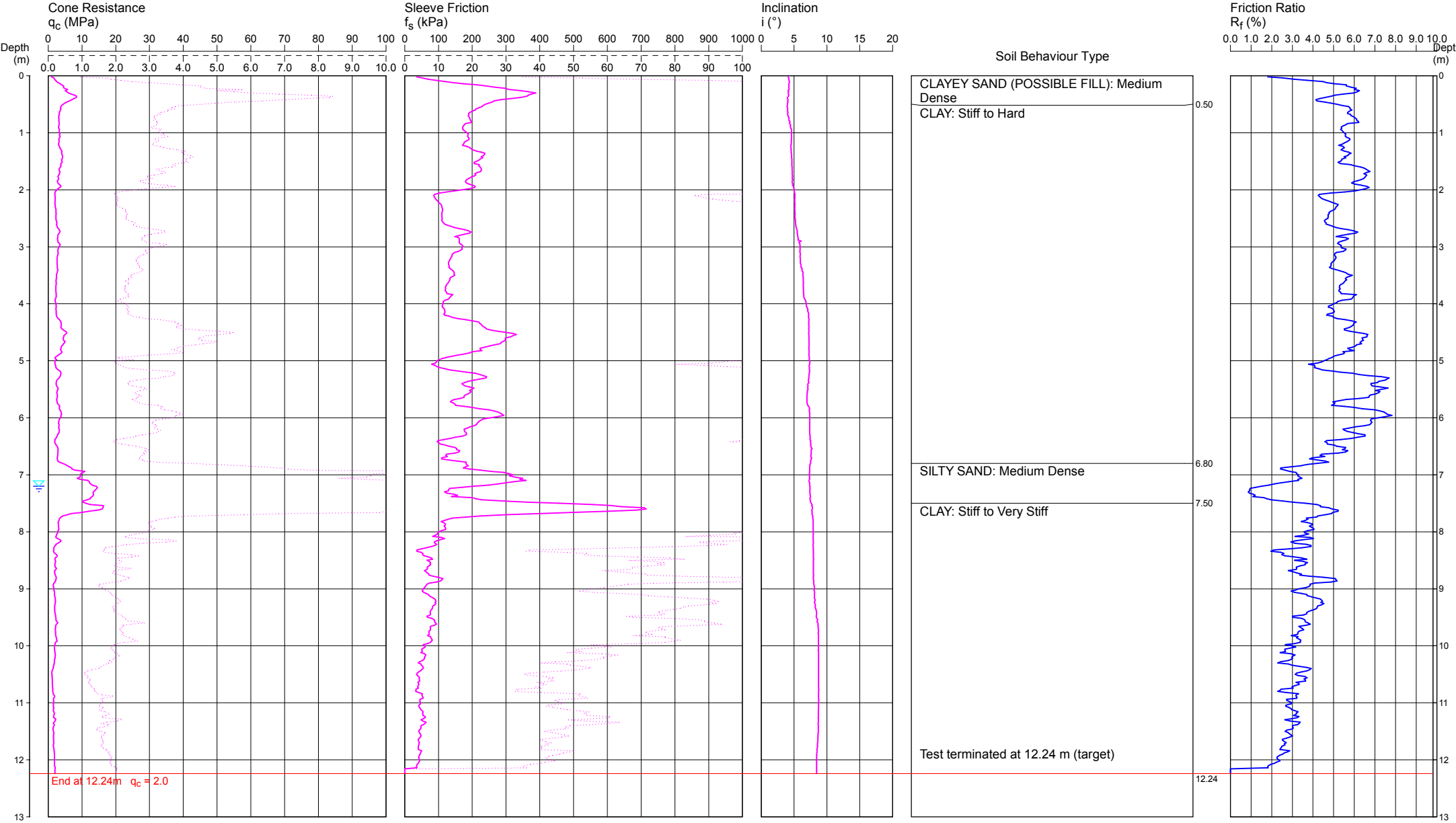
CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan, WA
REDUCED LEVEL: 5.9 m AHD
COORDINATES: 406463E 6473965N MGA Zone 50

CPT1

Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

File: P:\96584.01 - MIDDLE SWAN, 102 Gt Northern Highway\4.0 Field Work\CPTs\DP\96584.01 - CPT1.CP5
Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Water depth after test: 7.20m depth (measured)

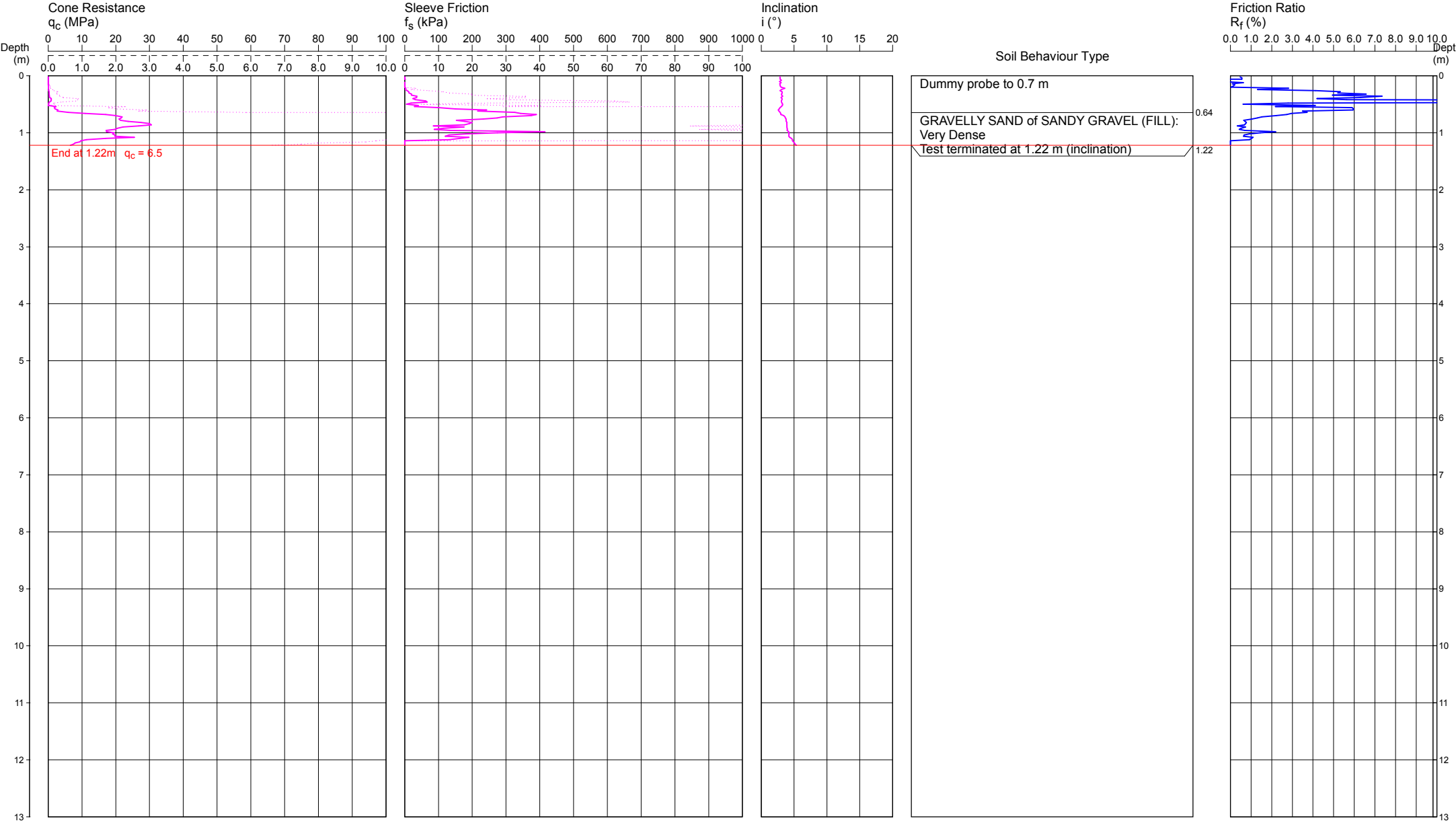


CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 5.5 m AHD
COORDINATES: 406483E 6473872N MGA Zone 50

CPT2A
Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



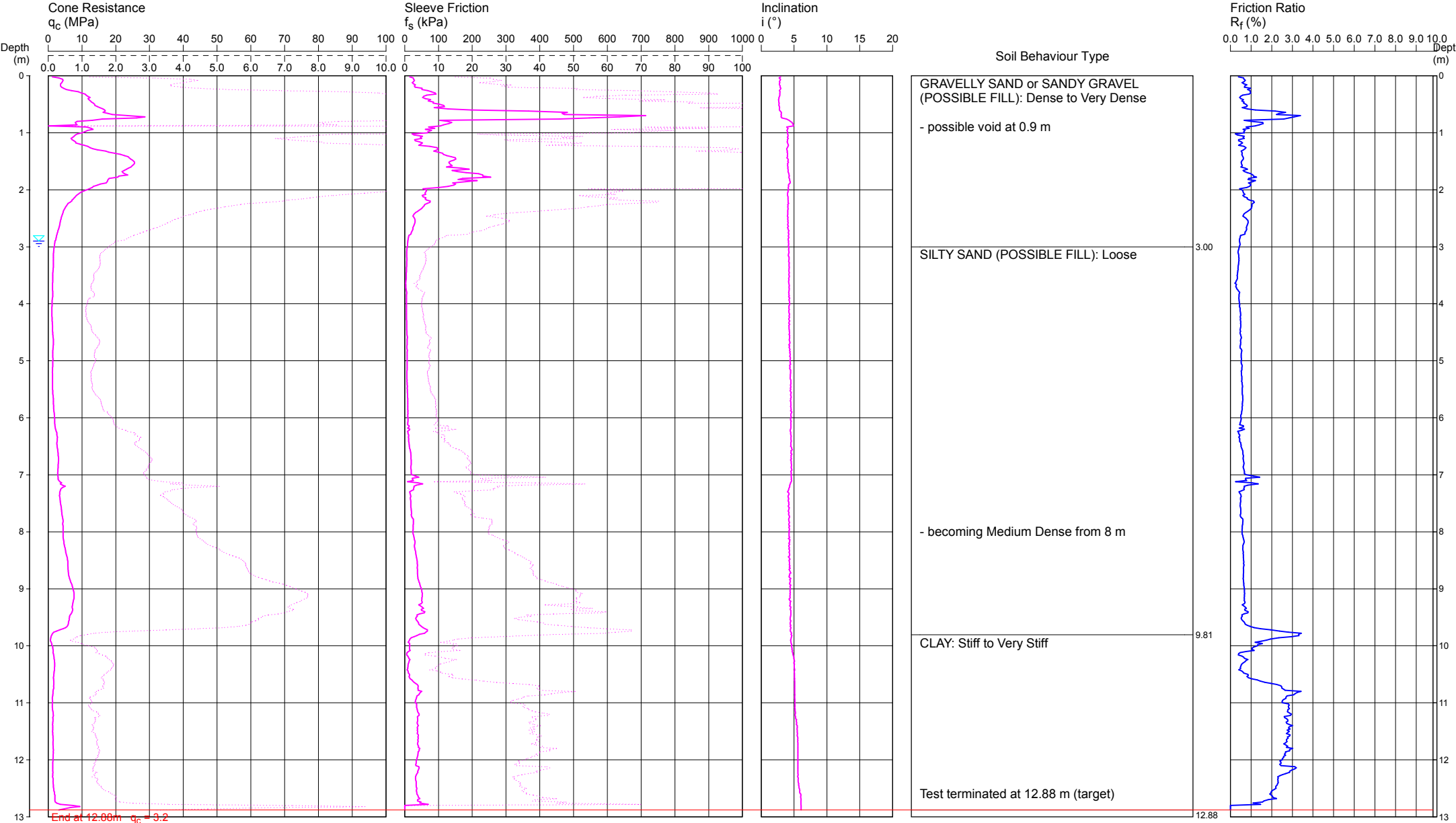
REMARKS: Surface levels estimated from publicly available LiDAR data and site observations.
Cone ID: Probedrill Type: EC26

CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 5.8 m AHD
COORDINATES: 406403E 6473637N MGA Zone 50

CPT3
Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

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Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
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Water depth after test: 2.90m depth (measured)

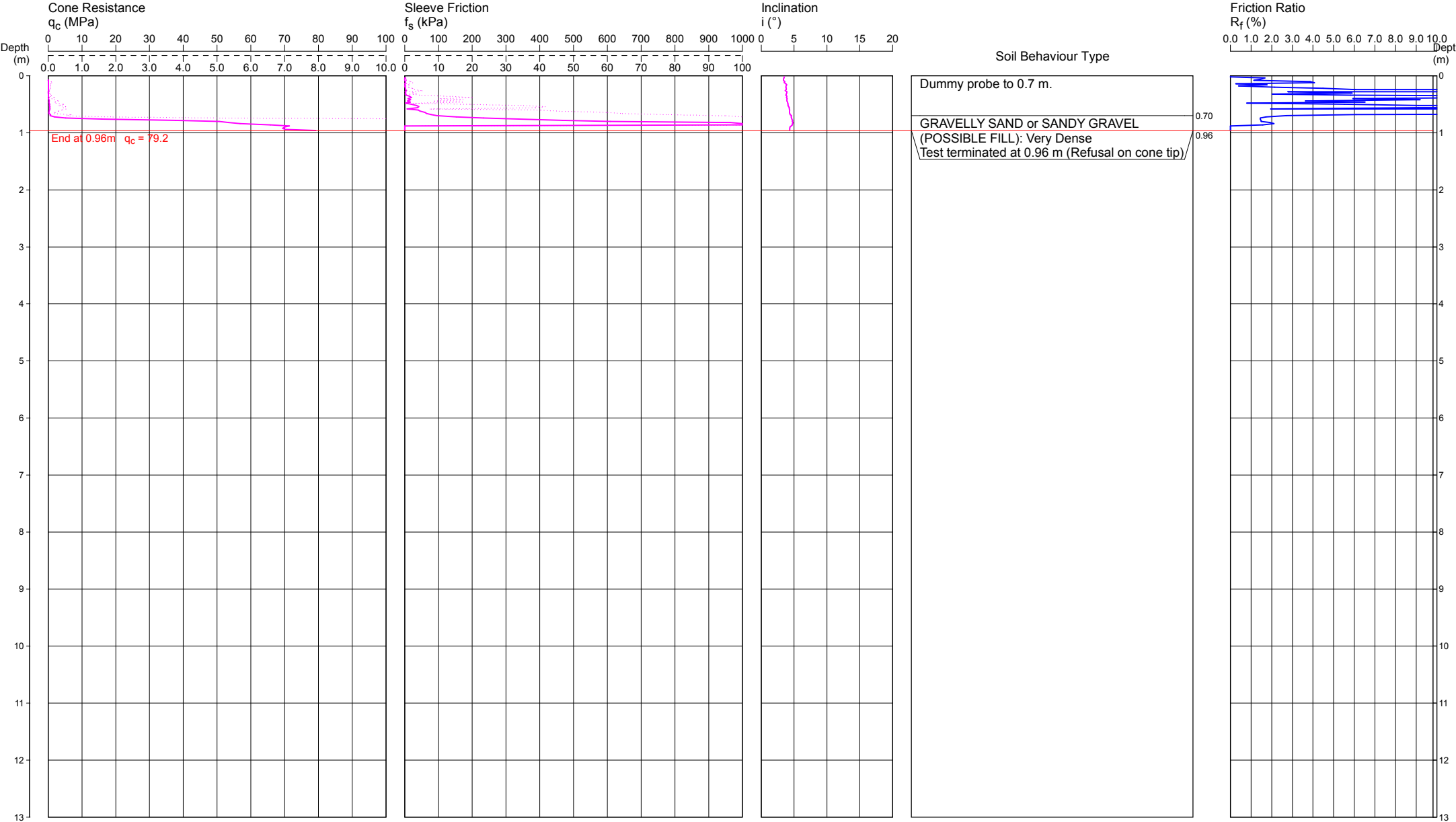


CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 11.7 m AHD
COORDINATES: 406120E 6473251N MGA Zone 50

CPT4
Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

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Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
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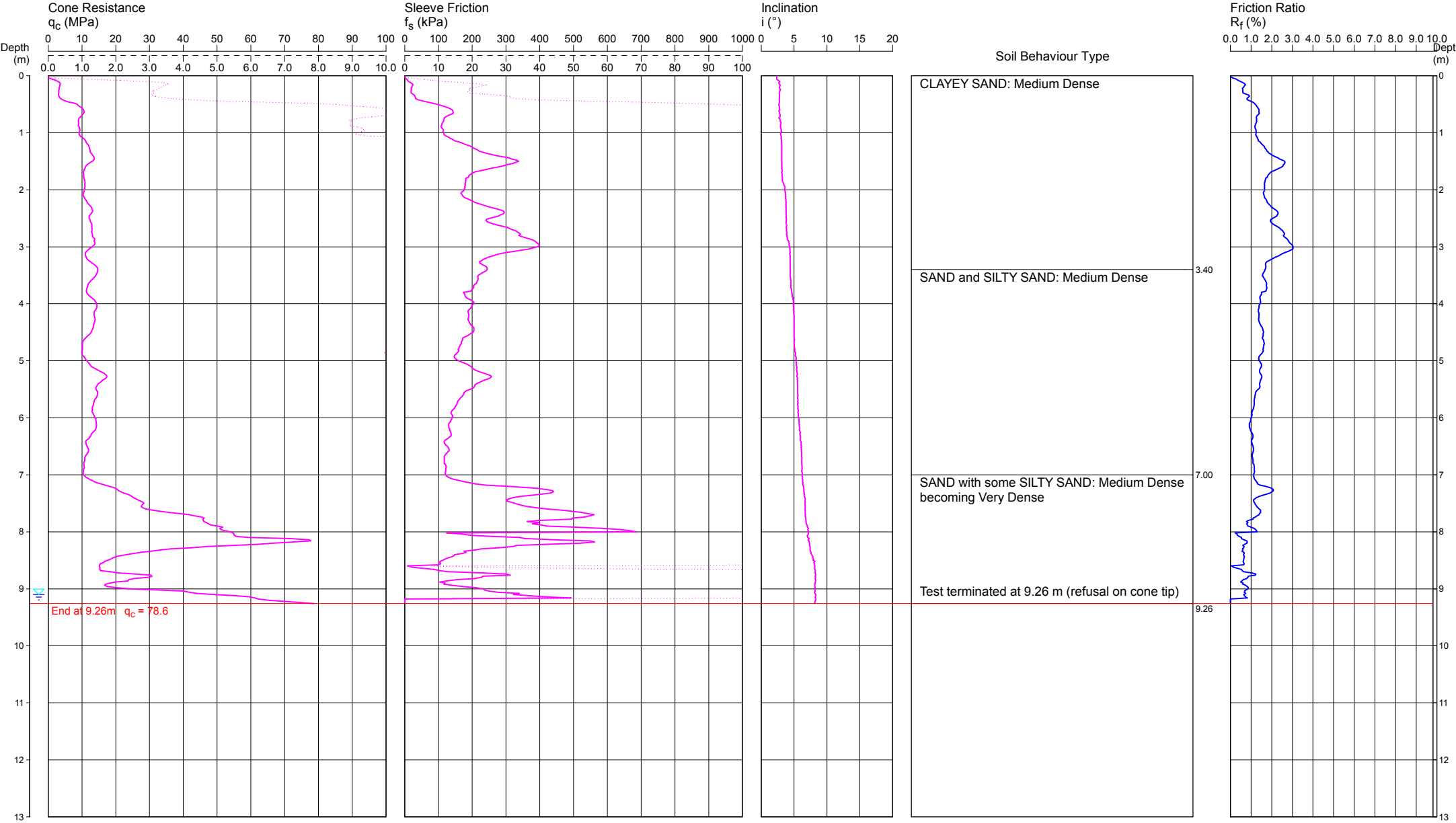


CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 9.2 m AHD
COORDINATES: 405343E 6473459N MGA Zone 50

CPT5
Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

File: P:\96584.01 - MIDDLE SWAN, 102 Gt Northern Highway\4.0 Field Work\CPTs\DP\96584.01 - CPT5.CP5
Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
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Water depth after test: 9.10m depth (measured)

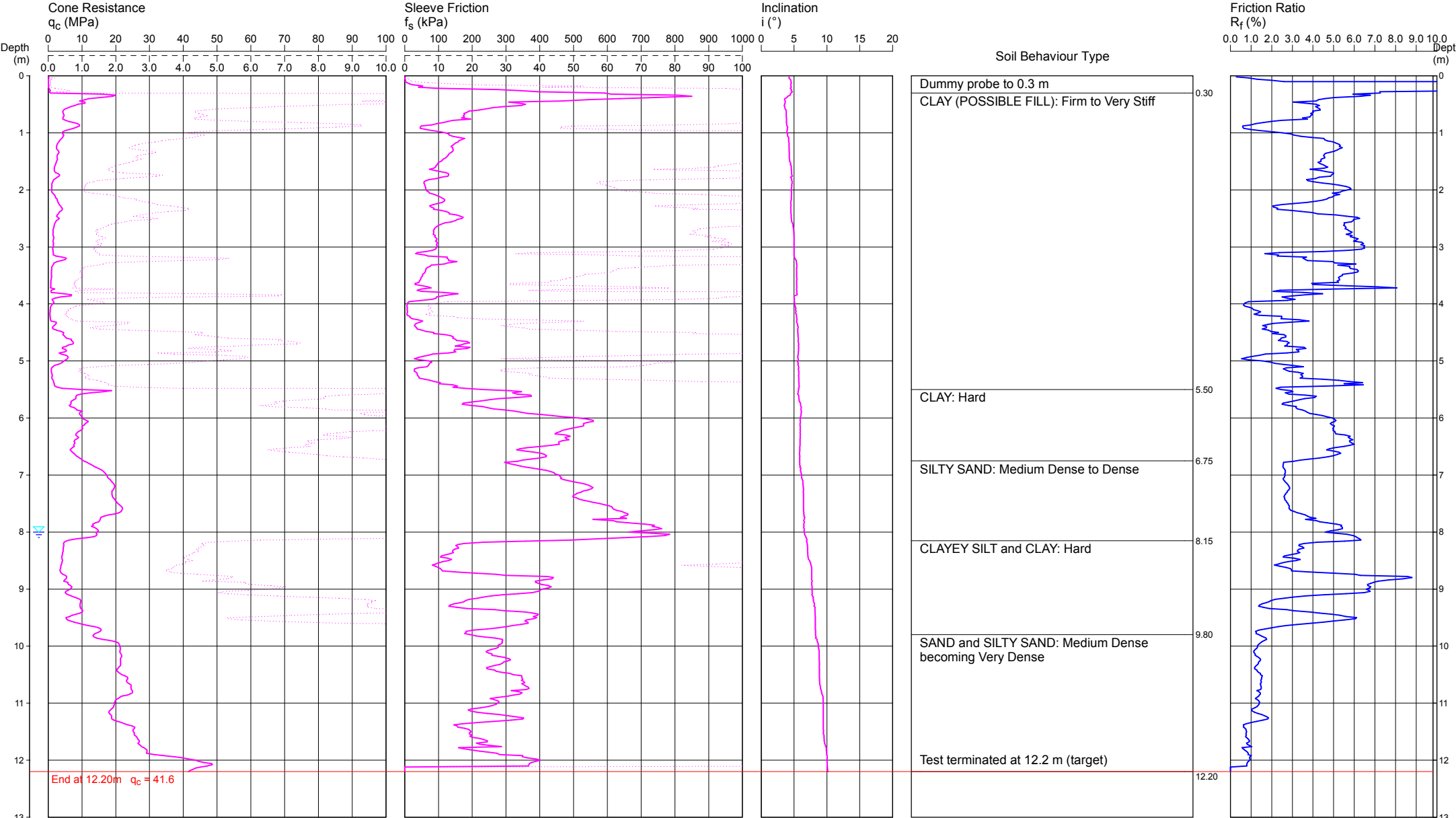


CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 9.2 m AHD
COORDINATES: 405713E 405713N MGA Zone 50

CPT6
Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

File: P:\96584.01 - MIDDLE SWAN, 102 Gt Northern Highway\4.0 Field Work\CPTs\DP\96584.01 - CPT6.CP5
Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Water depth after test: 8.00m depth (measured)



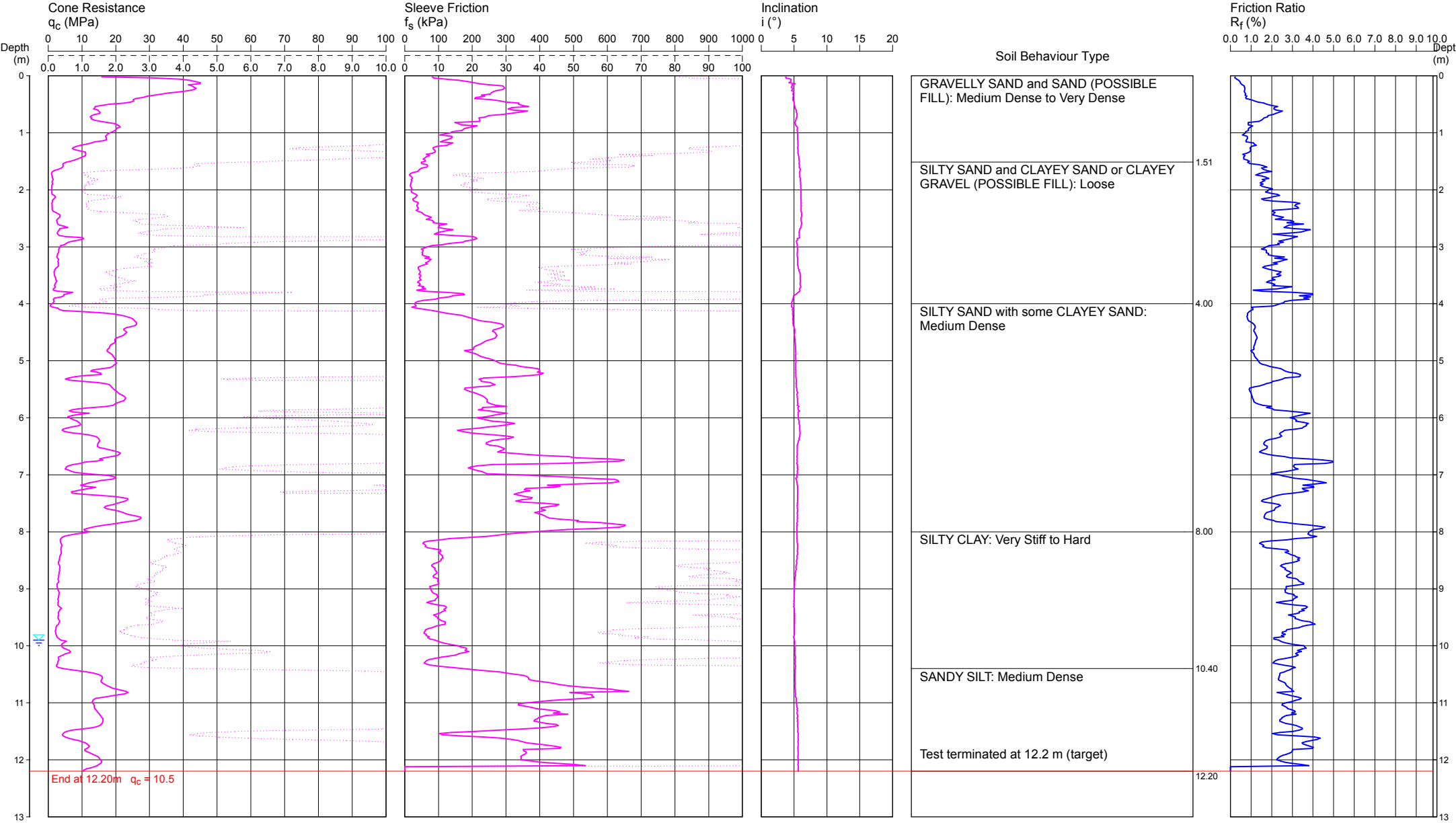
CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 8.3
COORDINATES: 405590E 6472813N MGA Zone 50

CPT7

Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

File: P:\96584.01 - MIDDLE SWAN, 102 Gt Northern Highway\4.0 Field Work\CPTs\DP\96584.01 - CPT7.CP5
Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Water depth after test: 9.90m depth (measured)

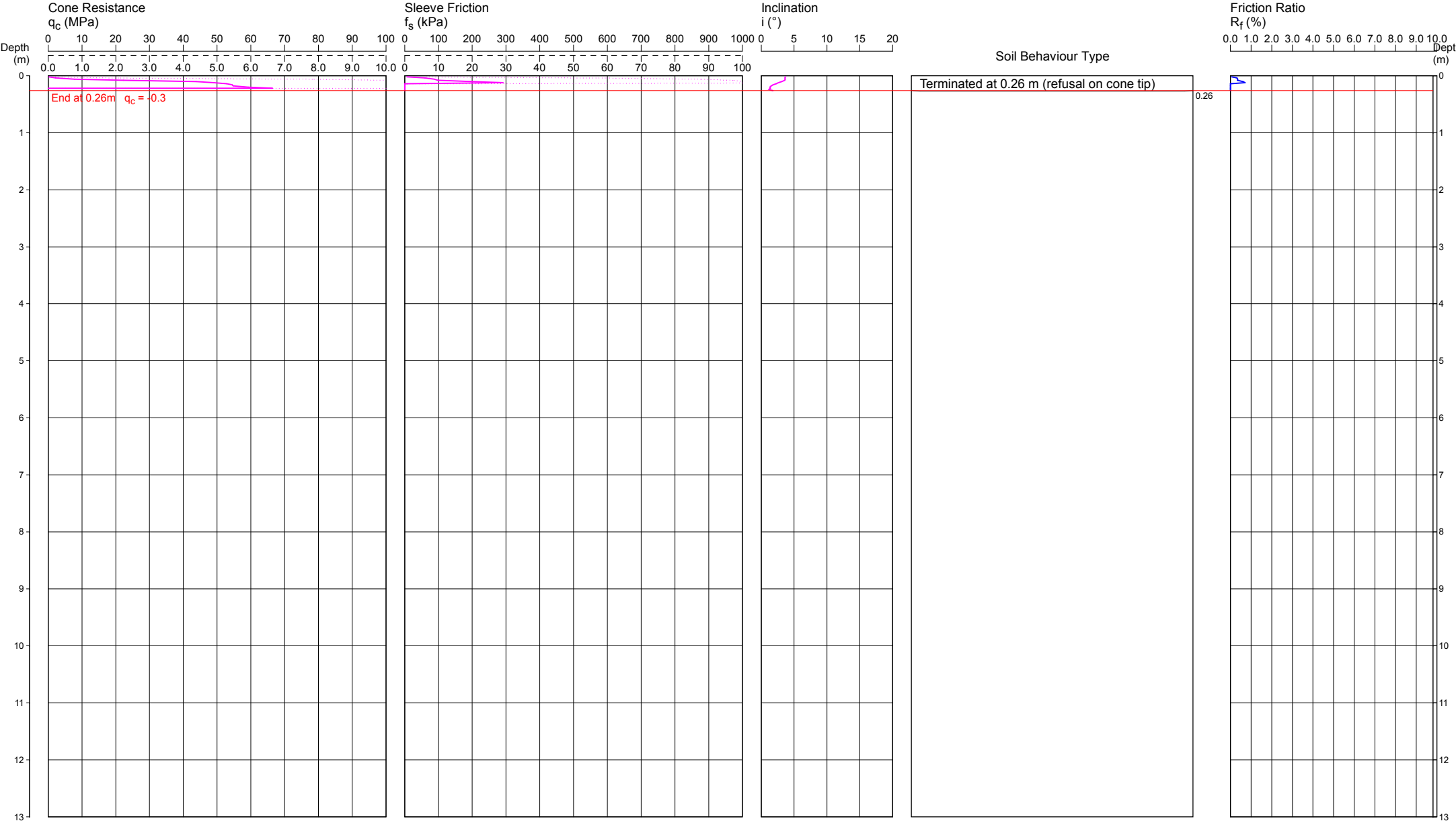


CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan
REDUCED LEVEL: 9.5 m AHD
COORDINATES: 405758E 6472805N MGA Zone 50

CPT8
Page 1 of 1
DATE 21/06/2019
PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

File: P:\96584.01 - MIDDLE SWAN, 102 Gt Northern Highway\4.0 Field Work\CPTs\DP\96584.01 - CPT8.CP5
Cone ID: Probedrill Type: EC26

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd



TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 10.2 m AHD*
EASTING: 406393
NORTHING: 6474041

PIT No: 9
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
10.0		FILL (SANDY CLAY, CI) - stiff, brown sandy clay, trace gravel and brick fragments and full sized bricks, moist. Sand is fine grained. Gravel is angular, fine to medium sized quartz).							
		- becoming hard from 0.45 m							
		- with brick fragments from 0.8 m to 1.0 m							
1.0		- slow digging and dry from 1.0 m							
1.3		Pit discontinued at 1.3m (slow digging)							
2.0									



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 5.7 m AHD*
EASTING: 406457
NORTHING: 6473795

PIT No: 10
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.55	FILL (GRAVELLY CLAY, CI) - hard, red-brown gravelly clay with sand, moist. Sand is fine to medium grained. Gravel is fine to coarse brick fragments). - red-brown mottled white and with cobble sized brick fragments from 0.25 m		B	0.3		PP >600 kPa					
					0.5		PP >600 kPa					
		FILL (SANDY CLAY, CI) - hard, brown mottled red-brown sandy clay, trace gravel and brick fragments, moist. Sand is fine to medium grained.			0.7		PP >600 kPa					
					0.9		PP >600 kPa					
	1.15				1.1		PP >600 kPa					
		Pit discontinued at 1.15m (slow digging)										



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 11.0 m AHD*
EASTING: 405541
NORTHING: 6473078

PIT No: 11
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
11 <												



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 11.5 m AHD*
EASTING: 406038
NORTHING: 6473420

PIT No: 12
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

[illegible]

RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _s	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W _{sp}	Water seep
E	Environmental sample	W _{lv}	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test (s(50) (MPa)
		PL(D)	Point load diametral test (s(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 5.7 m AHD*
EASTING: 405523
NORTHING: 6473542

PIT No: 13
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.05	FILL (TOPSOIL, SM) - dark brown, fine to medium grained silty sand, with organics, moist.										
	0.2	FILL (SANDY GRAVEL, GS) - very dense, red-brown, fine to coarse sized gravel, trace cobbles, moist. Gravel and cobbles are brick fragments.										
	0.25											
	0.4	FILL (GRAVELLY SAND, SP-SM) - pale brown, fine to coarse grained gravelly sand, moist. Gravel is fine to medium sized brick fragments.										
	0.45											
	1	FILL (GRAVELLY CLAY, CI) - red-brown gravelly clay, moist. Gravel is fine to coarse sized ferricrete and brick fragments.										
		FILL (SANDY GRAVEL, GM) - grey, fine to coarse sandy gravel, moist. Crushed rock roadbase.										
	1.6	FILL (BRICKS and SANDY GRAVEL, GS) - brick cobbles and fine to coarse sandy gravel (crushed bricks), dry. Occasional pieces of plastic, rubber, wood and wire observed.										
		Pit discontinued at 1.6m (bricks collapsing)										
	2											



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

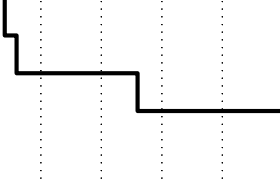
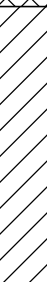
SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _s	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W _s	Water seep
E	Environmental sample	W _L	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 11.8 m AHD*
EASTING: 405522
NORTHING: 6473154

PIT No: 14
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
		FILL (CLAYEY SAND, CS) - very stiff becoming hard, red-brown and brown, fine to medium grained clayey sand, with pockets of silty sand, moist. Concrete boulder and fabric observed.							
	0.75	CLAY (CL) - red clay with sand, dry, low plasticity. Hard digging. - tree root approx. 5 cm diameter at 1 m deep.		B	1.2				
	1.85	Pit discontinued at 1.85m (slow digging)							



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 11.2 m AHD*
EASTING: 405898
NORTHING: 6473062

PIT No: 15
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
1.1		FILL (SANDY GRAVEL, GS) - very dense, red-brown, fine to coarse sized gravel, trace cobbles and boulders, moist. Gravel and cobbles are ferricrete.		B	0.4							
0.45		FILL (SANDY CLAY, CI) - stiff, brown sandy clay, trace gravel and brick fragments and full sized bricks, moist. Sand is fine grained. Gravel is angular, fine to medium sized quartz). Hard digging.		D	0.8							
1		- increasing sand content from 0.9 m deep										
1.6		FILL (CLAYEY GRAVELLY SAND, SC) - estimated dense, red-brown mottled light brown clayey gravelly sand, dry to moist. Gravel is fine to coarse sized brick fragments.										
2		- carpet, wood and fabric pieces from 1.8 m deep										
		- trace brick fragments and with ferricrete cobbles and occasional boulders from 2.2 m										
2.5		Pit discontinued at 2.5m (maximum excavator reach)		B	2.5							



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 8.3 m AHD*
EASTING: 405709
NORTHING: 6472872

PIT No: 16
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
	0.3	FILL (SANDY GRAVEL, GS) - very dense, red-brown, fine to coarse sized gravel, trace cobbles, moist. Gravel and cobbles are brick fragments.							5
	0.4	FILL (SAND, SP-SM) - blue-grey, fine to coarse grained sand with silt, moist.							10
	0.6	FILL (SANDY CLAYEY GRAVEL, GC) - very dense, orange-brown, fine to coarse sized sandy clayey gravel, moist. Gravel is ferricrete. Sand is fine to coarse grained.							15
1	1.2	FILL (BRICKS and SAND, SP-SC) - estimated dense, brown, fine to medium grained sand with clay and bricks, moist.						1	20
	1.35	FILL (CLAYEY GRAVEL, GC) - blue-grey, fine to medium sized clayey gravel, moist to wet. Gravel is subangular crushed granite aggregate.							
	1.6	FILL (BRICKS and SAND, SP-SC) - estimated dense, brown, fine to medium grained sand with clay and bricks, moist.							
2	2.0	FILL (GRAVELLY SANDY CLAY, CI) - grey-brown gravelly sandy clay, moist. Sand is fine to coarse grained. Gravel is fine to medium sized. - mottled red-brown and with brick fragments up to cobble size, moist to wet from 2.0 m						2	
	2.6	Pit discontinued at 2.6m (maximum excavator reach)		B	2.5				



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _s	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W _{seep}	Water seep
E	Environmental sample	W _{level}	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 6.0 m AHD*
EASTING: 405721
NORTHING: 6473142

PIT No: 17
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.4	FILL (SANDY GRAVEL, GP-SM) - grey-brown, fine to coarse sandy gravel, moist. Gravel is brick fragments, ferricrete and granitic. Plastic tape observed.										
		Pit discontinued at 0.4m (target depth)										
	1											
	2											



RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 11.0 m AHD*
EASTING: 405728
NORTHING: 6472758

PIT No: 18
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
	0.4	FILL (SANDY CLAY, Cl) - brown sandy clay with gravel, brick fragments and bricks, moist. Sand is fine to medium grained.										
		Pit discontinued at 0.4m (target depth)										
	1											
	2											




RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

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

TEST PIT LOG

CLIENT: Linc Property Pty Ltd
PROJECT: Proposed Residential & Industrial Development
LOCATION: 102 Great Northern Highway, Middle Swan

SURFACE LEVEL: 13.2 m AHD*
EASTING: 405519
NORTHING: 6473149

PIT No: 19
PROJECT No: 96584.01
DATE: 24/6/2019
SHEET 1 OF 1

[illegible]

RIG: 5 tonne excavator with 450 mm wide toothed bucket

LOGGED: DJB

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater

REMARKS: *surface levels interpolated from publicly available LiDAR

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U _s	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W _{sp}	Water seep
E	Environmental sample	W _{lv}	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test (s(50) (MPa)
		PL(D)	Point load diametral test (s(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



APPENDIX C

Existing Stormwater System Plates

PLATES



PLATE 1: View of Clay Basin storage area in Midland Brick end of winter October 2024



PLATE 2: View of Clay Basin storage area in Midland Brick following early winter rains June 2023



**PLATE 3: Blackadder Creek Tributary in vegetated area north of Eveline Rd.
Broad flat area. No clearly defined channel**



PLATE 4: Upstream and Downstream end of 450mm dia Culvert under Eveline Rd.



PLATE 5: Driveway across Blackadder Creek Tributary downstream of Eveline Rd.



PLATE 6: 400mm dia steel culvert under driveway largely blocked by large tree and sediment.



**PLATE 7: Blackadder Creek Tributary downstream of driveway.
Broad floodplain, no discernible flow channel present**



**PLATE 8: Fence crossing broad flat channel of Blackadder Creek Tributary further downstream opposite
LaSalle College playing fields**



PLATE 9: Culvert under Muriel St at low point.

Blackadder Creek Tributary is fully piped under development area immediately downstream of Muriel St.



PLATE 10: 900 mm dia pipe under Muriel St. Invert of pipe is several metres below road level. Standing water will occur following events due to level of downstream pipework



PLATE 11: Main Site Sump and Pump. Main Electric Pump (170 l/s) located in building



PLATE 12: Staff gauges showing water levels. Pump commencement level is 2.69 mAHD and turns off at 1.94 mAHD. Overflow to Swan River commences when water level rises above 4.29m AHD via manually operated valve. Historical high water mud mark on building at approximately 5.0 mAHD.



PLATE 13: Discharge from existing Clay Shed roof to storage area adjacent to TEC area



PLATE 14: Upstream and downstream end of 450mm concrete pipe taking compensated flow from storage area adjacent to TEC. Downstream end heavily overgrown.



PLATE 15: Storage area adjacent to TEC near Clay Sheds.



PLATE 16: Upstream end of existing outlet to Swan River near Clay Basin.

Flows from site into a pit then into a concrete box culvert (600mm x 500mm) outlet



PLATE 17: Southern sedimentation storage area, main storage.
(In process of decommissioning and relocation as part of Area 3 Stage 5 works)



PLATE 18: Southern sedimentation storage area, forebay
(In process of decommissioning and relocation as part of Area 3 Stage 5 works)



**PLATE 19: Inundation area downstream of Southern sedimentation storage area
(In process of decommissioning as part of Area 3 Stage 5 works)**



**PLATE 20: Open drain to southern outlet
(In process of decommissioning as part of Area 3 Stage 5 works)**



PLATE 21: 400 mm dia southern outlet upstream end in concrete tomb at end of open drain



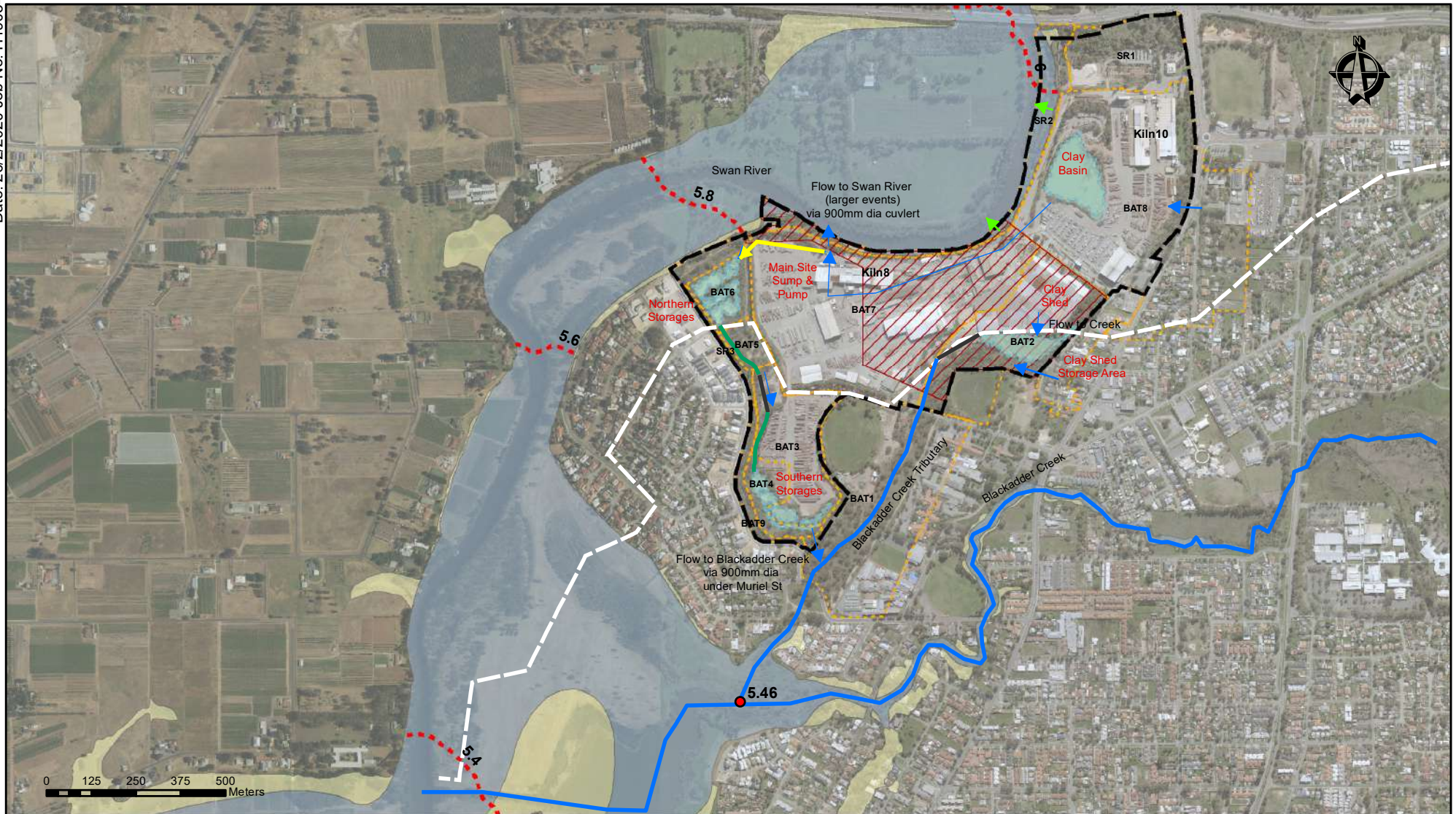
PLATE 22: Existing outlet from site to Blackadder Creek Tributary upstream of Muriel St.

APPENDIX D

Previous Hyd2o Report Stormwater Modelling Extracts

DWMS EXISTING SYSTEM & FLOODPLAIN MAPPING (HYD20,2020a)

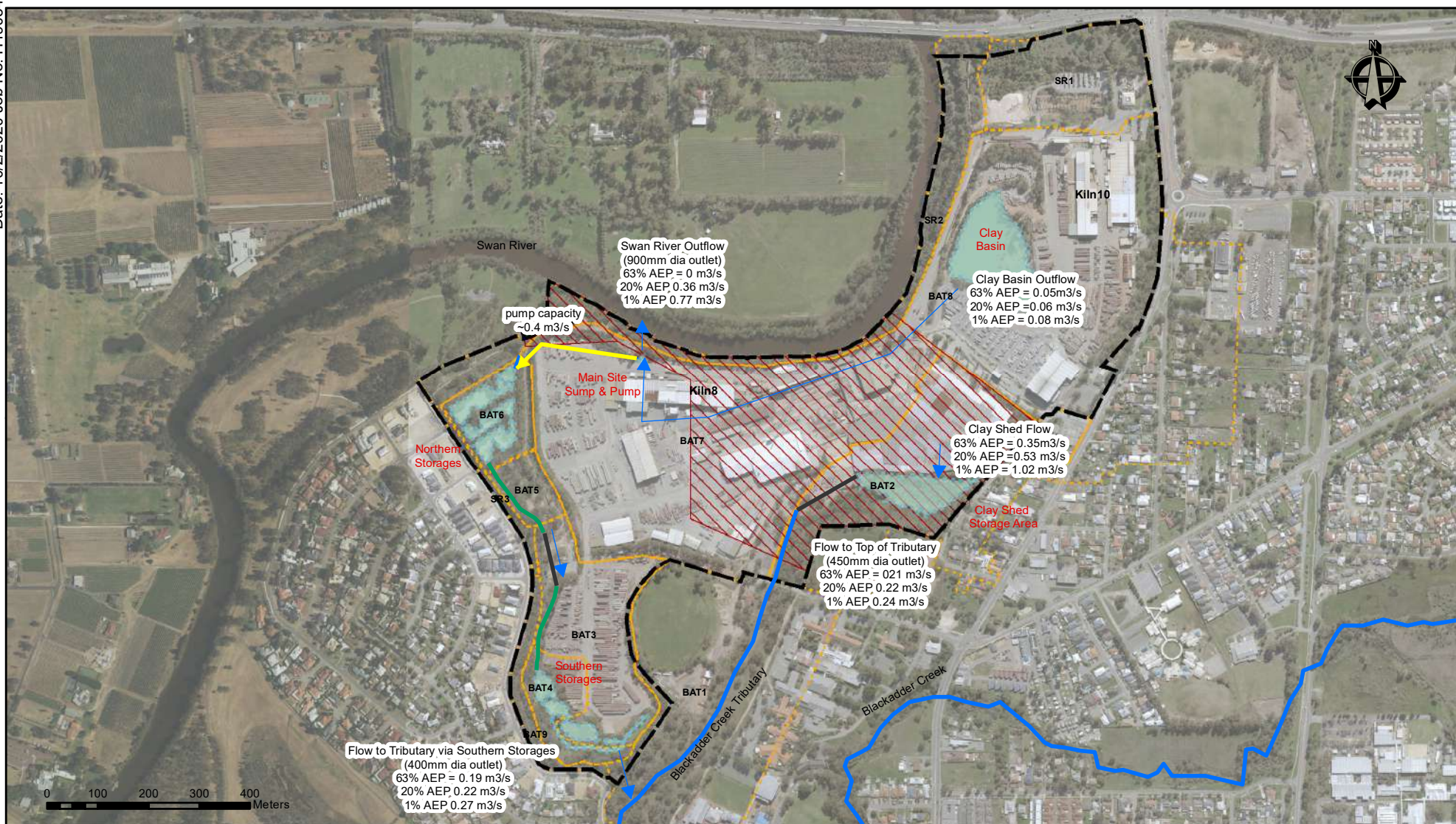
Date: 26/2/2020 Job No. H19054



- | | | |
|-----------------------------|--------------------------------------|--|
| Midland Brick Site Boundary | Blackadder Creek & Tributary | Previous River Connections |
| Subcatchment Boundaries | Open_Drain | Stormwater Flow Path (Gravity) |
| Existing Storages | Pipe Drain | Stormwater Flow Path (Pumped) |
| 1% AEP Floodway | Swan River Flood Level Contours | Previously Published Blackadder Creek Boundary |
| 1% AEP Flood Fringe | Blackadder Creek 1% AEP Level (mAHD) | |

hyd20
Midland Brick District Water Management Strategy
Surface Water Plan

DWMS EXISTING SYSTEM MODELLING (HYD20,2020a)



- Midland Brick Site Boundary
- Subcatchment Boundaries
- Existing Storages
- MRS Amendment Area

- Blackadder Creek & Tributary
- Open_Drain
- Pipe Drain

- Stormwater Flow Path (Gravity)
- Stormwater Flow Path (Pumped)

hyd2o

Midland Brick District Water Management Strategy
Stormwater Event Modelling of Existing System Flows

CLAY BASIN NEW STORAGE MODELLING (HYD20,2020b)

Date: 17/3/2020 Job No. H19054



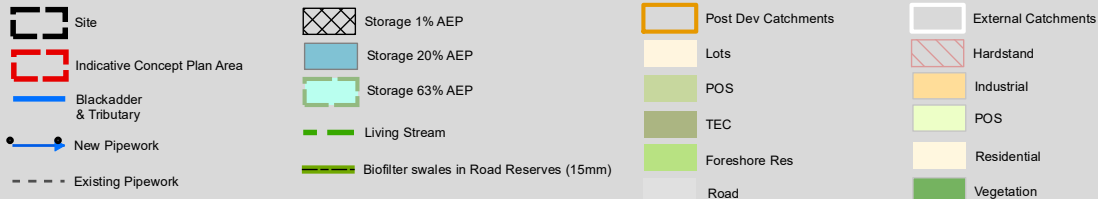
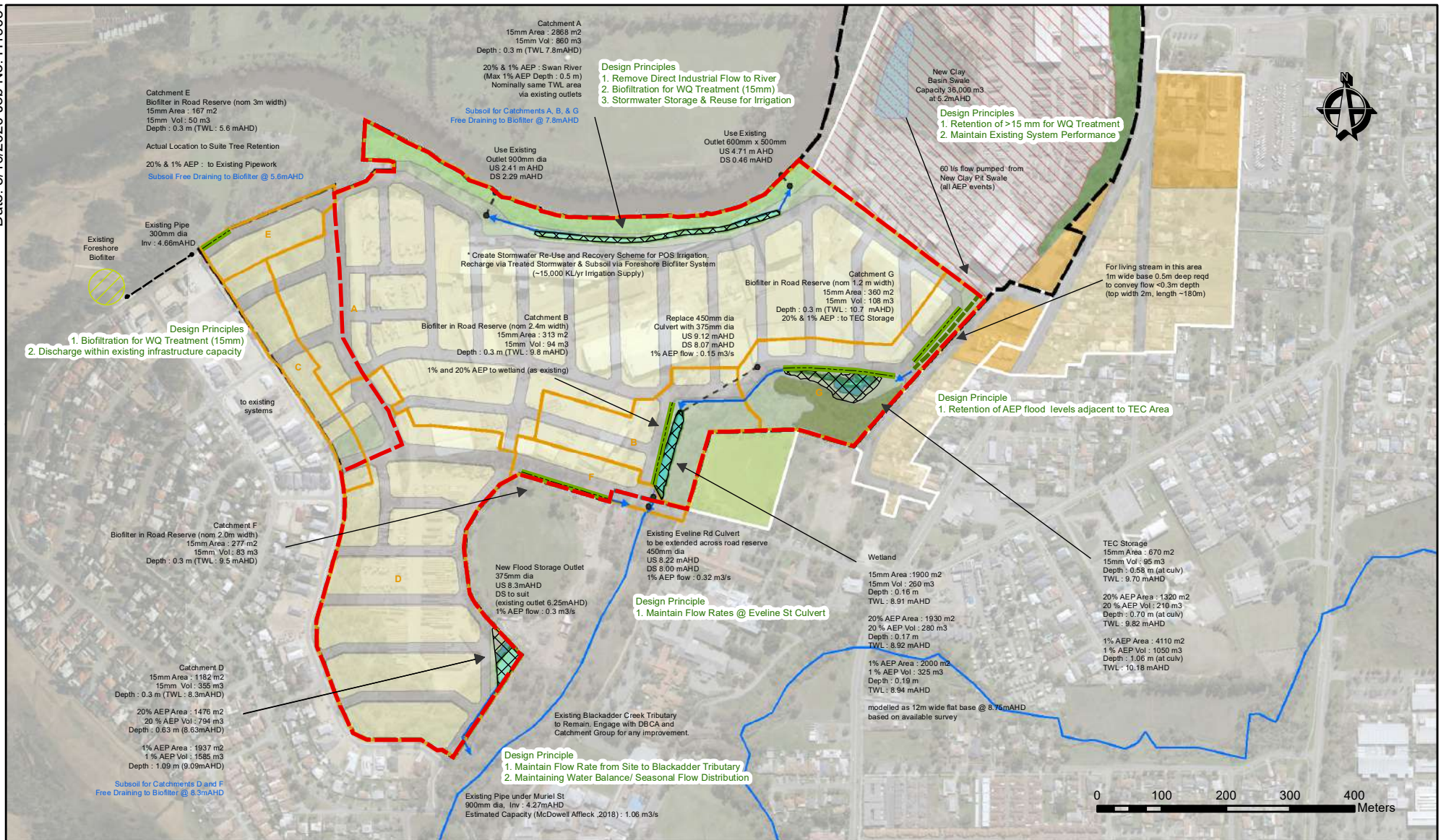
- Midland Brick Site Boundary
- Subcatchment Boundaries
- New Swale
- Previous River Connections
- Stormwater Flow Path (Gravity)
- Stormwater Flow Path (Pumped)

0 40 80 120 160 Meters

hyd2o
Midland Brick Kiln 10 Hardstand Area DA
Stormwater Management Amendment

DWMS POST DEVELOPMENT SYSTEM MODELLING (HYD20,2020a)

Date: 5/10/2020 Job No. H19054



hyd2o
Midland Brick District Water Management Strategy
Indicative Stormwater Management Event Plan

MASONRY PLANT NEW STORAGE MODELLING (HYD20,2020e)

Date: 12/5/2020 Job No. H19054



Midland Brick Site



Masonry Site



Clay Basin Catchment



New Hardstand



New Clay Basin



Masonry Storage



Existing Storages

0 50 100 150 200
Meters

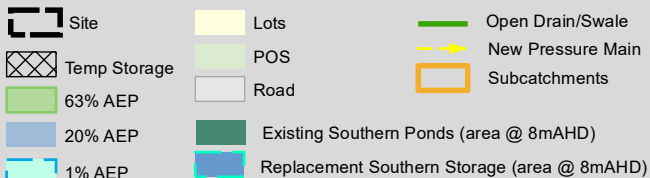
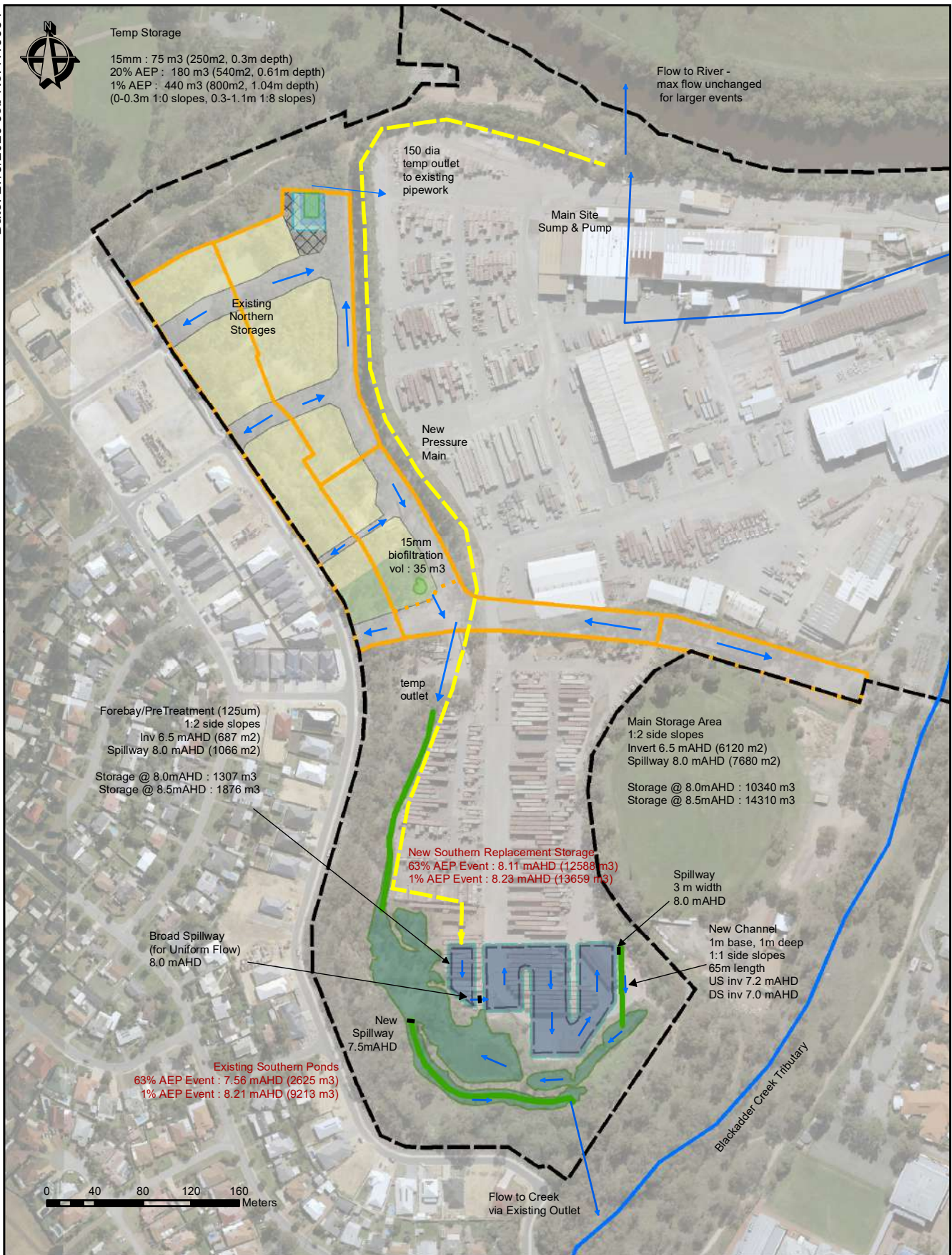
Midland Brick Middle Swan Brickworks: Masonry Site Stormwater Management

Site Stormwater Management Overview

hyd20

NEW SOUTHERN STORAGE MODELLING (HYD20,2020d)

Date: 27/5/2020 Job No. H19054



hyd2o
 Midland Brick Southern Replacement Storage Design
Stage 1 & Southern Storage Design

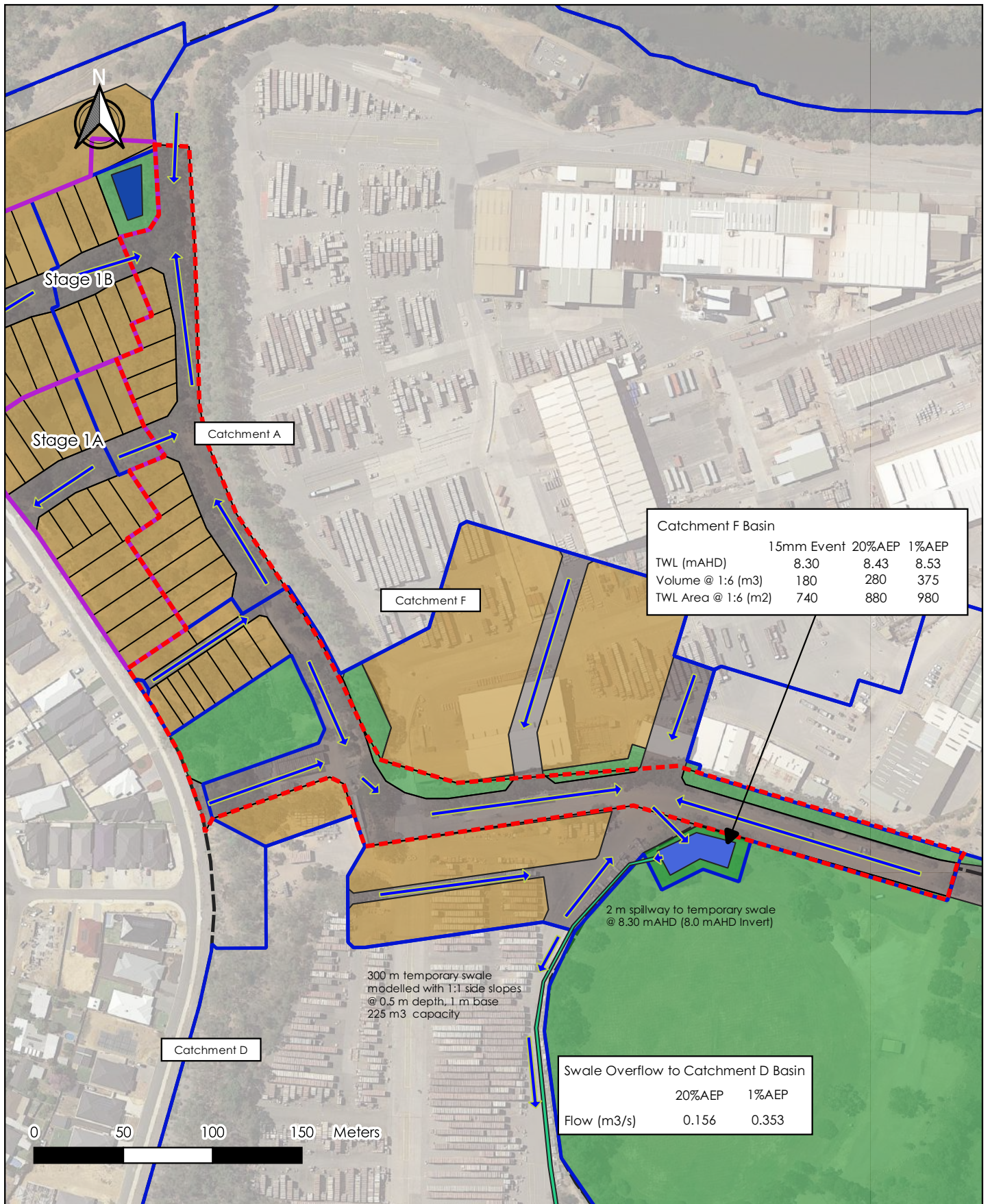
STAGE 1 UWMP MODELLING (HYD20,2020f)

Date: 18/9/2020 Job No. H20064



- | | |
|---|---|
| Site | Subcatchments |
| 63% AEP Inundation | Lots |
| 20% AEP Inundation | POS |
| 1% AEP Inundation | Road |
| — existing MBS pipework | Temp Drainage |

hyd2o
Cranwood Cres Viveash Stage 1A & 1B UWMP
Stage 1A & 1B Stormwater Management Plan
Figure 7



- ⬜ Site
- ⬜ Catchments
- ➔ Flow Direction
- ⬜ Stage 1
- ⬜ Stage 1 Temporary Storage
- ⬜ Lots
- ⬜ Roads
- ⬜ POS
- ⬜ Basin
- ⬜ Swale

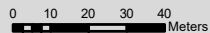
hyd₂o

Cranwood Crescent Viveash Stage 2
Urban Water Management Plan

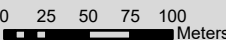
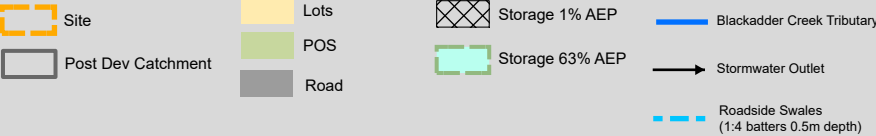
Stormwater Plan

Figure 9

Date: 7/5/2023 Job No. H22039



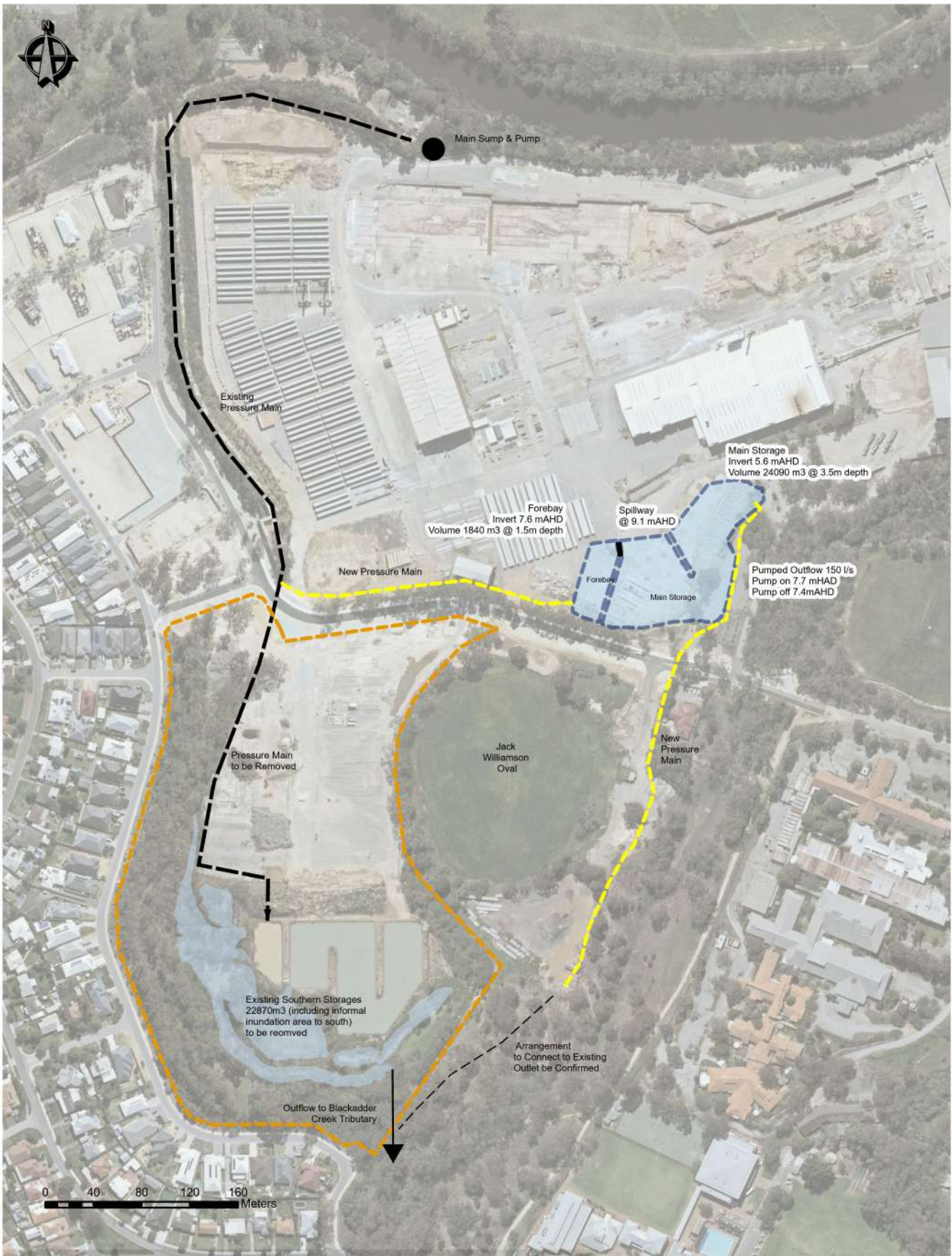
hyd2o



hyd2o
Rivermark Area 3 LWMS Addendum
Revised Stormwater Management Plan
Figure 1

SOUTHERN STORAGE RELOCATION MODELLING (HYD20,2024d)

Date: 12/11/2024 Job No. H23034

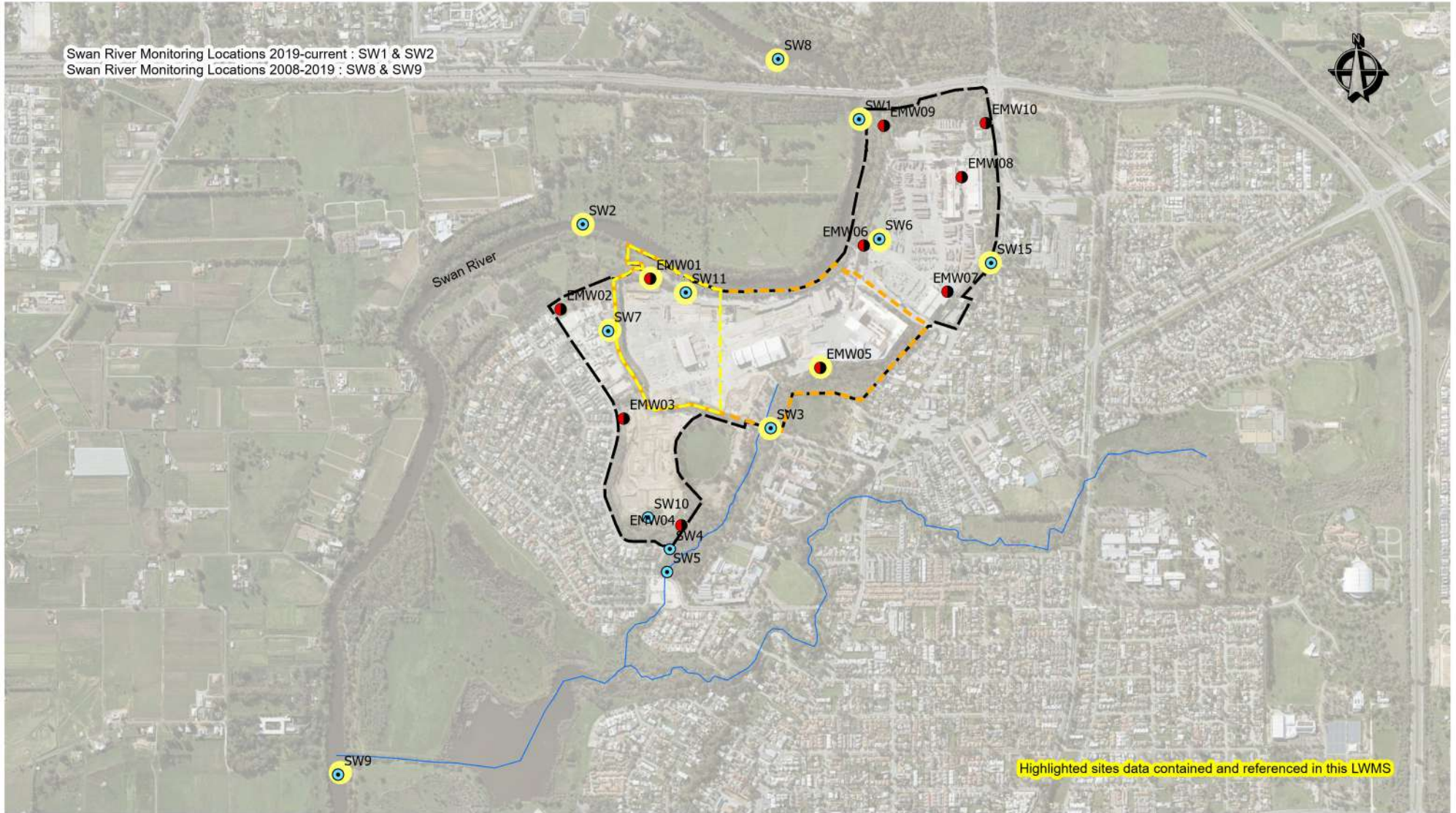


- Rivermark Area 3
- Existing Southern Storage
- Informal Inundation Area
- Existing Pressure Main
- New Relocated Storage
- New Pressure Main


 Midland Brick Southern Storage Relocation Design
Southern Storage Relocation & Design
Figure 1

APPENDIX E

Predevelopment Monitoring Data



- Area 4 Stage 1 (Site)
- Area 4 Boundary
- Blackadder Creek
- Midland Brick
- Groundwater Bores
- Surface Water Sites

0 200 400 600 800 Meters

H23024 Rivermark

EMW01 Groundwater Bore 1
North West of Kilne 7 & 8 Bore



Data Analysis Period Start Date
Data Analysis Period End Date

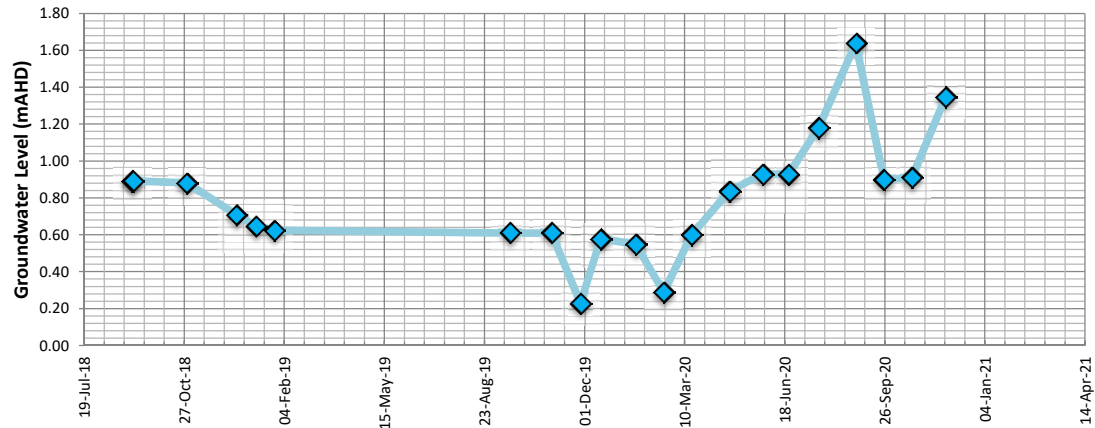
01-01-04
31-12-20

Easting
Northing

405597
6473545

Natural Surface (mAHD) 5.60
Top of Casing (m AHD) 6.05
End of Hole (mAHD) -2.10

Report Date : 07-12-21



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
05-09-18	5.16	0.89	4.71
06-09-18	5.16	0.89	4.71
30-10-18	5.17	0.88	4.72
19-12-18	5.34	0.71	4.89
07-01-19	5.40	0.65	4.95
25-01-19	5.42	0.63	4.98
18-09-19	5.44	0.61	4.99
29-10-19	5.44	0.61	4.99
27-11-19	5.82	0.23	5.37
17-12-19	5.47	0.58	5.02
21-01-20	5.50	0.55	5.05
18-02-20	5.76	0.29	5.31
17-03-20	5.45	0.60	5.00
24-04-20	5.21	0.84	4.76
27-05-20	5.12	0.93	4.67
22-06-20	5.12	0.93	4.67
22-07-20	4.87	1.18	4.42
28-08-20	4.41	1.64	3.96
25-09-20	5.15	0.90	4.70
23-10-20	5.14	0.91	4.69
26-11-20	4.70	1.35	4.25

Minimum Recorded Level (mAHD) 0.229
Maximum Recorded Level (mAHD) 1.639

H23024 Rivermark

EMW03 Groundwater Bore 3
Oval Storage Area East Bore



Data Analysis Period Start Date
Data Analysis Period End Date

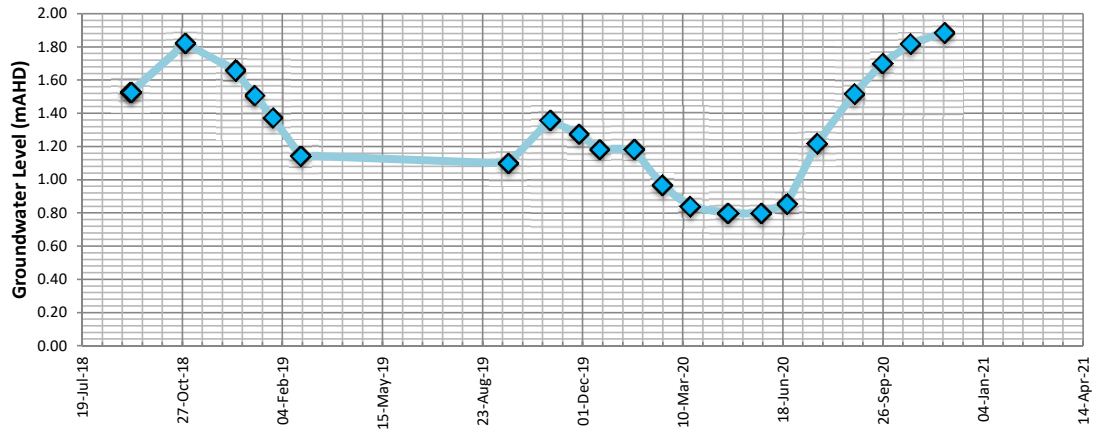
1/01/2004
21/12/2020

Easting
Northing

405530
6473108

Natural Surface (mAHD)	10.82
Top of Casing (m AHD)	11.34
End of Hole (mAHD)	-2.88

Report Date : 7/12/2021



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	9.81	1.53	9.29
6/09/2018	9.81	1.53	9.29
30/10/2018	9.52	1.82	9.00
19/12/2018	9.68	1.66	9.16
7/01/2019	9.83	1.51	9.31
25/01/2019	9.96	1.38	9.45
22/02/2019	10.19	1.15	9.67
18/09/2019	10.24	1.10	9.72
29/10/2019	9.98	1.36	9.46
27/11/2019	10.06	1.28	9.54
17/12/2019	10.15	1.19	9.63
21/01/2020	10.15	1.19	9.63
18/02/2020	10.37	0.97	9.85
17/03/2020	10.50	0.84	9.98
24/04/2020	10.54	0.80	10.02
27/05/2020	10.54	0.80	10.02
22/06/2020	10.48	0.86	9.96
22/07/2020	10.12	1.22	9.60
28/08/2020	9.82	1.52	9.30
25/09/2020	9.64	1.70	9.12
23/10/2020	9.52	1.82	9.00
26/11/2020	9.45	1.89	8.93

Minimum Recorded Level (mAHD)	0.797
Maximum Recorded Level (mAHD)	1.887

H23024 Rivermark

EMW05 Groundwater Bore 5
Clay Shed Bore



Data Analysis Period Start Date
Data Analysis Period End Date

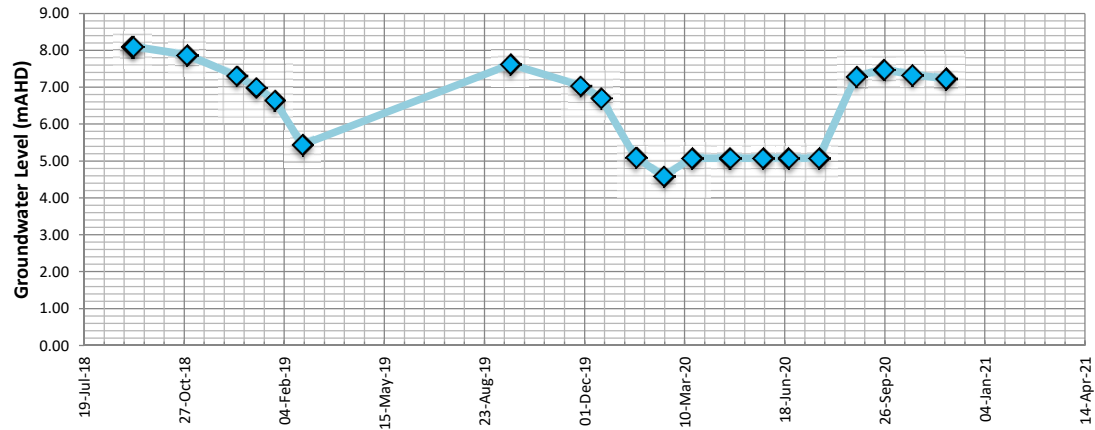
01-01-04
31-12-20

Easting
Northing

406135
6473245

Natural Surface (mAHD) 10.96
Top of Casing (m AHD) 11.39
End of Hole (mAHD) 4.06

Report Date : 07-12-21



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
05-09-18	3.28	8.10	2.86
06-09-18	3.28	8.10	2.86
30-10-18	3.51	7.88	3.08
19-12-18	4.08	7.30	3.66
07-01-19	4.39	6.99	3.97
25-01-19	4.73	6.66	4.31
22-02-19	5.95	5.44	5.52
18-09-19	3.77	7.62	3.34
27-11-19	4.34	7.05	3.91
17-12-19	4.66	6.73	4.23
21-01-20	6.29	5.10	5.86
18-02-20	6.79	4.60	6.36
17-03-20	6.31	5.08	5.88
24-04-20	6.31	5.08	5.88
27-05-20	6.31	5.08	5.88
22-06-20	6.31	5.08	5.88
22-07-20	6.31	5.08	5.88
28-08-20	4.09	7.30	3.66
25-09-20	3.90	7.49	3.47
23-10-20	4.05	7.34	3.62
26-11-20	4.15	7.24	3.72

Minimum Recorded Level (mAHD) 4.596
Maximum Recorded Level (mAHD) 8.104

H23024 Rivermark

EMW06 Groundwater Bore 6

Ticket Box / Clay Basin Bore



Data Analysis Period Start Date

1/01/2004

Easting

406305

Data Analysis Period End Date

21/12/2020

Northing

6473648

Natural Surface (mAHD)

5.57

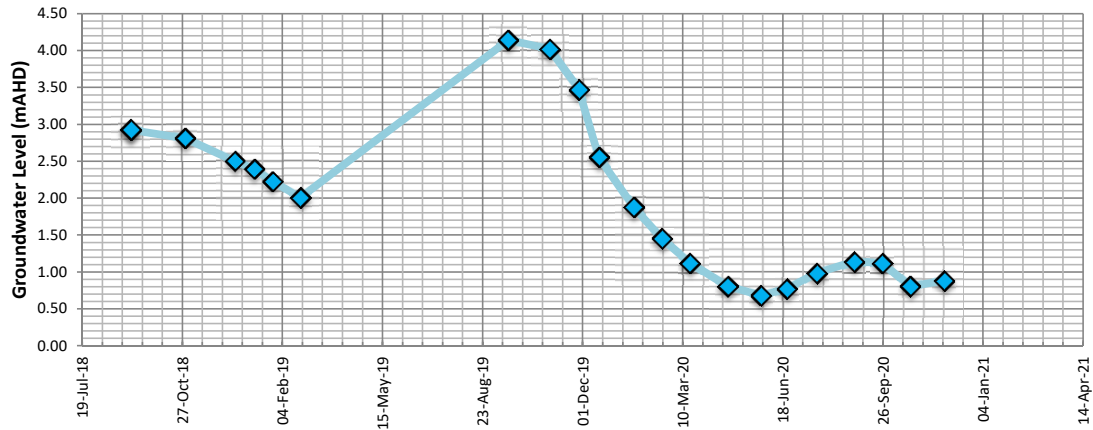
Top of Casing (m AHD)

5.92

End of Hole (mAHD)

-1.53

Report Date : 7/12/2021



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	3.00	2.93	2.64
6/09/2018	3.00	2.93	2.64
30/10/2018	3.11	2.81	2.76
19/12/2018	3.42	2.50	3.07
7/01/2019	3.53	2.40	3.17
25/01/2019	3.69	2.23	3.34
22/02/2019	3.91	2.01	3.56
18/09/2019	1.78	4.14	1.43
29/10/2019	1.90	4.02	1.55
27/11/2019	2.45	3.47	2.10
17/12/2019	3.37	2.55	3.02
21/01/2020	4.05	1.87	3.70
18/02/2020	4.47	1.45	4.12
17/03/2020	4.80	1.12	4.45
24/04/2020	5.12	0.80	4.77
27/05/2020	5.24	0.68	4.89
22/06/2020	5.15	0.77	4.80
22/07/2020	4.94	0.98	4.59
28/08/2020	4.78	1.14	4.43
25/09/2020	4.80	1.12	4.45
23/10/2020	5.12	0.80	4.77
26/11/2020	5.04	0.88	4.69

Minimum Recorded Level (mAHD)

0.684

Maximum Recorded Level (mAHD)

4.144

H23024 Rivermark

**EMW07 Groundwater Bore 7
Whitemans Bore**



Data Analysis Period Start Date
Data Analysis Period End Date

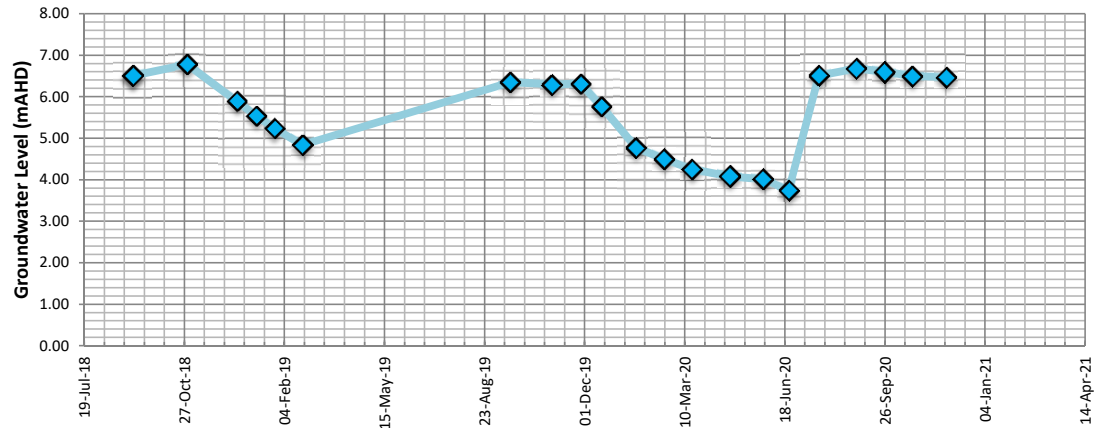
1/01/2004
21/12/2020

Easting
Northing

406580
6473504

Natural Surface (mAHD) 8.37
Top of Casing (m AHD) 8.90
End of Hole (mAHD) 1.67

Report Date : 7/12/2021



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	2.39	6.52	1.86
6/09/2018	2.39	6.52	1.86
30/10/2018	2.12	6.78	1.59
19/12/2018	3.02	5.88	2.49
7/01/2019	3.37	5.53	2.84
25/01/2019	3.66	5.24	3.13
22/02/2019	4.06	4.84	3.53
18/09/2019	2.55	6.35	2.02
29/10/2019	2.60	6.30	2.07
27/11/2019	2.59	6.31	2.06
17/12/2019	3.12	5.78	2.59
21/01/2020	4.12	4.78	3.59
18/02/2020	4.40	4.50	3.87
17/03/2020	4.64	4.26	4.11
24/04/2020	4.82	4.08	4.29
27/05/2020	4.89	4.01	4.36
22/06/2020	5.15	3.75	4.62
22/07/2020	2.39	6.51	1.86
28/08/2020	2.22	6.68	1.69
25/09/2020	2.30	6.60	1.77
23/10/2020	2.40	6.50	1.87
26/11/2020	2.43	6.47	1.90

Minimum Recorded Level (mAHD) 3.75
Maximum Recorded Level (mAHD) 6.776

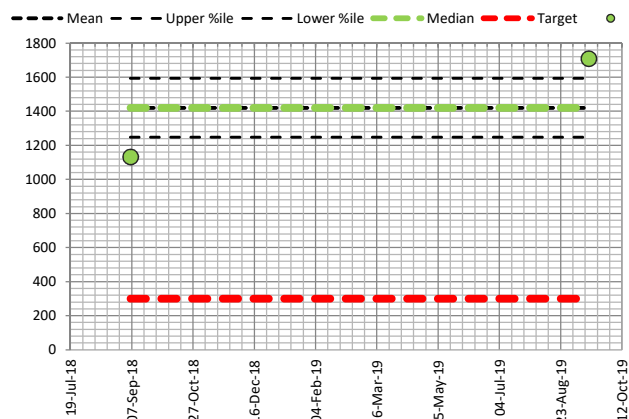
H23024 Rivermark

EMW01 Groundwater Bore 1
North West of Kilne 7 & 8 BoreEasting 405597
Northing 6473545Data Analysis Period Start Date 01-01-04
Data Analysis Period End Date 31-12-20

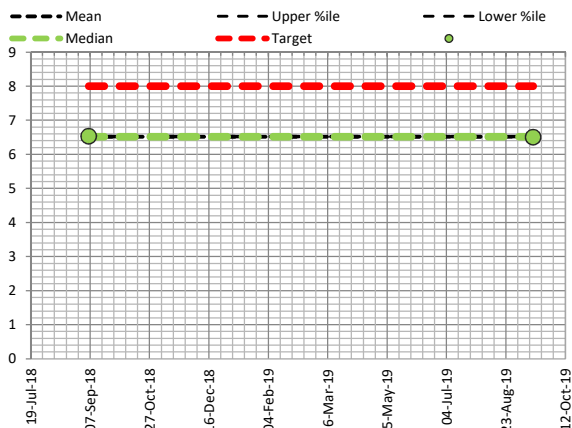
Report Date : 07-12-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	21	4.41	5.12	5.25	5.21	5.45	5.82		0
GWL mAHD	Groundwater Level	mAHD	21	0.23	0.60	0.80	0.84	0.93	1.64		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	2	20.80	21.06	21.45	21.45	21.84	22.10		0
EC	Electrical Conductivity	uS/cm	2	1131.00	1246.40	1419.50	1419.50	1592.60	1708.00	300.00	2
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
DO %	Dissolved Oxygen	%	2	13.40	15.20	17.90	17.90	20.60	22.40	80.00	0
pH	pH	pH	2	6.50	6.51	6.52	6.52	6.52	6.53	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	2	0.50	0.90	1.50	1.50	2.10	2.50	1.20	1
TKN	Total Kjeldahl Nitrogen	mg/L	1	0.50	0.50	0.50	0.50	0.50	0.50		0
NH3-N	Ammonia as N	mg/L	2	0.01	0.06	0.14	0.14	0.21	0.26	1.43	0
NO3-N	Nitrate as N	mg/L	2	0.01	0.01	0.02	0.02	0.03	0.04	3.40	0
NO2-N	Nitrite as N	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	2	0.25	0.32	0.42	0.42	0.52	0.59	0.07	2
FRP	Filterable Reactive Phosphorous	mg/L	2	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	2	0.00100	0.05380	0.13300	0.13300	0.21220	0.26500	0.00180	1
Pb	Lead	mg/L	2	0.00100	0.00420	0.00900	0.00900	0.01380	0.01700	0.00560	1
Ni	Nickel	mg/L	2	0.00300	0.00480	0.00750	0.00750	0.01020	0.01200	0.01300	0
Zn	Zinc	mg/L	2	0.00100	0.06660	0.16500	0.16500	0.26340	0.32900	0.01500	1
Hg	Mercury	mg/L	2	0.00005	0.00006	0.00008	0.00008	0.00009	0.00010	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Nox as N	Nox as N	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Tcoli	Total Coliforms	cfu/100mL	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0

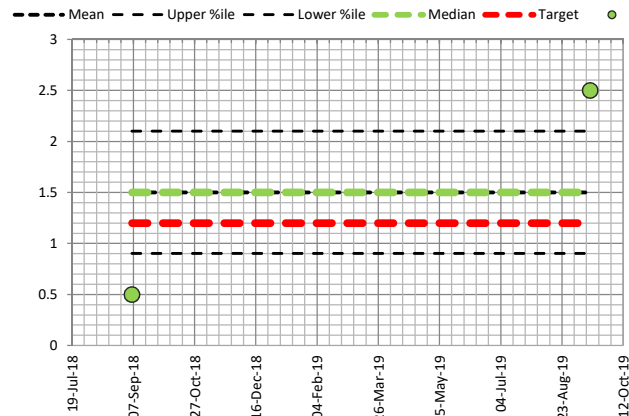
Electrical Conductivity



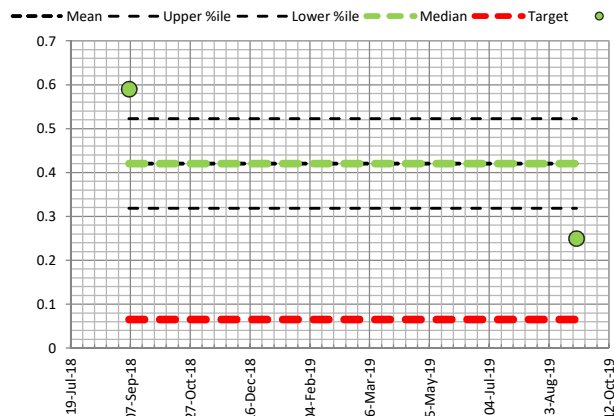
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark
EMW03 Groundwater Bore 3
Oval Storage Area East Bore

Easting 405530
Northing 6473108

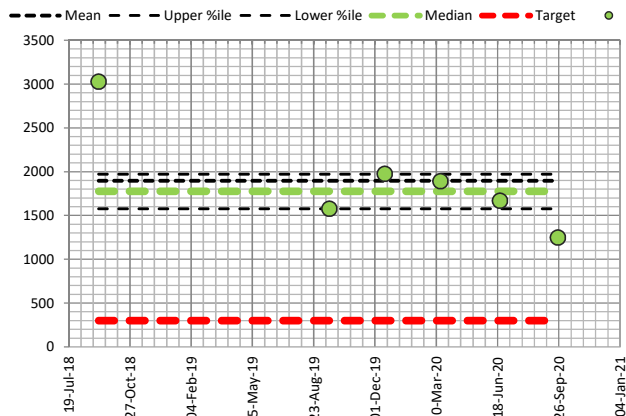
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Data Analysis Period End Date 21/12/2020



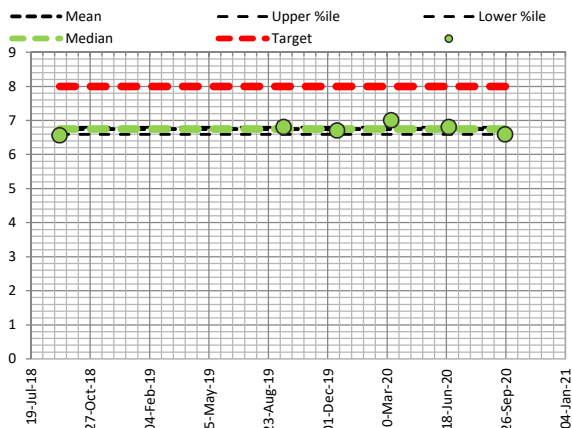
Report Date : 7/12/2021

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	22	9.45	9.70	10.02	10.02	10.34	10.54		0
GWL mAHD	Groundwater Level	mAHD	22	0.80	0.99	1.32	1.32	1.63	1.89		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	6	20.40	21.60	22.68	21.95	22.90	27.30		0
EC	Electrical Conductivity	uS/cm	6	1247.00	1576.00	1896.17	1777.50	1972.00	3027.00	300.00	6
DO	Dissolved Oxygen	mg/L	2	2.04	2.12	2.25	2.25	2.38	2.46		0
DO %	Dissolved Oxygen	%	6	14.20	17.90	28.19	25.97	36.00	49.10	80.00	0
pH	pH	pH	6	6.56	6.59	6.74	6.75	6.80	7.00	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	6	0.10	0.40	1.20	0.75	1.20	4.00	1.20	1
TKN	Total Kjeldahl Nitrogen	mg/L	3	0.10	0.22	0.33	0.40	0.46	0.50		0
NH3-N	Ammonia as N	mg/L	6	0.01	0.01	0.03	0.02	0.04	0.11	1.43	0
NO3-N	Nitrate as N	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.05	3.40	0
NO2-N	Nitrite as N	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	6	0.35	0.42	0.60	0.53	0.68	1.10	0.07	6
FRP	Filterable Reactive Phosphorous	mg/L	6	0.05	0.08	0.15	0.09	0.20	0.37	0.04	6
As	Arsenic	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	6	0.00100	0.00100	0.00133	0.00100	0.00100	0.00300	0.00180	1
Pb	Lead	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	6	0.00100	0.00100	0.00267	0.00150	0.00500	0.00600	0.01300	0
Zn	Zinc	mg/L	6	0.00200	0.00200	0.00483	0.00200	0.00300	0.01800	0.01500	1
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00006	0.00005	0.00005	0.00010	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Nox as N	Nox as N	mg/L	1	0.01	0.00500	0.01	0.01	0.00500	0.01		0
Tcoli	Total Coloiforms	cfu/100mL	0	0.00	0.0	0.00	0.00	0.0	0.00		0

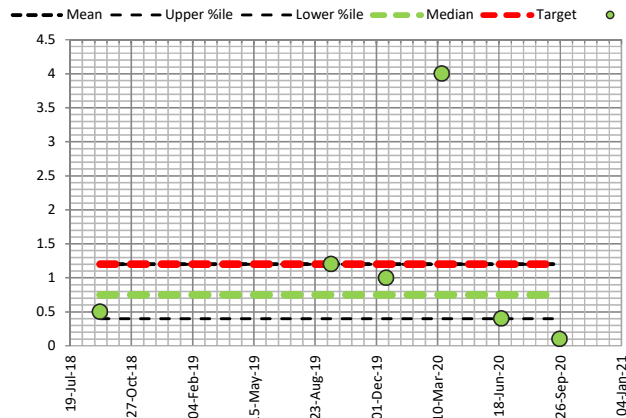
Electrical Conductivity



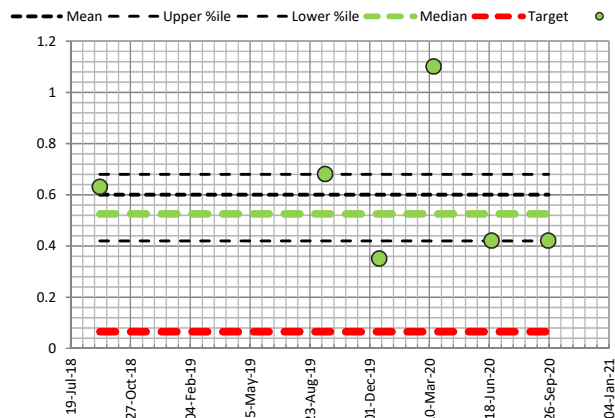
pH



Total Nitrogen



Total Phosphorous



H23024 Rivermark

EMW05 Groundwater Bore 5

Clay Shed Bore

Easting 406135

Northing 6473245

Data Analysis Period Start Date 01-01-04

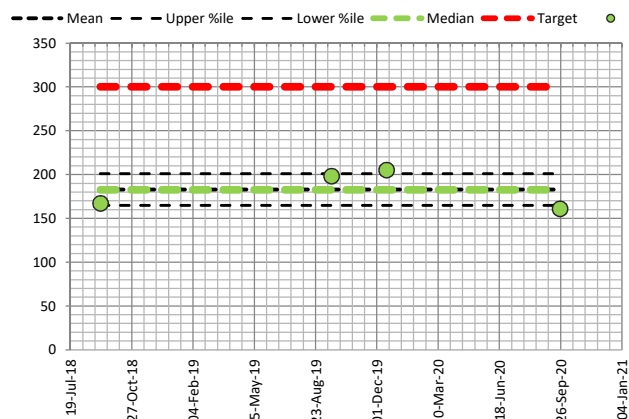
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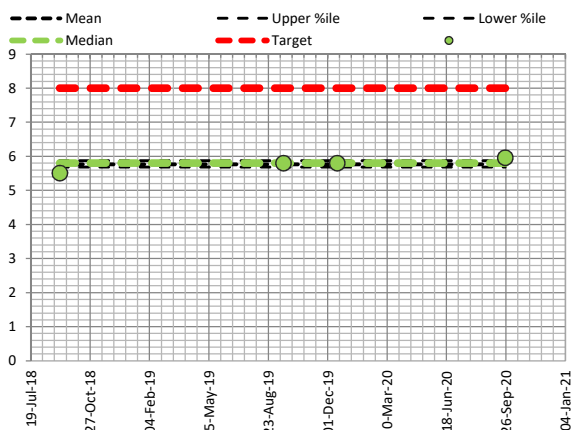
Report Date : 07-12-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	21	3.28	3.90	4.90	4.39	6.31	6.79		0
GWL mAHD	Groundwater Level	mAHD	21	4.60	5.08	6.49	6.99	7.49	8.10		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	4	17.90	18.80	21.38	20.35	23.54	26.90		0
EC	Electrical Conductivity	uS/cm	4	161.00	164.60	182.75	182.50	200.80	205.00	300.00	0
DO	Dissolved Oxygen	mg/L	1	1.95	1.95	1.95	1.95	1.95	1.95		0
DO %	Dissolved Oxygen	%	4	13.80	18.72	35.33	25.35	47.94	76.80	80.00	0
pH	pH	pH	4	5.51	5.68	5.77	5.80	5.86	5.96	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	4	0.20	0.38	0.63	0.55	0.84	1.20	1.20	0
TKN	Total Kjeldahl Nitrogen	mg/L	2	0.20	0.26	0.35	0.35	0.44	0.50		0
NH3-N	Ammonia as N	mg/L	4	0.01	0.01	0.04	0.03	0.06	0.07	1.43	0
NO3-N	Nitrate as N	mg/L	4	0.04	0.06	0.21	0.21	0.37	0.40	3.40	0
NO2-N	Nitrite as N	mg/L	4	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	4	0.05	0.05	0.11	0.08	0.16	0.25	0.07	2
FRP	Filterable Reactive Phosphorous	mg/L	4	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0
As	Arsenic	mg/L	4	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	4	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	4	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	4	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00180	0
Pb	Lead	mg/L	4	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	4	0.00100	0.00100	0.00150	0.00100	0.00180	0.00300	0.01300	0
Zn	Zinc	mg/L	4	0.00400	0.00580	0.00825	0.00800	0.01060	0.01300	0.01500	0
Hg	Mercury	mg/L	4	0.00005	0.00005	0.00006	0.00005	0.00007	0.00010	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Nox as N	Nox as N	mg/L	1	0.07	0.07000	0.07	0.07	0.07000	0.07		0
Tcoli	Total Coloiforms	cfu/100mL	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0

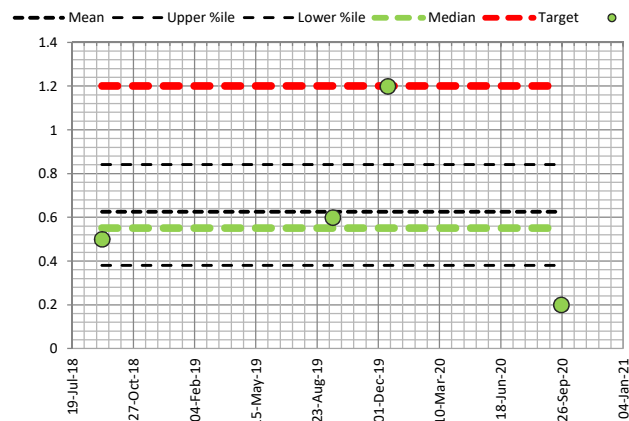
Electrical Conductivity



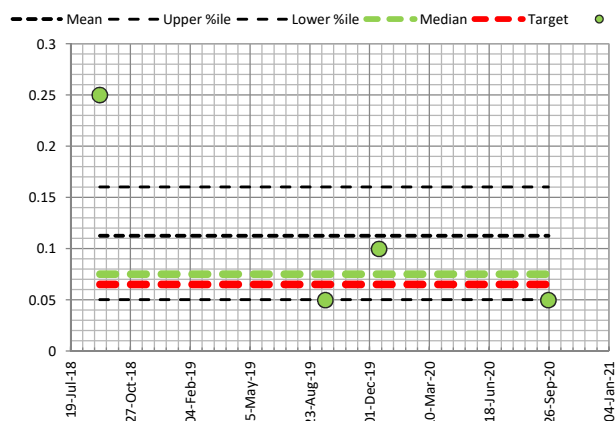
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark
EMW06 Groundwater Bore 6
Ticket Box / Clay Basin Bore

Easting 406305
 Northing 6473648

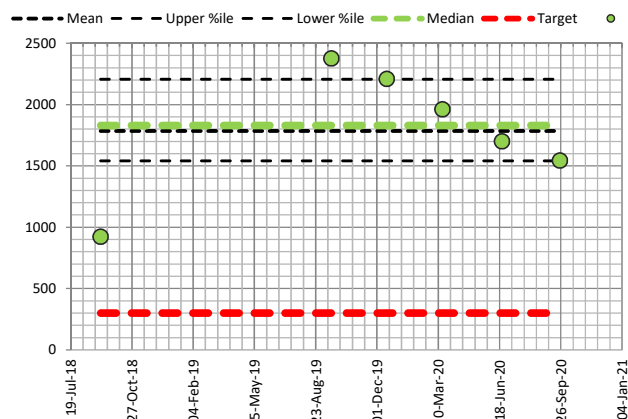
Data Analysis Period Start Date 1/01/2004
 Data Analysis Period End Date 21/12/2020



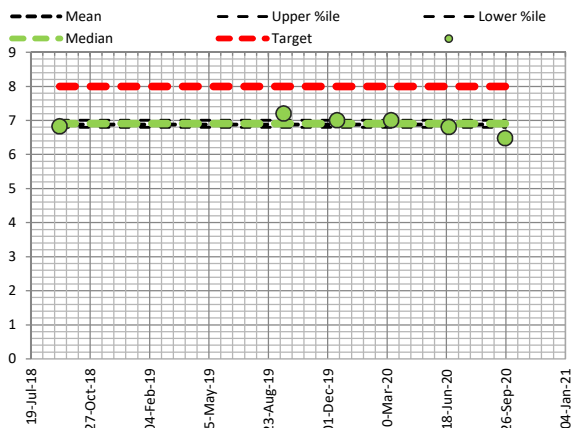
Report Date : 7/12/2021

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	22	1.78	3.02	3.94	3.98	5.02	5.24		0
GWL mAHD	Groundwater Level	mAHD	22	0.68	0.90	1.98	1.94	2.90	4.14		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	5	18.30	18.54	21.74	22.30	24.36	25.40		0
EC	Electrical Conductivity	uS/cm	6	922.00	1542.00	1784.50	1830.00	2207.00	2376.00	300.00	6
DO	Dissolved Oxygen	mg/L	1	1.56	1.56	1.56	1.56	1.56	1.56		0
DO %	Dissolved Oxygen	%	5	11.00	12.36	17.06	17.80	19.62	25.70	80.00	0
pH	pH	pH	6	6.47	6.80	6.88	6.91	7.00	7.20	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	6	0.30	0.40	0.52	0.50	0.60	0.80	1.20	0
TKN	Total Kjeldahl Nitrogen	mg/L	3	0.10	0.18	0.30	0.30	0.42	0.50		0
NH3-N	Ammonia as N	mg/L	6	0.01	0.01	0.02	0.01	0.02	0.08	1.43	0
NO3-N	Nitrate as N	mg/L	6	0.01	0.01	0.09	0.02	0.02	0.45	3.40	0
NO2-N	Nitrite as N	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	6	0.05	0.05	0.06	0.05	0.06	0.12	0.07	1
FRP	Filterable Reactive Phosphorous	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0
As	Arsenic	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	6	0.00100	0.00100	0.00117	0.00100	0.00100	0.00200	0.00180	1
Pb	Lead	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	6	0.00100	0.00100	0.00350	0.00150	0.00400	0.01200	0.01300	0
Zn	Zinc	mg/L	6	0.00300	0.00300	0.00883	0.00600	0.00700	0.02800	0.01500	1
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00006	0.00005	0.00005	0.00010	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Nox as N	Nox as N	mg/L	1	0.45	0.45000	0.45	0.45	0.45000	0.45		0
Tcoli	Total Coliforms	cfu/100mL	0	0.00	0.0	0.00	0.00	0.0	0.00		0

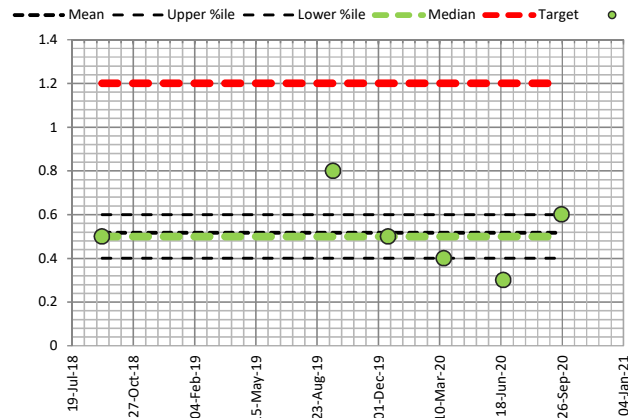
Electrical Conductivity



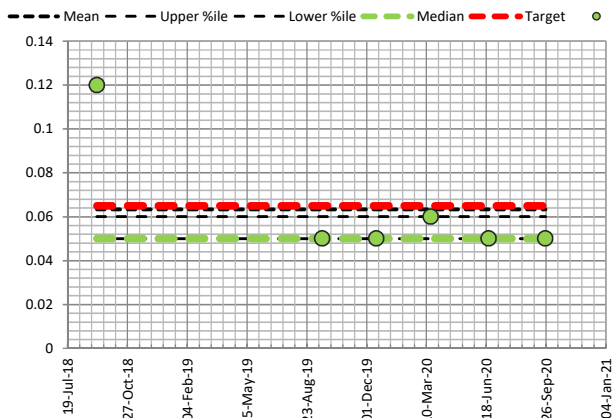
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark

EMW07 Groundwater Bore 7

Whitemans Bore

Easting 406580

Northing 6473504

Data Analysis Period Start Date 1/01/2004

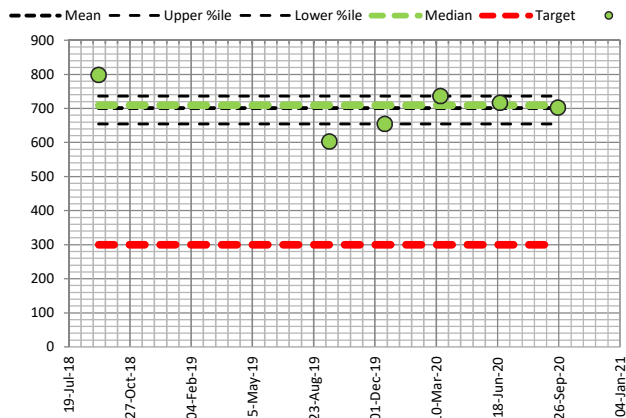
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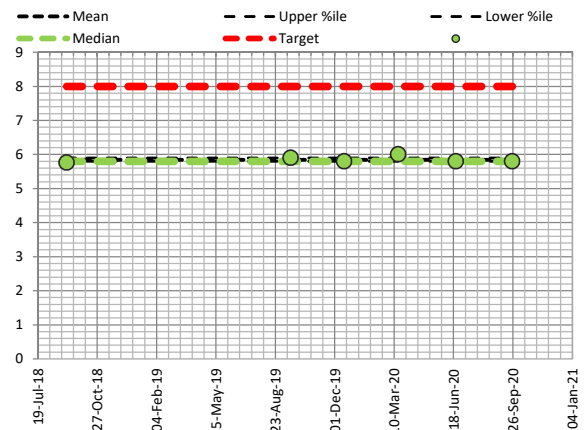
Report Date : 7/12/2021

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	22	2.12	2.39	3.26	2.81	4.34	5.15		0
GWL mAHD	Groundwater Level	mAHD	22	3.75	4.56	5.64	6.09	6.51	6.78		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	6	20.00	20.60	23.07	22.90	25.00	27.00		0
EC	Electrical Conductivity	uS/cm	6	602.00	654.00	701.33	709.00	736.00	798.00	300.00	6
DO	Dissolved Oxygen	mg/L	2	1.70	1.82	2.00	2.00	2.18	2.30		0
DO %	Dissolved Oxygen	%	6	18.20	19.90	24.80	24.95	29.90	30.90	80.00	0
pH	pH	pH	6	5.76	5.80	5.84	5.80	5.90	6.00	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	6	11.00	14.00	19.05	15.00	19.00	40.30	1.20	6
TKN	Total Kjeldahl Nitrogen	mg/L	3	0.10	0.34	2.67	0.70	4.60	7.20		0
NH3-N	Ammonia as N	mg/L	6	0.01	0.01	0.08	0.01	0.13	0.31	1.43	0
NO3-N	Nitrate as N	mg/L	6	10.00	10.00	15.85	11.00	20.00	33.10	3.40	6
NO2-N	Nitrite as N	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.03		0
TP	Total Phosphorous	mg/L	6	0.05	0.06	0.21	0.18	0.35	0.44	0.07	4
FRP	Filterable Reactive Phosphorous	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0
As	Arsenic	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	6	0.00100	0.00100	0.00133	0.00100	0.00100	0.00300		0
Cu	Copper	mg/L	6	0.00100	0.00100	0.00300	0.00150	0.00400	0.00900	0.00180	3
Pb	Lead	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	6	0.00100	0.00100	0.00150	0.00100	0.00200	0.00300	0.01300	0
Zn	Zinc	mg/L	6	0.00100	0.00100	0.00817	0.00500	0.01000	0.02700	0.01500	1
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00006	0.00005	0.00005	0.00010	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Nox as N	Nox as N	mg/L	1	20.00	20.00000	20.00	20.00	20.00000	20.00		0
Tcol	Total Coliforms	cfu/100mL	0	0.00	0.0	0.00	0.00	0.0	0.00		0

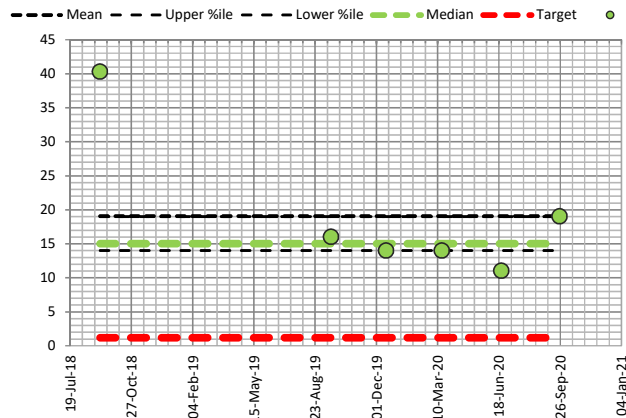
Electrical Conductivity



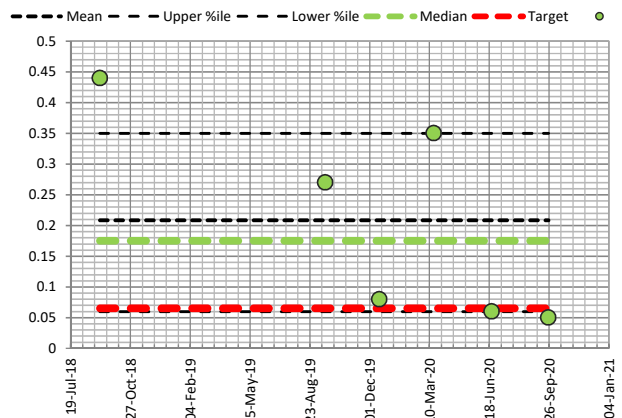
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark
SW6 Surface Water Site 6
MB : Clay Basin

Easting
Northing

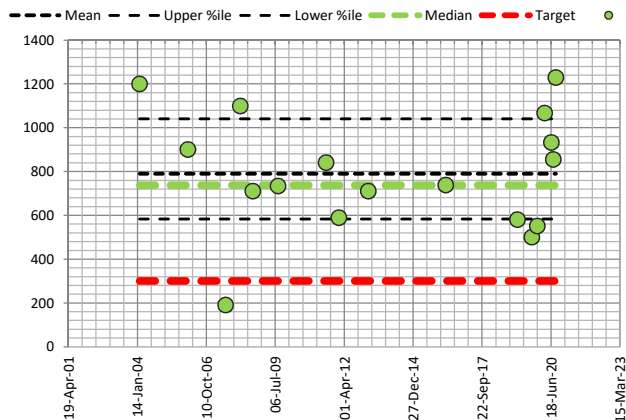
Data Analysis Period Start Date **01-01-04**
Data Analysis Period End Date **31-12-20**



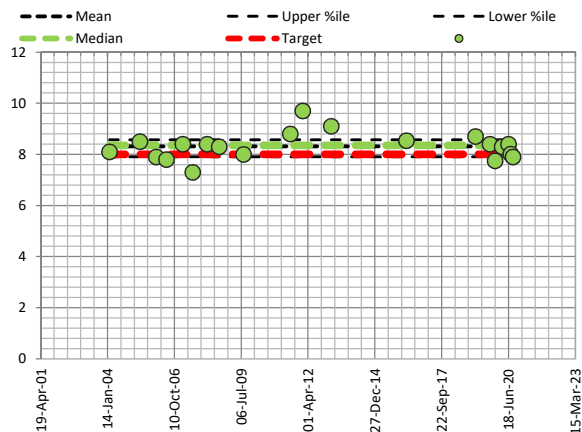
Report Date : 07-12-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	5	16.70	17.74	21.60	20.40	25.22	28.50		0
EC	Electrical Conductivity	uS/cm	17	190.00	582.00	789.88	738.00	1040.20	1230.00	300.00	16
DO	Dissolved Oxygen	mg/L	15	6.10	7.53	8.51	8.50	9.39	11.20		0
DO %	Dissolved Oxygen	%	5	60.40	76.48	87.20	84.00	98.08	118.00	80.00	4
pH	pH	pH	20	7.30	7.90	8.31	8.35	8.56	9.70	8.00	14
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	1	8.07	8.07	8.07	8.07	8.07	8.07	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	18	0.30	0.46	0.72	0.66	0.94	1.30	1.20	2
TKN	Total Kjeldahl Nitrogen	mg/L	9	0.53	0.56	0.77	0.70	0.89	1.30		0
NH3-N	Ammonia as N	mg/L	15	0.01	0.01	0.05	0.02	0.08	0.26	1.43	0
NO3-N	Nitrate as N	mg/L	19	0.01	0.01	0.17	0.05	0.20	1.60	3.40	0
NO2-N	Nitrite as N	mg/L	10	0.01	0.01	0.03	0.03	0.05	0.06		0
TP	Total Phosphorous	mg/L	20	0.01	0.01	0.03	0.03	0.05	0.09	0.07	3
FRP	Filterable Reactive Phosphorous	mg/L	8	0.00	0.01	0.00	0.01	0.01	0.01	0.04	0
As	Arsenic	mg/L	23	0.00100	0.00100	0.00174	0.00100	0.00200	0.00500	0.09400	0
Cd	Cadmium	mg/L	23	0.00010	0.00010	0.00136	0.00010	0.00340	0.00500	0.00040	10
Cr	Chromium	mg/L	22	0.00010	0.00100	0.01387	0.00200	0.04480	0.05000		0
Cu	Copper	mg/L	23	0.00010	0.00100	0.01283	0.00100	0.03400	0.05000	0.00180	10
Pb	Lead	mg/L	23	0.00010	0.00100	0.00840	0.00100	0.00500	0.05000	0.00560	3
Ni	Nickel	mg/L	23	0.00100	0.00100	0.00874	0.00100	0.00500	0.05000	0.01300	3
Zn	Zinc	mg/L	23	0.00100	0.00500	0.02013	0.00900	0.05000	0.11000	0.01500	6
Hg	Mercury	mg/L	21	0.00005	0.00005	0.00009	0.00005	0.00005	0.00080	0.00190	0
TDS	Total Dissolved Solids	mg/L	1	358.00	358.00000	358.00	358.00	358.00000	358.00		0
Nox as N	Nox as N	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Tcoli	Total Coloiforms	cfu/100mL	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0

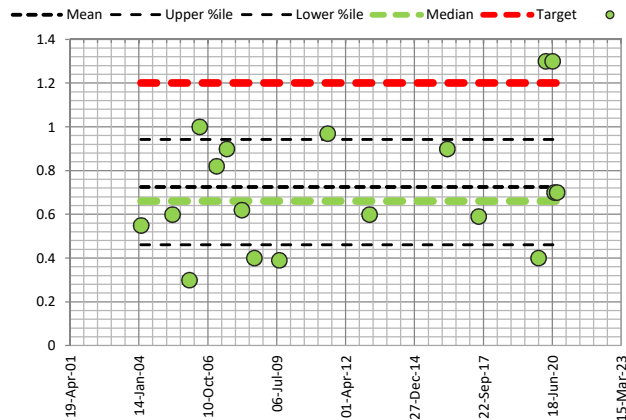
Electrical Conductivity



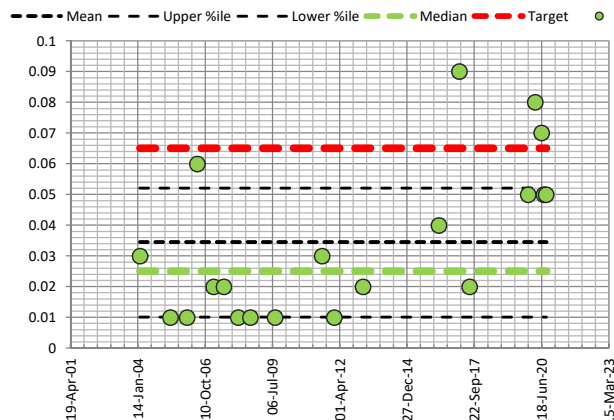
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark
SW7 Surface Water Site 7
MB : Northern Storage Pond 4

Easting
Northing

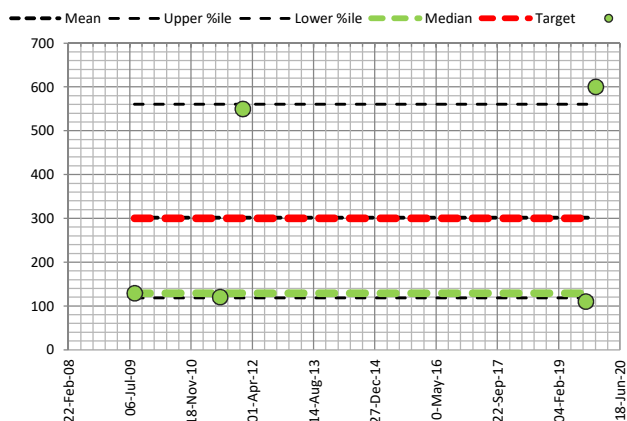
Data Analysis Period Start Date **01-01-04**
Data Analysis Period End Date **31-12-20**



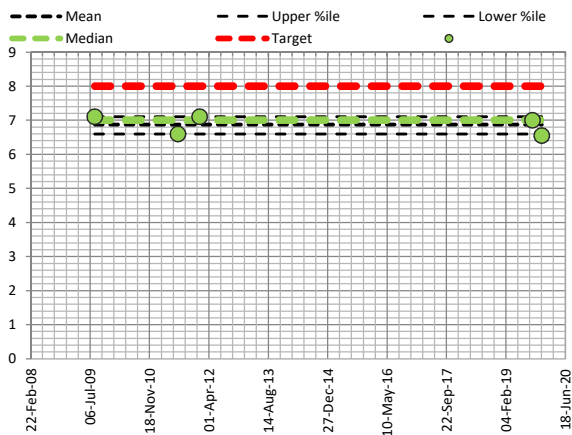
Report Date : 07-12-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	1	27.20	27.20	27.20	27.20	27.20	27.20		0
EC	Electrical Conductivity	uS/cm	5	110.00	118.00	301.80	129.00	560.00	600.00	300.00	2
DO	Dissolved Oxygen	mg/L	4	4.10	4.23	4.92	4.56	5.46	6.45		0
DO %	Dissolved Oxygen	%	1	81.70	81.70	81.70	81.70	81.70	81.70	80.00	1
pH	pH	pH	5	6.55	6.59	6.87	7.00	7.10	7.10	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	1	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	4	0.26	0.34	0.51	0.45	0.64	0.86	1.20	0
TKN	Total Kjeldahl Nitrogen	mg/L	3	0.36	0.41	1.28	0.48	1.99	3.00		0
NH3-N	Ammonia as N	mg/L	2	0.01	0.02	0.03	0.03	0.04	0.05	1.43	0
NO3-N	Nitrate as N	mg/L	4	0.01	0.01	0.07	0.03	0.11	0.20	3.40	0
NO2-N	Nitrite as N	mg/L	2	0.01	0.10	0.25	0.25	0.40	0.50		0
TP	Total Phosphorous	mg/L	5	0.05	0.05	0.13	0.07	0.15	0.36	0.07	3
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0
As	Arsenic	mg/L	7	0.00100	0.00100	0.00186	0.00100	0.00200	0.00500	0.09400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00023	0.00010	0.00010	0.00100	0.00040	1
Cr	Chromium	mg/L	6	0.00100	0.00100	0.16917	0.00300	0.00700	1.00000		0
Cu	Copper	mg/L	7	0.00100	0.00100	0.28829	0.00100	0.00820	2.00000	0.00180	3
Pb	Lead	mg/L	7	0.00100	0.00100	0.00214	0.00100	0.00420	0.00500	0.00560	0
Ni	Nickel	mg/L	7	0.00100	0.00120	0.00757	0.00200	0.00680	0.03400	0.01300	1
Zn	Zinc	mg/L	7	0.00500	0.00600	0.04343	0.02800	0.06340	0.14000	0.01500	4
Hg	Mercury	mg/L	7	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	1	387.00	387.00000	387.00	387.00	387.00000	387.00		0
Nox as N	Nox as N	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Tcoli	Total Coloiforms	cfu/100mL	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0

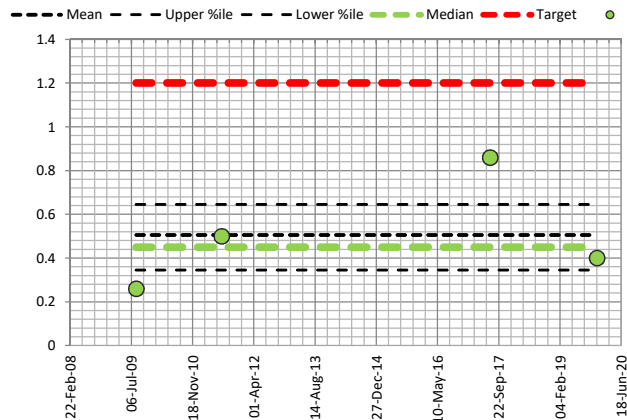
Electrical Conductivity



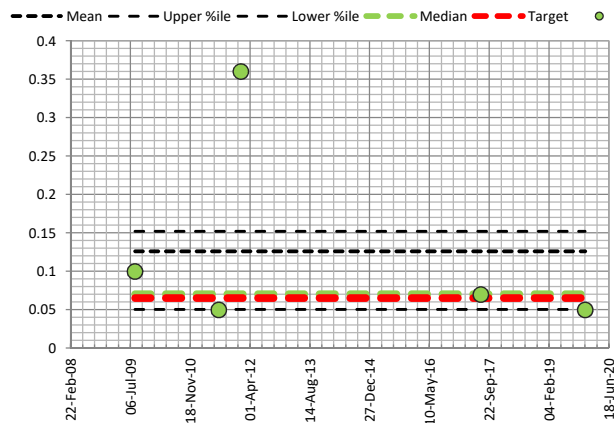
pH



Total Nitrogen



Total Phosphorous



H23024 Rivermark

SW11 Surface Water Site 11

MB : Main Site Sump and Pump

Easting

Northing

Data Analysis Period Start Date

01-01-04

Data Analysis Period End Date

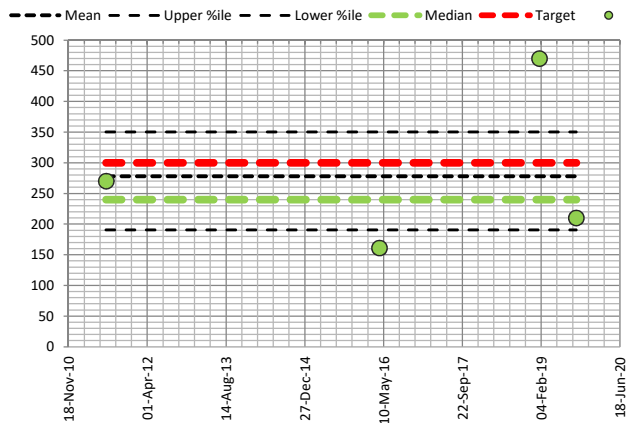
31-12-20



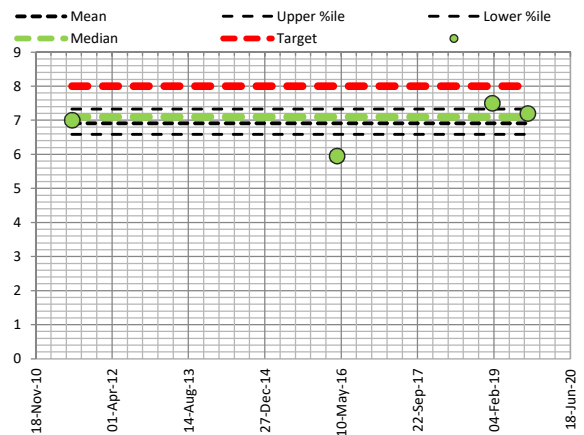
Report Date : 07-12-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
COD	Chemical Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
BOD	Biological Oxygen Demand	mg/L	0	0.00	0.000	0.000	0.000	0.000	0.000		0
T	Temperature	°C	0	0.00	0.00	0.00	0.00	0.00	0.00		0
EC	Electrical Conductivity	uS/cm	4	161.00	190.40	277.75	240.00	350.00	470.00	300.00	1
DO	Dissolved Oxygen	mg/L	2	0.87	0.90	0.94	0.94	0.97	1.00		0
DO %	Dissolved Oxygen	%	0	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0
pH	pH	pH	4	5.95	6.58	6.91	7.10	7.32	7.50	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	3	0.51	0.99	1.50	1.70	2.06	2.30	1.20	2
TKN	Total Kjeldahl Nitrogen	mg/L	4	0.47	0.60	1.27	1.20	1.90	2.20		0
NH3-N	Ammonia as N	mg/L	3	0.05	0.05	0.22	0.05	0.35	0.55	1.43	0
NO3-N	Nitrate as N	mg/L	4	0.05	0.05	0.06	0.05	0.06	0.07	3.40	0
NO2-N	Nitrite as N	mg/L	3	0.05	0.05	0.05	0.05	0.05	0.05		0
TP	Total Phosphorous	mg/L	4	0.03	0.07	2.05	0.24	3.30	7.70	0.07	3
FRP	Filterable Reactive Phosphorous	mg/L	3	0.01	0.01	0.02	0.01	0.03	0.05	0.04	1
As	Arsenic	mg/L	7	0.00100	0.00100	0.00129	0.00100	0.00100	0.00300	0.09400	0
Cd	Cadmium	mg/L	7	0.00010	0.00010	0.00023	0.00010	0.00010	0.00100	0.00040	1
Cr	Chromium	mg/L	6	0.00010	0.00100	0.00085	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	7	0.00010	0.00100	0.00087	0.00100	0.00100	0.00100	0.00180	0
Pb	Lead	mg/L	7	0.00010	0.00100	0.00087	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	7	0.00100	0.00140	0.00529	0.00400	0.00680	0.01500	0.01300	1
Zn	Zinc	mg/L	7	0.00200	0.00500	0.00957	0.00800	0.01160	0.02500	0.01500	1
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Nox as N	Nox as N	mg/L	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0
Tcoli	Total Coliforms	cfu/100mL	0	0.00	0.00000	0.00	0.00	0.00000	0.00		0

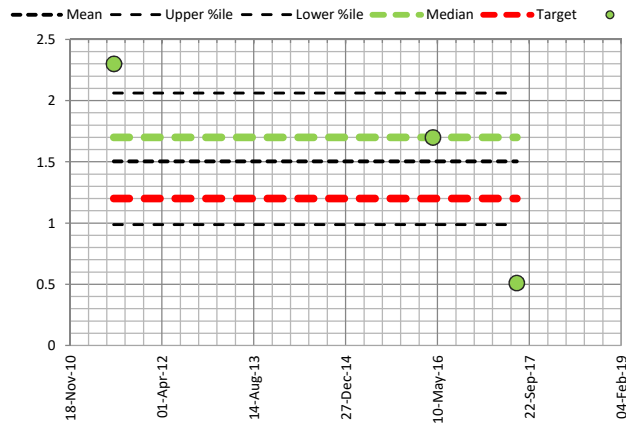
Electrical Conductivity



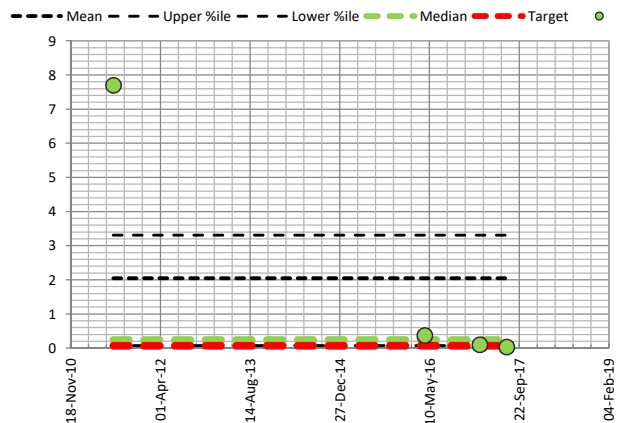
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark Area 3
Swan River Sites
Swan River Upstream Site

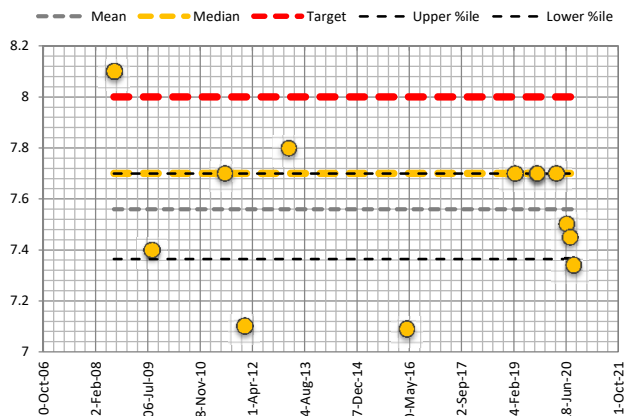
Data Analysis Period Start Date 01-01-04
Data Analysis Period End Date 31-12-20



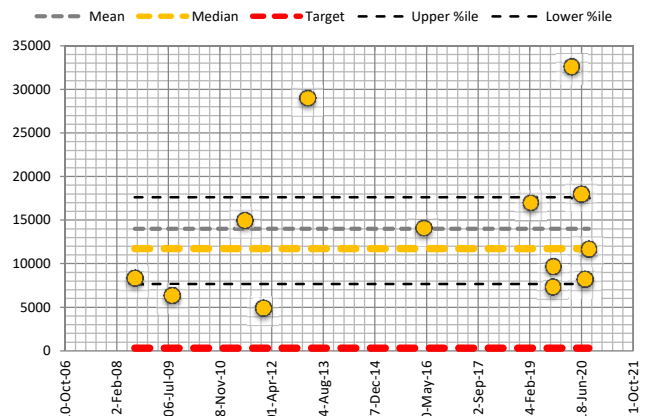
Report Date : 01-09-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
SWL	Surface Water Level	m	0	0.00	0.00	0.000	0.000	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.00	0.000	0.000	0.000	0.000		0
T	Temperature	°C	5	15.20	16.16	18.52	17.30	20.86	23.50		0
EC	Electrical Conductivity	uS/cm	13	4900.00	7656.00	14012.08	11720.00	17631.80	32612.00	300.00	13
DO	Dissolved Oxygen	mg/L	9	3.16	4.72	6.51	5.74	9.08	10.30		0
DO %	Dissolved Oxygen	%	5	46.30	47.74	53.03	53.20	56.45	62.65	80.00	0
pH	pH	pH	13	7.09	7.36	7.56	7.70	7.70	8.10	8.00	1
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	11	0.80	0.90	1.24	1.10	1.54	2.20	1.20	4
TKN	Total Kjeldahl Nitrogen	mg/L	9	0.80	0.86	1.49	1.10	2.16	2.70		0
NH3-N	Ammonia as N	mg/L	9	0.01	0.03	0.12	0.06	0.20	0.40	1.43	0
NO3-N	Nitrate as N	mg/L	12	0.01	0.04	0.43	0.10	0.41	2.25	3.40	0
NO2-N	Nitrite as N	mg/L	9	0.01	0.01	0.05	0.01	0.07	0.25		0
TP	Total Phosphorous	mg/L	13	0.01	0.04	0.08	0.06	0.10	0.23	0.07	6
FRP	Filterable Reactive Phosphorous	mg/L	8	0.01	0.01	0.02	0.01	0.03	0.08	0.04	2
As	Arsenic	mg/L	15	0.00100	0.00100	0.00340	0.00400	0.00500	0.01000	0.09400	0
Cd	Cadmium	mg/L	15	0.00010	0.00010	0.00092	0.00010	0.00060	0.00500	0.00040	7
Cr	Chromium	mg/L	14	0.00050	0.00100	0.00411	0.00100	0.00500	0.02500		0
Cu	Copper	mg/L	15	0.00050	0.00100	0.00437	0.00300	0.00500	0.02500	0.00180	10
Pb	Lead	mg/L	15	0.00050	0.00100	0.00250	0.00100	0.00500	0.00500	0.00560	0
Ni	Nickel	mg/L	15	0.00100	0.00100	0.00467	0.00300	0.00500	0.02500	0.01300	1
Zn	Zinc	mg/L	15	0.00100	0.00460	0.01600	0.01300	0.02500	0.05000	0.01500	6
Hg	Mercury	mg/L	13	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
Nox as N	Nox as N	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0

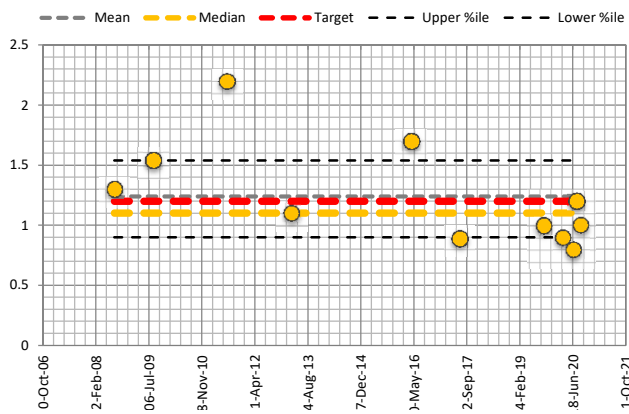
pH



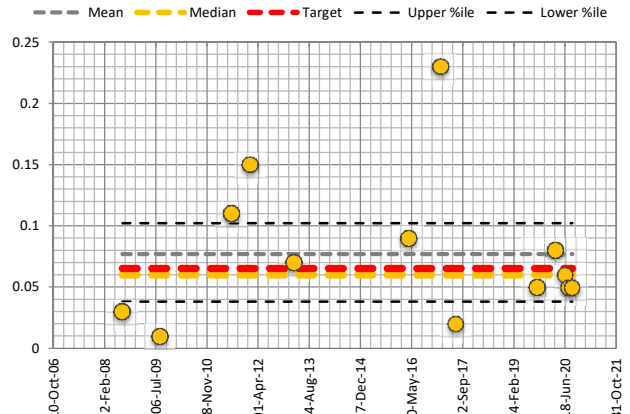
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H23024 Rivermark Area 3
Swan River Sites
Swan River Downstream Site

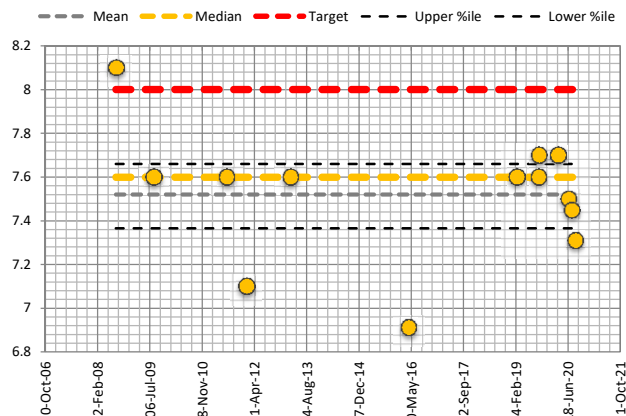
Data Analysis Period Start Date 01-01-04
Data Analysis Period End Date 31-12-20



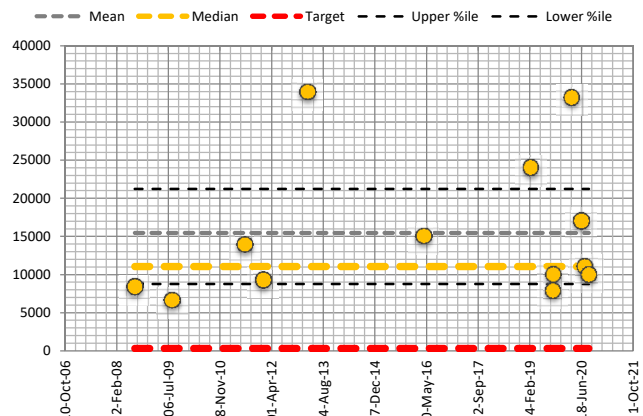
Report Date : 01-09-21

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToc	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
SWL	Surface Water Level	m	0	0.00	0.00	0.000	0.000	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.00	0.000	0.000	0.000	0.000		0
T	Temperature	°C	5	15.70	15.78	18.48	17.80	20.38	23.50		0
EC	Electrical Conductivity	uS/cm	13	6675.00	8760.00	15455.31	11061.00	21227.60	34000.00	300.00	13
DO	Dissolved Oxygen	mg/L	9	2.85	4.86	6.42	5.82	8.80	10.20		0
DO %	Dissolved Oxygen	%	5	37.50	42.30	53.85	62.30	62.69	63.47	80.00	0
pH	pH	pH	13	6.91	7.37	7.52	7.60	7.66	8.10	8.00	1
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	0	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	11	0.80	0.90	1.31	1.10	1.69	2.30	1.20	5
TKN	Total Kjeldahl Nitrogen	mg/L	9	0.70	0.83	1.57	1.40	2.26	3.00		0
NH3-N	Ammonia as N	mg/L	9	0.01	0.02	0.13	0.07	0.22	0.43	1.43	0
NO3-N	Nitrate as N	mg/L	12	0.01	0.05	0.48	0.12	0.39	2.68	3.40	0
NO2-N	Nitrite as N	mg/L	9	0.01	0.01	0.06	0.01	0.08	0.30		0
TP	Total Phosphorous	mg/L	13	0.03	0.04	0.09	0.06	0.12	0.23	0.07	6
FRP	Filterable Reactive Phosphorous	mg/L	8	0.01	0.01	0.03	0.01	0.06	0.08	0.04	3
As	Arsenic	mg/L	15	0.00100	0.00100	0.00320	0.00200	0.00500	0.01000	0.09400	0
Cd	Cadmium	mg/L	15	0.00010	0.00010	0.00092	0.00010	0.00060	0.00500	0.00040	7
Cr	Chromium	mg/L	14	0.00050	0.00100	0.00411	0.00100	0.00500	0.02500		0
Cu	Copper	mg/L	15	0.00050	0.00180	0.00510	0.00500	0.00500	0.02500	0.00180	12
Pb	Lead	mg/L	15	0.00050	0.00100	0.00257	0.00100	0.00500	0.00500	0.00560	0
Ni	Nickel	mg/L	15	0.00100	0.00100	0.00547	0.00500	0.00560	0.02500	0.01300	1
Zn	Zinc	mg/L	15	0.00100	0.00500	0.01853	0.02100	0.02560	0.05000	0.01500	8
Hg	Mercury	mg/L	13	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
Nox as N	Nox as N	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0

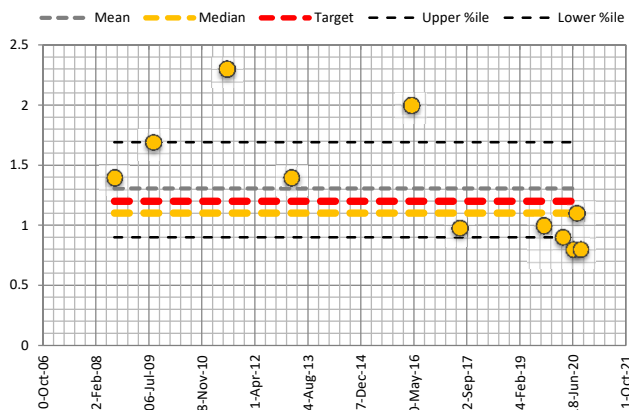
pH



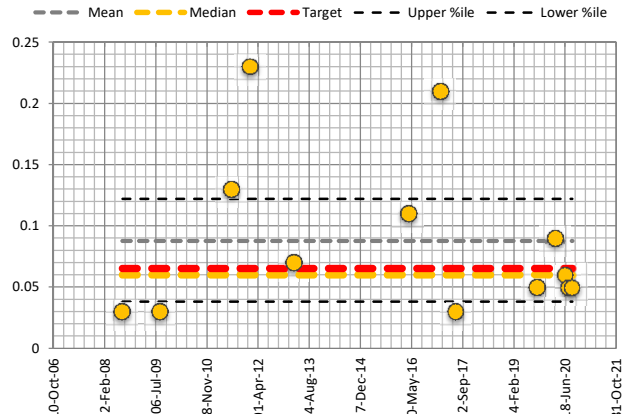
Electrical Conductivity



Total Nitrogen



Total Phosphorous



TOTAL RECOVERABLE HYDROCARBONS (µg/L)

below detectable limit

Surface Water Site : SW6 (Clay Basin)

Parameter	9/08/2021	29/09/2021	27/10/2021	21/12/2021
TRH C6 - C9	10	10	10	10
TRH C6 - C10	10	10	10	10
TRH C6 - C10 less BTEX (F1)	10	10	10	10
MTBE	1	1	1	1
Benzene	1	1	1	1
Toluene	1	1	1	1
Ethylbenzene	1	1	1	1
m+p-xylene	2	2	2	2
o-xylene	1	1	1	1
TRH C10 - C14	50	50	50	50
TRH C15 - C28	100	100	100	100
TRH C29 - C36	100	100	100	100
TRH >C10 - C16	50	50	50	50
TRH >C10 - C16 less N (F2)	50	50	50	50
TRH >C16 - C34	100	100	100	100
TRH >C34 - C40	100	100	100	100
Napthalene	1	1	1	1

H23024 Rivermark

SW3 Surface Water Site 3

Blackadder Tributary : Eveline Rd

Easting

Northing

Data Analysis Period Start Date

1/01/2021

Data Analysis Period End Date

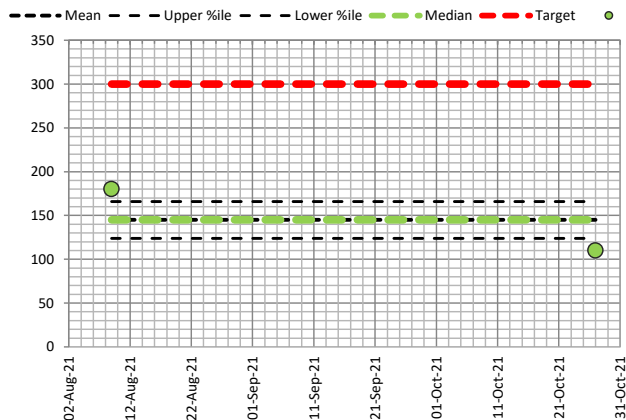
31/12/2024



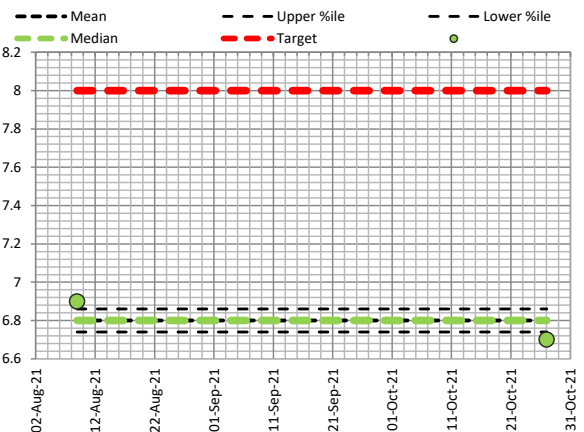
Report Date : 18/03/2025

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
COD	Chemical Oxygen Demand	mg/L	2	68.00	70.200	73.500	73.500	76.800	79.000		0
BOD	Biological Oxygen Demand	mg/L	2	5.00	6.000	7.500	7.500	9.000	10.000		0
T	Temperature	°C	0	0.00	0.00	0.00	0.00	0.00	0.00		0
EC	Electrical Conductivity	uS/cm	2	110.00	124.00	145.00	145.00	166.00	180.00	300.00	0
DO	Dissolved Oxygen	mg/L	2	4.70	4.76	4.85	4.85	4.94	5.00		0
DO %	Dissolved Oxygen	%	0	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0
pH	pH	pH	2	6.70	6.74	6.80	6.80	6.86	6.90	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	3	15.00	21.00	61.67	30.00	96.00	140.00	20.00	2
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	3	0.50	0.78	1.07	1.20	1.38	1.50	1.20	1
TKN	Total Kjeldahl Nitrogen	mg/L	3	0.50	0.78	1.07	1.20	1.38	1.50		0
NH3-N	Ammonia as N	mg/L	3	0.01	0.03	0.07	0.06	0.11	0.14	1.43	0
NO3-N	Nitrate as N	mg/L	3	0.01	0.01	0.01	0.01	0.01	0.01	3.40	0
NO2-N	Nitrite as N	mg/L	3	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	3	0.05	0.06	0.07	0.07	0.08	0.08	0.07	2
FRP	Filterable Reactive Phosphorous	mg/L	3	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0
As	Arsenic	mg/L	3	0.00100	0.00100	0.00113	0.00100	0.00124	0.00140	0.09400	0
Cd	Cadmium	mg/L	3	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	3	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	3	0.00100	0.00100	0.00133	0.00100	0.00160	0.00200	0.00180	1
Pb	Lead	mg/L	3	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	3	0.00100	0.00124	0.00187	0.00160	0.00244	0.00300	0.01300	0
Zn	Zinc	mg/L	3	0.00410	0.01726	0.02737	0.03700	0.03940	0.04100	0.01500	2
Hg	Mercury	mg/L	3	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	1	84.00	84.00000	84.00	84.00	84.00000	84.00		0
Nox as N	Nox as N	mg/L	3	0.01	0.00620	0.01	0.01	0.01220	0.02		0
Tcoli	Total Coliforms	cfu/100mL	0	0.00	0.0	0.00	0.00	0.0	0.00		0

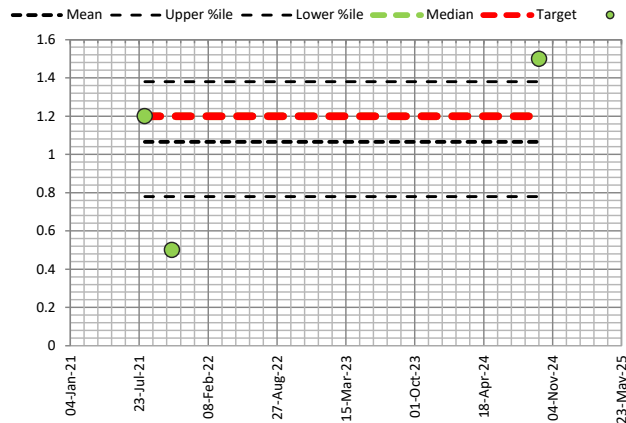
Electrical Conductivity



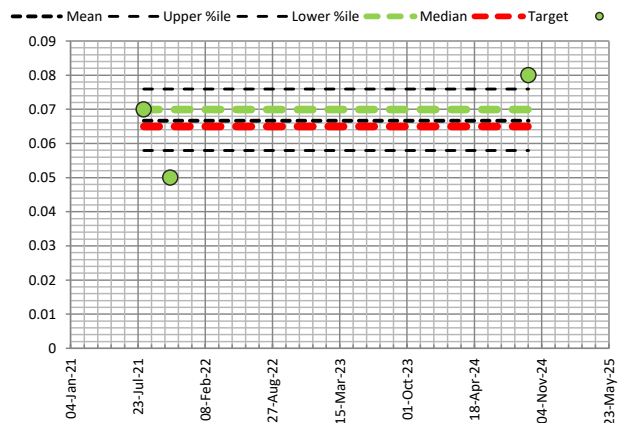
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark

SW6 Surface Water Site 6

MB : Clay Basin

Easting

Northing

Data Analysis Period Start Date

1/01/2021

Data Analysis Period End Date

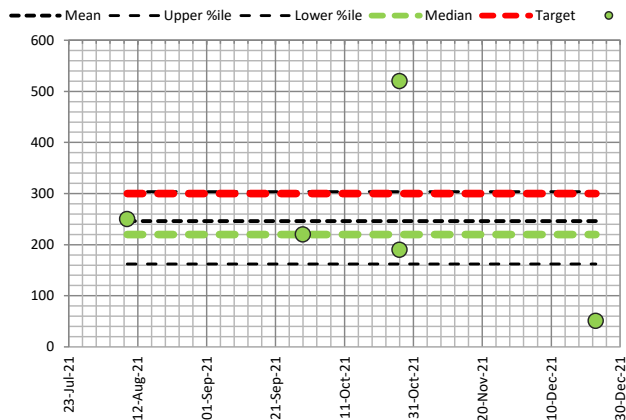
31/12/2024



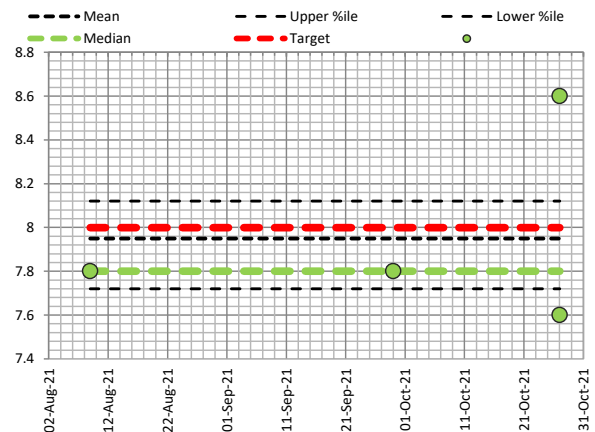
Report Date : 18/03/2025

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
COD	Chemical Oxygen Demand	mg/L	3	20.00	24.400	30.333	31.000	36.400	40.000		0
BOD	Biological Oxygen Demand	mg/L	3	5.00	7.000	11.667	10.000	16.000	20.000		0
T	Temperature	°C	0	0.00	0.00	0.00	0.00	0.00	0.00		0
EC	Electrical Conductivity	uS/cm	5	51.00	162.20	246.20	220.00	304.00	520.00	300.00	1
DO	Dissolved Oxygen	mg/L	3	8.70	8.74	9.17	8.80	9.52	10.00		0
DO %	Dissolved Oxygen	%	0	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0
pH	pH	pH	4	7.60	7.72	7.95	7.80	8.12	8.60	8.00	1
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	6	1.50	2.80	11.48	4.80	16.00	39.00	20.00	1
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	6	0.30	0.39	0.52	0.50	0.70	0.72	1.20	0
TKN	Total Kjeldahl Nitrogen	mg/L	6	0.30	0.30	0.42	0.37	0.57	0.60		0
NH3-N	Ammonia as N	mg/L	6	0.01	0.01	0.03	0.03	0.06	0.06	1.43	0
NO3-N	Nitrate as N	mg/L	6	0.01	0.01	0.05	0.03	0.06	0.14	3.40	0
NO2-N	Nitrite as N	mg/L	6	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	6	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphorous	mg/L	6	0.01	0.01	0.02	0.01	0.01	0.08	0.04	1
As	Arsenic	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	6	0.00100	0.00110	0.00157	0.00165	0.00200	0.00200	0.00180	3
Pb	Lead	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	6	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.01300	0
Zn	Zinc	mg/L	6	0.00200	0.00700	0.01283	0.01050	0.01300	0.03400	0.01500	1
Hg	Mercury	mg/L	6	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	3	82.00	113.20000	174.00	160.00	232.00000	280.00		0
Nox as N	Nox as N	mg/L	5	0.01	0.04420	0.08	0.07	0.13400	0.15		0
Tcoli	Total Coliforms	cfu/100mL	4	150.00	840.0	8312.50	4050.00	14080.0	25000.00		0

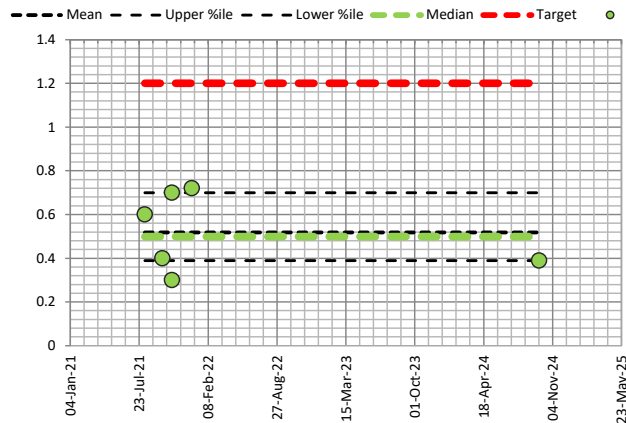
Electrical Conductivity



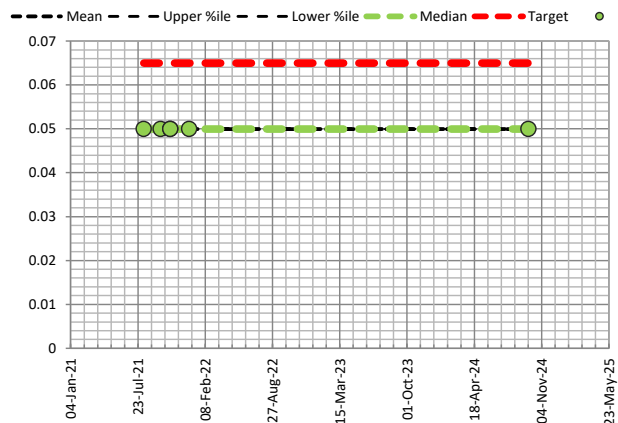
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

H23024 Rivermark

SW15 Surface Water Site 15

MB: City of Swan Inlet

Easting

Northing

Data Analysis Period Start Date

1/01/2021

Data Analysis Period End Date

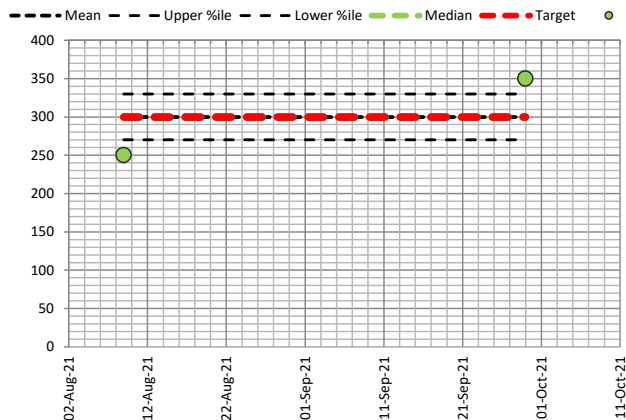
31/12/2024



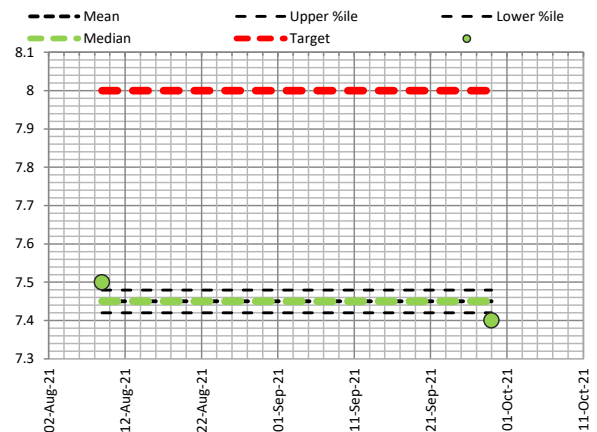
Report Date : 18/03/2025

Parameter	Description	Units	Samples	Minimum	Low %ile	Mean	Median	High %ile	Maximum	Target	Times Exceeded
					20			80		ANZECC 90%	
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	0.00	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	0.00	0.00	0.00		0
COD	Chemical Oxygen Demand	mg/L	1	20.00	20.000	20.000	20.000	20.000	20.000		0
BOD	Biological Oxygen Demand	mg/L	1	10.00	10.000	10.000	10.000	10.000	10.000		0
T	Temperature	°C	0	0.00	0.00	0.00	0.00	0.00	0.00		0
EC	Electrical Conductivity	uS/cm	2	250.00	270.00	300.00	300.00	330.00	350.00	300.00	1
DO	Dissolved Oxygen	mg/L	1	7.90	7.90	7.90	7.90	7.90	7.90		0
DO %	Dissolved Oxygen	%	0	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0
pH	pH	pH	2	7.40	7.42	7.45	7.45	7.48	7.50	8.00	0
ORP	Oxidation Reduction Potential	mV	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TUR	Turbidity	NTU	2	4.10	10.08	19.05	19.05	28.02	34.00	20.00	1
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	0.00	0.00	0.00		0
TN	Total Nitrogen	mg/L	2	0.80	0.90	1.05	1.05	1.20	1.30	1.20	1
TKN	Total Kjeldahl Nitrogen	mg/L	2	0.30	0.34	0.40	0.40	0.46	0.50		0
NH3-N	Ammonia as N	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01	1.43	0
NO3-N	Nitrate as N	mg/L	2	0.01	0.20	0.50	0.50	0.80	1.00	3.40	0
NO2-N	Nitrite as N	mg/L	2	0.01	0.01	0.01	0.01	0.01	0.01		0
TP	Total Phosphorous	mg/L	2	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0
FRP	Filterable Reactive Phosphorous	mg/L	2	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0
As	Arsenic	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.09400	0
Cd	Cadmium	mg/L	2	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00040	0
Cr	Chromium	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100		0
Cu	Copper	mg/L	2	0.00200	0.00220	0.00250	0.00250	0.00280	0.00300	0.00180	2
Pb	Lead	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.00560	0
Ni	Nickel	mg/L	2	0.00100	0.00100	0.00100	0.00100	0.00100	0.00100	0.01300	0
Zn	Zinc	mg/L	2	0.02400	0.03460	0.05050	0.05050	0.06640	0.07700	0.01500	2
Hg	Mercury	mg/L	2	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00190	0
TDS	Total Dissolved Solids	mg/L	2	140.00	148.00000	160.00	160.00	172.00000	180.00		0
Nox as N	Nox as N	mg/L	2	0.25	0.40000	0.63	0.63	0.85000	1.00		0
Tcoli	Total Coloiforms	cfu/100mL	0	0.00	0.0	0.00	0.00	0.0	0.00		0

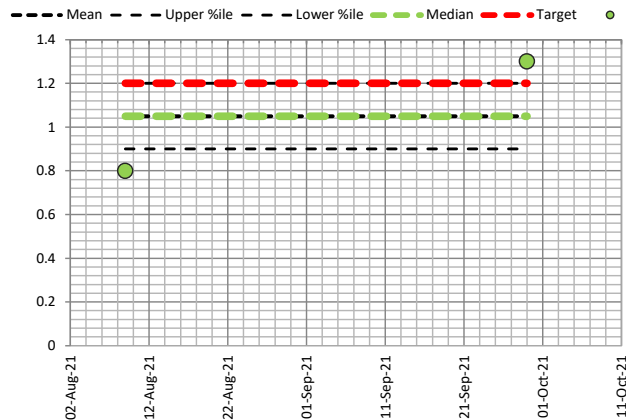
Electrical Conductivity



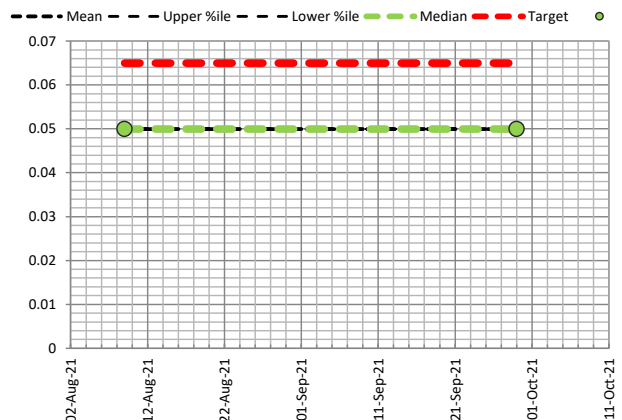
pH



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

APPENDIX F

Lithological Logs

PROJECT NUMBER: EP18-062(01)

CLIENT: Boral Limited

DATE INSTALLED: 20/08/2018

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Sonic

LOGGED BY: MM

PROJECT NAME: Boral Midland Groundwater Assessment

PROJECT LOCATION: 102 Great Northern Highway Midvale

SURVEY SOURCE: Surveyed

EASTING: 405596.622

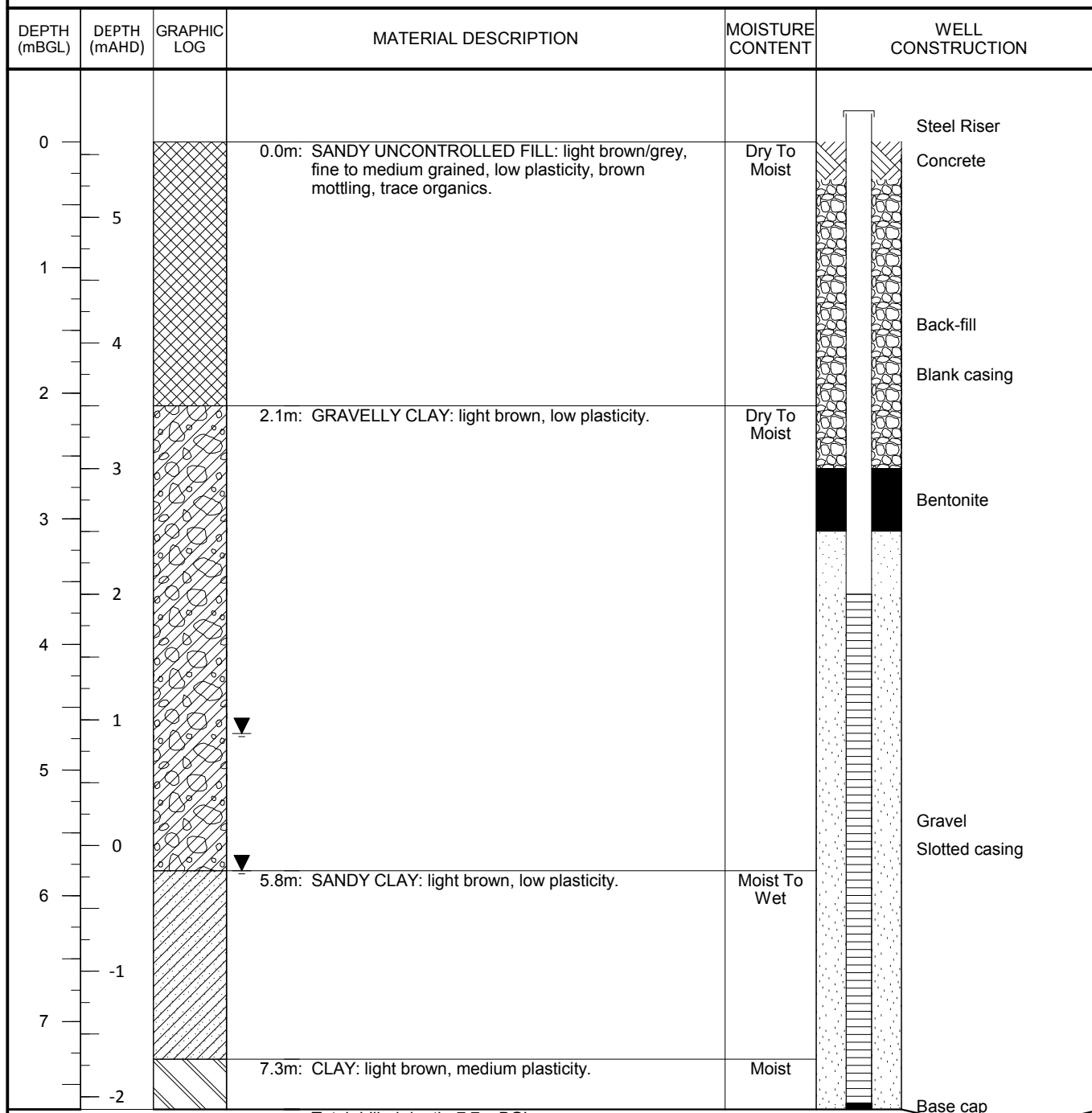
NORTHING: 6473544.743

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 5.6 mAHD

ELEVATION (TOP OF CASING): 6.0 mAHD

CASING DIAMETER: 50 mm



COMMENTS: Water was observed at 5.80 mBGL during well install. Standing water level recorded in September 2018 was 4.708 mBGL

PROJECT NUMBER: EP18-062(01)

CLIENT: Boral Limited

DATE INSTALLED: 20/08/2018

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Auger

LOGGED BY: MM

PROJECT NAME: Boral Midland Groundwater Assessment

PROJECT LOCATION: 102 Great Northern Highway Midvale

SURVEY SOURCE: Surveyed

EASTING: 405529.696

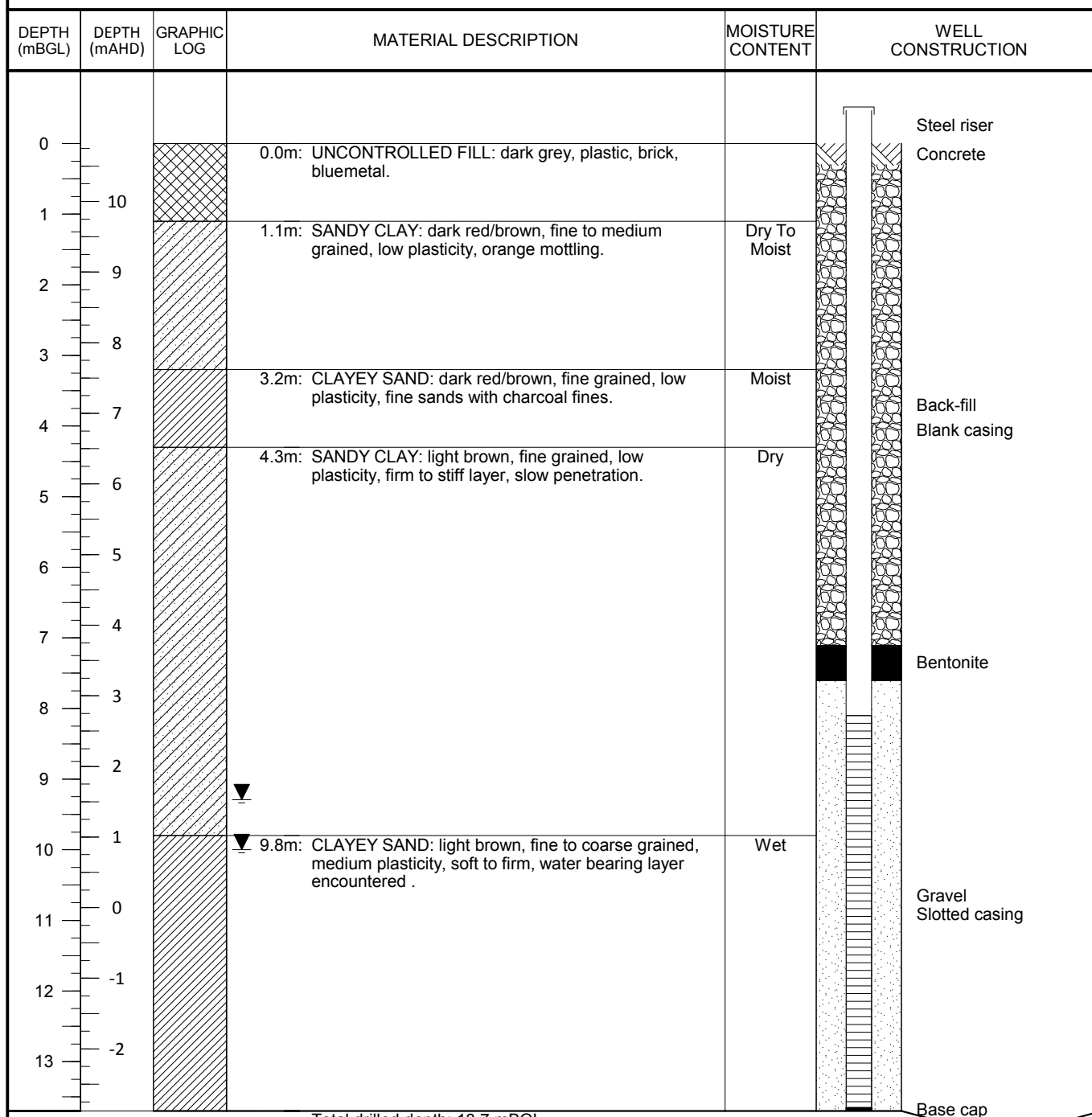
NORTHING: 6473108.240

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 10.8 mAHD

ELEVATION (TOP OF CASING): 11.3 mAHD

CASING DIAMETER: 50 mm



COMMENTS: Water was observed at 10.00 mBGL during well install. Standing water level recorded in September 2018 was 9.291 mBGL

PROJECT NUMBER: EP18-062(01)

CLIENT: Boral Limited

DATE INSTALLED: 20/08/2018

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Sonic

LOGGED BY: MM

PROJECT NAME: Boral Midland Groundwater Assessment

PROJECT LOCATION: 102 Great Northern Highway Midvale

SURVEY SOURCE: Surveyed

EASTING: 406135.275

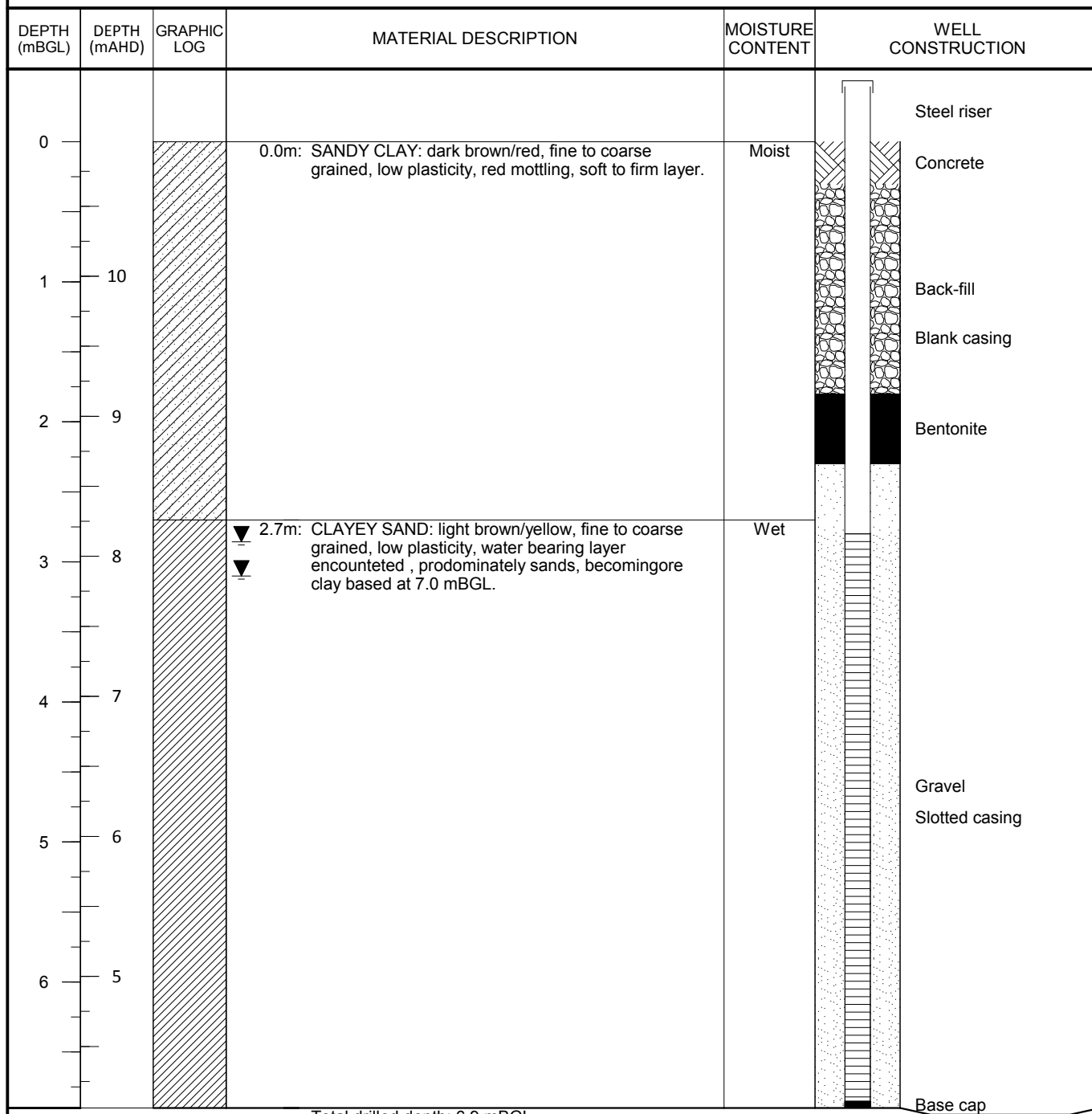
NORTHING: 6473245.355

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 11.0 mAHD

ELEVATION (TOP OF CASING): 11.4 mAHD

CASING DIAMETER: 50 mm



COMMENTS: water was observed at 3.10 mBGL during well install. Standing water level recorded in September 2018 was 2.856 mBGL

PROJECT NUMBER: EP18-062(01)

CLIENT: Boral Limited

DATE INSTALLED: 20/08/2018

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Sonic

LOGGED BY: MM

PROJECT NAME: Boral Midland Groundwater Assessment

PROJECT LOCATION: 102 Great Northern Highway Midvale

SURVEY SOURCE: Surveyed

EASTING: 406304.724

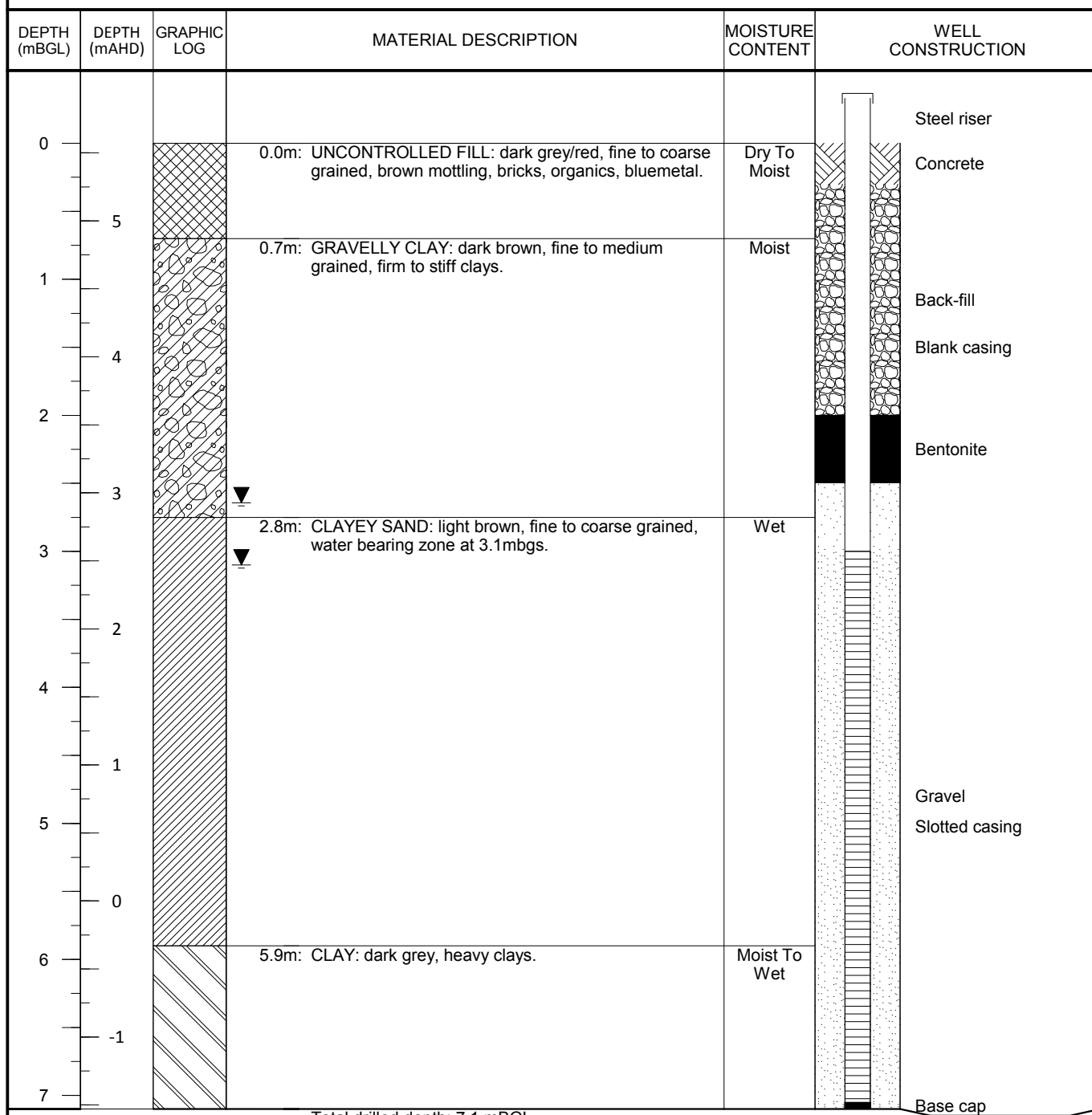
NORTHING: 64736648.388

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 5.6 mAHD

ELEVATION (TOP OF CASING): 5.9 mAHD

CASING DIAMETER: 50 mm



COMMENTS: water was observed at 3.1 mBGL during well install. Standing water level recorded in September 2018 was 2.643 mBGL

PROJECT NUMBER: EP18-062(01)

CLIENT: Boral Limited

DATE INSTALLED: 20/08/2018

DRILLING CONTRACTOR: Strataprobe

DRILLING METHOD: Sonic

LOGGED BY: MM

PROJECT NAME: Boral Midland Groundwater Assessment

PROJECT LOCATION: 102 Great Northern Highway Midvale

SURVEY SOURCE: Surveyed

EASTING: 406580.039

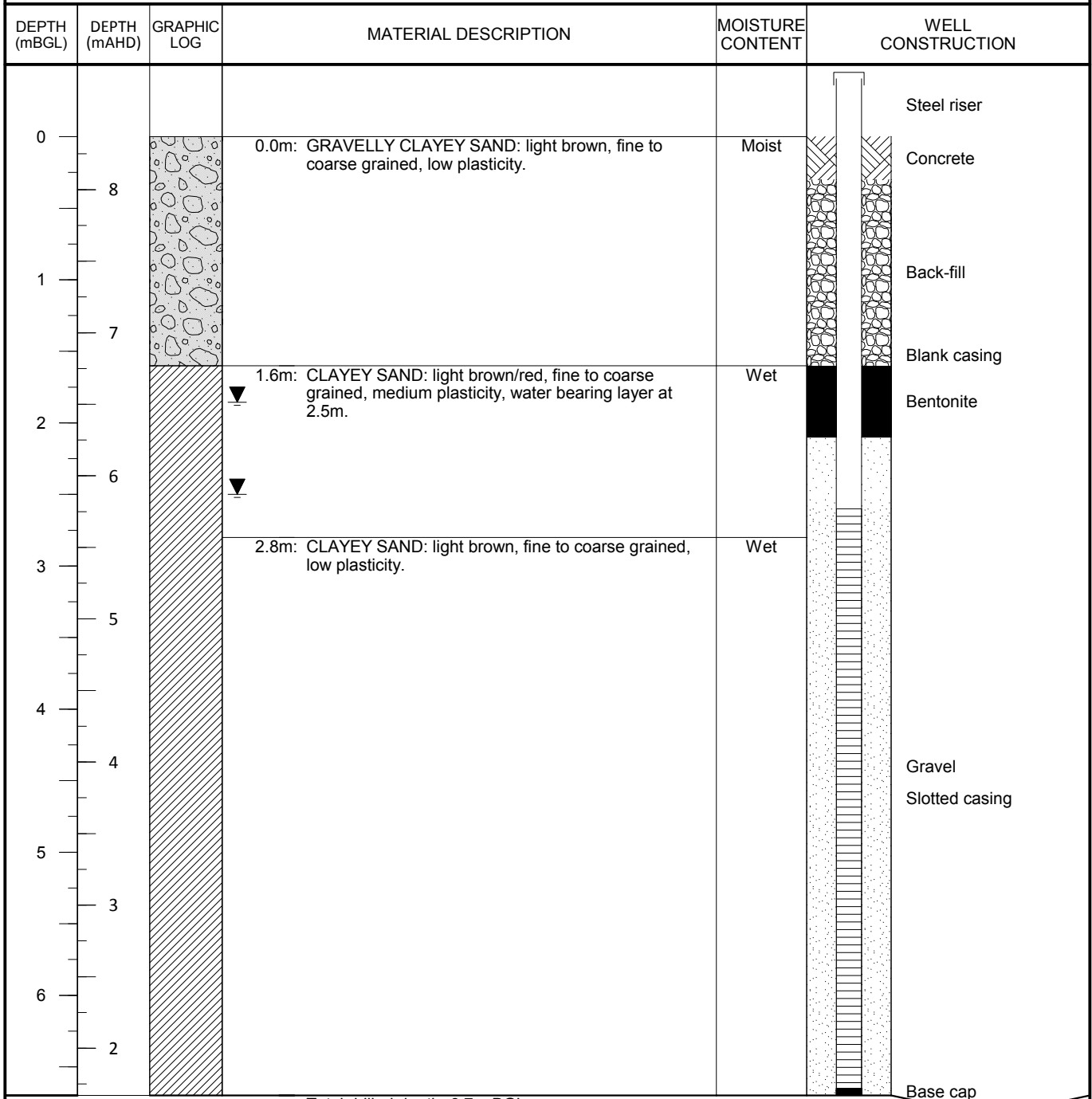
NORTHING: 6473503.855

PROJECTION: MGA, GDA94

ELEVATION (GROUND): 8.4 mAHD

ELEVATION (TOP OF CASING): 8.9 mAHD

CASING DIAMETER: 50 mm



COMMENTS: Water was observed at 2.5 mBGL during well install. Standing water level recorded in September 2018 was 1.855 mBGL

APPENDIX G

DWER Groundwater Bore Data

Department of Water and Environmental Regulation

HYPLIT V134 Output 26/11/2024

Period 47 Year 01/01/1978 to 01/01/2025

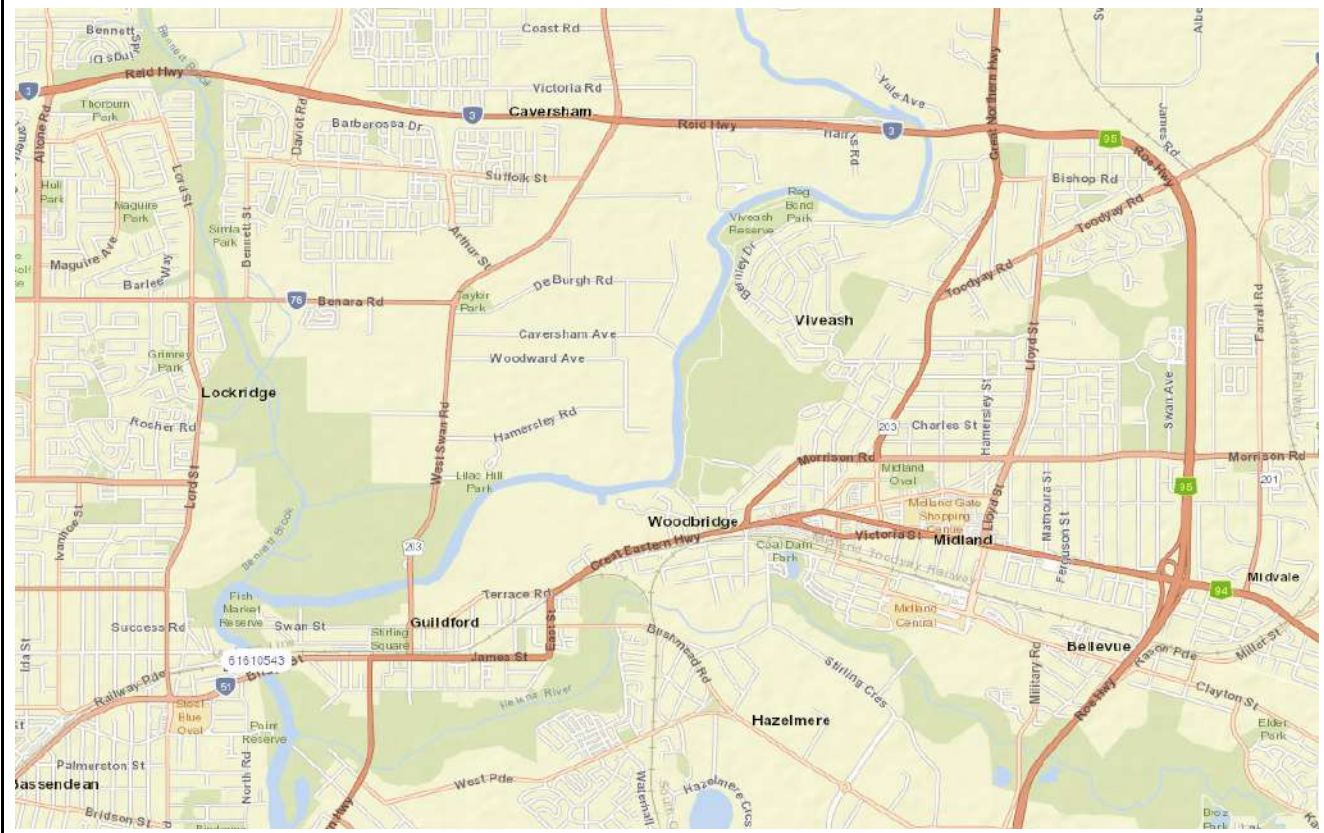
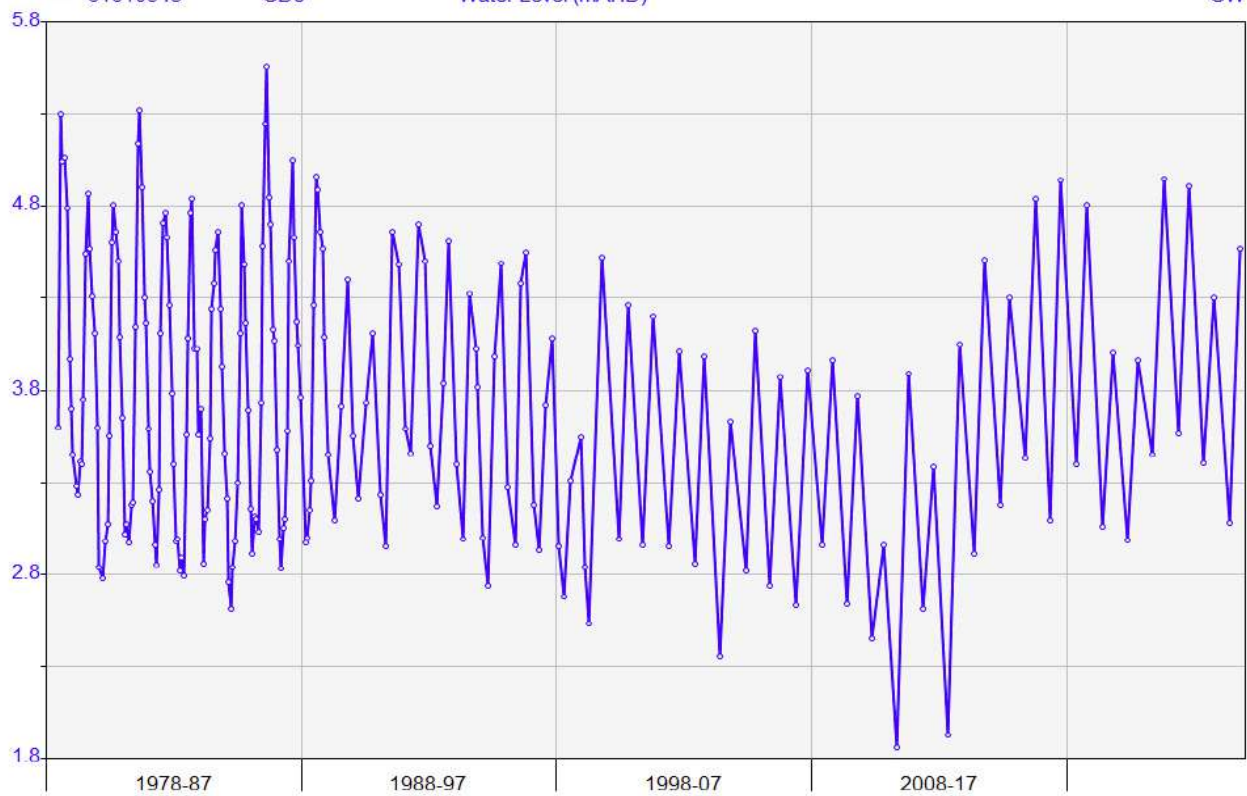
1978-2024

61610543

GD8

Water Level (mAHD)

GW



Source: Department of Water and Environmental Regulation (2025)

hyd₂o

Rivermark Area 4 Stage 1 Local Water Management Strategy

DWER Bore Hydrographs : GD8

Appendix G1

Department of Water and Environmental Regulation

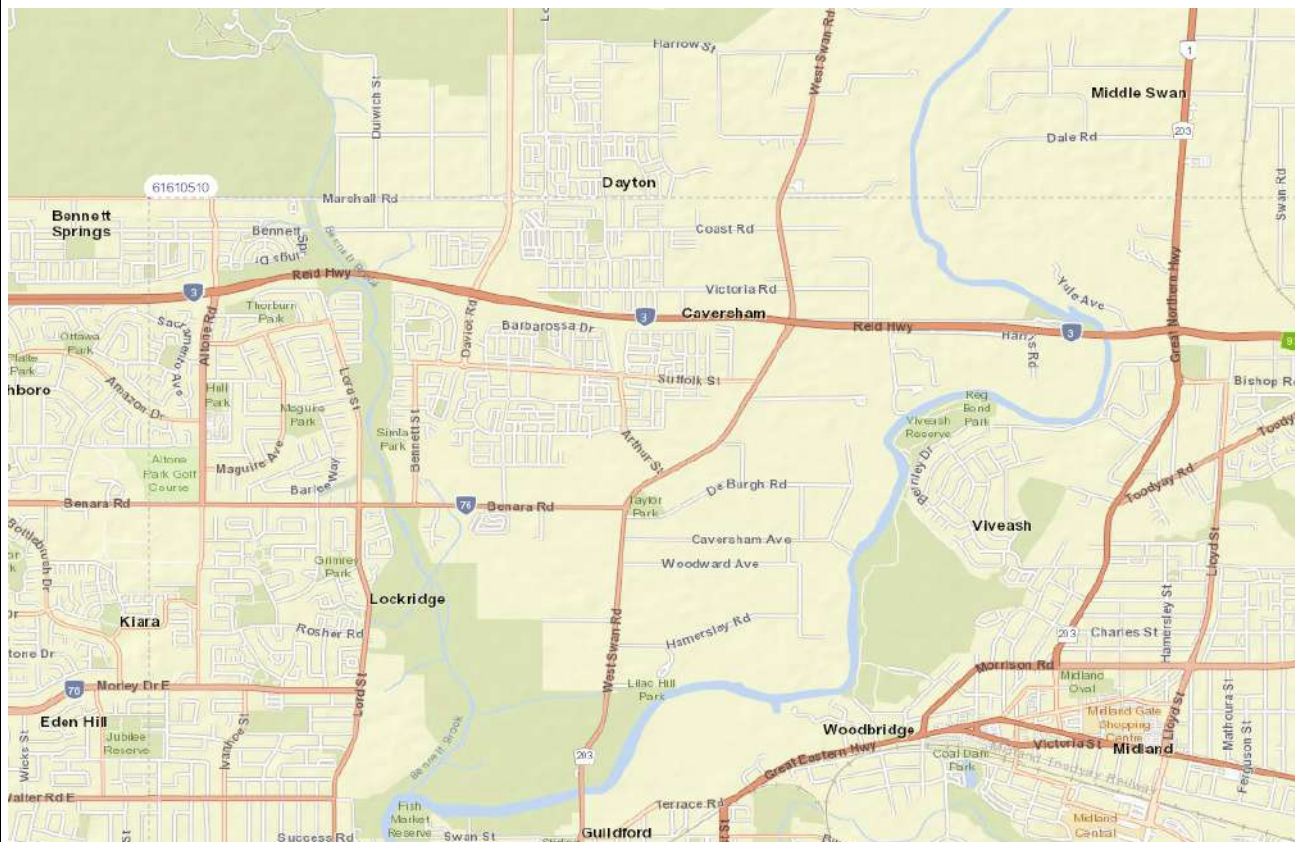
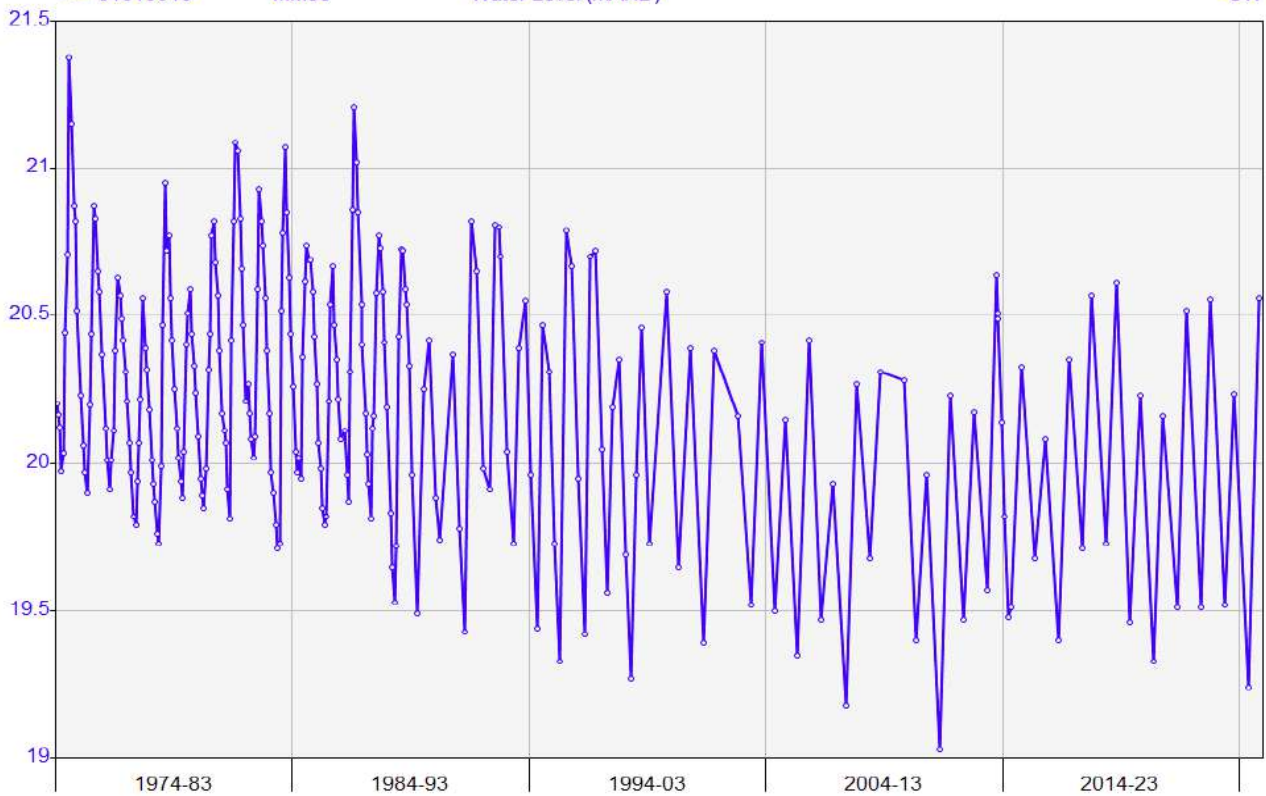
HYPLOT V134 Output 23/10/2024

Period 51 Year 01/01/1974 to 01/01/2025

1974-2024

61610510 MM38 Water Level (mAHD)

GW



Source: Department of Water and Environmental Regulation (2025)

hyd₂o

Rivermark Area 4 Stage 1 Local Water Management Strategy

DWER Bore Hydrographs : MM38

Appendix G2

APPENDIX H

DWER Water REgister Extracts

← Licence details

☒ Selected 1 of 2

Licence Number: 205521

Licence Type: Groundwater Licence

Issue Date: 28/7/2025

Expiry Date: 18/2/2031

Licence Allocation: 55000 KL

Parties: Capitary No.2 Pty Ltd

Postal Address: Level 3 338 Barker Road Subiaco WA 6008 Australia

Groundwater Area: Perth

Groundwater Subarea: Shire of Swan South

Aquifer: Perth - Superficial Swan

Surface Water Area:

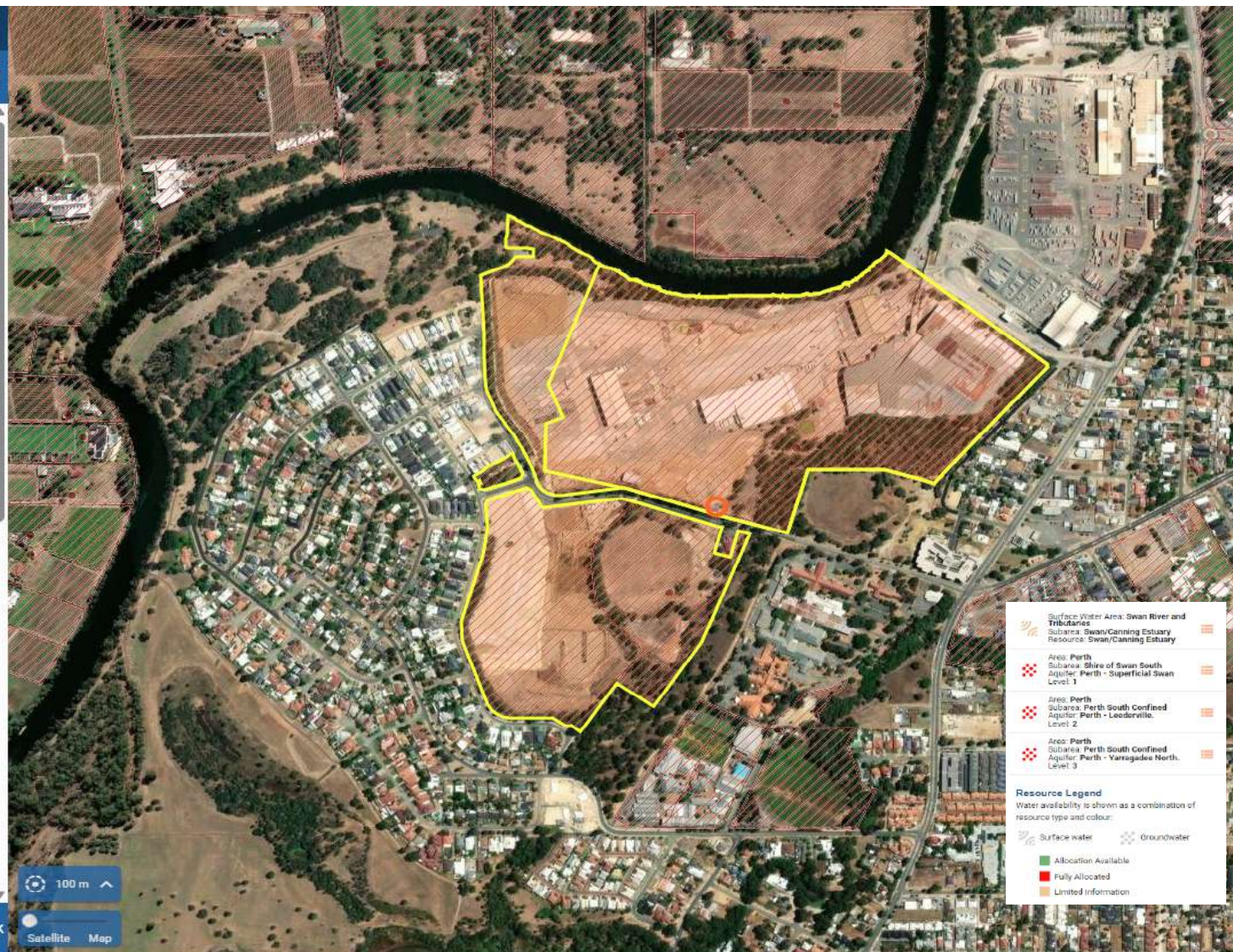
Surface Water Subarea:

Surface Water Resource:

Licence Address: LOT 196 ON PLAN 9113
Volume/Folio 1336/335
Lot 196 ; LOT 167 ON PLAN 9113
Volume/Folio 1366/686
Lot 167 SURREY WAY VIVEASH; LOT
9009 ON PLAN 400991
Volume/Folio 4037/315
Lot 9009 ; LOT 13517 ON PLAN
194579
Volume/Folio LR3033/635
Lot 13517 ; LOT 169 ON PLAN 9113
Volume/Folio 1336/328
Lot 169 SURREY WAY VIVEASH; LOT
162 ON PLAN 9113
Volume/Folio 1336/321
Lot 162 HARFORD AV VIVEASH; LOT
166 ON PLAN 9113
Volume/Folio 1366/685
Lot 166 ; LOT 72 ON DEPOSITED
PLAN 408605
Volume/Folio 2916/634
Lot 72 EVELINE RD MIDDLE SWAN

Instrument number: 205521 ☐ Track

Satellite Map



Source : DWER Water Register (online)

← Licence details

Selected

< 2 of 2

Licence Number:212324

Licence Type:Groundwater Licence

Issue Date:31/7/2025

Expiry Date:30/7/2030

Licence Allocation:75000 KL

Parties:Capitary No.2 Pty Ltd

Postal Address:Level 3 338 Barker Road Subiaco WA 6008 Australia

Groundwater Area:Perth

Groundwater Subarea:Perth South Confined

Aquifer:Perth - Leederville.

Surface Water Area:

Surface Water Subarea:

Surface Water Resource:

Licence Address:LOT 72 EVELINE ROAD MIDDLE SWAN 6056

Security Interests:No

Convictions:No

Agreements:No

Notations:No

Directions:No

Instrument number: 212324

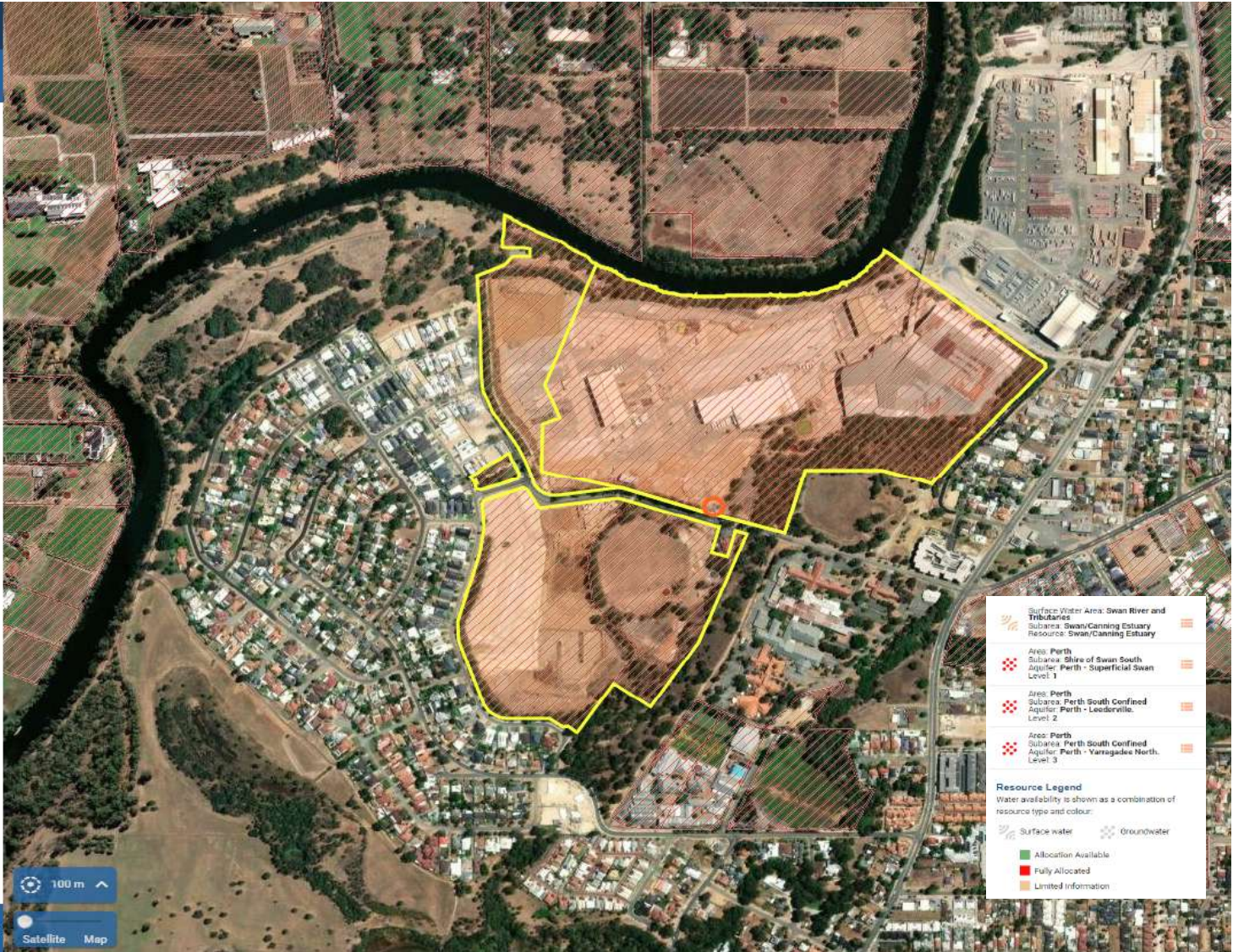
☐ Track

100 m

Satellite

Map

Source : DWER Water Register (online)



← Licence details

☒ Selected
 < 1 of 1 >

Licence Number:	168139
Licence Type:	Groundwater Licence
Issue Date:	8/9/2021
Expiry Date:	28/8/2029
Licence Allocation:	295775 KL
Parties:	City of Swan
Postal Address:	PO BOX 196 Midland DC WA 6936 Australia
Groundwater Area:	Perth
Groundwater Subarea:	Perth South Confined
Aquifer:	Perth - Leederville.
Surface Water Area:	
Surface Water Subarea:	
Surface Water Resource:	
Licence Address:	LOT 503 ON PLAN 75177 Volume/Folio LR3021/922 Lot 503 CLAYTON ST KOONGAMIA; Crown Reserve 37172 Lot 10174 Gray Dr Midvale Ron Jose Oval; Lot 13421 On Plan 220279 Volume/Folio Lr3114/605 Lot 13421 Eddie Barron Dr Middle Swan Velodrome; Lot 5 On Diagram 48300 Volume/Folio 1406/686 Lot 5 Great Northern Hwy Middle Swan Lot 56 On Plan ; Lot 144 On Plan 222536 Volume/Folio 1228/232 Lot 144 Helena St Guildford Spring Reserve; Crown Reserve 37172 Lot 10174 Gray Dr Midvale Ron Jose Oval And Gray Drive Lot 18 On Diagram 5876; Lot 70 On Diagram 58407 Volume/Folio 1790/161 Lot 70 Bishop Rd Middle Swan Jack Mann Oval; Crown Reserve 28356 Lot 8156 Minchin Cr Middle Swan Velgrove Park; Lot 98

100 m

Satellite Map

Surface Water Area: Swan River and
 Tributaries
 Subarea: Swan/Canning Estuary
 Resource: Swan/Canning Estuary

Area: Perth
 Subarea: Shire of Swan South
 Aquifer: Perth - Superficial Swan
 Level: 1

Area: Perth
 Subarea: Perth South Confined
 Aquifer: Perth - Leederville.
 Level: 2

Area: Perth
 Subarea: Perth South Confined
 Aquifer: Perth - Varagadee North.
 Level: 3

Resource Legend
 Water availability is shown as a combination of
 resource type and colour:

Surface water

Groundwater

Allocation Available

Fully Allocated

Limited Information

Instrument number: 168139
☐ Track

Source : DWER Water Register (online)

APPENDIX I

Landscape Masterplan

AREA 4 - LANDSCAPE

MASTER PLAN

GENERAL

- 01 STAGE ONE RESIDENTIAL
Status - Civil and landscape works completed
- 02 STAGE TWO RESIDENTIAL
Status - Civil and landscape works completed
- 03 AREA 3
Status - Civil works in progress
- 04 JACK WILLIAMSON OVAL
Status - Civil and landscape design in progress
- 05 EVELINE ROAD STREETSCAPE - A vegetated linear green link that retains existing healthy trees and reinforces with local species that support east/west fauna movement

AREA 4 - STAGE 1

- 6 FORESHORE POS 1 (CENTRAL) - Community facilities including potential cafe, parking and recreation space.
- 7 FORESHORE POS 2 (WEST) - Community facilities and gathering space with information node & stormwater treatment areas.
- 8 COMMERCIAL LOT
- 9 SERVICES - Service infrastructure:
- Existing Gas Infrastructure
- 10 NORTHERN CONNECTOR(WEST) - A strong linear tree lined and vegetated corridor providing a pedestrian friendly environment and enhancing safe fauna movement. Pedestrians given priority with limited vehicle crossovers required and minimal road crossings.
- 11 FORESHORE BUSH FOREVER - Protect existing vegetation, fenced to limit pedestrian access.
- 12 EXISTING TREES - Existing trees retained within residential lots.
- 13 NORTHERN CONNECTOR (CENTRAL) - A strong, tree lined vegetated linear pedestrian connection, reinforced with local plant species that support the movement of north/south fauna and pedestrians. (no vehicle crossovers)
- 14 PUBLIC ACCESS WAYS - Access ways with pedestrian connections, tree planting and native shrub planting.
- 15 DUAL USE PATH - Future PSP connection to the existing Reg Bond Reserve.

AREA 4 - STAGE 2 (SUBJECT TO FUTURE REZONING)

- 16 FORESHORE POS 3 (EAST) - Community facilities and gathering space, pump station and stormwater treatment areas.
- 17 SERVICES - Service infrastructure:
- Proposed Sewer Pump Station
- 18 THREATENED ECOLOGICAL COMMUNITY(TEC)- Protection and enhancement of existing vegetation reserve. Fencing where required to protect existing TEC
- 19 CONSERVATION POS 1 - Protection of existing vegetation, with paths, minor seating nodes, interpretive signage & drainage swale.



** Existing gas alignment within Foreshore Reserve.
Detailed design to review gas provider requirements.

RIVERMARK, VIVEASH

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LANDSCAPE MASTERPLAN

JOB NO. 2105505



PLAN
E

LANDSCAPE ARCHITECTS

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AREA 4 - LANDSCAPE

FACILITIES PLAN

SOFT LANDSCAPE

- LANDSCAPE BUFFER
- REVEGETATION CONSERVATION
- STORMWATER STORAGE / BIOFILTER / LIVING STREAM
- FENCING

INFRASTRUCTURE(PLAY/ COMMUNITY)

- EXERCISE CIRCUIT / FUTSAL
- INFANT / JUNIOR PLAY
- ALL AGES PLAY
- LOOKOUT / POINT OF INTEREST
- COMMUNITY FACILITY OR CAFE
- SIGNAGE / ARTWORK

- PARKING

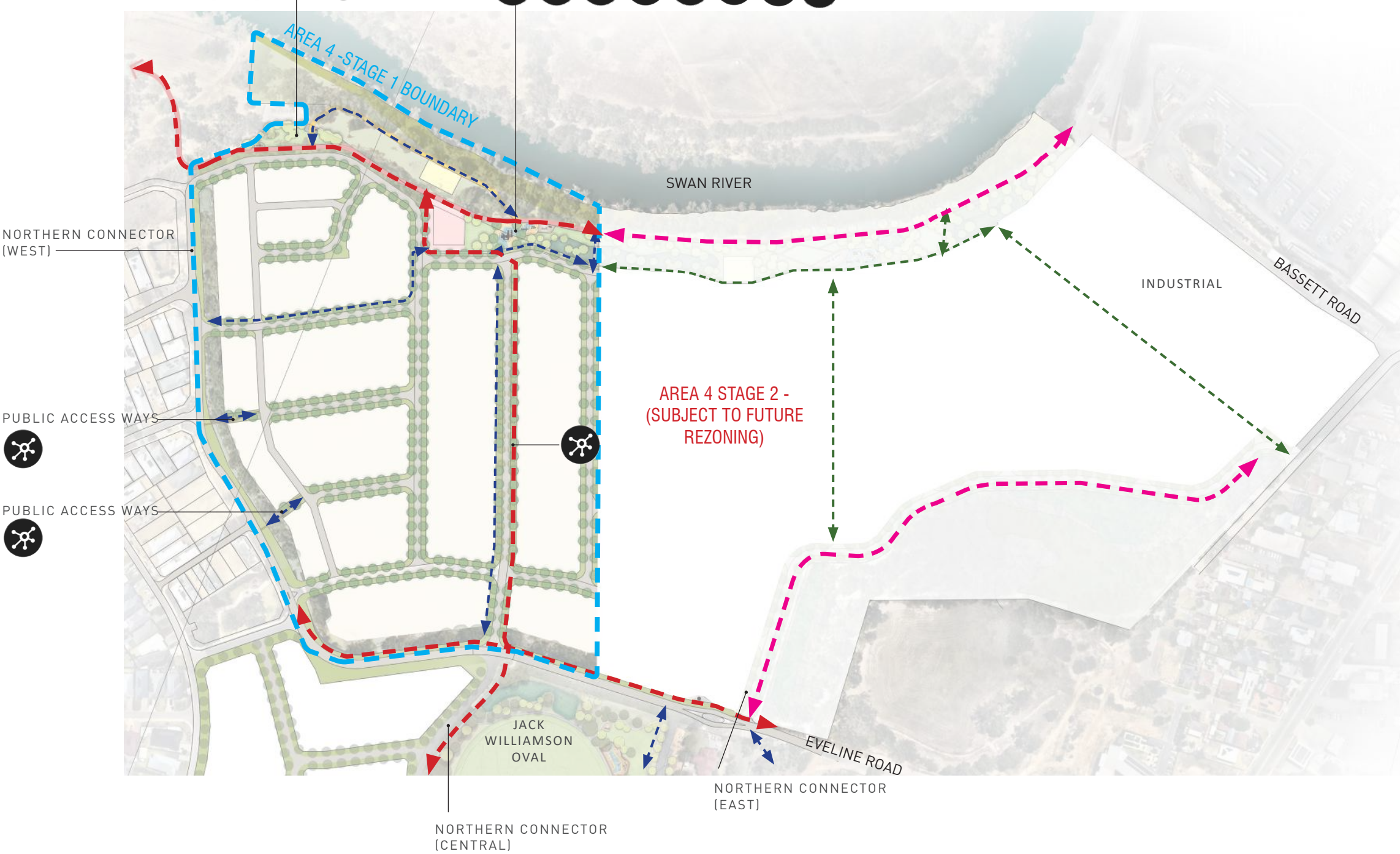
HARD LANDSCAPE AND FURNITURE

- DUAL USE PATH NETWORK
- KEY PEDESTRIAN CONNECTIONS
- FUTURE CONNECTIONS
- MAJOR SERVICES REQUIRING INTEGRATION
- LIGHTING
- BIKE STANDS
- DRINKING FOUNTAIN
- TABLES, BENCHES, SEATS
- SHELTER / SEATING
- BBQ / PICNIC FACILITIES

FORESHORE POS 2 (WEST)



FORESHORE POS 1 (CENTRAL)



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LANDSCAPE FACILITIES PLAN

JOB NO. 2105505

C1.102

REV J



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• VIVEASH •



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AREA 4 - LANDSCAPE

PEDESTRIAN NETWORK PLAN

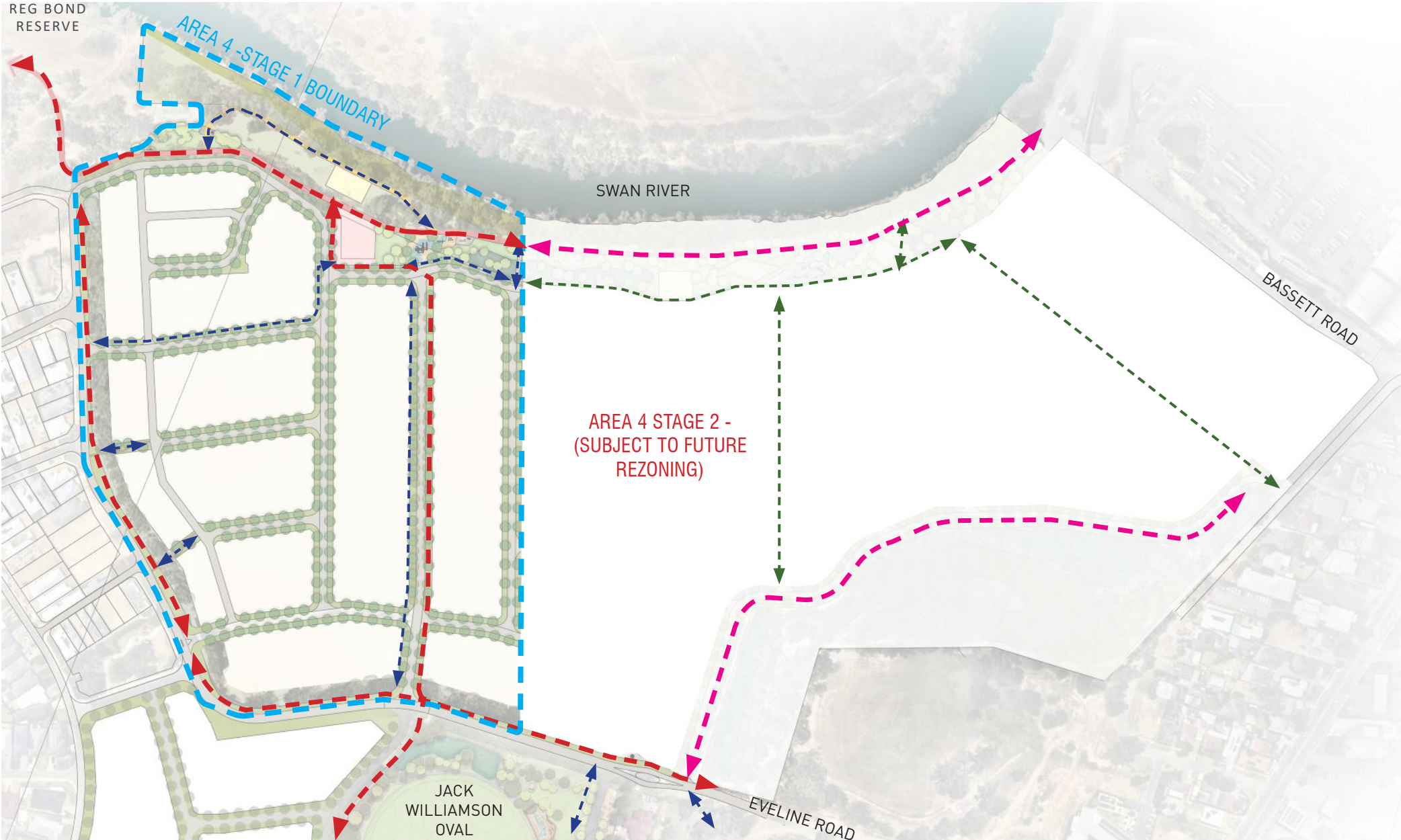
LEGEND

DUAL USE PATHWAY

FUTURE DUAL USE PATHWAY

KEY PEDESTRIAN CONNECTIONS

FUTURE PEDESTRIAN CONNECTIONS



AREA 4 - LANDSCAPE

STREET TREE MASTERPLAN



- FORESHORE MIX**
- MEL - MELALEUCA PREISSIANA
 - EUW - EUCALYPTUS WANDOO



- MIX 1**
- EUW - EUCALYPTUS WANDOO
 - EUR - EUCALYPTUS RUDIS
 - COC - CORYMBIA CALOPHYLLA (EXISTING)



- MIX 2**
- EUV - EUCALYPTUS VICTRIX
 - EUL - EUCALYPTUS LANE-POOLEI
 - EUT - EUCALYPTUS TODTIANA



- MIX 3**
- EUL - EUCALYPTUS LANE-POOLEI
 - AGF - AGONIS FLEXUOSA



- WHADJUK NOONGAR SPECIES
- WEST AUSTRALIAN NATIVE

- NOTES**
- TREE PLANTING IN ROADS CONTROLLED BY CITY OF SWAN
1. GENERALLY COMPRISED MIXED SPECIES.
 2. BE A MAXIMUM OF 3 TREES / LOT AT MINIMUM SPACING OF 3500 MM.
 3. GREATER THAN 6M FROM A STREET LIGHT.
 4. GREATER THAN 1.5M FROM THE DRIVING EDGE, FACE OF A KERB OR PATH.
 5. GREATER THAN 2.5M OF A CROSS-OVER, POWER POLE, SIGN, FIRE HYDRANT, PUBLIC SERVICE INSPECTION PIT, OVERHEAD WIRES LEADING INTO A PROPERTY, BUS STOP OR ANY OTHER STRUCTURAL ELEMENT.
 6. GREATER THAN 8M OF THE INTERSECTING KERBS (FOR CORNER PROPERTIES).

RIVERMARK, VIVEASH

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STREET TREE MASTERPLAN

JOB NO. 2105505

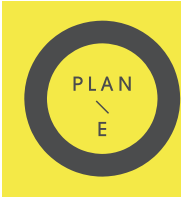
C1.104

REV J

0 40 80 120 200m

RIVERMARK

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AREA 4 - LANDSCAPE

FORESHORE CONCEPT

Foreshore POS 1, 2 and 3, along with the Foreshore Bush Forever area, are the key recreation and conservation nodes within the Rivermark Estate. The Foreshore POS connects the residents with the Swan River and existing parkland beyond.

The Bush Forever site shall be fenced with maintenance gates providing dedicated access. Vegetated stormwater treatment areas will be provided to the periphery of the POS to treat stormwater, located to minimise disturbance of existing vegetation.

A dual use path will link the recreational functions of the foreshore and connect people beyond the foreshore to the existing Reg Bond Reserve and into the proposed residential development.

Vegetation will be predominantly Whadjuk Noongar and Western Australian species.

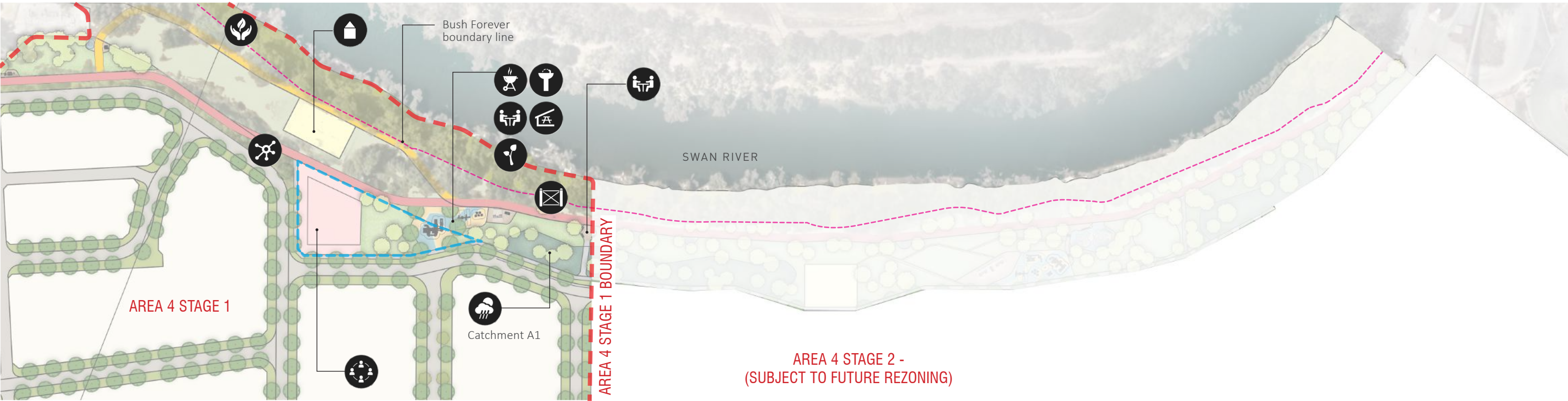
The Foreshore landscape design shall be integrated with the existing and new services including gas alignment (through POS) and sewer pump station.

FACILITIES DESCRIPTION

-  Lookout / point of interest
-  Water fountain
-  Exercise circuit / Futsal
-  Commercial area (Cafe)
-  Infant / Junior Play
-  Signage / Art
-  Conservation Fencing
-  BBQ / Picnic facilities
-  Active / Court / Youth
-  Revegetation / Conservation
-  Shelter / seating
-  Dual Use Path
-  Tables, benches and seats
-  Bike stands
-  Kickabout
-  Stormwater Storage / Biofilter
-  Major services to be integrated (gas alignment and sewer pump station)



KEY PLAN



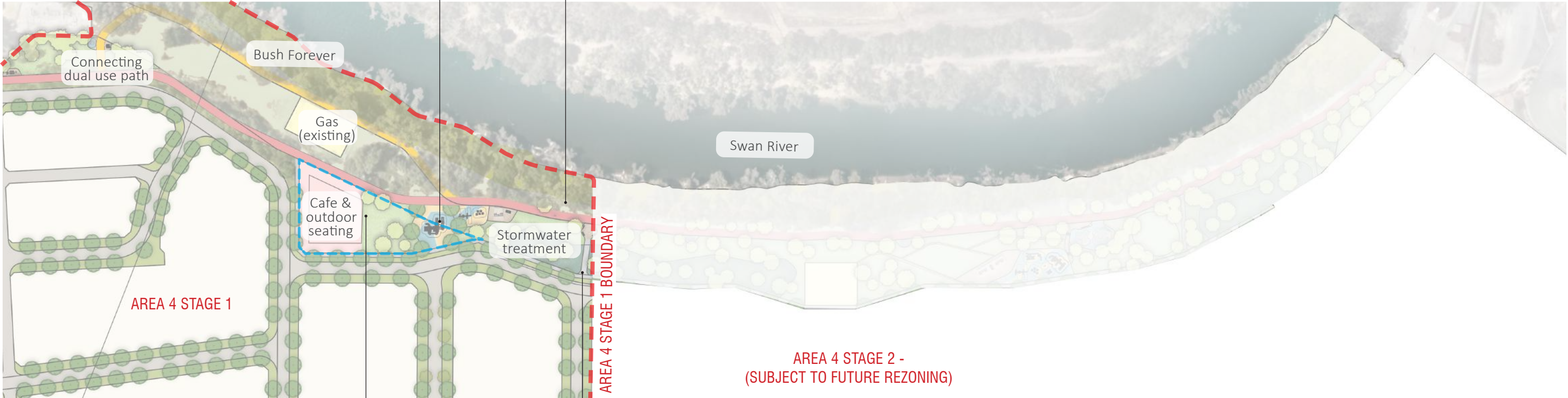
FORESHORE CONCEPT IMAGERY



Iconic Play Area



Conservation and access control



Outdoor seating (cafe)



Pedestrian connections

AREA 4 - LANDSCAPE

BIODIVERSITY AND PLANT SELECTION

BIODIVERSITY SENSITIVE URBAN DESIGN

- BIODIVERSITY SENSITIVE URBAN DESIGN

Strong tree canopy and native understorey planting within POS areas and residential front lot landscapes
- BLACKADDER CREEK TRIBUTARY

Conservation of existing tributary
- BIRD NEST BOXES, BIRD WATERER & BAT BOXES

Conservation of local fauna and promoting movement across the site.

PROPOSED PLANT LIST

The plant list is predominantly Whadjuk Noongar species and Western Australian Species. Below is the list of proposed Whadjuk Noongar species incorporated into the planting design.

- Shrub Planting (all sizes)

Acacia lasiocarpa prostrate

Acacia saligna

Acacia pulchella

Anigozanthos pulcherrimus

Anigozanthos flavidus

Bankia armata

Banksia nivea

Billardia heterophylla

Calothamnus emerald carpet

Calothanus quadrifidus Pencil

Calothanus quadrifidus prostrate

Callistemon phoeniceus

Conosytlis candicans

Dampiera linearis

Darwinia citriodora Seaspray

Eremophila glabra prostrate

Gompholobium marginatum

Grevillea gin gin gem

Grevillea preissii seaspray

Hakea erinacea

Hakea laurina

Hakea prostrata

Hakea varia

Hemiandra pungens

Hibbertia hyericoides

Hypocalymmas angustifolium

Hypocalymma robustum

Jacksonia sterneriana

Juncus kraussii

Kennedia prostrata

Kunzea micrantha

Machaerina juncea (for. Baumea)

Melaleuca laterita

Myriophyllym crispatum

Olearia axillaris

Pimelea ferrugina

Verticordia densiflora
- Trees

Agonis flexuosa

Corymbia calophylla

Eucalyptus accedens

Eucalyptus gomphocephala

Eucalyptus lane poolie

Eucalyptus rudis

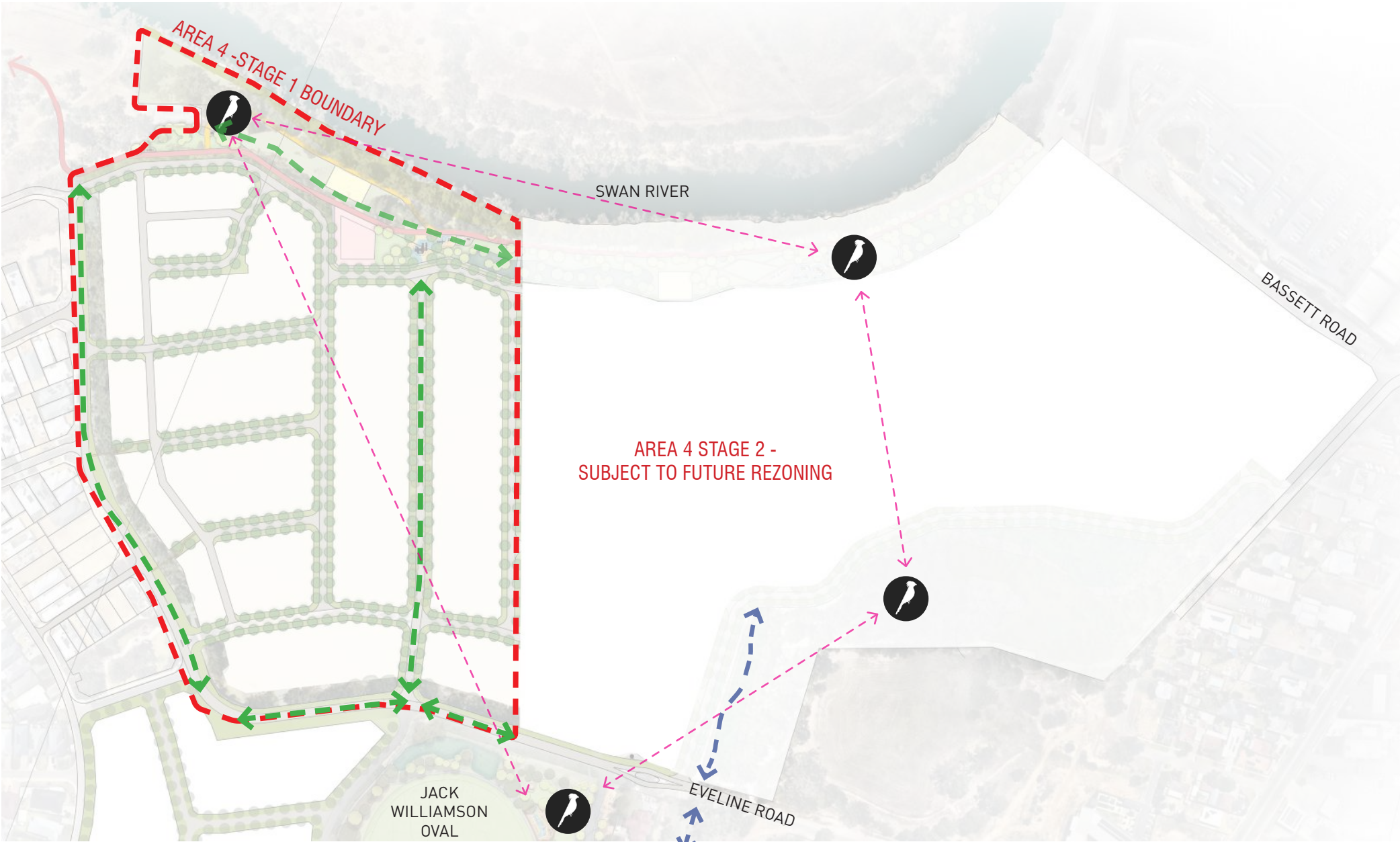
Eucalyptus wandoo

Macrozamia riedlei

Melaleuca raphiphylla

Melaleuca cuticularis

Xanthorrea preisii



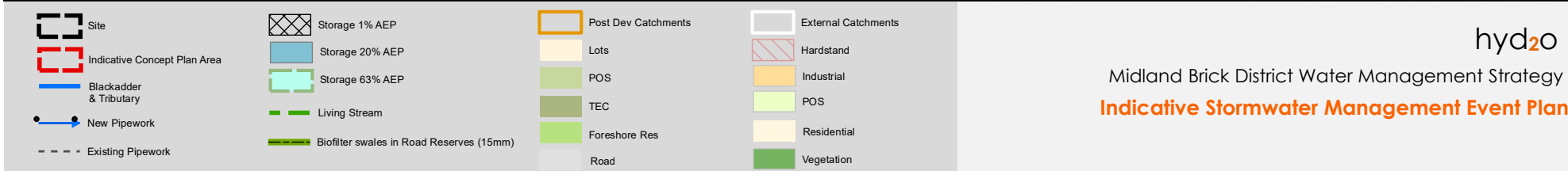
RIVERMARK, VIVEASH

PREPARED FOR HESPERIA

LANDSCAPE BIODIVERSITY AND PLANTING

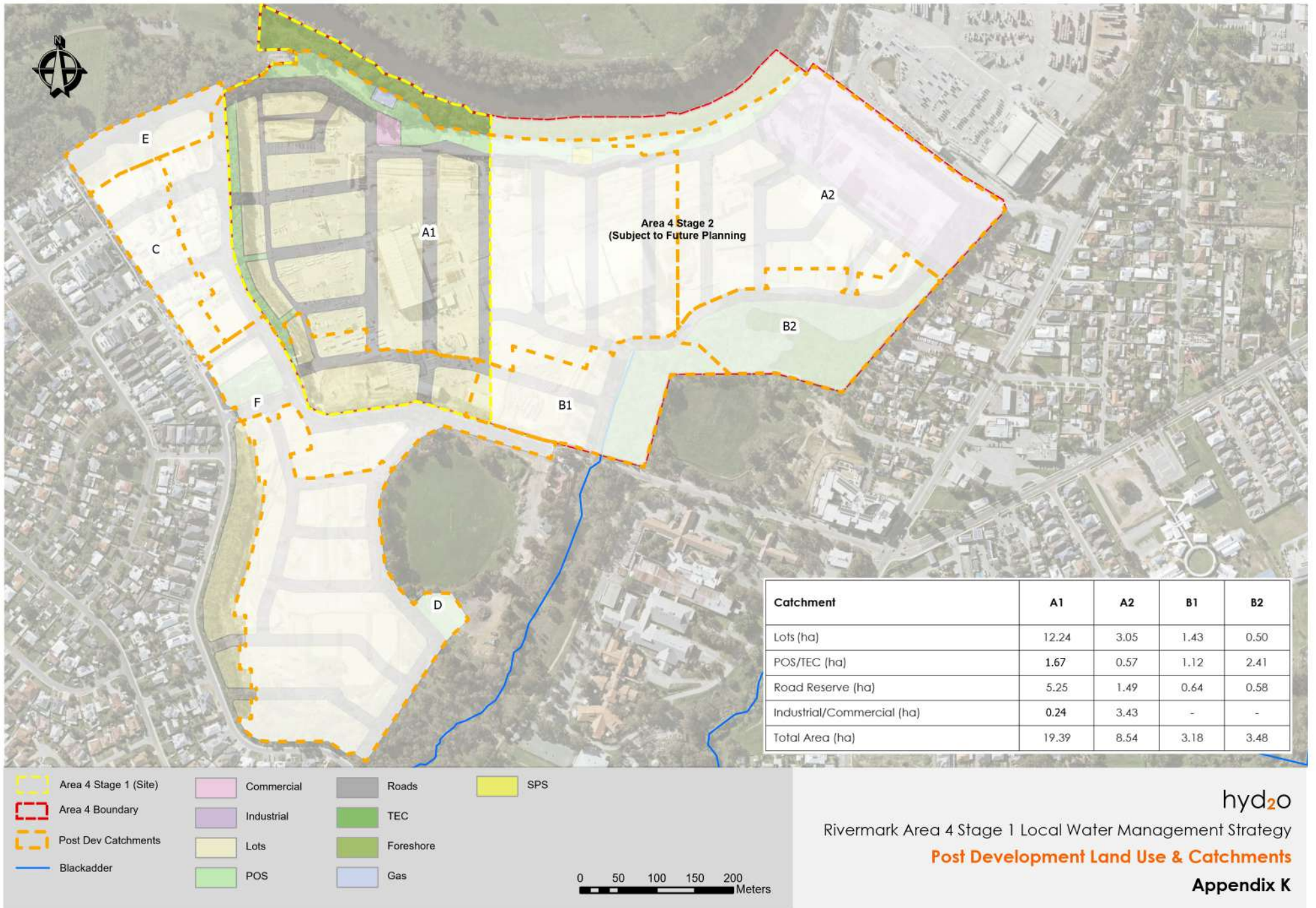
APPENDIX J

Post Development DWMS Stormwater Modelling Extract (Hyd2o, 2020a)



APPENDIX K

Post Development Runoff Estimation



CURRV

Calculator for Urban Runoff Rates & Volumes
14/10/2025

Land Use Description	Area (ha)	Use in Calc	Imperv	Perv	Perv	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
			Initial Loss mm	Initial Loss mm	Continue Loss mm/hr							
1 Residential Lots	12.24	Yes	1.5	20.0	4.0	15.0	1.00	60%	65	22	13	
2 Roads	5.25	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	70	30	
3 POS/Foreshore	1.67	Yes	1.5	10.0	2.0	0.0	1.00	30%	0	5	95	
4 Industrial/Commercial	0.24	Yes	1.5	20.0	4.0	15.0	1.00	80%	60	35	5	
5			1.5	20.0	4.0		1.00					
6			1.5	20.0	4.0		1.00					
7			1.5	20.0	4.0		1.00					
8			1.5	20.0	4.0		1.00					
9			1.5	20.0	4.0		1.00					
10			0.0	20.0	4.0		1.00					

EIA : Effective Impervious Area, TIA : Total Impervious Area

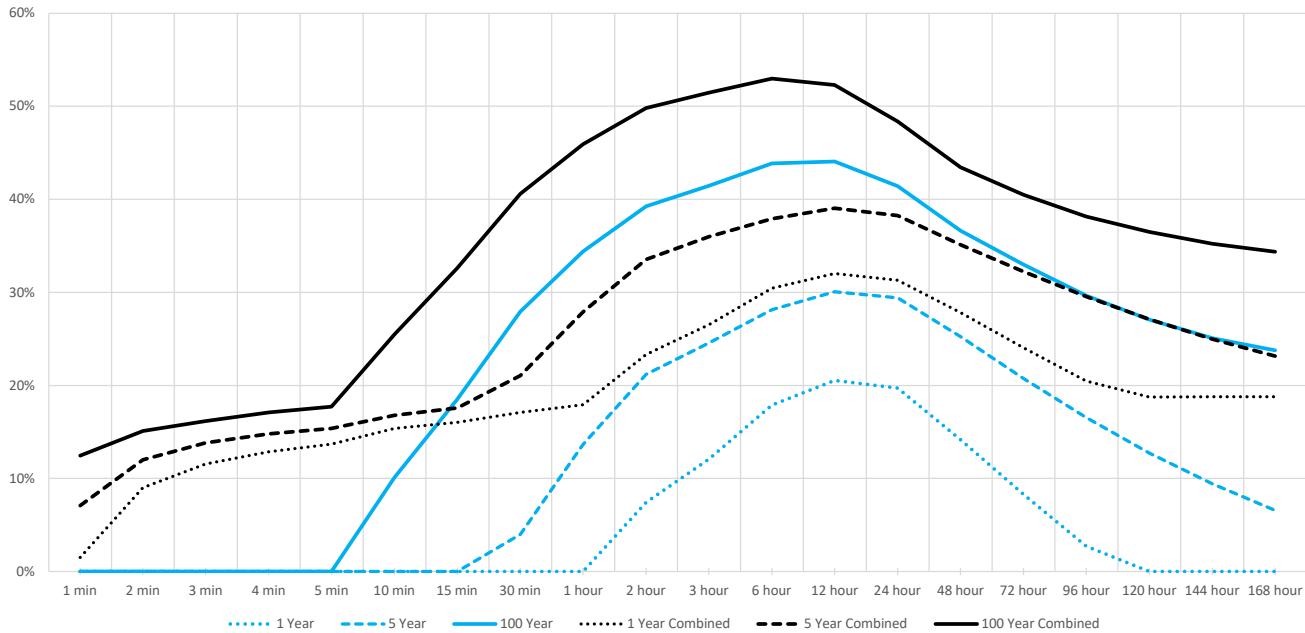
Land Use Graph Selector

1

(11 - combined total)

Residential Lots

Estimated Runoff Rates for Various Land Use and ARI



Project Rivermark Area 4 Catchment A1 : Post Development Model Design Runoff Rates

Rainfall IFD Data

Annual Exceedence Probability

Duration	63.2%	50%	20%	10%	5%	2%	1%
	1.00	1.44	4.48	10	20	50	100
1 1 min	1.6	1.8	2.4	2.8	3.2	3.8	4.3
2 2 min	2.8	3.1	4.1	4.7	5.4	6.4	7.2
3 3 min	3.8	4.2	5.5	6.4	7.3	8.7	9.8
4 4 min	4.6	5.1	6.7	7.8	9.0	10.7	12.1
5 5 min	5.3	5.9	7.7	9.1	10.4	12.4	14.0
6 10 min	7.8	8.6	11.4	13.4	15.5	18.3	20.6
7 15 min	9.4	10.4	13.8	16.2	18.7	22.1	24.9
8 30 min	12.5	13.8	18.2	21.3	24.6	29.0	32.7
9 1 hour	16.1	17.8	23.2	27.2	31.4	37.3	42.2
10 2 hour	20.7	22.7	29.5	34.7	40.2	48.3	55.2
11 3 hour	23.9	26.2	34.1	40.2	46.8	56.6	65.1
12 6 hour	30.8	33.7	43.9	52.0	61.0	74.7	86.7
13 12 hour	39.6	43.3	56.6	67.1	78.8	96.7	112.0
14 24 hour	50.6	55.4	72.1	84.7	98.3	119.0	137.0
15 48 hour	63.8	70.1	90.0	104.0	118.0	139.0	156.0
16 72 hour	73.1	80.2	102.0	116.0	130.0	151.0	167.0
17 96 hour	80.7	88.5	112.0	127.0	141.0	162.0	177.0
18 120 hour	87.6	96.0	121.0	137.0	152.0	174.0	190.0
19 144 hour	94.1	103.0	130.0	148.0	164.0	187.0	205.0
20 168 hour	101.0	110.0	139.0	158.0	177.0	203.0	223.0

Estimated Runoff Rates

Annual Exceedence Probability

Maximum of All Events	63.2%	50%	20%	10%	5%	2%	1%
	1.00	1.44	4.48	10	20	50	100
Residential Lots	21%	23%	30%	34%	37%	42%	44%
Roads	69%	69%	69%	74%	77%	81%	84%
POS/Foreshore	11%	13%	17%	19%	20%	22%	23%
Industrial/Commercial	30%	34%	44%	49%	53%	58%	61%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	32%	34%	39%	43%	46%	50%	53%

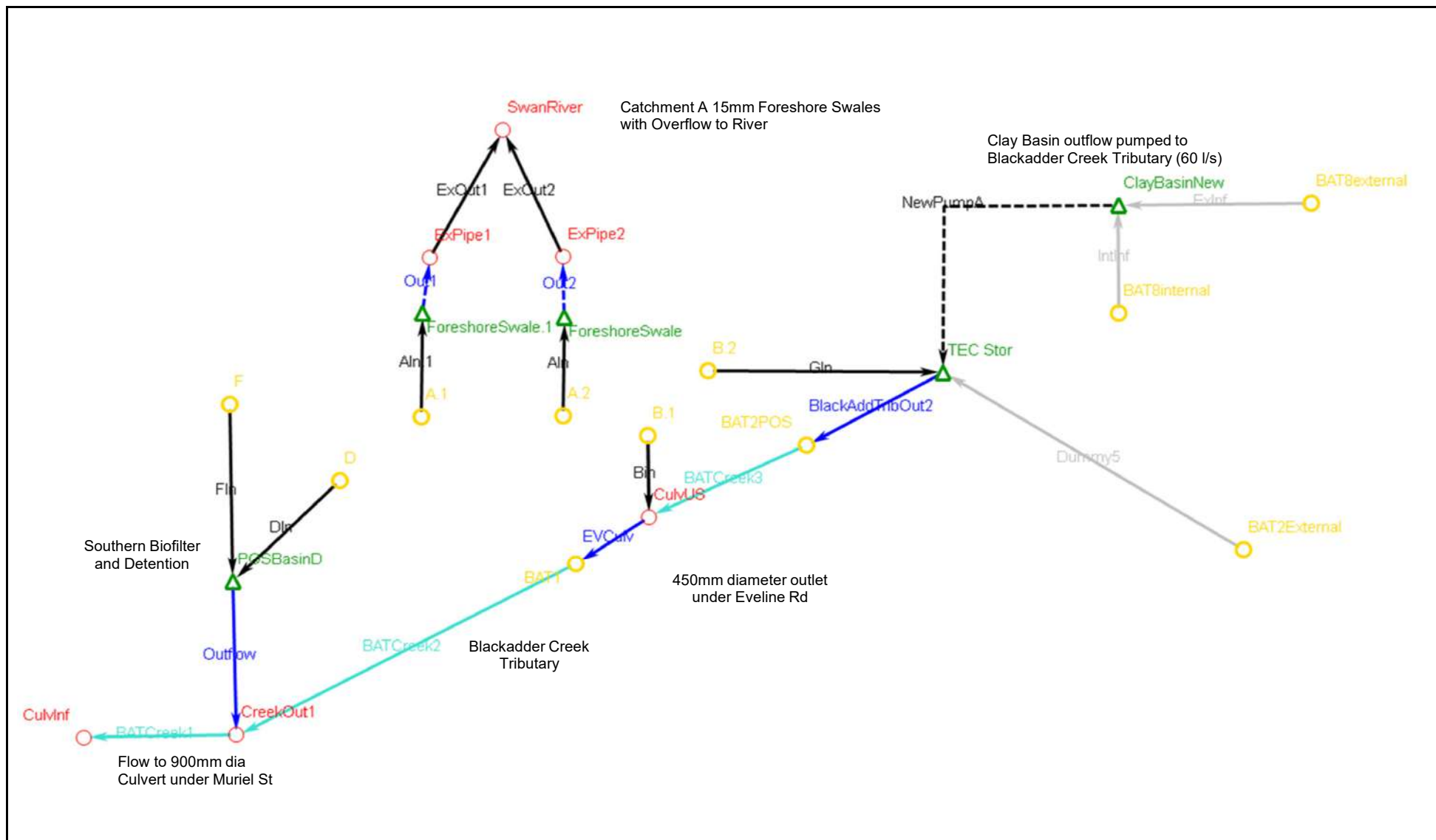
Event Selector

9 1 hour

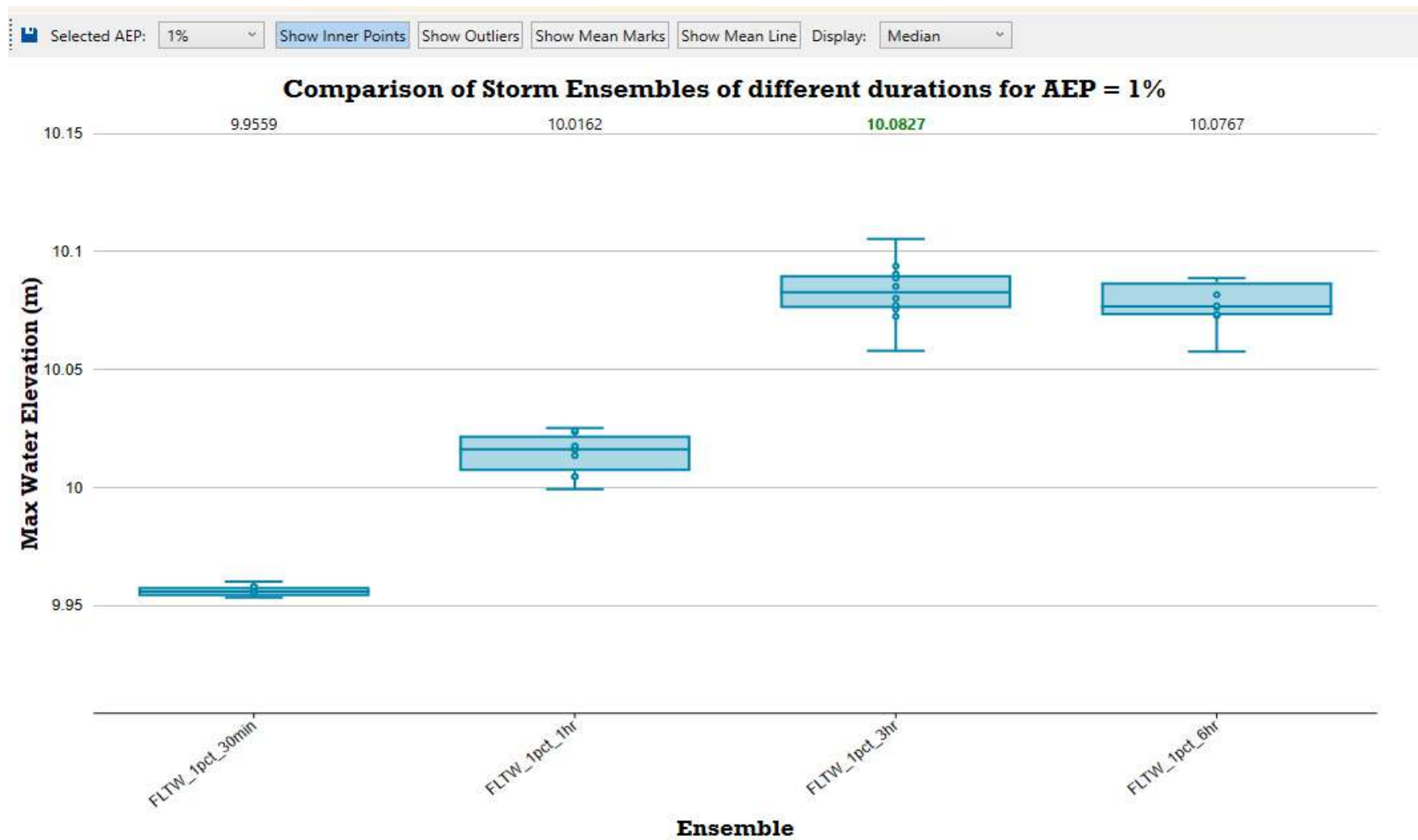
Residential Lots	0%	2%	14%	20%	26%	31%	34%
Roads	63%	64%	65%	70%	74%	78%	80%
POS/Foreshore	9%	11%	15%	17%	19%	21%	22%
Industrial/Commercial	0%	3%	20%	29%	35%	43%	47%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	18%	20%	28%	33%	38%	43%	46%

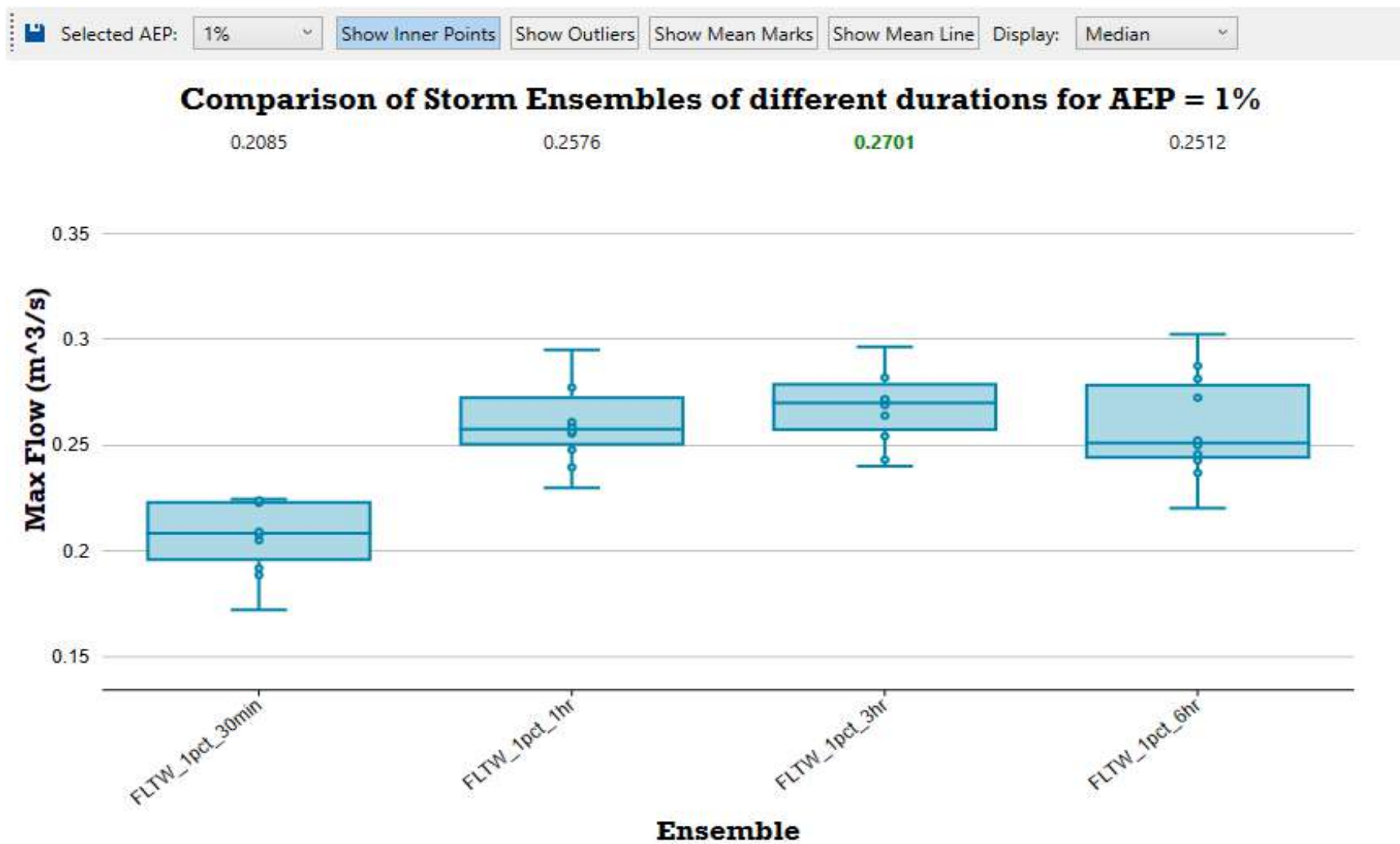
APPENDIX L

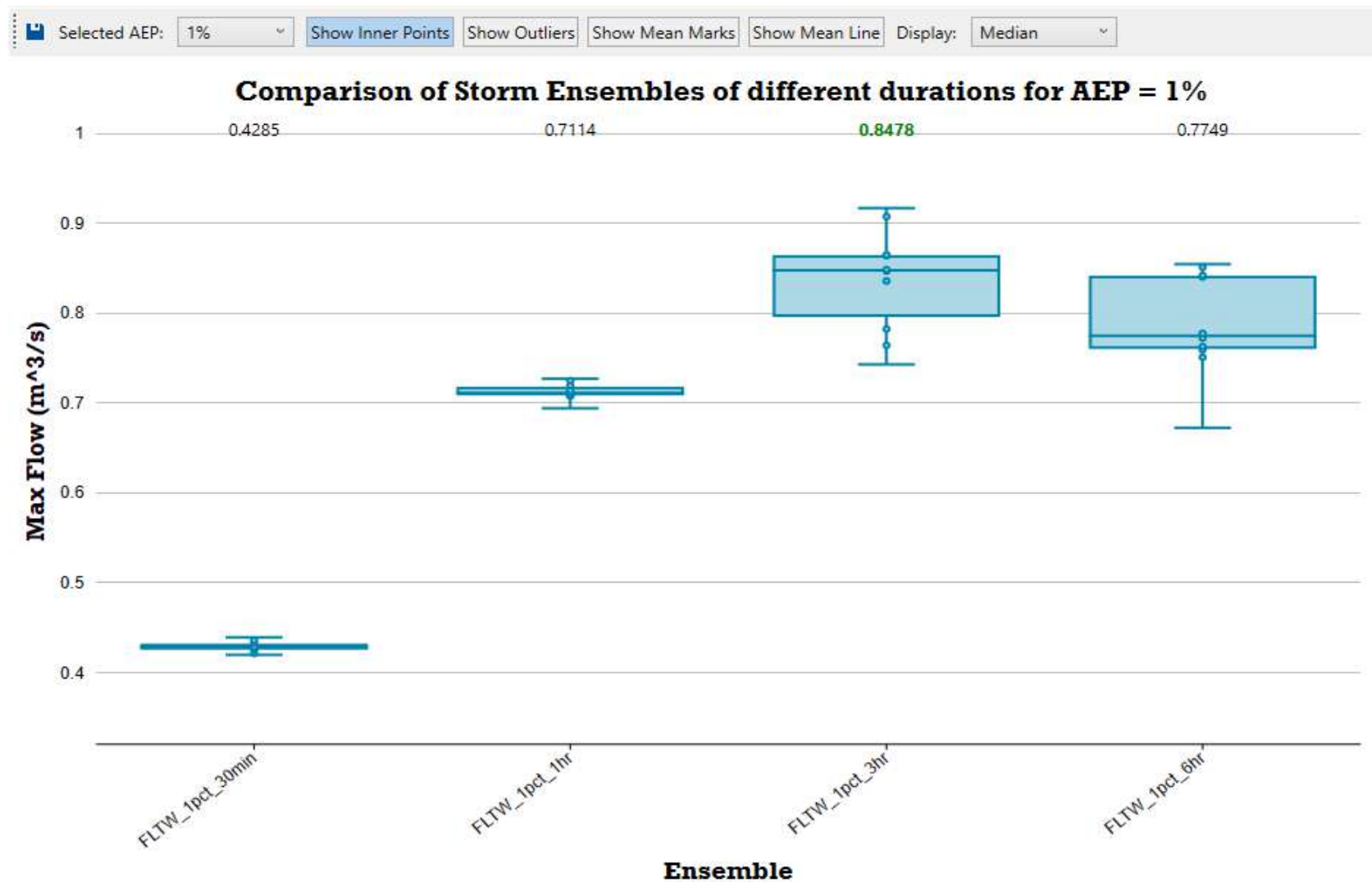
Area 4 Stormwater Modelling Outputs



Blue links represent site outflows, yellow nodes catchments, triangles are storage nodes



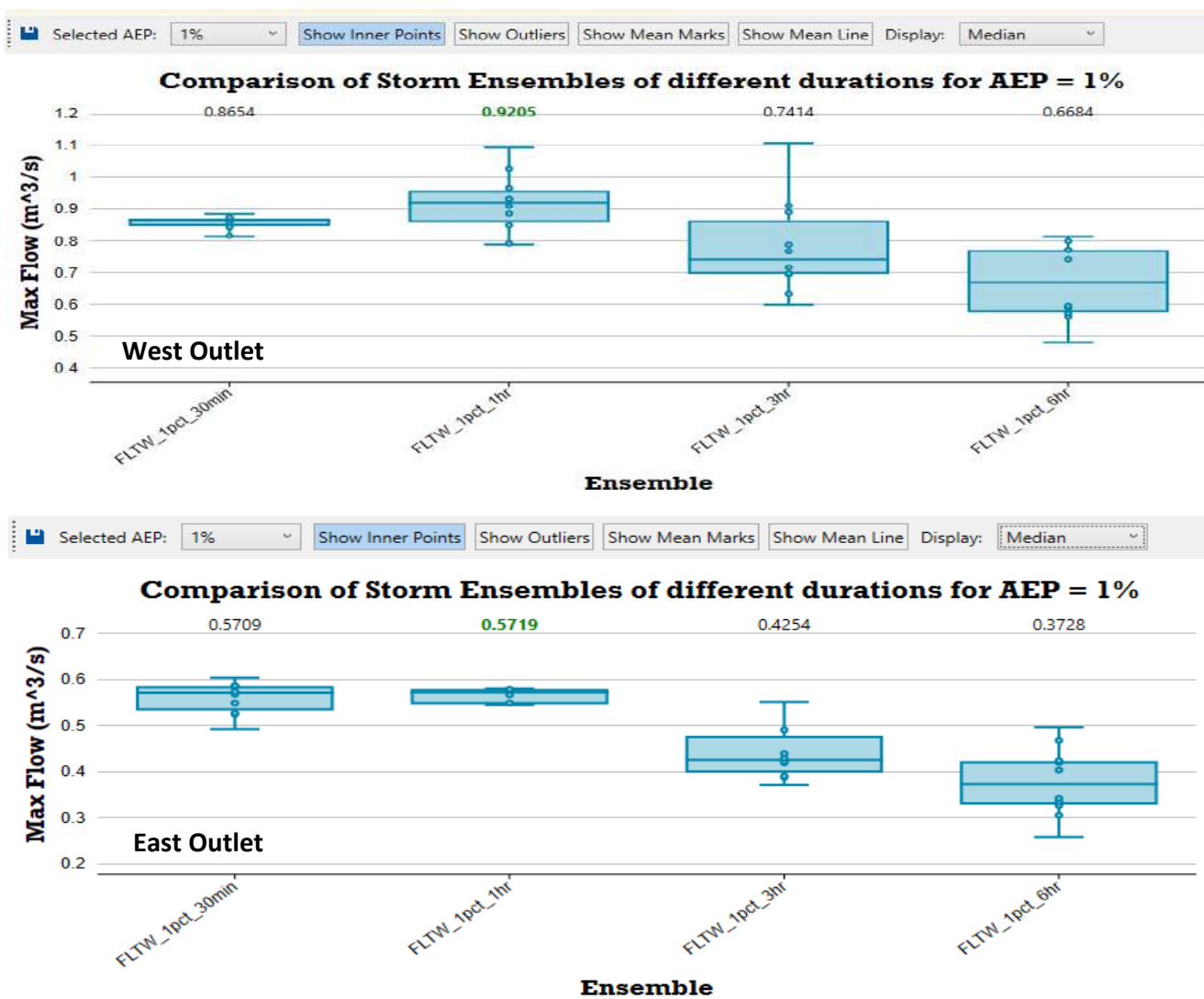


hyd₂o

Rivermark Area 4 Stage 1 Local Water Management Strategy

Post Development System : Modelling Results at Muriel St (Box & Whisker)

Appendix L4



APPENDIX M

Pre & Post Development Water Balance Modelling

Midland Brick Water Balance : Existing System - Conceptual Model



Catchment 1 : Midland Brick

Water In : Catchment Runoff (31.74 ha)
 Water Use : Dust Suppression
 Water Use : Evaporation
 Water Out : To Catchment 2
 Post Dev - Same Area

Catchment 2 : Northern

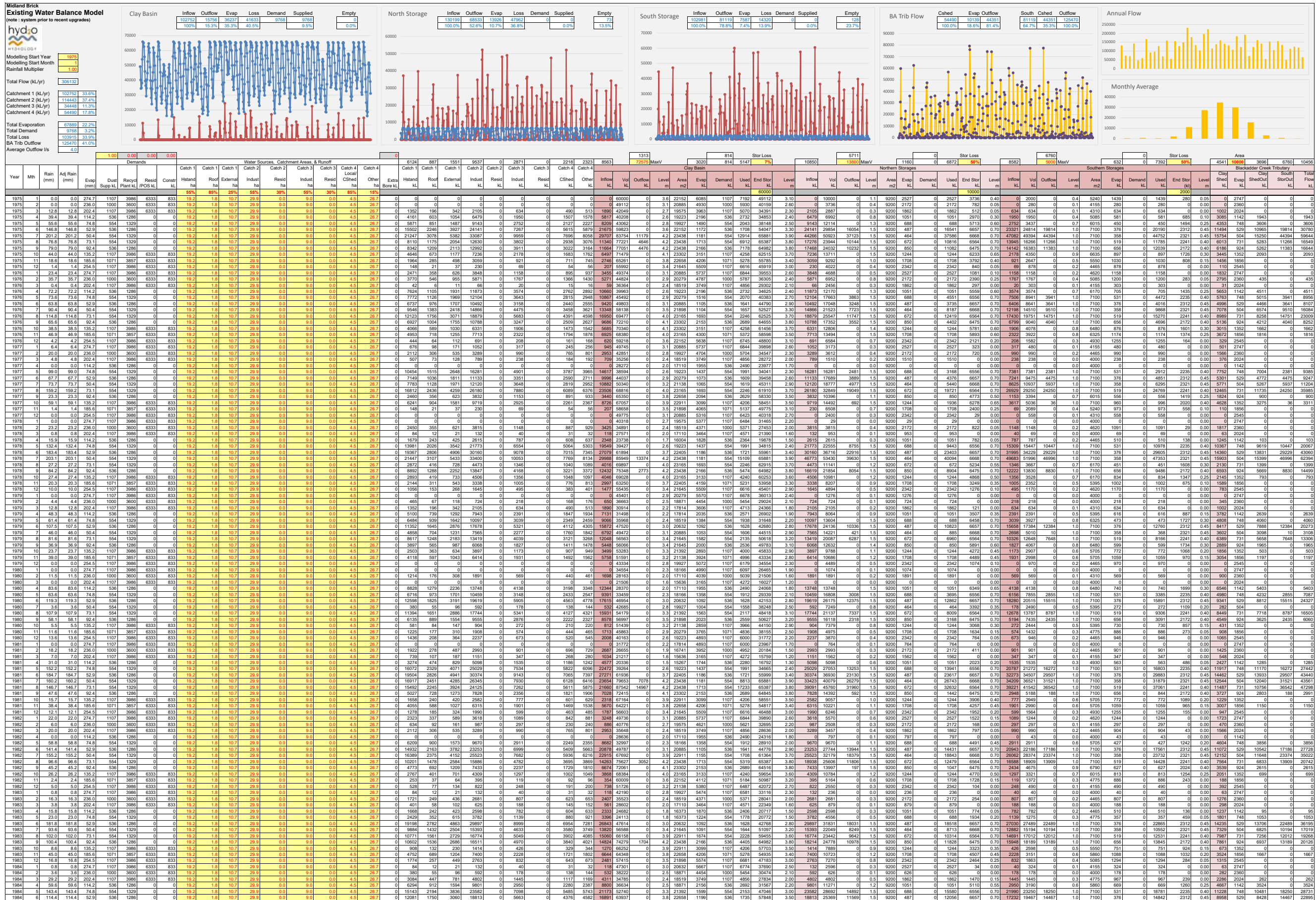
Water In : from Catchment 1
 Water In : Catchment Runoff (29.88 ha)
 Water Use : Evaporation
 Water Out : to Catchment 3
 Post Dev - Catchments A,E and C

Catchment 3 : Southern

Water In : from Catchment 2
 Water In : Catchment Runoff (9.00 ha)
 Water Use : Evaporation
 Water Out : to Blackadder
 Post Dev - Catchments D,F

Catchment 4 : Clay Shed

Water In : Catchment Runoff (31.15 ha)
 Water Use : Evaporation
 Water Out : to Blackadder
 Post Dev - Catchments B, Same External



APPENDIX N

Engineering Report Extracts & Earthworks

RIVERMARK LAND HOLDINGS PTY LTD
RIVERMARK AREA 4 STAGE 1
Engineering Infrastructure Report
SEPTEMBER 2025

CLIENT: RIVERMARK LAND HOLDINGS PTY LTD

PROJECT: 2419 – RIVERMARK AREA 4 STAGE 1

TITLE: RIVERMARK STAGE 4 ENGINEERING INFRASTRUCTURE REPORT

DOCUMENT REVIEW				
Revision	Date Issued	Written By	Reviewed By	Approved By
0	25 February 2020	BF	CB	CB
1	16 March 2020	BF	CB	CB
2	1 April 2020	BF	CB	CB
3	3 April 2020	BF	BC	CB
4	14 March 2025	JZ	CB	CB
5	5 August 2025	JZ	CB	CB
6	14 October 2025	JZ	CB	CB

Note:

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1 INTRODUCTION

Rivermark Land Holdings Pty Ltd is proposing to redevelop part of the Rivermark Area 4 in Viveash and Middle Swan (the Site). The following report provides a broad overview of the existing conditions and engineering advice on the capability and possible future infrastructure requirements of the site to support the proposed development. The report has been prepared for Rivermark Land Holdings to support the planned Metropolitan Regional Scheme (MRS) amendment for a portion of the site and assist with their Local Structure Plan (LSP) for the proposed development.

This report has been prepared in support of the first stage of the residential development, known as Stage 1 - Area 4. The 14.4ha portion of Area 4 is estimated to yield approximately 219 residential lots. Stage 2 of Area 4 will be subsequently rezoned and structure planned as part of a future application.



Figure 1 – Area 4 Stage 1 Structure Plan (studioCFM, October 2025)

The investigation and preparation of the report is mainly based on preliminary advice from the various service authorities. The information is current as of September 2025 and is subject to change as development proceeds around the site.

2 THE SITE

2.1 Site Description

The Rivermark Area 4 is located about 17km northeast of the Perth CBD within the City of Swan that has operated for nearly 75 years as a clay extraction and brick manufacturing facility.

The Rivermark Area 4 is generally bounded by the Swan River to the north, Bassett and Leslie Roads to the east and Eveline Road to the south and west. The sites frontage to the Swan River foreshore extends for approximately 740m and the existing residential area of Viveash is located on the western boundary.



Figure 2 – Rivermark Area 4 Site, Middle Swan (MNG Access Aerial Image, September 2025)

The majority of the site is zoned General Industrial under Local Planning Scheme No. 17. The western interface of the site, adjacent to Cranwood Crescent, has been developed as Rivermark Stages 1 and 2, with 59 residential titled lots.

Most of the site is currently utilised for the manufacture of reinforced concrete bridge beams and hence has been cleared of vegetation. A border of natural and regrowth vegetation generally extends around the perimeter of the site.

No declared rare flora species are located within the application area. However, the stand of vegetation along the Swan River foreshore within the site is identified as Bush Forever and a Threatened Ecological Community (TEC) within a portion of the site located close to Leslie Street (as part of future stage 2).

2.2 Landform / Topography

Over the many years the Midland Brick facility has operated, the natural topography across the site has been heavily modified.

Current levels across the site generally vary from 0.0m AHD along the Swan River edge up to levels of around 5.0m to 8.0m AHD in near proximity to the foreshore, to between 10.0m to 12.0m AHD along the road frontages on the southern and eastern margins of the site.

Some anomalies exist in parts of the site where there are excavations, bunds and stockpiles that have elevations up to 16.0m to 18.0m AHD although these areas are minimal in the context of the overall site area.

The north western portion of the site also contains three shallow settlement ponds which store the peak stormwater runoff from the current Midland Brick facility prior to discharging to the Blackadder Creek tributary.



Figure 3 – Topographic Survey (MNG, April 2019)

The plan below provides a colour representation of existing levels of the Rivermark Area 4.

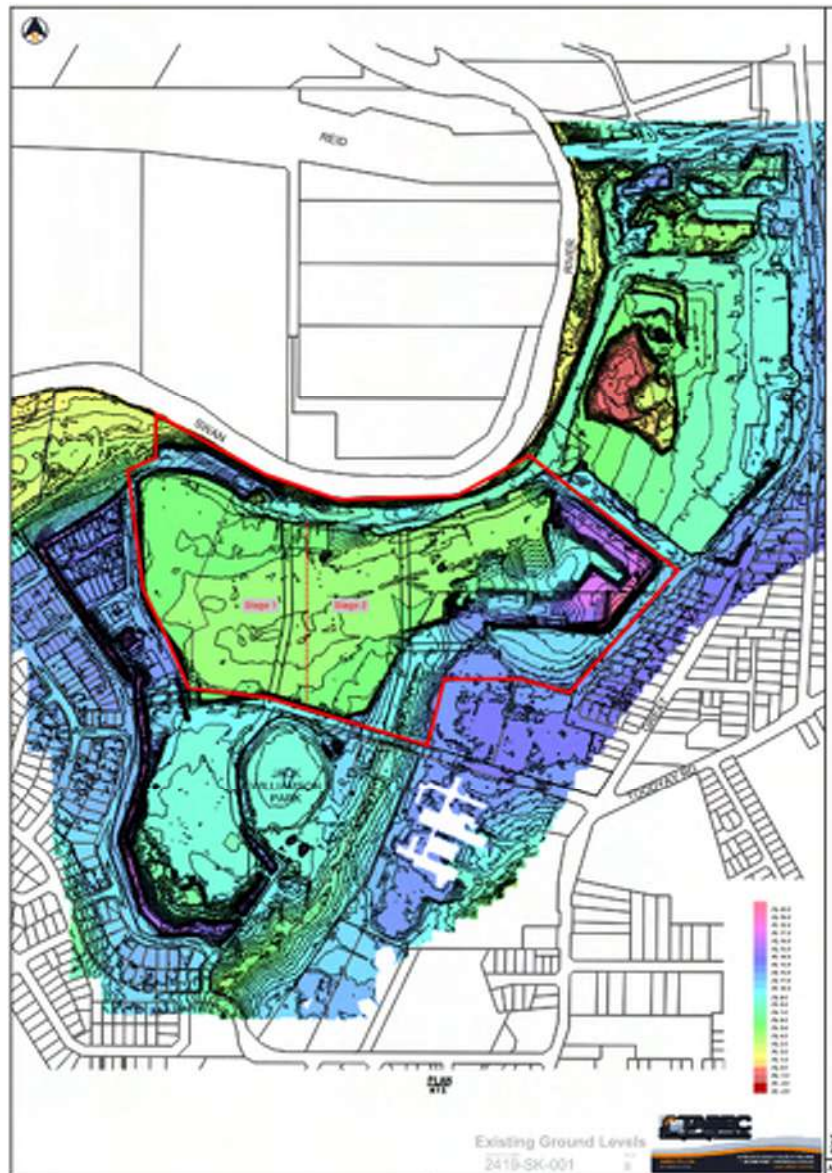


Figure 4 – Existing Ground Elevation Bands (TABEC, July 2019)

2.3 Ground Conditions

During the earlier days of brick manufacture, clay was sourced from within the site and over the years, much of the previous excavation has been backfilled and formed the subgrade for extensive hardstand areas across the site.

Much of the site is covered by hardstand or buildings/sheds. Several geotechnical investigations have been undertaken across the Rivermark Area 4 and the site, the most recent, completed by Douglas Partners.

Results of the Douglas Partners investigation are generally consistent with previous investigations that indicate that the site is generally underlain by clayey and silty soils (both fill and natural material). The encountered soils were generally very stiff to hard or at least medium dense, apart from some locations in the vicinity of the settlement ponds where a shallow layer of soft to firm sandy clay and sandy silt was encountered near the perched water level.

The existing fill is not formally controlled, albeit where encountered, was generally medium dense or very stiff to hard. The fill generally contains some minor brick fragments, and occasionally contains traces of other materials such as wood, fabric, wire, plastic, rubber and concrete.

In its present state the previously filled portions of the site would be classified as 'P' and the natural areas classified as 'M' in accordance with AS 2870-2011.

2.4 Groundwater

The Perth Groundwater Atlas (2004) indicates that the groundwater levels beneath the site ranges from 1m to 2m AHD, with groundwater flow generally in a westerly direction towards the Swan River. Groundwater levels in the Atlas are representative of typical end of summer groundwater levels and are subject to variation due to the influence of rainfall, temperature, tides, local drainage and the seasons.

Perched groundwater was observed during the Douglas Partners investigation, ranging from less than 4.4m AHD to 10.7m AHD. The higher groundwater observed at locations during the investigation is anticipated to be due to the settlement ponds in the immediate area, rather than the regional surficial aquifer. It is expected that once the settlement ponds are decommissioned, the perched groundwater in this area will subside.

Emerge Associates installed 10 groundwater monitoring bores within the Midland Brick landholding including parts of the site. Water levels in all bores were measured monthly from September 2018 to February 2019 with monitoring recommencing in September 2019 and ongoing on a monthly basis.

Based on the existing data, Consultant Hydrologist, hyd2o have calculated the estimated average annual maximum groundwater levels (AAMGL) for the Rivermark Area 4 and site which are shown below. Hyd2o also noted that perching of groundwater appears to be occurring at some bores due to their proximity to existing stormwater attenuation areas.

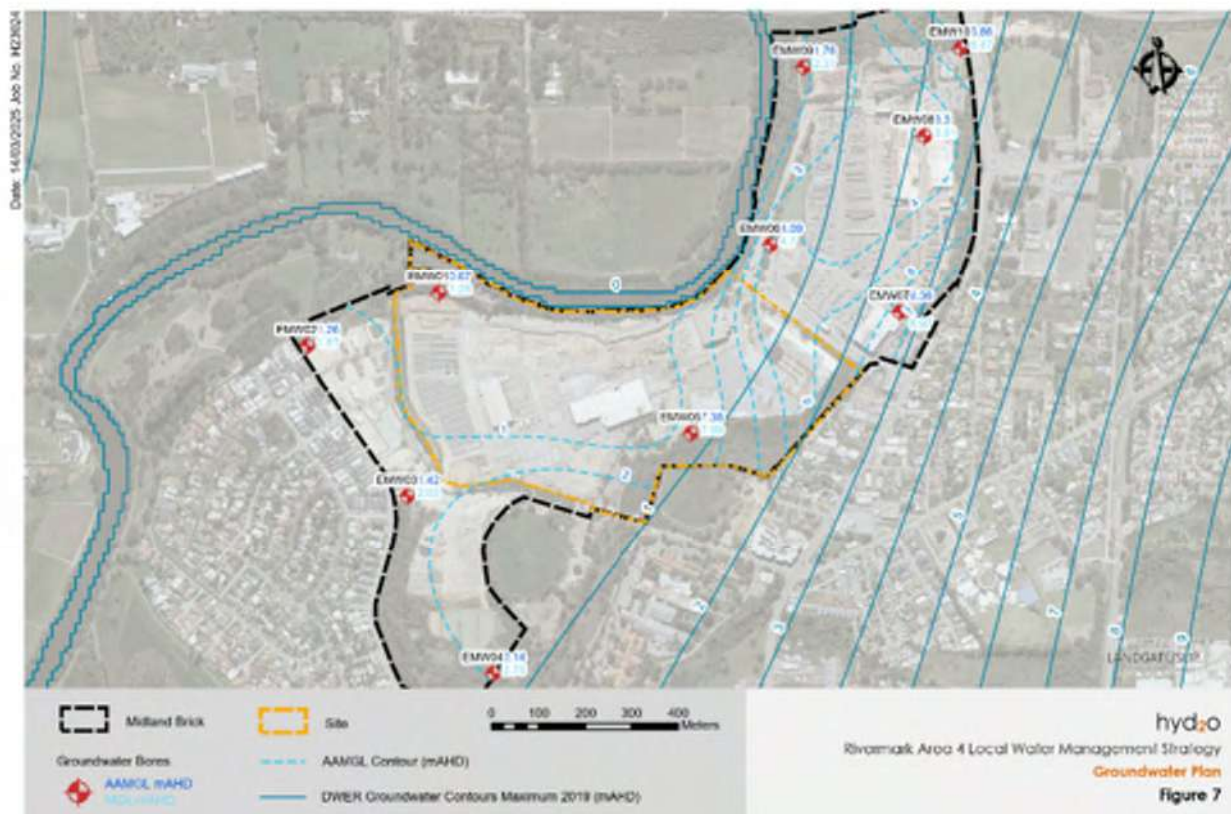


Figure 5 –AAMGL Groundwater Levels (hyd2o, March 2025)

2.5 Acid Sulfate Soils

A review of the DWER Acid Sulfate Soils (ASS) mapping indicates that the site is located in an area as having “no known risk” of ASS, however it is adjacent to an area of “high to moderate ASS disturbance risk” that is associated with the Swan River foreshore. The ASS risk mapping is provided below.

If ASS is to be disturbed, a suitably qualified environmental consultant will be engaged to conduct an investigation of the area and if necessary, prepare an ASS Management Plan. The ASS Management Plan will detail the actions to minimise and mitigate potential adverse environmental effects during the works.

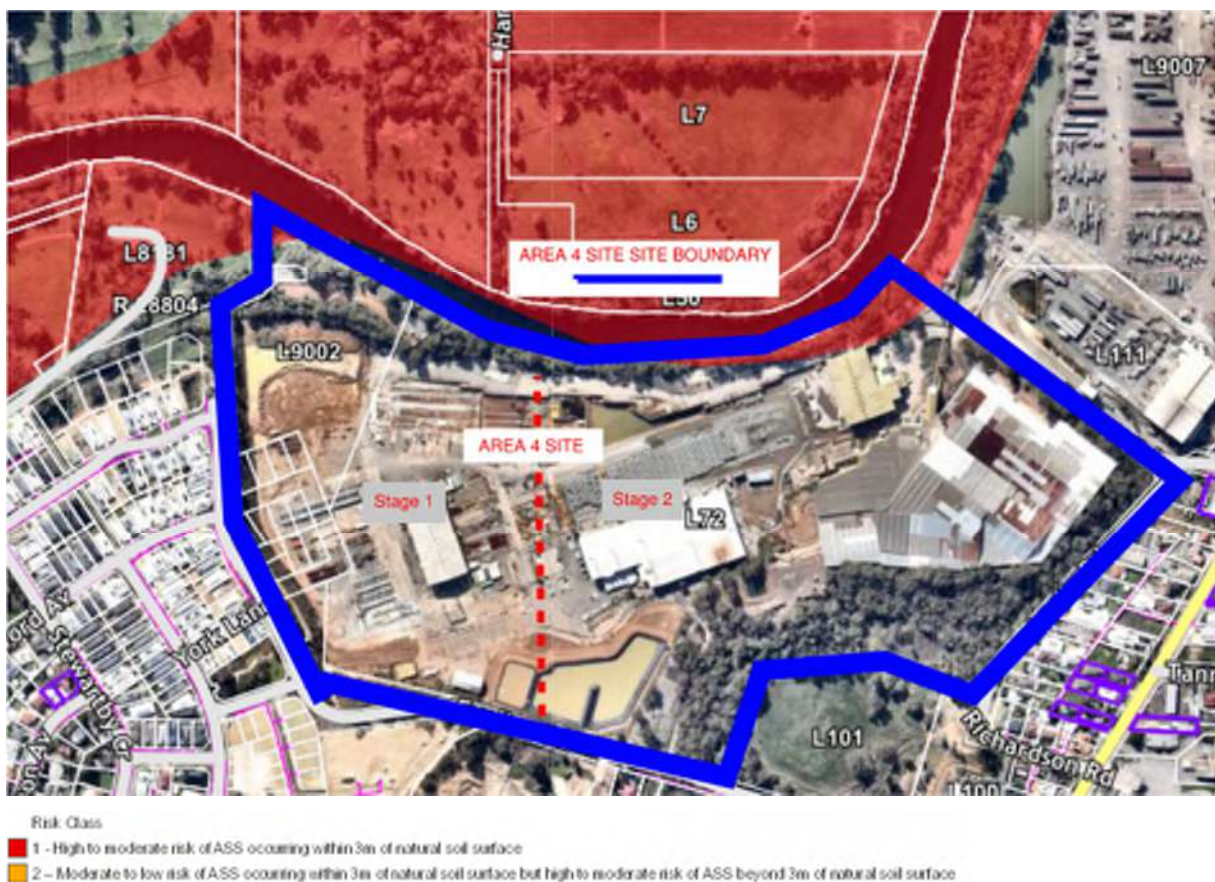


Figure 6 – Acid Sulfate Soil Risk Mapping (DWER)

3 SITEWORKS AND EARTHWORKS

Siteworks to support residential urban development will generally comprise the clearing of existing vegetation, stripping of topsoil, earthworking of the existing ground surface, compaction to areas of existing fill and import of a sand topping to facilitate the proposed form of development.

While the majority of the site is utilised for the manufacture of bricks and masonry product, there are some stands of vegetation which may ultimately impact on the concept design. One of these is along the Swan River foreshore within an area identified as Bush Forever and the other is near the Leslie Road frontage.

Given the existing soils within the site consist of material unsuitable for residential development in its current state and the geotechnical requirement for imported sand fill, limited vegetation will be able to be retained during site preparation. However, some of the more significant trees have been identified with the planning and conceptual earthworks design taking in to account these trees for retention.

Development of the site will require removal of all brick and clay stock on site as well as the demolition of existing buildings, pavements and services prior to undertaking site earthworks, servicing and roadworks to produce the desired development form. Following demolition of existing infrastructure, earthworking will take place to provide for a desired development form while addressing the engineering constraints of the site.

The clayey subgrade surface will be earthworked and shaped, before the sand is placed, to ensure no ponding of perched water occurs. Following the subgrade works, a layer of clean sand fill will be imported and placed above the clayey material to achieve the proposed finished levels and desired site classification. Earthworking of the site is also required to ensure the positive drainage of the allotments to the road and drainage reserves for disposal.

The Douglas Partners geotechnical review recommends that there is a minimum depth zone of at least 1.2m of compacted clay fill that sits below the sand topping layer. Therefore, areas where there is less than 1.2m of clay filling required below the sand layer will need to be over-excavated and recompacted. Where the excavated material has brick or other deleterious inclusions, a screening and crushing process will be required to downsize material to less than 50mm to ensure there are no voids in the future structural fill matrix.

The imported material used for filling should be a free drainage clean sand material having a fines content less than 5% and permeability greater than 5m/day to avoid the imported material having a negative impact on site drainage.

Once an appropriate level of site preparation is undertaken to address the geotechnical risk from the existing fill, compaction of the clayey subgrade and depending on the thickness of the proposed sand fill layer over the clayey soils, it is expected that the post development site classification will be "S", in accordance with AS2870.

It is anticipated that the final levels across the site will be dictated by either the fill required for improvement of the AS2870 site classification or the minimum level required to ensure adequate separation from the Guildford formation and groundwater levels. Additionally, final levels will need to accommodate interface levels with the adjacent developments and existing infrastructure. Furthermore, finished floor levels for the buildings will need to be at least 500mm above the estimated 1% average exceedance probability (AEP) flood levels.

In accordance with current market expectations flat residential allotments will generally be created. Due to the proposed earthworks strategy, stepping between allotments is likely to be achieved with the minimal use of retaining.

4 ROADS AND TRAFFIC

The site is well connected to the surrounding road network with access via Bassett Road which is currently used primarily for the delivery of clay used in the brickmaking process is located and a second access located off Eveline Road, just to the east of Jack Williamson Oval. In addition to these current access locations, the site has frontage to Eveline Road to the south and West.

Cardno have undertaken a transport assessment for the Local Structure Plan which has forecast traffic generation from the consolidated brickworks and site along with the impact on the surrounding road network. The traffic assessment suggests minor upgrades may be required.

Access to the site is proposed via the extension of Eveline Road and connection to Cranwood Crescent. The future internal connections to Eveline Road extension and the continuation of Bernley Drive will likely provide the main local distribution of traffic within the residential development.

The high-level objective for the LSP is to provide a well-connected road network for access and to develop safe, attractive streets for living.

The internal road network will be in accordance with the current IPWEA Subdivision Guidelines, Liveable Neighbourhoods and City of Swan standards. Roadworks will generally consist of kerbed and asphalted pavement.

A network of pedestrian paths will also be required as part of the subdivision to facilitate pedestrian movement throughout the development.

5 STORMWATER MANAGEMENT

Hyd2o, on behalf of Rivermark Land Holdings Pty Ltd, has prepared a District Water Management Strategy (DWMS) for the site to support the proposed MRS amendment and have prepared a Local Water Management Strategy (LWMS) to support the LSP.

The DWMS and LWMS have been prepared in accordance with the principles and objectives of Better Urban Water Management (WAPC, 2008) and following discussions with key agencies ultimately involved with its implementation including the City of Swan, Department of Biodiversity, Conservation, and Attractions (DBCA) and Department of Water and Environmental Regulation (DWER). Implementation of the strategies will be undertaken through the development and implementation of an Urban Water Management Plan(s) for stages of subdivision development within the site.

The site lies between two watercourses which receive stormwater runoff from the Rivermark Area 4, the Swan River to the north and a tributary of Blackadder Creek to the south. The Rivermark Area 4 also receives inflow from an approximate 10-hectare external catchment to the east of Great Northern Highway, adjacent to the proposed consolidated brickworks.

The Swan River 1% Annual Exceedance Probability (AEP) levels adjacent to the site range from 5.8m AHD at the western margin of the site rising to 6.0m AHD at the northern boundary of the Rivermark Area 4. The site is predominantly located outside the 1% AEP floodplain of the adjacent Swan River with only a minor area within the site classified as floodway and flood fringe.

Due to the presence of clay soils, infiltration is limited and stormwater is managed through offsite discharge. The Rivermark Area 4's current stormwater system comprises various storage ponds for attenuation and settlement of stormwater and a series of outlets to the Swan River and Blackadder Creek tributary.

The majority of stormwater from the Rivermark Area 4 flows to an existing sump, via a 1.8-hectare open water body, where it is then pumped to the storage ponds in the northwest of the site and Rivermark Area 4. Water then flows south along the western boundary of the site, entering a further series of storage ponds and ultimately discharging to a tributary of Blackadder Creek, in the southwest corner of the site and landholding. Major events have an outlet to the Swan River.

Flows from the roof area of the Clay Shed at the eastern extent of the site represent a separate stormwater system which discharge into a vegetated storage area behind the Clay Shed (including the TEC) and then into the Blackadder Creek tributary.

Post development, stormwater management will be in accordance with the aim of Better Urban Water Management and the requirements of the Australian Rainfall and Runoff Guide and the City of Swan.

In general, stormwater discharge volumes and peak flows are typically required to be maintained relative to predevelopment conditions. The proposed stormwater management system post development will also consider providing a reliable POS water supply scheme for the site as well as providing stormwater quantity and quality management. The proposed stormwater storage and recovery scheme will utilise treated water from frequently occurring events to recharge the underground storage for use during the summer irrigation period.

Residential lots will capture the first 15mm of rainfall for infiltration at source via soakwells or landscaped areas. During future detailed design, consideration will be given to opportunities to use this water as part of the stormwater storage and recovery scheme via lot connections.

Runoff from road reserves will be managed via a piped stormwater drainage system, with the first 15mm of rainfall being treated prior to any discharge offsite. The stormwater drainage system will be designed and constructed in accordance with Local Authority requirements.

Major event overland flow paths within the development will be directed towards the Blackadder Creek tributary or Swan River.

For areas draining to the Blackadder Creek tributary, the stormwater management areas will be required to provide stormwater storage to attenuate flows to existing levels for events up to the 1% AEP. These storage areas will be integrated with landscaped POS.

In the case of flows to the Swan River, discussion between hyd2o, DWER and DBCA have indicated the magnitude of major event post development flows to the River relative to the existing flows of the Swan River is not a major consideration as the peak times of concentration of flows from the site and the River are not coincident and therefore larger flows from the site are not considered a flood risk. Therefore, for catchments draining to the Swan River, provide 1-year (15mm) biofiltration areas located outside designated foreshore buffer areas, with all larger events permitted to discharge to Swan River via overland flow paths.

These storage areas and volumes will be determined at UWMP stage based on more detailed modelling in parallel with the engineering design.

Development levels are generally not dominated by fill requirements to achieve adequate separation to groundwater, given the proximity of groundwater levels to natural surface. However, due to the underlying impermeable soils, it is envisaged that subsoil drainage may be required within the development to alleviate the perching of groundwater from rainfall.

Subsoil drains will require a free outfall and will be treated prior to any off site discharge. The subsoil drainage network will be integrated with the piped stormwater drainage network.

6 WASTEWATER

Presently, the Rivermark Area 4 is not connected to the sewer network operated by Water Corporation. Effluent is currently treated/infiltrated by a number of standalone septic and leach drain systems that service various buildings across the site.

The proposed development is within the Water Corporation license area and all lots created will be connected to the Water Corporation sewer.



Figure 7 – Existing Wastewater Infrastructure (Water Corporation, 2025)

In accordance with current Water Corporation wastewater planning, the majority of the site falls into the catchment of the future Wexcombe Pump Station C, which is proposed to be located adjacent to Swan River, west of Bassett Road, nominally at a central point in the LSP area. The proposed wastewater pump station will also require an approximate 600m long pressure main that discharges to the existing 225mm diameter sewer in Great Northern Highway, near Bassett Road. The location of the proposed Area 4 waste water pump station can have suitable maintenance access and serviceability from Stage 1.

Headworks infrastructure is planned through the Corporation's 5-year capital investment program which provides developers the ability to service their subdivisions. If there is enough certainty of orderly growth, the infrastructure can be planned and delivered by the Corporation's capital investment program, however the timing of development is normally controlled by the Developer. As a result, the most common delivery method is where the Developer initially funds the project and is recouped by the Corporation for the cost of the works.

Previously, Water Corporation advised that its planning has this pump station to be constructed as part of their capital investment program in 2028. Should this timing be brought forward, a submission for reconsideration of the timing of the project which justifies inclusion in the 5-year capital investment program would need to be made to the Water Corporation.

For previous stages at Rivermark, Stage 1 and Stage 2, wastewater feeds into the Eden Hill gravity sewer that abuts Cranwood Crescent. This sewer is not anticipated to be available for Area 4 due to level differences.

The image below highlights the wastewater catchments.

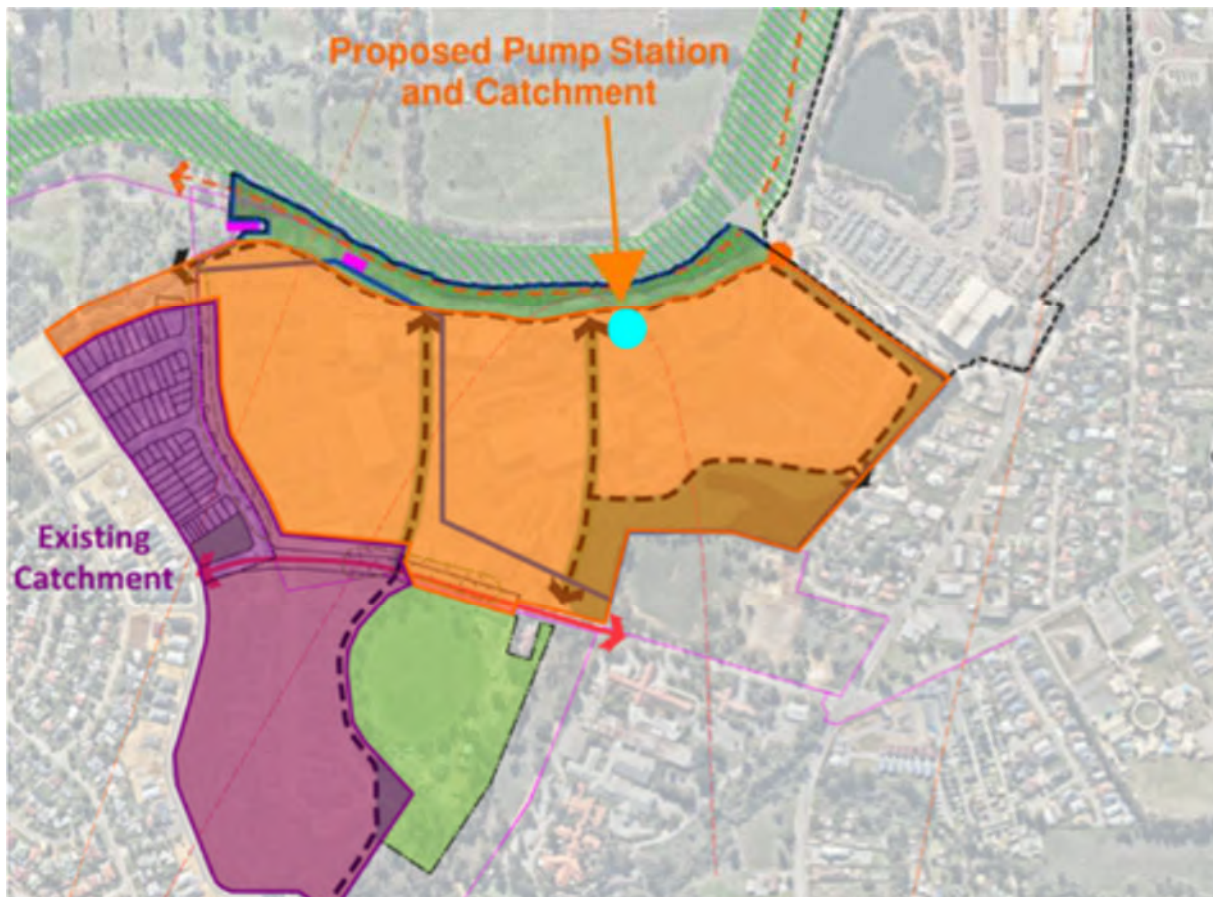


Figure 8 – Wastewater Catchments (Water Corporation, 2020)

From a development perspective, providing the site with a reticulated sewer system will be achieved through the orderly development of the site. Wastewater infrastructure will be designed and constructed in accordance with Water Corporation standards and requirements. Standard Water Corporation wastewater headworks are applicable in this area.

7 WATER SUPPLY

The site is within the Water Corporation license area and can be served via connections to and extensions of the existing water mains adjacent to the landholding.

Existing Water Corporation infrastructure in the vicinity of the site includes a 150mm diameter main in Bassett Road, 250mm diameter main in Eveline Road, 100mm diameter main in Cranwood Crescent and a 200mm diameter main traversing the site between Eveline Road and Cranwood Crescent, just north of Trent Street.



Figure 9 – Existing Water Infrastructure (Water Corporation, 2025)

The existing Midland Brick water and fire supply network within the site is intended to be removed as part of the proposed demolition works.

The extension of the existing water mains surrounding the site will provide the internal reticulation network. An internal water reticulation network will be constructed within the site to provide a service to all lots in accordance with the Water Corporation requirements. Standard Water Corporation water headworks are applicable in this area.

8 POWER SUPPLY

There is currently capacity within Western Power's (WP) broader network to service the development with their network mapping tool indicating that there is in excess of 25MVA capacity in the area which is serviced from Midland Junction WP-009 and Hadfields WP-009 substations.

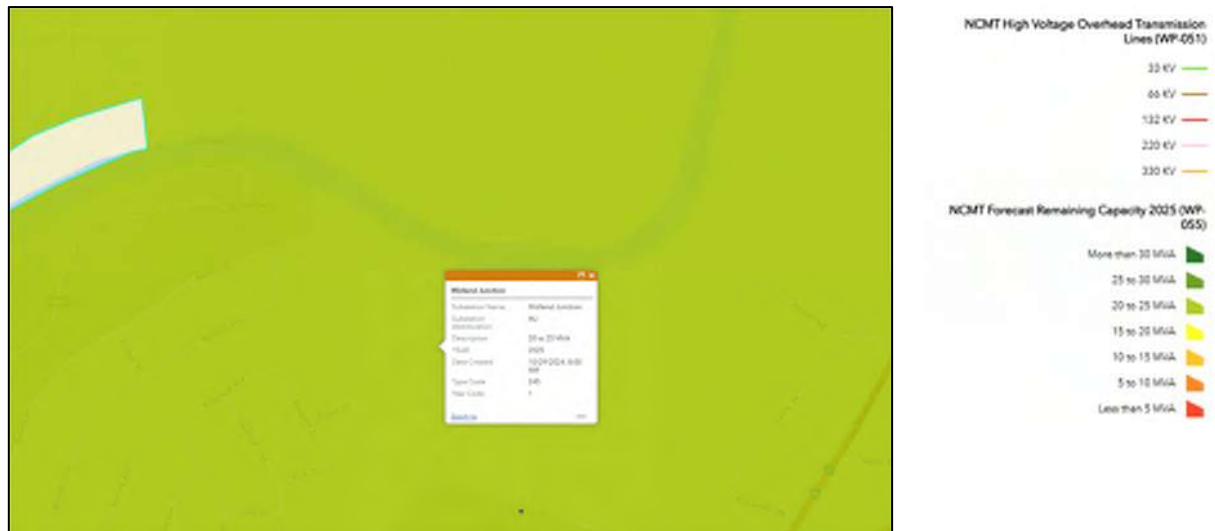


Figure 10 – Power Network Forecast Remaining Capacity (Western Power, 2025)

The WP Network Mapping indicates that Midland Junction Substation services approximately the eastern half of the site, with the Hadfield substation servicing the western half of the site.

The majority of the Rivermark Area 4 is connected to the Midland Switching Station located within the landholding at the western extent of Eveline Road. This switching station is connected to a series of 19 ground mounted and 6 pole mounted transformers within the Rivermark Area 4 that have a combined capacity of 20.7MVA. Another connection to the landholding is located off Great Northern Highway at Kiln 9 which comprises 4 transformers with a combined capacity of 5.0MVA. Therefore, the current power capacity for the Rivermark Area 4 is 25.7MVA.

Based on the Western Power UDS Manual requirements and a projected yield of approximately 456 residential lots the estimated load for the proposed residential development of the site is in the order of 2.3MVA. Given the current Midland Brick landholding capacity, this would leave in excess of 22MVA capacity for the consolidated Brickworks facility.

As part of the development process, it is expected that the existing power infrastructure within the site will be removed and it will be replaced as part of the stage construction works.

New high voltage cables will be connected to the existing infrastructure and extended through the proposed development. Within the development the high voltage cables will connect to the switchgear and transformers which will function to reduce the voltage suitable for consumer usage. Generally, this infrastructure would be located in public open space throughout the development. However, this is dependent on the staged layout for the development and will ultimately be determined during detail design.

Power will then be reticulated underground throughout the development via low voltage feeders that will extend from the transformer feeding the pillar units servicing each new lot. The provision of LV and HV interconnection to the adjoining development areas will also have to be catered for. Western

Power standard system charges and HV pool credits would be applicable to the proposed residential development.

Street lighting will also be required as part of the development in accordance with Western Power and City of Swan guidelines.

9 TELECOMMUNICATIONS

The site is within the NBN fibre to the node fixed line footprint and therefore can be serviced.

The NBN network is located adjacent to the site, within the existing residential subdivision in Cranwood Crescent and provides a connection point for an NBN compliant pit and pipe network to be extended within the proposed development.

The site would enter into an agreement with NBN (or other service provider). NBN is required to recover part of the cost of deploying the NBN network infrastructure by applying a Developer contribution charge per premises.



Figure 11 – NBN Rollout Map (NBN, March 2025)

10 GAS SUPPLY

The Midland Brick facility is a significant user of gas. Presently, gas is supplied to the site from a 100mm diameter 'lateral' pipeline off the Parmelia Gas Pipeline operated by APA. Associated with this gas supply is a pressure reducing station (PRS) located near Swan River at the western end of Kilns 7 and 8 within the Rivermark Area 4.

An easement for the new private gas connection from the APA station to the consolidated brickworks facility will be required. The easement, in favour of Midland Brick, is expected to be located along the northern edge of the site within the Parks and Recreation reserve and be 4m wide.

Atco Gas also have a steel high-pressure gas pipeline within and in near proximity to the site, along with a PRS located at the north-west corner of the site. Unlike the Parmelia 'single user' supply, the Atco Gas infrastructure forms part of a broader network. The Atco Gas pipes traverse the site through the future development and along Eveline Road and Leslie Street.

The LSP concept plan and subsequent conceptual earthworks modelling has taken into consideration the existing Atco Gas steel high-pressure pipeline such that it can remain in situ. However, it is an Atco requirement that no sensitive land uses such as aged care, child care etc. are located immediately adjacent to any HP gas pipes located within future road reserves, with any suggested amendments to this requiring further discussion with Atco Gas.

A connection to the existing Atco Gas infrastructure main will allow for a gas reticulation network to be provided to the proposed development if desired. The general arrangement is that the Developer supplies the trench and Atco Gas install the main at their cost.

A Safety Management Study (risk assessment) has been undertaken on the high-pressure APA gas pipe that runs into the north-west corner of the site, adjacent to Swan River. The high-pressure APA gas pipe is at a higher operating pressure than the Atco Gas pipe. The risk assessment has highlighted that there should be no sensitive land uses adjacent to the site and that the proposed structure plan, with a road separating the APA HP gas pipe, is considered to be acceptable.

11 SUMMARY

All required utilities are available and can be extended to service the proposed development for Stage 1.

Based on the preliminary engineering servicing review, there would appear to be no engineering or servicing constraints to the development of the site that cannot be resolved through orderly standard engineering design and construction. Significant planning has already been undertaken by the relevant authorities to support existing developments within the vicinity of the site.



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Amendment No. (TBC) To City of Swan Local Planning Scheme No.17

To Rezone Lots 72, 160–169, 195–198, 9002, 9010 Eveline Road, Viveash To 'Urban Development' Zone
Stage 1 of Area 4 Rivermark Residential Estate