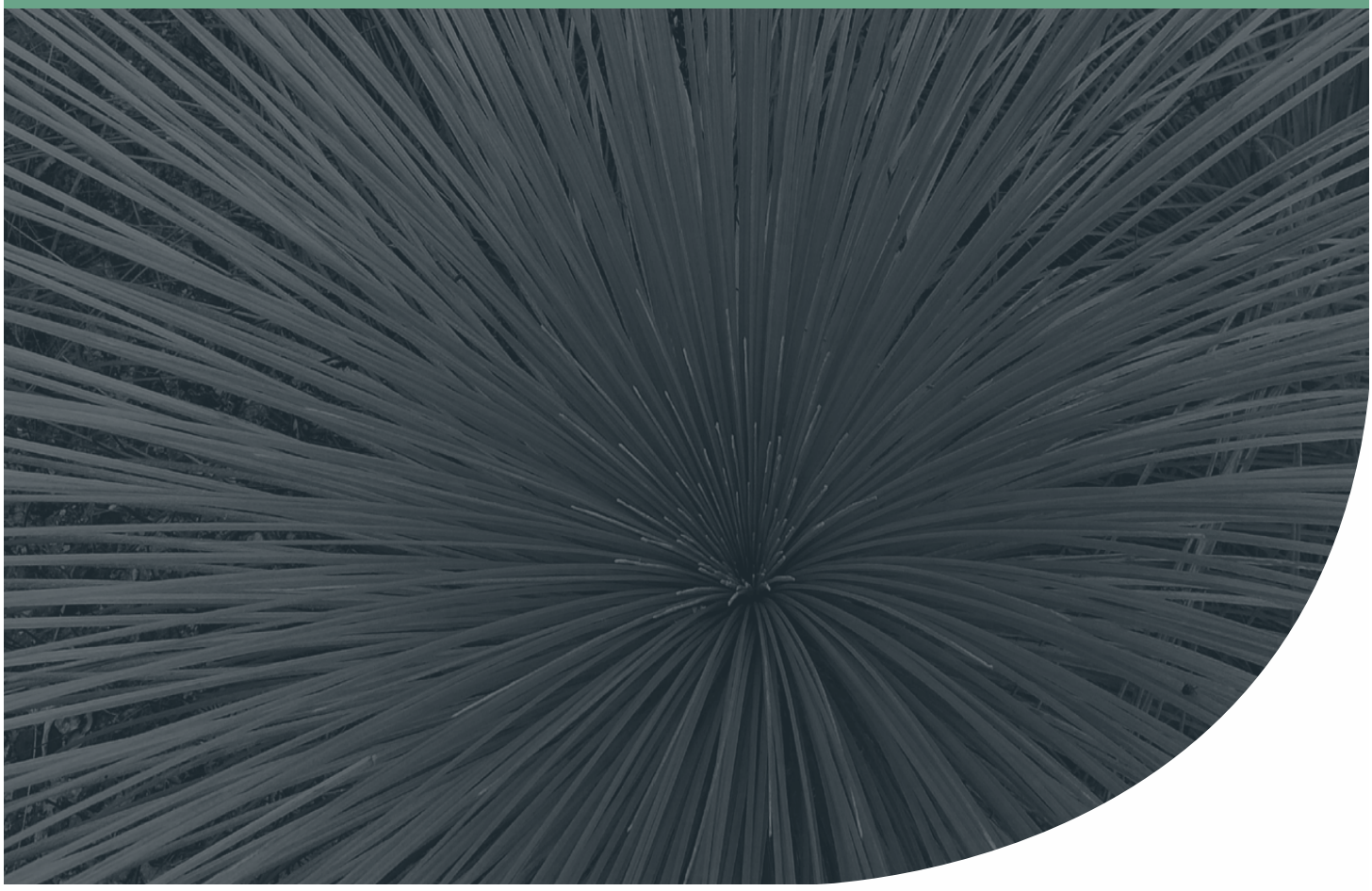
Decommissioning and Rehabilitation Plan

Middle Swan Brickworks

Project No: EP19-105

Prepared for Capitary No. 3 Pty Ltd
August 2020



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1 Introduction

Emerge Associates has prepared this plan on behalf of Capitary No. 3 Pty Ltd (Capitary), to allow for the decommissioning of various buildings, structures, settlements ponds and hardstand areas within the area of the Middle Swan Brickworks site that is included within approval boundary of Ministerial Statement 1124 (the site), as illustrated in **Figure 1**. This plan has been prepared to comply with condition 5 of Ministerial Statement 1124 (MS 1124), which requires:

> *5-1 At least six (6) months prior to decommissioning, the proponent shall prepare and submit a Decommissioning and Rehabilitation Plan, to the satisfaction of the CEO.*
>
> *5-2 The proponent shall implement the Decommissioning and Rehabilitation Plan required by condition 5-1.*

The site is comprised of the lots detailed in **Table 1**, and decommissioning activities may occur to a greater or lesser extent within all of them.

Table 1: Lots and Landowner details

Lot	Volume/Folio	Plan/Diagram	Landowner
71	2916/633	P408605	Boral Bricks Western Australia Pty Ltd
72	2916 / 634	P408605	
23	2898 / 388	P77549	
9000	2905 / 766	P405292	
103	2668/413	P54208	
104	2668/413	P54208	
87	1880/987	P5036	
16	1172/39	P1193	Midland Brick Co Pty Ltd
15	1592/475	P1193	
6	1631/260	D4102	
214	1332/349	P010145	
215	1332/350	P010145	
216	1332/351	P010145	
217	1332/352	P010145	
218	1332/353	P010145	
219	1332/354	P010145	
220	1332/355	P010145	
221	1332/356	P010145	

Table 1: Lots and Landowner details (continued)

Lot	Volume/Folio	Plan/Diagram	Landowner
200	1332/338	P010145	Midland Brick Co Pty Ltd
201	1332/339	P010145	
202	1332/340	P010145	
203	1332/341	P010145	
204	1332/342	P010145	
205	1332/342	P010145	
190	1336/329	P010145	
191	1336/330	P009113	
192	1336/331	P009113	
193	1336/332	P009113	
194	1336/333	P009113	
195	1336/334	P009113	
196	1336/335	P009113	
197	1336/336	P009113	
198	1336/337	P009113	
142	1336/301	P009113	
143	1336/302	P009113	
144	1336/303	P009113	
145	1336/304	P009113	
146	1336/305	P009113	
147	1336/306	P009113	
148	1336/307	P009113	
149	1336/308	P009113	
150	1336/309	P009113	
151	1336/310	P009113	
152	1336/311	P009113	
153	1336/312	P009113	
154	1336/313	P009113	
155	1336/314	P009113	
156	1336/315	P009113	
157	1336/316	P009113	

Table 1: Lots and Landowner details (continued)

Lot	Volume/Folio	Plan/Diagram	Landowner
158	1336/317	P009113	Midland Brick Co Pty Ltd
159	1336/318	P009113	
160	1336/319	P009113	
161	1336/320	P009113	
162	1336/321	P009113	
160	1336 / 319	P9113	
161	1336 / 320	P9113	
162	1336 / 321	P9113	
163	1336 / 322	P9113	
164	1336 / 323	P9113	
165	1336 / 324	P9113	
166	1336 / 685	P9113	
167	1336 / 686	P9113	
168	1336 / 327	P9113	
169	1336 / 328	P9113	
195	1336 / 334	P9113	
196	1336 / 335	9113	
197	1336 / 336	9113	
198	1336 / 337	9113	

Capitary proposes to undertake decommissioning in a staged manner, as part of a broader strategy to rationalise and consolidate the footprint of the brickworks' operations to the north-east of Bassett Road, in anticipation of future redevelopment of the south-western portions of the brickworks to residential land use. This decommissioning plan has been written on the basis that the areas to be decommissioned will be redeveloped for residential or industrial purposes and therefore no specific revegetation rehabilitation plan is required.

However, it is relevant to note that Lot 72 is classified as 'Possibly contaminated – investigation required'. As such, the 'rehabilitation' of this lot will be undertaken in accordance with the requirements of the *Contaminated Sites Act 2003* and remediation requirements are likely to include the excavation and treatment of affected soils and groundwater remediation.

2 Site context

2.1 Historic and existing land uses

A review of publicly available historic aerial imagery indicates the majority of the site was cleared of native vegetation prior to 1953, likely for grazing and subsequently clay quarrying and brick making. The existing brickworks facility was originally established and operated as two separate brickworks, the Whitemans Brickworks established in 1889 to the north, and Midland Brickworks established to the south in the mid 1950s. The operations were combined in 1989 and have operated as the Midland Brickworks to the present day.

Between 1985 and 1989, earthworks were undertaken within the western portion of the site to facilitate the use of an area as sedimentation ponds (settlement pond 4 as shown in **Figure 1**) as a part of the brickworks' stormwater drainage system. Since the establishment of the sedimentation basins, there has been extensive revegetation with non-native species across this area.

The existing clay basin within the north-eastern portion for the site (settlement pond 2 as shown in **Figure 1**) has been utilised for extraction and quarrying purposes until 1977, after which the clay basin was decommissioned and became inundated. From 1977 until present, the clay basin has changed shape several times due to areas being reclaimed/backfilled.

2.2 Authorised operations

As set out in MS 1124 and **Table 2** below, the physical elements of brickworks site currently include five drainage settlement ponds, which include the inundated clay pit in the northern section of the site, and various industrial buildings and facilities, which include brick kilns, various sheds/ warehouses for storage of material, vehicle workshop, masonry plant, sales offices, and administration buildings, as well as several large areas of hardstand utilised for the storage of bricks. Vehicle access to the brickworks site is provided from Bassett Road, Eveline Road and the Great Northern Highway.

Figure 1 shows the extent of physical and operational elements within the site.

Table 2: Location and authorised extent of physical and operational elements

Element	Authorised Extent
Physical elements	
Project life	50 years
Area of disturbance	65.83 hectares
Brickworks and associated infrastructure	Five kilns, four stacks and associated storage and laydown facilities
Operational elements	
Brick manufacturing	No more than 1,000,000 tonnes per year
Water management	Five settlement ponds

2.3 Surrounding land uses

The site is bound by the Swan River to the west and north as well as existing brickworks sheds (which are not within MS 1124's boundary) and Reid Highway to the north. To the east, the site is bound by residential and commercial properties, Great Northern Highway and Jack Williamson Park. Vacant and undeveloped land is present to the south, and existing urban development to the west.

3 Decommissioning and Rehabilitation

The section of the brickworks to the south-west of Bassett Road (the southern section of the site) will be redeveloped for residential purposes. The redevelopment will involve the decommissioning of authorised elements in the southern section of the site. The infilling of the inundated clay pit in the northern section of the site (settlement pond 1 and 2) is required to facilitate the relocation of operational areas from the southern section of the site; these infilling works are included in this plan. The full extent of the decommissioning and rehabilitation works covered by this plan are:

- The demolition of various plant and infrastructure which are either redundant/unused or will not be required for the long-term operating strategy for the site, as shown within the development/subdivision boundaries in **Figure 1**.
- The decommissioning of existing stormwater settlement ponds, (ponds 1, 2 and 4) and associated infrastructure.
- Remediation of any areas of the southern section of the site deemed to be contaminated or require remediation due to interaction with the *Contaminated Sites Act 2003*.

The timing, methodology and existing controls associated with the above works are outlined below.

3.1 Timing and planning approvals

The decommissioning of the two settlements ponds (Ponds 1 and 2) within the footprint of the inundated clay pit will commence in spring 2020. This will involve the infilling of these two existing ponds and the creation of two new swales. The City of Swan and WAPC granted Development Approval for these works in February 2020; the final layout is shown in the approval documents in **Appendix A**.

The decommissioning works in the southern section of the site shall be undertaken on a staged basis, commencing in the west and progressively moving eastward to meet Bassett Road.

The removal of settlement pond 4 on the western boundary will commence in Spring 2020. These works will be undertaken in accordance with the Stage 1 subdivision plan. The WAPC granted approval for the Stage 1 subdivision in August 2020; the final layout is shown in the approval document in **Appendix B**.

The decommissioning of the remaining elements within the southern section of the site is expected to commence in late 2020 and be completed in 2023. Approval to demolish these elements, with the exception of the Plasterboard Shed, the Clay Shed and settlement pond 3, was granted by the City of Swan and the WAPC in early 2020; the approval documents are provided in **Appendix C**. The necessary planning approvals for the Plasterboard and Clay sheds and Pond 3 will be obtained closer to the point in time when they become surplus to requirements, expected to be in the order of five years time; this decommissioning plan will be updated then to include the approval documents.

3.2 Plant and infrastructure

3.2.1 Authorised elements to be decommissioned

This following plant and infrastructure will be decommissioned as part of this plan, as illustrated in **Figure 1**:

- Yard Office.
- Kilns 7 and 8 (currently not operational).
- Kiln 11 (proposed to be decommissioned).
- Administration (Operations) Building.
- Lintel Bed.
- Plaster Board Bulk Warehouse.
- Admin Hut and Building.
- Export Shed.
- Additives Shed.
- Materials Shed.
- Logistics House
- Other Sheds 44, 45, 46.
- Vehicle Workshop and Stores.
- Miscellaneous minor structures and hardstand are also to be demolished.

3.2.2 Methodology and controls

The demolition plan accompanying the development application for the demolition of the plant and infrastructure listed in **Section 3.2.1**, outlined a number of commitments that would be met by the demolition contractor including:

- All trees and existing vegetation marked for retention must be protected and retained throughout the duration of the works.
- All existing services will be removed and capped in accordance with relevant authority and Australian Standards.
- All existing services that are owned and operated by other authorities and within the works boundary are to remain protected at all times.
- The contractor shall provide erosion and sediment control measures throughout the duration of the works.
- The contractor shall provide dust fencing as required in accordance with Dust Control Guidelines.

In addition to the above commitments, the development application approvals from the City of Swan and the WAPC, see **Appendix C**, contain a number of planning conditions which must be adhered to including:

- Preparation and implementation of a noise, dust and vibration management plan prior to a demolition permit being issued.
- Preparation and implementation of a Construction Management Plan addressing:
    - Dust

  - Noise
  - Waste management
  - Storage of materials
  - Traffic management
  - Site safety and security.
- Retention and protection of all trees and ensuring that no vegetation within Bush Forever area 302 is disturbed as a result of the works.
- Taking appropriate preventative measures during the demolition works to ensure that no chemicals, woody debris, construction material, or soil enters Blackadder Creek, Bush Forever Area 302, the stormwater system or Swan River as a result of the works.
- Requiring that all septic sewer systems and associated drainage systems (soak wells or leach drains) are to be decommissioned, in accordance with the *Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974*, removed, filled with clean sand and compacted. Proof of decommissioning is to be provided in the form of either certification from a licenced plumber or a statutory declaration from the landowner/applicant, confirming that the site has been inspected and all septic tanks, soak wells, leach drains and any associated pipework have been removed.

As referenced in the above conditions, Capitary is required to apply for a demolition permit in accordance with the *Building Act 2011*, before any works can commence. This permit may place further requirements on the demolition contractor.

The detailed decommissioning methodology for plant and infrastructure will be determined in conjunction with the demolition contractor. However, the following generic tasks are anticipated:

- Disconnect services.
- Securing site.
- Remove any hazardous materials (as required).
- Remove ancillary structures, fittings, salvageable materials, deleterious materials etc.
- Deconstruct demolition structures.
- Further breakdown demolished or deconstructed structures.
- Transport demolished or deconstructed materials from site.

Where possible some structures will be sold whole, deconstructed and removed from site to be re-purposed elsewhere. Capitary will also salvage, reuse and recycle demolished materials where possible for use in the consolidate brickworks located in the northern section of the site. Demolition will be by mechanical means, and no blasting will be required.

Noise generated by demolition activities will not exceed the levels as set out under the *Environmental Protection (Noise) Regulations 1997*. The City of Swan's Development Approval requires that "Noisy Construction Work" outside the period 7.00 am to 7.00 pm Monday to Saturday and at any time on Sundays and Public Holidays is not permitted unless a Noise Management Plan for the construction site has been approved in writing by the City.

3.3 Stormwater management system

3.3.1 Authorised elements to be decommissioned

The redevelopment of the southern section of the site and the consolidation of the brickworks onto the northern section of the site will ultimately require the decommissioning of the site's existing stormwater management system that includes Settlements Pond 1 to 5. The Local Water Management Strategy (Hyd2o Hydrology 2020) that supports the proposed Local Structure Plan for the southern section of the site describes the future drainage system for the site, see **Appendix D**.

At this point in time, this plan addresses the decommissioning of settlement ponds 1, 2 and 4, as shown in **Figure 1**. The plan will be updated with the necessary planning approvals that will facilitate the decommissioning of settlement ponds 3 and 5 nearer to the point in time when they become surplus to requirements.

3.3.2 Methodology and controls

3.3.2.1 Inundated Clay Pit – Settlement ponds 1 and 2

Planning approval has a been issued by the WAPC and the City of Swan for a new hardstand area for the storage of bricks, to be located within Lot 87 and 103 Great Northern Highway as attached in **Appendix A**. A clearing permit for these works has also been obtained from the Department of Water and Environmental Regulation CPS 8745/1 (**Appendix E**).

The clay pit purpose clearing permit (CPS 8745/1) outlined a number of commitments that would be met on condition of approval. The development application (DA) has a number of planning conditions which must be adhered to including:

- Stormwater management for the site shall be implemented in accordance with the Stormwater Management Report (hyd2o, 2019) submitted with the application, with the location of the Pump B outlet to be approved by the WAPC.
- An acid sulphate soils (ASS) self-assessment form and, if required as a result of the self-assessment, an acid sulphate soils report and an acid sulphate soils management plan shall be submitted to CoS and approved.
- Prior to the commencement of any dewatering, the applicant shall prepare a Dewatering Management Plan.
- Taking appropriate preventative measures during the clearing works to minimise the risk of the introduction and spread of weeds.
- The relocation of south-western snake-necked turtles shall be implemented in accordance with the *Management of snake-necked turtles in the Midland Brickworks Middle Swan clay pit* proposal. Preparation of a fauna relocation plan is required to support construction activities to manage any potential impacts to fauna within the application area.

3.3.2.2 Settlement pond 4

A subdivision application (WAPC Ref: 158848) has been approved for a 3.1 ha area of land located between Cranwood Crescent and Somerset Street in Viveash. The Stage 1 subdivision area contains three existing drainage ponds (collectively referred to as settlement pond 4) which are situated within the northern portion of the proposed residential development. These ponds are currently utilised for storing stormwater runoff from the Midland Brick facility prior to being discharged to the Blackadder Creek tributary via settlement pond 5.

Implementation of the Stage 1 subdivision will require the decommissioning of the settlement ponds, with stormwater from the main site sump (settlement pond 3) redirected to a new settlement pond 4 located adjacent to settlement pond 5. This will require construction of a new rising main from the main site sump to new settlement pond 4 which will then discharge via spillway into settlement pond 5. New settlement pond 4 will include a small forebay area and a large settlement storage area before discharging via a spillway into settlement pond 5. The system will be designed to maximise the removal of fine silts and sands.

There is the potential, albeit low, for ASS to have developed at the base of the settlement ponds. If present, the ASS is expected to be minimal in terms of extent due to the seasonal nature of water being present in the ponds and it is likely to only exist as a thin layer on the sediment.

The future stormwater drainage requirements for the decommissioning of the settlement ponds have been detailed in the subdivision conditions (WAPC 2020) included in **Appendix B**, and summarised below:

- Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the City of Swan, the Department of Water and Environmental Regulation, and the Department of Biodiversity, Conservation and Attractions, consistent with any approved Drainage and Water Management Plan.
- Engineering drawings and specifications are to be submitted and approved, on advice from the Department of Biodiversity, Conservation and Attractions, and works undertaken in accordance with the approved engineering drawings and specifications and approved plan of subdivision, for the filling and/or draining of the land, including ensuring that stormwater is contained on-site, or appropriately treated and connected to the local drainage system. Engineering drawings and specifications are to be in accordance with an approved Urban Water Management Plan (UWMP) for the site, or where no UWMP exists, to the satisfaction of the Western Australian Planning Commission.

3.4 Contamination remediation

3.4.1 Preliminary Site Investigation

A Preliminary Site Investigation (PSI) considering the entire brickworks was completed in 2019 (Emerge Associates (2019)), and identified multiple known and potential sources of contamination from current and historical works, predominantly on Lot 72, which is within the southern section of the site. Lot 72 currently has a classification of '*Contaminated - restricted use*' pursuant to the *Contaminated Sites Act 2003* (the CS Act). No other lots within the site have been reported to DWER as known or suspected as contaminated, and no others are listed on the Contaminated Sites Database.

With regards to fill materials that are present across much the site, the investigations completed in 2019 indicate that, from a contamination perspective, the majority of the general fill is generally comprised of clayey sands with varying degrees of bricks and brick fragments with no other significant presence of other deleterious materials, and were therefore expected to be suitable for the intended future residential land use.

Recent investigations in the Stage 1 subdivision area have confirmed that the fill in that area is not contaminated and is indeed suitable for re-use in a residential setting. The fill in the Stage 1 area is consistent in appearance and composition with the fill that has been observed across the remainder of the site; therefore, there is no reason to expect that it is contaminated.

Given the current classification of Lot 72 and the historical industrial related use of this lot and other lots within the site, it is expected that future subdivision applications in accordance with the proposed Local Structure Plan for the southern section of the site, will trigger the requirement for a Mandatory Auditor's Report (MAR) by an accredited Contaminated Sites Auditor (CSA).

3.4.2 Methodology and existing controls

Investigations completed in August 2019 within three areas of the site identified residual petroleum hydrocarbon concentrations present in either soil or groundwater that exceed human health assessment levels for a residential land use. All three area are located within Lot 72.

The investigations identified various exceedances of the assessment levels for vapour intrusion, direct contact and management limits, typically at depths in the order of 3 m below ground level or deeper. Whilst the investigations completed to date indicate that a residential land use could be undertaken across these areas with some restrictions or controls, Capitary will undertake soil and groundwater remediation achieve a '*Decontaminated*' classification for Lot 72.

Any further contaminated site investigations will comply with the DWER Contaminated Sites Guideline document *Assessment and Management of Contaminated Sites* (DER 2014a) which requires a Mandatory Auditor's Report as per the Contaminated Sites Act in order for the site to be reclassified as '*Decontaminated'.*

The Capitary is currently working with an accredited Contaminated Sites Auditor to undertake and report on investigations as per the document *Assessment and Management of Contaminated Sites* (DER 2014a). Depending on the timing of the remediation works, future subdivision approvals may include conditions relating to the control and management of contaminates.

4 Conclusion

The methodology and existing controls for the decommissioning of the site is supported by various planning and environmental approvals processes including:

- Development application approval from the City of Swan and the WAPC under the *Planning and Development Act 2015.*
- A Native Vegetation Clearing Permit from DWER, approved under the *Environmental Protection Act 1986*
- Subdivision approval from the WAPC under the *Planning and Development Act 2015.*
- Contaminated sites remediation process under the *Contaminated Sites Act 2003.*

These approvals and the associated conditions provide a framework that manages the potential environmental impacts associated with the decommissioning of the site.

Table 3 provides a summary of the environmental management framework associated with the decommissioning plan based upon these existing approvals.

Table 3: Summary of environmental management framework

Potential impacts	Existing controls	
	Plant and infrastructure	Stormwater management system
Vegetation and Bush Forever Site 302	Stage 1 subdivision approval conditions require: (13) *A Construction Environmental Management Plan, inclusive of arborist report to ensure the identification and protection of any vegetation on the site worthy of retention that is not impacted by subdivisional works, and fauna relocation plan to manage potential impacts on fauna* WAPC DA approval requires: *4.The applicant shall take appropriate preventative measures during the demolition works to ensure no vegetation within Bush Forever area 302 is disturbed as a result of the works.* CoS DA approval requires: *5 All vegetation and trees are to be protected and retained.*	WAPC DA approval requires: 2. *The applicant shall take appropriate preventative measures during the demolition works to ensure that no chemicals, woody debris, construction material, or soil enters Blackadder Creek, Bush Forever Area 302, the stormwater system or Swan River as a result of the works.* EP Act CPS 8745/1 approval requires: *When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take steps to minimise the risk of the introduction and spread of weeds.*
Fauna	Stage 1 subdivision approval conditions require: (13) *A Construction Environmental Management Plan, inclusive of arborist report to ensure the identification and protection of any vegetation on the site worthy of retention that is not impacted by subdivisional works, and fauna relocation plan to manage potential impacts on fauna*	WAPC DA approval requires: 5. *The relocation of south-western snake-necked turtles shall be implemented in accordance with the Management of snake-necked turtles in the Midland Brickworks Middle Swan clay pit proposal (Beatty, Santoro, & Chambers, 2020).*

Table 3: Summary of environmental management framework (continued).

Potential impacts	Existing controls	
	Plant and infrastructure	Stormwater management system
Swan River and water management	CoS DA approval requires: 6. No *earthworks are to encroach into the Bush Forever or the Swan River Trust Development Control Area or upon any other land not subject to this approval* *10. A management plan detailing how risk of erosion and sedimentation impacts into nearby water bodies will be minimised during subdivision is to be: a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works; and b) implemented during subdivisional works.*	Stage 1 subdivision approval conditions require: *8. Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the City of Swan, the Department of Water and Environmental Regulation, and the Department of Biodiversity, Conservation and Attractions, consistent with any approved Drainage and Water Management Plan.* WAPC DA approval requires: *2. Stormwater management for the site shall be implemented in accordance with Stormwater Management Report (hyd2o, 2019) submitted with the application, with the location of the Pump B outlet to be approved by the Western Australian Planning Commission on advice from the DBCA.* CoS DA approval requires: *2. All stormwater must be contained and disposed of on-site at all times, to the satisfaction of the City of Swan.* *3. No stormwater drainage is to be discharged within Bush Forever or the Swan River Trust Development Control Area to the satisfaction of the City.*
Noise	Stage 1 subdivision approval conditions require: *2. A noise management plan outlining the recommended type and specification of physical noise barrier to achieve acceptable noise levels at surrounding sensitive land uses, and the extent of proposed lot(s) requiring Quiet House design and notification on title, where applicable, is to be:* *a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works to the satisfaction of the local government on advice of the Department of Water and Environmental Regulation; and,* *b) implemented during subdivisional works; to the satisfaction of the local government.*	CoS DA advice: *(j) The noise generated by activities on-site, including machinery motors or vehicles is not to exceed the levels as set out under the Environmental Protection (Noise) Regulations 1997.* *Noisy Construction Work outside the period 7.00am to 7.00 pm Monday to Saturday and at any time on Sundays and Public Holidays is not permitted unless a Noise Management Plan for the construction site has been approved in writing by the City.*

Table 3: Summary of environmental management framework (continued).

Potential impacts	Existing controls	
	Plant and infrastructure	Stormwater management system
Noise (continued from above)	CoS DA approval requires: *3. Prior to a demolition permit being issued, the applicant must submit, have approved by the City of Swan and thereafter implement, noise, dust and vibration management plans to the satisfaction of the City of Swan for the proposed demolition works.* *4. A Construction Management Plan shall be submitted for approval to the City of Swan prior to commencement of works. The Construction Management Plan shall address dust, noise, waste management, storage of materials, traffic management and site safety/security. The Construction Management Plan is to be complied with for the duration of the development.*	(continued from above)
Erosion and Sediment	Demolition Plan DA notes *The contractor shall provide erosion and sediment control measures throughout the duration of the works. (including within City of Swan DA approval)* Stage 1 subdivision approval conditions require: *10. A management plan detailing how risk of erosion and sedimentation impacts into nearby water bodies will be minimised during subdivision is to be: a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works; and b) implemented during subdivisional works.*	WAPC DA approval requires: 4. *Prior to the commencement of any dewatering, the applicant shall prepare a Dewatering Management Plan to the satisfaction of the Western Australian Planning Commission on advice from the Department of Biodiversity, Conservation and Attractions.*
Dust	Stage 1 subdivision approval conditions require: *3. A notification, pursuant to Section 165 of the Planning and Development Act 2005 is to be placed on the certificates of title of the proposed lots advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows:* *"This lot is in close proximity to an existing bricks works and may be adversely affected by virtue of gaseous, odour, noise and/or dust emissions from that facility."* CoS DA approval requires: *3. Prior to a demolition permit being issued, the applicant must submit, have approved by the City of Swan and thereafter implement, noise, dust and vibration management plans to the satisfaction of the City of Swan for the proposed demolition works.* *4. A Construction Management Plan shall be submitted for approval to the City of Swan prior to commencement of works. The Construction Management Plan shall address dust, noise, waste management, storage of materials, traffic management and site safety/security. The Construction Management Plan is to be complied with for the duration of the development.*	CoS DA advice: *The carrying on of the development must not cause a dust nuisance to neighbours. Where appropriate such measures as installation of sprinklers, use of water tanks, mulching or other land management systems should be installed or implemented to prevent or control dust nuisance, and such measures shall be installed or implemented within the time and in the manner directed by the City's Manager Health and Building Services if it is considered that a dust nuisance exists.*

Table 3: Summary of environmental management framework (continued).

Potential impacts	Existing controls	
	Plant and infrastructure	**Stormwater management system**
Contamination	CoS DA approval requires: 8. *An acid sulphate soils self-assessment form and, if required as a result of the selfassessment, an acid sulphate soils report and an acid sulphate soils management plan shall be submitted to and approved by the Department of Water and Environmental Regulation before any subdivision works or development are commenced.* *Where an acid sulphate soils management plan is required to be submitted, all subdivision works shall be carried out in accordance with the approved management plan*.	WAPC DA approval requires: 3. *All septic sewer systems including all tanks, pipes and associated drainage systems (soak wells or leach drains) are to be decommissioned, in accordance with the Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974, removed, filled with clean sand and compacted.*
Waste Disposal	CoS DA approval requires: *4. A Construction Management Plan shall be submitted for approval to the City of Swan prior to commencement of works. The Construction Management Plan shall address dust, noise, waste management, storage of materials, traffic management and site safety/security. The Construction Management Plan is to be complied with for the duration of the development.*	

5 References

5.1 Strategy and Policy

Perth and Peel @ 3.5 Million

Metropolitan Central Sub-Regional Planning Framework

State Planning Policy 3.1 Residential Design Codes

State Planning Policy 3.7 Planning in Bushfire Prone Areas

State Planning Policy 5.1 Land Use Planning in the Vicinity of Perth Airport

City of Swan Draft Local Planning Strategy

5.2 General references

Department of Environment Regulation (DER) 2014a, *Assessment and Management of Contaminated Sites*, State of Western Australia, Perth.

Department of Environment Regulation (DER) 2014b, *Site classifications and appeals, Contaminated Sites Fact Sheet 4*.

Emerge Associates 2019, *Preliminary Site Investigation, Boral Midland Brickworks*, EP18-062(09)--007 DWP, Version C.

Hyd2o Hydrology 2020, *Midland Brick Local Water Management Strategy*, 0.

Western Australian Planning Commission (WAPC) 2004, *Statement of Planning Policy 5.1: Land Use Planning in the vicinity of the Perth Airport*, Gazetted in February 2004, Perth.

Western Australian Planning Commission (WAPC) 2006, *State Planning Policy 2.10: Swan-Canning River System*, Perth.

Western Australian Planning Commission and Department of Planning, Lands and Heritage (WAPC and DPLH) 2019, *Model Subdivision Conditions Schedule*, Perth.

5.3 Online references

Department of Water (DoW) 2001, *Perth Groundwater Atlas (groundwater contours)*, viewed 1 April 2020, <http://atlases.water.wa.gov.au/idelve/gwa/>.

Department of Water and Environmental Regulation (DWER) 2016a, *Acid Sulfate Soil – Swan Coastal Plain Database*, viewed 1 April 2020, <http:// https://www2.landgate.wa.gov.au/bmvf/app/waatlas/>.

Department of Water and Environmental Regulation (DWER) 2016b, *Contaminated Sites Database*, viewed 1 April 2020, <https://secure.dec.wa.gov.au/idelve/css/>.

Figures

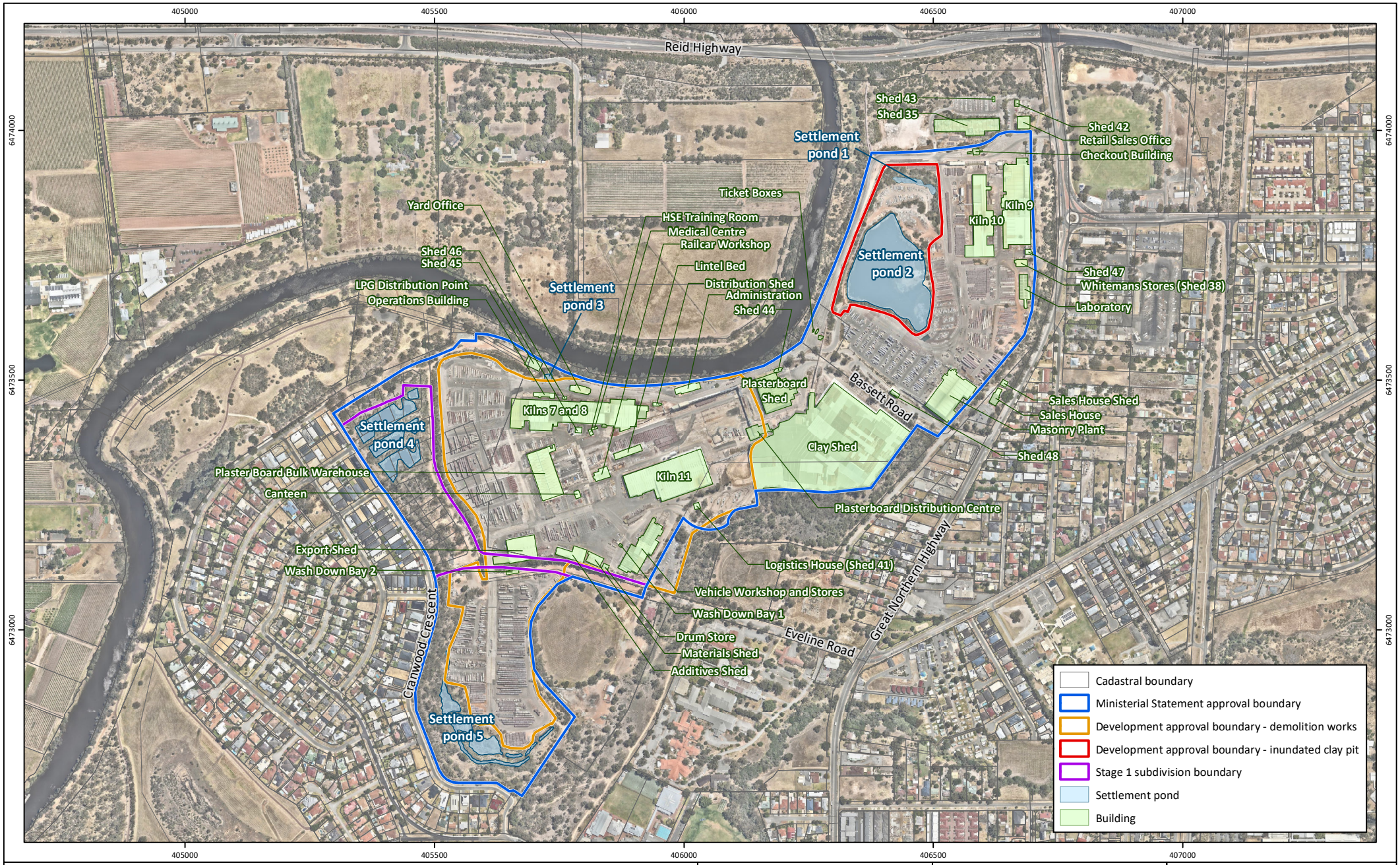


Figure 1: Authorised Elements and Approval Boundaries

Project: Middle Swan Brickworks Decommissioning and Rehabilitation Plan

Client: Linc Property Pty Ltd

Plan Number:
EP19-105(30)--F186

Drawn:	GAR
Date:	30/04/2020
Checked:	BRB
Approved:	CKK
Date:	5/08/2020

N

0 200 400
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

City of Swan and WAPC inundated clay pit DA approvals

Western Australian Planning Commission

Our Ref : 21-50319-7
Enquiries : Caitriona Slane (Ph 6551 9353)

Midland Brick Co Pty Ltd
102 Great Northern Highway
MIDDLE SWAN WA 6056

Application for Approval to Commence Development dated 16 December 2019 received 17 December 2019.

Lot Number	:	87, 103
Plan / Diagram	:	5036, 54208
Volume/Folio	:	1166/209, 2668/413
Locality	:	No. 321 Great Northern Highway, Middle Swan
Owner	:	Boral Bricks Western Australia Pty Ltd 130 Fauntleroy Avenue, PERTH AIRPORT WA 6105

Under the provisions of the Metropolitan Region Scheme this application has been referred for determination by the Western Australian Planning Commission.

The application has now been considered by the Commission and the formal notice setting out the terms of the decision is attached.

A copy of this decision has been forwarded to the Local Government for information.

You are advised of the need to consult with the Local Government with regard to the gaining of all necessary approvals and the issuing of the requisite building licence.

This decision is issued pursuant to the provisions of the Metropolitan Region Scheme, and has been made by the Commission after due consideration of the regional planning implications of the proposal. The development must also comply with the requirements of Council's Local Planning Scheme(s) and any determination in this regard must be made by the local government. The Commission's decision, therefore, is made without prejudice to any others that may be separately required from Council.

Should the applicant be aggrieved by this decision there is a right to apply for a review pursuant to the provisions of Clause 33 of the Metropolitan Region Scheme. Such an application for review must be submitted to the State Administrative Tribunal, Level 6, State Administrative Tribunal Building, 565 Hay Street, PERTH WA 6000 in accordance with Part 14 of the *Planning and Development Act 2005*. It is recommended that you contact the State Administrative Tribunal for further details (telephone 9219 3111) or go to its website: http://www.sat.justice.wa.gov.au.

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

ADVICE TO APPLICANT

1. This decision constitutes planning approval under the Metropolitan Region Scheme only. It is the proponent's responsibility to comply with all other applicable legislation and obtain all required approvals, licences and permits prior to commencement of this development, including approval of the proposed development under the City of Swan's Local Planning Scheme No.17.

2. In regard to Condition 2, the applicant is advised that an occurrence of a Threatened Ecological Community (TEC) (SCP3c: Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain) has been confirmed within the Eveline Road reserve and may also occur within Lot 72 Eveline Road, Middle Swan. This TEC is listed as Critically Endangered in Western Australia and Endangered under the Environmental Protection and Biodiversity Conservation Act 1999. The applicant is advised that any modification to the stormwater system that may affect the outflow to the TEC (which currently receives rainfall run-off from the Clay Shed) will require referral to the Department of Biodiversity, Conservation and Attractions.

3. Regarding Condition 3, the applicant is advised that the biofiltration swales are to be designed in accordance with the Adoption Guidelines for Stormwater Biofiltration Systems (CRC for Water Sensitive Cities, 2015) and the Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia (Monash University, 2014).

4. Regarding Condition 4, the applicant is advised that the Department of Biodiversity, Conservation and Attractions' Policy 50: Planning for dewatering affecting the Swan Canning Development Control Area has dewatering effluent discharge standards, which are required to be met if it is proposed to discharge directly or indirectly (via the stormwater system system) to the river. The Dewatering Management Plan will need to address:

    a. water quality of dewatering effluent;

    b. volumes of dewatering effluent;

    c. ongoing monitoring to ensure dewatering volumes are appropriate and contaminants are not being mobilised:

        i. monitoring to determine if any scouring, turbidity or disturbance of contaminants is occurring within the existing drainage network (e.g. stirring of sediments or contaminants within the storage ponds); and

        ii. contingency methods, such as reducing dewatering volumes, should the monitoring reveal mobilisation of contaminants.

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

5. The applicant/landowner is advised an 'acid sulphate soils self-assessment form' can be downloaded from the Western Australian Planning Commission's website www.dplh.wa.gov.au. The 'acid sulphate soils self-assessment form' makes reference to the Department of Water and Environment Regulation's 'Identification and Investigation of Acid Sulphate Soils' guideline. This guideline can be obtained from the Department of Water and Environment Regulation's website.www.dwer.wa.gov.au

Ms Sam Fagan
Secretary
Western Australian Planning Commission
26 February 2020

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

Our Ref : 21-50319-7
Enquiries : Caitriona Slane (Ph 6551 9353)

METROPOLITAN REGION SCHEME

City of Swan

APPROVAL TO COMMENCE DEVELOPMENT

Name and Address of Owner and Land on which Development Proposed:

Owner	:	Boral Bricks Western Australia Pty Ltd 130 Fauntleroy Avenue, PERTH AIRPORT WA 6105
Lot Number	:	87, 103
Plan / Diagram	:	5036, 54208
Volume/Folio	:	1166/209, 2668/413
Locality	:	No. 321 Great Northern Highway, Middle Swan
Application Date	:	16 December 2019
Application Receipt	:	17 December 2019
Development Description	:	Earthworks (Fill) And Additional Hardstand For Brick Storage

CONDITIONS

1. This approval relates to the proposed earth works and hardstand for brick storage in accordance with the development plans date stamped **19 December 2019** by the Department of Planning, Lands and Heritage on behalf of the Western Australian Planning Commission. It does not relate to any other development on the lot.

2. Stormwater management for the site shall be implemented in accordance with Stormwater Management Report H19054Av1 (hyd_2o, 2019) submitted with the application, with the location of the Pump B outlet to be approved by the Western Australian Planning Commission on advice from the Department of Biodiversity, Conservation and Attractions.

3. Prior to the commencement of works or any development being undertaken on the site, the applicant shall prepare and have approved detailed design drawings for the biofiltration swales to the satisfaction of the Western Australian Planning Commission on advice from the Department of Biodiversity, Conservation and Attractions.

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

4. Prior to the commencement of any dewatering, the applicant shall prepare a Dewatering Management Plan to the satisfaction of the Western Australian Planning Commission on advice from the Department of Biodiversity, Conservation and Attractions.

5. The relocation of south-western snake-necked turtles shall be implemented in accordance with the *Management of snake-necked turtles in the Midland Brickworks Middle Swan clay pit* proposal (Beatty, Santoro, & Chambers, 2020).

If the development the subject of this approval is not substantially commenced within a period of two years from the date of this letter, the approval shall lapse and be of no further effect. Where an approval has so lapsed, no development shall be carried out without the further approval of the responsible authority having first been sought and obtained.

Ms Sam Fagan
Secretary
Western Australian Planning Commission
26 February 2020

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

Our Ref: DA-759/2019

14 February 2020

Midland Brick Company Pty Ltd
102 Great Northern Hwy
MIDDLE SWAN WA 6056

Dear Sir/Madam

DEVELOPMENT APPLICATION: EARTHWORKS AND ADDITIONAL HARDSTAND FOR BRICK STORAGE - LOT 103 (NO.321) GREAT NORTHERN HIGHWAY, MIDDLE SWAN

I refer to your Application for Planning Approval on the above lot received on 28 November 2019.

In accordance with the provisions of the City's *Local Planning Scheme No.17* and the *Planning and Development (Local Planning Schemes) Regulations 2015* (*Regulations*) **approval to commence development has been granted**, subject to conditions. This application has been determined by delegated authority of Council in accordance with cl.83 of the *Regulations*. Attached is the form of approval stating the conditions that must be complied with.

If an applicant is aggrieved by this Determination, there is a right of review under Part 14 of the *Planning and Development Act 2005*. An application for review should be lodged with the State Administrative Tribunal (Level 4, 12 St George Terrace, Perth) within twenty eight (28) days of the date of this determination (application may be made to the Tribunal to extend this time period). The necessary "Application for Review" forms are available from the State Administrative Tribunal.

In addition, acting under the authority delegated by the Western Australian Planning Commission (WAPC), the City has determined the application under the Metropolitan Region Scheme (MRS) on behalf of the WAPC with regard to development abutting a Primary Regional Road Reservation (DEL2017/02).

It should be noted that this approval does not constitute a building permit.

A copy of this decision has been forwarded to the Western Australian Planning Commission.

Should you have any queries regarding this matter, please do not hesitate to contact Jonathan Lendich on 08 9278 9692.

Yours faithfully

Lyn Leong
Coordinator Planning Process
STATUTORY PLANNING

city of swan

2 Midland Square, Midland
PO Box 196, Midland WA 6936
enquiries 08 9267 9267
facsimile 08 9267 9444
sms 0428 520 544

www.swan.wa.gov.au

Planning and Development Act 2005

CITY OF SWAN

Notice of Determination on Application for Planning Approval

Ref. No: DA-759/2019
Determination Date: 14-Feb-2020
Est. Value: $950000

Location:	LOT 103 (NO.321) GREAT NORTHERN HIGHWAY, MIDDLE SWAN		
Title (Vol/Folio):	CT-2668/413	**Plan/Diagram:**	5420854208
Application date:	**28 NOVEMBER 2019**	**Received on:**	**05-DEC-2019**

Description of proposed development:

EARTHWORKS AND ADDITIONAL HARDSTAND FOR BRICK STORAGE

The application for development approval is:

☒ **Approved subject to the following conditions**

CONDITIONS

1.	The approved development must comply in all respects with the attached approved plans, as dated, marked and stamped, together with any requirements and annotations detailed thereon by the City of Swan. The plans approved as part of this application form part of the development approval issued.
2.	All stormwater must be contained and disposed of on-site at all times, to the satisfaction of the City of Swan.
3.	No stormwater drainage is to be discharged within Bush Forever or the Swan River Trust Development Control Area to the satisfaction of the City.
4.	The applicant to provide as constructed drawings of the project demonstrating they have complied with the Stormwater Management Report prepared by Hyd20 dated 16 November 2019. Submitted drawings are to include details of swales, pipes and pumps.

5.	The fill material shall be clean.
6.	No earthworks are to encroach into the Bush Forever or the Swan River Trust Development Control Area or upon any other land not subject to this approval.
7.	If the earthworks cause any obstruction, alteration or interference with a natural flow of surface water to the detriment of surrounding land, then the landowner shall rectify the cause of such obstruction, alteration or interference to the satisfaction of the City.
8.	An acid sulphate soils self-assessment form and, if required as a result of the self-assessment, an acid sulphate soils report and an acid sulphate soils management plan shall be submitted to and approved by the Department of Water and Environmental Regulation before any subdivision works or development are commenced. Where an acid sulphate soils management plan is required to be submitted, all subdivision works shall be carried out in accordance with the approved management plan.
9.	The development including construction, access, drainage and any maintenance, is not to result in any clearing or disturbance to the regionally significant bushland within BFA 302 and/or adverse impacts to the River.
10.	If not installed, fencing where considered appropriate, be installed to mitigate any adverse impacts from pedestrian traffic on BFA 302.
11.	No construction materials, rubbish or any deleterious matter shall be deposited within Bush Forever or the River.
12.	The applicant is to obtain the relevant works approval or license amendment in accordance with the provisions of section 53 of the Environmental Protection Act 1986. (refer to advice note i)

ADVICE TO APPLICANT

a)	This is a Development Approval issued by the City of Swan under its Local Planning Scheme No. 17. It is not a building permit or an approval to commence or carry out development under any other law. It is the responsibility of the applicant to obtain any other necessary approval, consents or licenses required under any other law, and to commence and carry out development in accordance with all relevant laws.
b)	Development may be carried out only in accordance with the details of the application as approved herein and any approved plan.
c)	This approval does not authorise commencement of any building and/or demolition works. In accordance with the Building Act 2011 and Building Regulations 2012, a building and/or demolition permit must be obtained prior to the commencement of any works.

d)	This approval is not an authority to ignore any constraint to development on the land, which may exist through contract or on title, such as an easement or restrictive covenant. It is the responsibility of the applicant and not the City to investigate any such constraints before commencing development. This approval will not necessarily have regard to any such constraint to development, regardless of whether or not it has been drawn to the City's attention.
e)	Under the provisions of the Metropolitan Region Scheme, approval to commence development must also be obtained from the Western Australian Planning Commission (WAPC) and therefore your application has been forwarded to the Commission for its determination. Development must not be commenced until approval under the Metropolitan Region Scheme has been given, additionally to any other required approval, licence certificate or permission. The WAPC can be contacted on 6551 8002 if you wish to be advised of its progress.
f)	The applicant must liaise with the Department of Water and Environment Regulation regarding the requirement to obtain a native vegetation clearing permit.
g)	The carrying on of the development must not cause a dust nuisance to neighbours. Where appropriate such measures as installation of sprinklers, use of water tanks, mulching or other land management systems should be installed or implemented to prevent or control dust nuisance, and such measures shall be installed or implemented within the time and in the manner directed by the City's Manager Health and Building Services if it is considered that a dust nuisance exists.
h)	Condition 7 makes reference to an "acid sulphate soils self-assessment form". This form can be downloaded from the Western Australian Planning Commission's website at: www.dplh.wa.gov.au. The "acid sulphate soils self-assessment form" makes reference to the Department of Water and Environmental Regulation's "Identification and Investigation of Acid Sulphate Soils" guideline. This guideline can be obtained from the Department of Water and Environmental Regulation's website at: www.dwer.wa.gov.au
i)	The Department of Water and Environmental Regulation will retain discretion on whether a works approval or licence amendment application is appropriate – further guidance on changes to prescribed premises can be found in the Department's Industry Regulation Guide to Licensing which can be accessed at: https://www.der.wa.gov.au/our-work/licences-and-works-approvals/540-guideline-industry-regulation-guide-to-licensing Subject to any other necessary approvals or restrictions, the Licence holder may be able to undertake site preparation works (including clearing, levelling and construction of access roads) without a works approval or licence amendment from the Department. However, the Department cannot guarantee that a works approval or licence amendment will be approved even if substantial and costly preparation works have been undertaken. A copy of the EP Act and the EP Regulations is publicly available at https://www.legislation.wa.gov.au/legislation/statutes.nsf/home.html
j)	The noise generated by activities on-site, including machinery motors or vehicles is not to exceed the levels as set out under the Environmental Protection (Noise) Regulations 1997.

	Noisy Construction Work outside the period 7.00am to 7.00 pm Monday to Saturday and at any time on Sundays and Public Holidays is not permitted unless a Noise Management Plan for the construction site has been approved in writing by the City.

Note 1: **If the development the subject of this approval is not substantially commenced within a period of 2 years, or another period specified in the approval after the date of the determination, the approval will lapse and be of no further effect.**

Note 2: **Where an approval has so lapsed, no development must be carried out without the further approval of the local government having first been sought and obtained.**

Note 3: **If an applicant or owner is aggrieved by this determination there is a right of review by the State Administrative Tribunal in accordance with the *Planning and Development Act 2005* Part 14. An application must be made within 28 days of the determination.**

Lyn Leong
Coordinator Planning Process
STATUTORY PLANNING

CITY OF SWAN

APPROVED PLAN

This plan relates to the approval to commence development dated:

14 Feb 2020

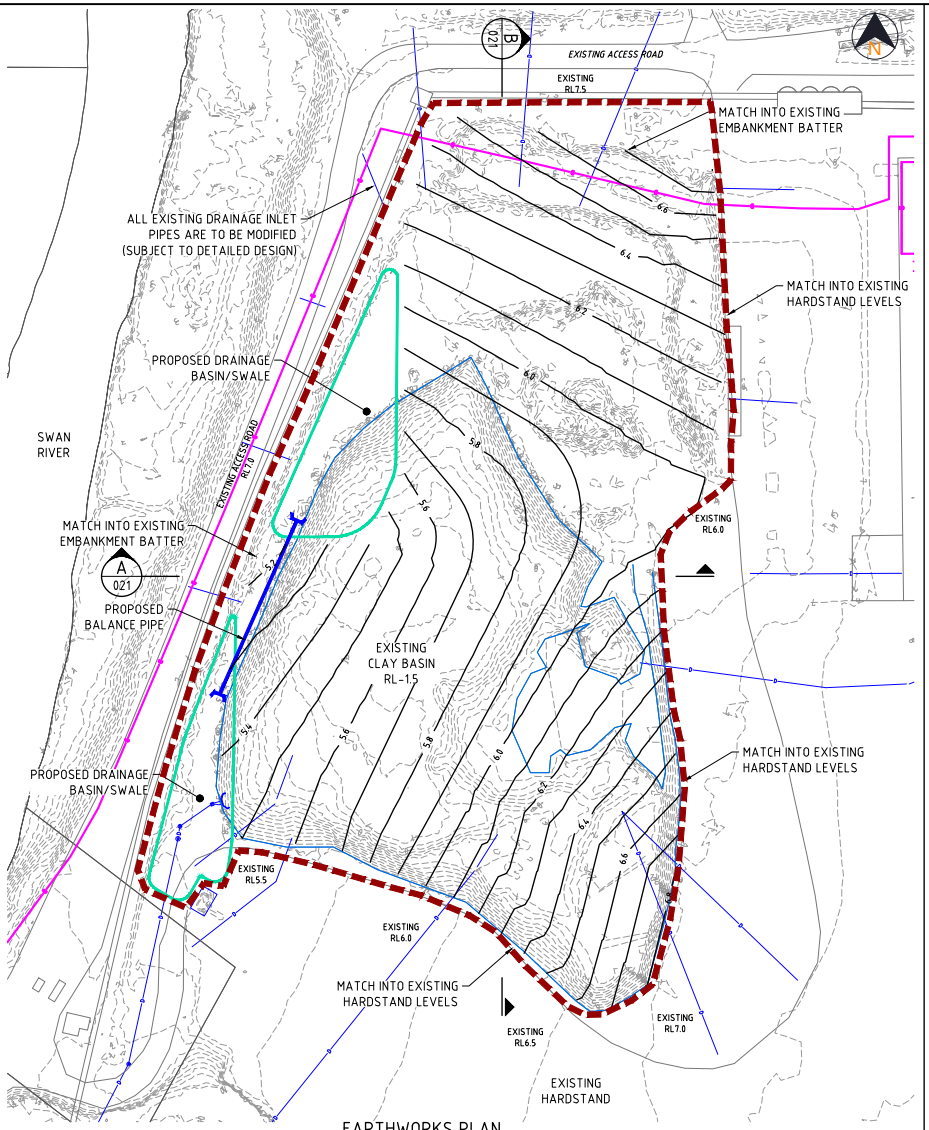
No.: 1 of 3

Ref.: DA-759/2019

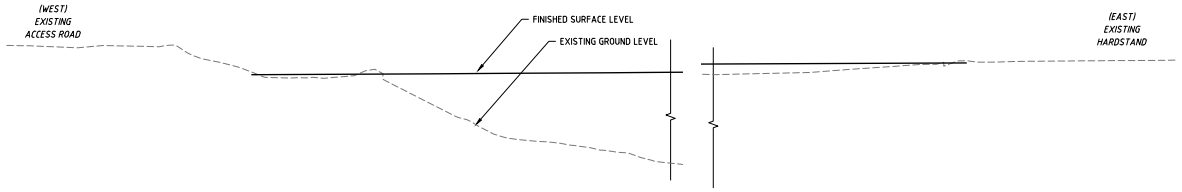
DELEGATED OFFICER
STATUTORY PLANNING

LEGEND

- EXTENT OF WORKS
- EXISTING GROUND CONTOURS
- FINISHED SURFACE LEVEL CONTOURS
- EXISTING GAS MAIN
- EXISTING DRAINAGE PIPE



EARTHWORKS PLAN
1:1000



SECTION A-A
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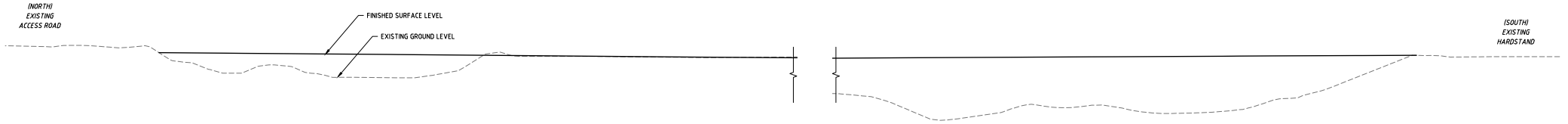


SECTION B-B
1:200

SCALE 1:1000 0 20 40 60

D.A. SUBMISSION

A1

No.	DATE	DRAWN	APPROVED	AMENDMENT
C	21.11.19	RDE	CCB	MINOR AMENDMENTS.
B	12.11.19	RDE	CCB	MINOR AMENDMENTS.
A	06.11.19	RDE	CCB	ISSUED FOR COMMENTS.

This plan shall not to be used for construction unless issued as rev 0 and signed as approved.

CLIENT: LINC PROPERTY

DESIGNED: RDE | CHECKED: | APPROVED: C.BITMEAD

DRAWN: RDE | CHECKED: | DATE: 21.11.19

TABEC Civil Engineering Consultants
TABEC PTY LTD ACN 090 796 204
14 Wickham Street, East Perth WA 6004
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

PROJECT: MIDLAND BRICK - CLAY BASIN EARTHWORKS D.A.

TITLE: EARTHWORKS PLAN AND TYPICAL CROSS SECTIONS

DRAWING NUMBER: 2419-00-DA-021

ISSUE: C

T:\Projects\2419\Design\CAD\Drawings\Stage 00\2419-00-DA-020-021.dwg 21/11/19 2:06:57 nevans

CITY OF SWAN

APPROVED PLAN

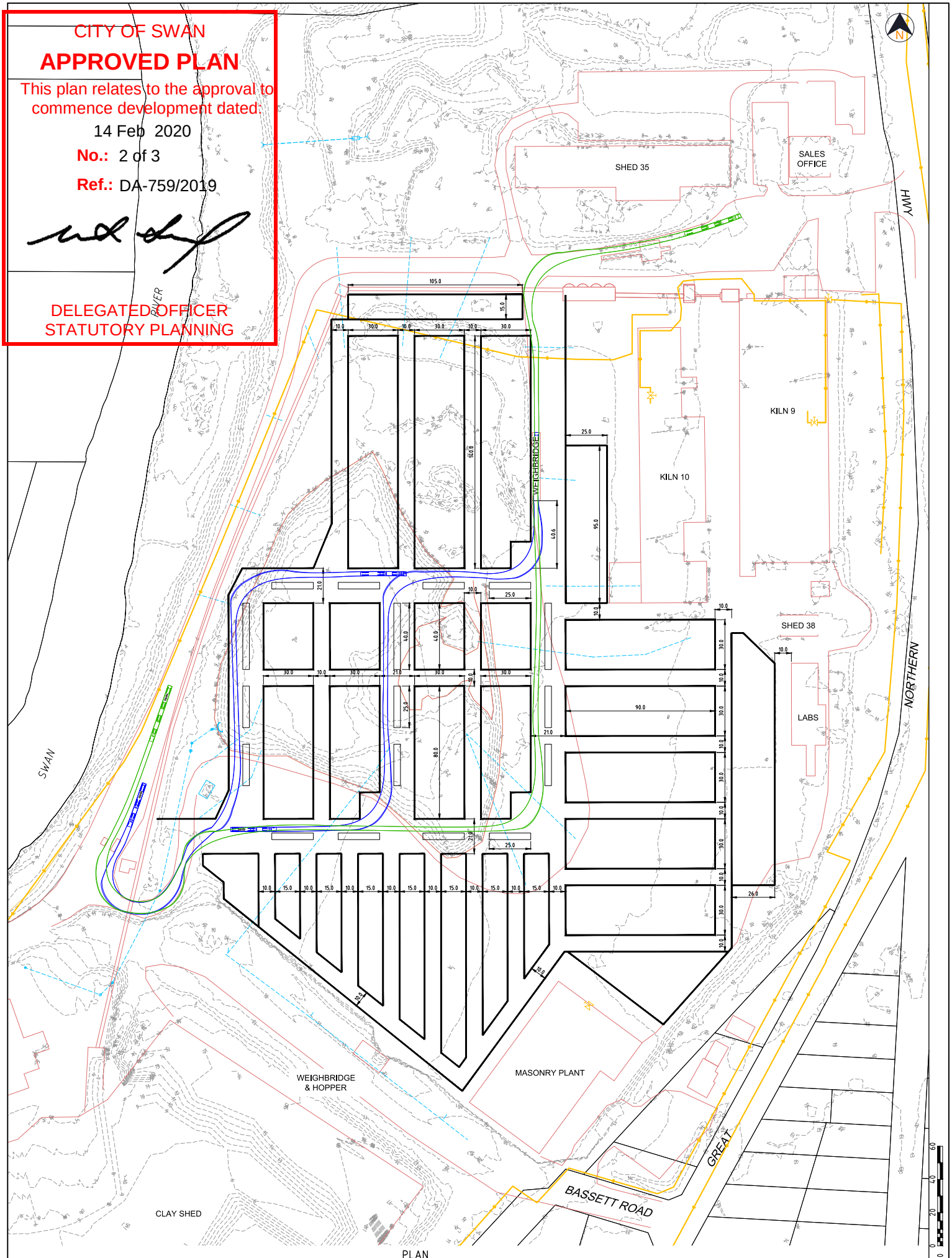
This plan relates to the approval to commence development dated:

14 Feb 2020

No.: 2 of 3

Ref.: DA-759/2019

DELEGATED OFFICER
STATUTORY PLANNING



PLAN
1:1000

Brick Laydown Area

DRAWING NUMBER 2419-SK-006-1

ISSUE B

TABEC
Civil Engineering Consultants

TABEC PTY LTD
ACN 090 796 204

14 Wickham Street, East Perth WA 6004
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

SCALE 1:1000

A1

Plotted By: revans Plot Date: 13/11/19 - 11:55 Cad File: T:\Projects\2419\Design\CAD\Drawings\Sketches\2419-SK-006 Brick Laydown Area.dwg

CITY OF SWAN

APPROVED PLAN

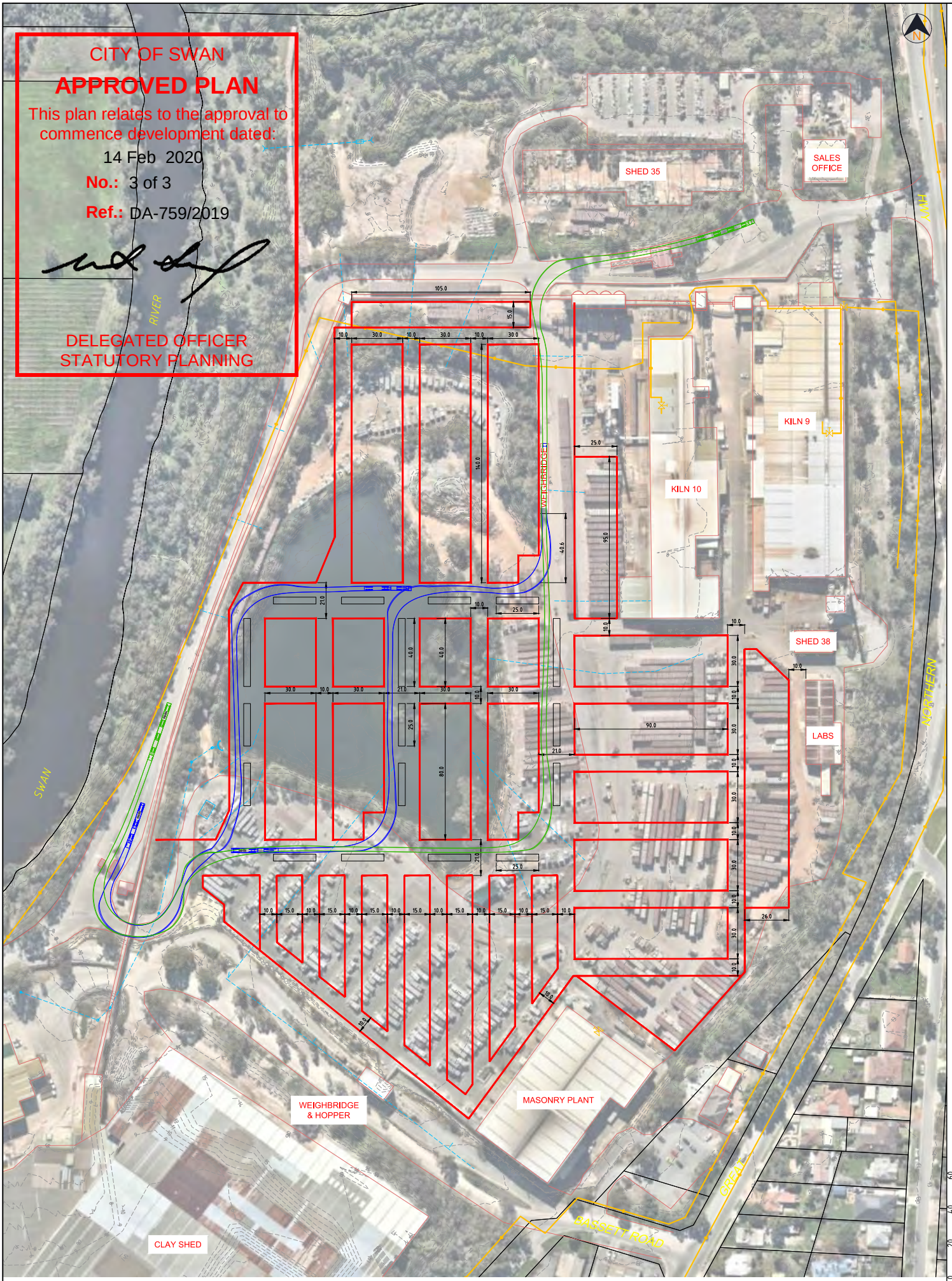
This plan relates to the approval to commence development dated:

14 Feb 2020

No.: 3 of 3

Ref.: DA-759/2019

DELEGATED OFFICER
STATUTORY PLANNING



PLAN
1:1000

35.4m B-TRIPLE

27.5m B-DOUBLE

Brick Laydown Area

DRAWING NUMBER 2419-SK-006-2

ISSUE B

TABEC Civil Engineering Consultants
TABEC PTY LTD ACN 090 796 204
14 Wickham Street, East Perth WA 6004
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

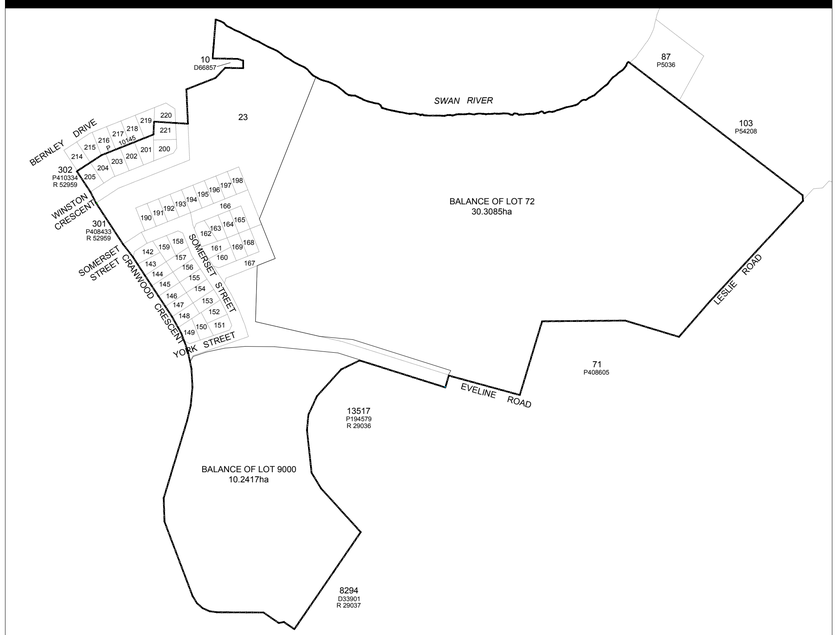
SCALE 1:1000 A1

Plotted By: revans Plot Date: 13/11/19 - 11:56 Cad File: T:\Projects\2419\Design\CAD\Drawings\Sketches\2419-SK-006 Brick Laydown Area.dwg

Appendix B

Stage 1 Subdivision Approval (WAPC 2020)

BALANCE OF TITLE PLAN



LEGEND

- Subject Site
- Existing Lot Boundary
- Existing Easement
- Proposed Lot Boundary
- Existing ATCO Gas Main
- 20-25 ANEF (LPS17)
- 20-25 ANEF (draft Master Plan 2020)
- 11 — Existing Contour (1m interval)
- 11.0 — Indicative Bulk Earthwork Level (0.5m interval) (subject to detailed engineering design)
- 385 — Tree to be retained (where possible)

SUBDIVISION SUMMARY

EXISTING LOT SUMMARY

Lot 23	4.4704ha	Lot 163	812m²
Lot 72	30.4962ha	Lot 164	809m²
Lot 9000	11.4315ha	Lot 165	809m²
Lot 142	862m²	Lot 166	2891m²
Lot 143	809m²	Lot 167	2763m²
Lot 144	809m²	Lot 168	809m²
Lot 145	809m²	Lot 169	809m²
Lot 146	809m²	Lot 190	809m²
Lot 147	809m²	Lot 191	809m²
Lot 148	815m²	Lot 192	809m²
Lot 149	819m²	Lot 193	809m²
Lot 150	817m²	Lot 194	809m²
Lot 151	824m²	Lot 195	809m²
Lot 152	852m²	Lot 196	809m²
Lot 153	810m²	Lot 197	809m²
Lot 154	809m²	Lot 198	809m²
Lot 155	809m²	Lot 200	1007m²
Lot 156	809m²	Lot 201	1041m²
Lot 157	832m²	Lot 202	1011m²
Lot 158	819m²	Lot 203	1011m²
Lot 159	812m²	Lot 204	1011m²
Lot 160	839m²	Lot 205	1011m²
Lot 161	834m²	Lot 221	1032m²
Lot 162	905m²		

No. of Existing Lots: 47
Total Area of Existing Lots: 50.5400ha

PROPOSED LOT SUMMARY

Residential Lots
No. of Proposed Lots: 60
Minimum Lot Size: 210m²
Maximum Lot Size: 734m²
Average Lot Size: 440m²
Total Area of Proposed Lots: 2.6384ha

Balance Lots
No. of Proposed Lots: 3
Total Area of Proposed Lots: 46.2709ha

Public Open Space
No. of Proposed Lots: 1
Total Area of Proposed Lots: 3341m²

Temporary Drainage Lots
No. of Proposed Lots: 1
Total Area of Proposed Lots: 1626m²

DEPARTMENT OF PLANNING, LANDS AND HERITAGE

DATE 29-May-2020 FILE 158848

PLAN OF SUBDIVISION (Modified in response to City of Swan comments)

LOT 23 on P77549; LOT 72 on P408605; LOT 9000 on P405292; LOTS 142-169 & 190-198 on P9113; and LOTS 200-205, & 221 on P10145
WINSTON CRESCENT / SOMERSET STREET / YORK STREET / CRANWOOD CRESCENT, VIVEASH

LINC PROPERTY

Date: 4 February 2020 Scale: 1:1000 @ A1 File: 19-402 SU02L Staff: TP/MR/LC Checked: MR

element.

Level 18, 191 St Georges Terrace, Perth Western Australia 6000
PO Box 7375 Cloisters Square, Perth Western Australia 6850
T: +61 8 9289 8300 E: hello@elementwa.com.au elementwa.com.au

Western Australian Planning Commission

Your Ref : 19-402
Enquiries : June Wang (Ph 6551 9242)

Element
P O Box 7375
PERTH WA 6000

Approval Subject To Condition(s)
Freehold (Green Title) Subdivision

Application No : 158848

Planning and Development Act 2005

Applicant	:	Element P O Box 7375 PERTH WA 6000
Owner	:	Boral Bricks Western Australia Pty Ltd Level 18, 15 Blue Street NORTH SYDNEY NSW 2060
Application Receipt	:	24 December 2019

Lot Number	:	142-169, 190-198, 200-205, 221, 23, 72 & 9000
Diagram / Plan	:	Plans 10145, 9113, Deposited Plans 405292, 408605, 77549
Location	:	-
C/T Volume/Folio	:	1332/338-1332/343, 1336/301-1336/324, 1366/685, 1366/686, 1336/327-1336/337, 1332/356, 2898/388, 2916/634, 2905/766
Street Address	:	Winston Crescent, Somerset Street, York Street, Cranwood Crescent, Surrey Court, Viveash & Eveline Road, Middle Swan
Local Government	:	City of Swan

The Western Australian Planning Commission has considered the application referred to and is prepared to endorse a deposited plan in accordance with the plan date-stamped **24 December 2019** once the condition(s) set out have been fulfilled.

This decision is valid for **four years** from the date of this advice, which includes the lodgement of the deposited plan within this period.

The deposited plan for this approval and all required written advice confirming that the requirement(s) outlined in the condition(s) have been fulfilled must be submitted by **04 August 2024** or this approval no longer will remain valid.

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

Reconsideration - 28 days

Under section 151(1) of the *Planning and Development Act 2005*, the applicant/owner may, within 28 days from the date of this decision, make a written request to the WAPC to reconsider any condition(s) imposed in its decision. One of the matters to which the WAPC will have regard in reconsideration of its decision is whether there is compelling evidence by way of additional information or justification from the applicant/owner to warrant a reconsideration of the decision. A request for reconsideration is to be submitted to the WAPC on a Form 3A with appropriate fees. An application for reconsideration may be submitted to the WAPC prior to submission of an application for review. Form 3A and a schedule of fees are available on the WAPC website: http://www.planning.wa.gov.au

Right to apply for a review - 28 days

Should the applicant/owner be aggrieved by this decision, there is a right to apply for a review under Part 14 section 251 of the *Planning and Development Act 2005*. The application for review must be submitted in accordance with part 2 of the *State Administrative Tribunal Rules 2004* and should be lodged within 28 days of the date of this decision to: the State Administrative Tribunal, Level 6, State Administrative Tribunal Building, 565 Hay Street, PERTH, WA 6000. It is recommended that you contact the tribunal for further details: telephone 9219 3111 or go to its website: http://www.sat.justice.wa.gov.au

Deposited plan

The deposited plan is to be submitted to the Western Australian Land Information Authority (Landgate) for certification. Once certified, Landgate will forward it to the WAPC. In addition, the applicant/owner is responsible for submission of a Form 1C with appropriate fees to the WAPC requesting endorsement of the deposited plan. A copy of the deposited plan with confirmation of submission to Landgate is to be submitted with all required written advice confirming compliance with any condition(s) from the nominated agency/authority or local government. Form 1C and a schedule of fees are available on the WAPC website: http://www.planning.wa.gov.au

Condition(s)

The WAPC is prepared to endorse a deposited plan in accordance with the plan submitted once the condition(s) set out have been fulfilled.

The condition(s) of this approval are to be fulfilled to the satisfaction of the WAPC.

The condition(s) must be fulfilled before submission of a copy of the deposited plan for endorsement.

The agency/authority or local government noted in brackets at the end of the condition(s) identify the body responsible for providing written advice confirming that the WAPC's requirement(s) outlined in the condition(s) have been fulfilled. The written advice of the agency/authority or local government is to be obtained by the applicant/owner. When the written advice of each identified agency/authority or local government has been obtained, it should be submitted to the WAPC with a Form 1C and appropriate fees and a copy of the deposited plan.

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If there is no agency/authority or local government noted in brackets at the end of the condition(s), a written request for confirmation that the requirement(s) outlined in the condition(s) have been fulfilled should be submitted to the WAPC, prior to lodgement of the deposited plan for endorsement.

Prior to the commencement of any subdivision works or the implementation of any condition(s) in any other way, the applicant/owner is to liaise with the nominated agency/authority or local government on the requirement(s) it considers necessary to fulfil the condition(s).

The applicant/owner is to make reasonable enquiry to the nominated agency/authority or local government to obtain confirmation that the requirement(s) of the condition(s) have been fulfilled. This may include the provision of supplementary information. In the event that the nominated agency/authority or local government will not provide its written confirmation following reasonable enquiry, the applicant/owner then may approach the WAPC for confirmation that the condition(s) have been fulfilled.

In approaching the WAPC, the applicant/owner is to provide all necessary information, including proof of reasonable enquiry to the nominated agency/authority or local government.

The condition(s) of this approval, with accompanying advice, are:

CONDITIONS:

1. The plan of subdivision is to be modified in accordance with the attached plan date stamped 29 May 2020 to the satisfaction of the Western Australian Planning Commission. (Local Government)

2. A noise management plan outlining the recommended type and specification of physical noise barrier to achieve acceptable noise levels at surrounding sensitive land uses, and the extent of proposed lot(s) requiring Quiet House design and notification on title, where applicable, is to be:

   a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works to the satisfaction of the local government on advice of the Department of Water and Environmental Regulation; and,

   b) implemented during subdivisional works; to the satisfaction of the local government.

   (Local Government)

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3. A notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificates of title of the proposed lots advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows:

   "This lot is in close proximity to an existing bricks works and may be adversely affected by virtue of gaseous, odour, noise and/or dust emissions from that facility."

   (Western Australian Planning Commission)

4. Prior to the endorsement of a diagram or plan of survey (deposited plan) for the creation of the lots proposed by this application, the applicant is to demonstrate to the satisfaction of the Department of Water and Environmental Regulations that Kilns 7 and 8 are removed from the Part V operating Licence to the satisfaction of the Western Australian Planning Commission. (The Department of Department of Water and Environmental Regulations)

5. Prior to endorsement of a diagram or plan of survey (deposited plan) for the creation of the lots proposed by this application, the applicant is to demonstrate to the satisfaction of the Western Australian Planning Commission and the Department of Water and Environmental Regulations that it has scoped, designed, implemented and validated noise mitigation measures from the brickworks and demonstrate that noise emissions comply with the EP (Noise) Regulations 1997. (The Department of Water and Environmental Regulations)

6. A notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificates of title of the proposed Lots 53, 54, 55 and 56 advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan). The notification is to state as follows:

   'This lot is situated in the vicinity of Perth Airport, and is currently affected, or may in the future, be affected by aircraft noise. Noise exposure levels are likely to increase in the future as a result of increases in numbers of aircraft using the airport, changes in aircraft type or other operational changes. Further information about aircraft noise, including development restrictions and noise insulation requirements for noise-affected properties, are available on request from the relevant local government offices.'

   (Western Australian Planning Commission)

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7. Engineering drawings and specifications are to be submitted, approved, and works undertaken in accordance with the approved engineering drawings, specifications and approved plan of subdivision, for grading and/or stabilisation of the site to ensure that:

   a) lots can accommodate their intended use; and

   b) finished ground levels at the boundaries of the lot(s) the subject of this approval match or otherwise coordinate with the existing and/or proposed finished ground levels of the land abutting.

   (Local Government)

8. Prior to the commencement of subdivisional works, an urban water management plan is to be prepared and approved, in consultation with the City of Swan, the Department of Water and Environmental Regulation, and the Department of Biodiversity, Conservation and Attractions, consistent with any approved Drainage and Water Management Plan. (Local Government)

9. Engineering drawings and specifications are to be submitted and approved, on advice from the Department of Biodiversity, Conservation and Attractions, and works undertaken in accordance with the approved engineering drawings and specifications and approved plan of subdivision, for the filling and/or draining of the land, including ensuring that stormwater is contained on-site, or appropriately treated and connected to the local drainage system. Engineering drawings and specifications are to be in accordance with an approved Urban Water Management Plan (UWMP) for the site, or where no UWMP exists, to the satisfaction of the Western Australian Planning Commission. (Local Government)

10. A management plan detailing how risk of erosion and sedimentation impacts into nearby water bodies will be minimised during subdivision is to be: a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works; and b) implemented during subdivisional works. (Department of Biodiversity, Conservation and Attractions – Rivers and Estuaries Division)

11. Prior to the commencement of subdivisional works, the landowner/applicant is to provide a pre-works geotechnical report certifying that the land is physically capable of development or advising how the land is to be remediated and compacted to ensure it is capable of development; and in the event that remediation works are required, the landowner/applicant is to provide a post geotechnical report certifying that all subdivisional works have been carried out in accordance with the pre-works geotechnical report. (Local Government)

12. Drainage easements and reserves as may be required by the local government for drainage infrastructure being shown on the diagram or plan of survey (deposited plan) as such, granted free of cost, and vested in that local government under Sections 152 and 167 of the *Planning and Development Act 2005*. (Local Government)

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13. A Construction Environmental Management Plan, inclusive of arborist report to ensure the identification and protection of any vegetation on the site worthy of retention that is not impacted by subdivisional works, and fauna relocation plan to manage potential impacts on fauna, is to be:

    a) prepared by the landowner/applicant and approved prior to the commencement of subdivisional works; and

    b) implemented prior to and during subdivisional works (as required); to the satisfaction of the Western Australian Planning Commission.

    (Local Government)

14. The Bushfire Management Plan prepared by Emerge Associates (Version 1, dated December 2019) being updated, approved and relevant bushfire protection measures therein implemented during subdivisional works to address the following:

    a) include details of a water licence and/or landscaping strategy to demonstrate to the City's satisfaction that vegetation within the Public Open Space (POS) and road reserves can be managed consistent with low-threat vegetation, or otherwise re-classify the vegetation and update the BAL Contour Map and indicative BAL ratings for all lots accordingly;

    b) specify the requirement for the proposed Eveline Road connection, or an interim bushfire emergency access arrangement approved by the City of Swan, to be constructed in the first stage of subdivision in order to achieve Acceptable Solution A3.1 – Two Access Routes of the Guidelines for Planning in Bushfire Prone Areas.

    This information should include a completed 'Certification by Bushfire Consultant' from the bushfire management plan.

    (Local Government)

15. A notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level(BAL) rating of 12.5 or above, advising of the existence of a hazard or other factor. Notice of this notification is to be included on the diagram or plan of survey (deposited plan).

    The notification is to state as follows:

    "This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land".

    (Western Australian Planning Commission)

16. Local Development Plan(s) being prepared and approved for lots shown on the approved plan of subdivision that address the following:

    a) "Quiet House" design requirements for lots affected by noise as identified in an approved Noise Management Plan; and,

    b) Building setbacks and orientation, including major openings, outdoor living areas and fencing for passive surveillance, vehicle access and servicing requirements (bin pads) for lots abutting public open space;

    to the satisfaction of the Western Australian Planning Commission.

    (Local Government)

17. The landowner/applicant shall make arrangements to ensure that prospective purchasers of lots subject of a Local Development Plan are advised in writing that Local Development Plan provisions apply. (Local Government)

18. The proposed public open space reserve shown on the approved plan of subdivision being shown on the diagram or plan of survey (deposited plan) as reserve for Recreation and vested in the Crown under Section 152 of the *Planning and Development Act 2005*, such land to be ceded free of cost and without any payment of compensation by the Crown. (Local Government)

19. Arrangements being made for the proposed public open space to be developed by the landowner/applicant to a minimum standard and maintained for two summers through the implementation of an approved landscape plan providing for the development and maintenance of the proposed public open space in accordance with the requirements of Liveable Neighbourhoods and to the specifications of the local government. (Local Government)

20 Uniform fencing being constructed along the boundaries of all of the proposed lots abutting the proposed temporary drainage lot and public open space. Where lots abut public open space, fencing is to be visually permeable. (Local Government)

21. Engineering drawings and specifications are to be submitted, approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications, to ensure that those lots not fronting an existing road are provided with frontage to a constructed road(s) connected by a constructed road(s) to the local road system and such road(s) are constructed and drained at the landowner/applicant's cost.

    As an alternative, and subject to the agreement of the Local Government the Western Australian Planning Commission (WAPC) is prepared to accept the landowner/applicant paying to the local government the cost of such road works as estimated by the local government and the local government providing formal assurance to the WAPC confirming that the works will be completed within a reasonable period as agreed by the WAPC.

    (Local Government)

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22. Engineering drawings and specifications are to be submitted and approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications to ensure that:

    a) street lighting is installed on all new subdivisional roads to the standards of the relevant licensed service provider;

    b) roads that have been designed to connect with existing or proposed roads abutting the subject land are coordinated so the road reserve location and width connect seamlessly;

    c) temporary turning areas are provided to those subdivisional roads that are subject to future extension;

    d) embayment parking is provided within the road reserves abutting the proposed public open space; and

    e) retention of existing mature trees where practical within the proposed road reserves,

    to the satisfaction of the Western Australian Planning Commission.

    (Local Government)

23. Engineering drawings and specifications are to be submitted, approved, and subdivisional works undertaken in accordance with the approved plan of subdivision, engineering drawings and specifications, for the provision of shared paths through and connecting to the application area to the satisfaction of the Western Australian Planning Commission. The approved shared paths are to be constructed by the landowner/applicant. (Local Government)

24. Satisfactory arrangements being made with the local government for the full cost of upgrading and/or construction of Eveline Road and York Street in the locations as shown on the approved plan of subdivision to a standard of Neighbourhood Connector A and Neighbourhood Connector B. (Local Government)

25. York Street being widened in accordance with the approved plan of subdivision by the landowner transferring the land required to the Crown free of cost for the purpose of road widening. (Local Government)

26. The section of York Street widened in accordance with this approval, is to be constructed and drained at the full cost of the landowner/applicant. (Local Government)

27. All local streets within the subdivision being truncated in accordance with the Western Australian Planning Commission's *Liveable Neighbourhoods* policy. (Local Government)

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28. Suitable arrangements being made with the local government for the provision of vehicular crossovers to service the proposed Lots 10, 12 and 43 shown on the approved plan of subdivision. (Local Government)

29. Pursuant to Section 150 of the *Planning and Development Act 2005* and Division 3 of the *Planning and Development Regulations 2009* a covenant preventing vehicular access being lodged on the certificate(s) of title of the proposed Lots 45, 46, 53 and 60 at the full expense of the landowner/applicant. The covenant is to prevent access, to the benefit of the local government, in accordance with the approved plan of subdivision and the covenant is to specify:

    "*No vehicular access is permitted*."

    (Local Government)

30 Arrangements being made with a licensed water provider for the provision of a suitable water supply service to each lot shown on the approved plan of subdivision. (Water Corporation)

31. Arrangements being made with the Water Corporation for the provision of a sewerage service to each of the lot(s) shown on the approved plan of subdivision. (Water Corporation)

32. Arrangements being made to the satisfaction of the Western Australian Planning Commission and to the specification of Western Power for the provision of an underground electricity supply to the lot(s) shown on the approved plan of subdivision. (Western Power)

33. The transfer of land as a Crown reserve free of cost to Western Power for the provision of electricity supply infrastructure. (Western Power)

34. Prior to the commencement of subdivisional works, the landowner/applicant shall prepare and implement as part of the subdivisional works a pipeline risk management/protection plan in accordance with Planning Bulletin 87 High Pressure Gas Transmission Pipelines in the Perth Metropolitan Region. (ATCO)

ADVICE:

1. Condition 8 has been imposed in accordance with *Better Urban Water Management Guidelines (WAPC 2008).* Further guidance on the contents of urban water management plans is provided in *'Urban Water Management Plans: Guidelines for preparing and complying with subdivision conditions' (Published by the then Department of Water 2008).*

    The applicant is advised that biofiltration areas are to be designed in accordance with the *Adoption Guidelines for Stormwater Biofiltration System* (CRC for Water Sensitive Cities 2015) and *the Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia* (Monash University 2014).

2. With regard to Condition 19, the development is to include full earthworks, basic reticulation, grassing of key areas, and pathways that form part of the overall pedestrian and/or cycle network.

   The applicant is advised that the public open space should consist of locally native species where possible and should not include any non-native deciduous trees (with the exception of retained trees) due to their high leaf litter load over a brief period, which blocks or rapidly fills stormwater systems and releases nutrients in receiving water bodies. It is also recommended that any turfed area is not directly adjacent to the stormwater drainage basin to avoid the leaching of nutrients from fertilisers into the waterway.

3. The landowner/applicant and the local government are advised to refer to the Institute of Public Works Engineering Australia Local Government Guidelines for Subdivisional Development (current edition). The guidelines set out the minimum best practice requirements recommended for subdivision construction and granting clearance of engineering conditions imposed.

4. In regard to Conditions 21, 22, 23, 24 and 25 the landowner/applicant is advised that the road reserves, including the constructed carriageways, laneways, truncations, footpaths/dual use paths and car embayments, are to be generally consistent with the approved plan of subdivision.

5. In regard to Conditions 30 and 31, the landowner/applicant shall make arrangements with the Water Corporation for the provision of the necessary services. On receipt of a request from the landowner/applicant, a Land Development Agreement under Section 83 of the *Water Services Act 2012* will be prepared by the Water Corporation to document the specific requirements for the proposed subdivision.

6. In regard to Condition 32, Western Power provides only one underground point of electricity supply per freehold lot.

7. In regard to Condition 34, the applicant is advised of the following:

   - The proposed areas fall within the WAPC Draft Development Control Policy 4.3 Trigger Distance for ATCO Infrastructure. Any development within this Trigger Distance of a High Pressure Gas Pipeline requires further consultation with ATCO prior to preliminary designs being finalised. The principles applied to development in the vicinity of the APA Transmission Pipeline Easement, also need to be applied to the ATCO Steel High Pressure Gas Main located within the Easement registered on the existing Certificate of Titles for the land.

   - ATCO identifies that the proposed future development of the subdivision may require additional safety measures to be considered, identified and in place for the high pressure gas pipeline. All costs associated with mitigating any introduced risk to the HP pipeline are to be met by the proponent.

- Future construction, installation of services and any proposed access roads across the ATCO gas mains (including proposed roads and road upgrades) need to be managed in accordance with the ATCO document Additional Information for Working Around Gas Infrastructure - AGA-O&M-PR24.

- As the land is presently encumbered with ATCO Easements, when the proposed road reserves are to be dedicated, all Easement document preparation and costs associated with the partial or full surrendering of the existing easements will be the responsibility of the proponent, to enable the land tenure to be formalised as dedicated road. ATCO will work with the proponents to assist in signing of surrender documentation to allow for the dedication of the roads to be lodged and registered.

Ms Sam Fagan
Secretary
Western Australian Planning Commission

4 August 2020

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Appendix C

City of Swan and WAPC approvals for Demolition Works

Western Australian Planning Commission

Our Ref : 21-50606-1
Your Ref : -
Enquiries : Aamon Zothner (Ph 6551 9237)

Midland Brick Co Pty Ltd
102 Great Northern Highway
MIDDLE SWAN WA 6056

Application for Approval to Commence Development dated 18 November 2019 received 18 November 2019.

Lot Number	:	160-165, 168, 169, 195-198, 166, 167, 23, 9000, 72
Location	:	-
Plan / Diagram	:	Deposited Plans 408605, 77549, 405292, Plan 9113
Volume/Folio	:	2916/634,2898/388,2905/766,1336/319,1336/320,1336/321,1336/322,1336/323,1336/324,1366/685,1366/686,1336/327,1336/328,1336/334,1336/335,1336/336,1336/337
Locality	:	Eveline Road, Somerset Street & Surrey Court, Viveash
Owner	:	Boral Bricks Western Australia Pty Ltd (Formerly Midland Brick Co Pty Ltd) (Formerly Midland Brick Co Pty Ltd) 130 Fauntleroy Avenue, Perth Airport CLOVERDALE WA 6105

Under the provisions of the Metropolitan Region Scheme this application has been referred for determination by the Western Australian Planning Commission.

The application has now been considered by the Commission and the formal notice setting out the terms of the decision is attached.

A copy of this decision has been forwarded to the Local Government for information.

You are advised of the need to consult with the Local Government with regard to the gaining of all necessary approvals and the issuing of the requisite building licence.

This decision is issued pursuant to the provisions of the Metropolitan Region Scheme, and has been made by the Commission after due consideration of the regional planning implications of the proposal. The development must also comply with the requirements of Council's Local Planning Scheme(s) and any determination in this regard must be made by the local government. The Commission's decision, therefore, is made without prejudice to any others that may be separately required from Council.

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Should the applicant be aggrieved by this decision there is a right to apply for a review pursuant to the provisions of Clause 33 of the Metropolitan Region Scheme. Such an application for review must be submitted to the State Administrative Tribunal, Level 6, State Administrative Tribunal Building, 565 Hay Street, PERTH WA 6000 in accordance with Part 14 of the *Planning and Development Act 2005*. It is recommended that you contact the State Administrative Tribunal for further details (telephone 9219 3111) or go to its website: http://www.sat.justice.wa.gov.au.

ADVICE TO APPLICANT

1. This decision constitutes planning approval under the Metropolitan Region Scheme only. It is the proponent's responsibility to comply with all other applicable legislation and obtain all required approvals, licences and permits prior to commencement of this development, including approval of the proposed development under the City of Swan's Local Planning Scheme No. 17.

2. The Department of Water and Environmental Regulation advises that an appropriate management plan should be prepared to address the risks associated with potential exposure of soil contamination beneath the site.

3. ATCO Gas Australia advises that it has High Pressure gas mains and critical infrastructure within Lot 72, within an Easement and proposed area for Access and also within Eveline Road. ATCO Gas must be notified of any works within 15 metres of High Pressure gas infrastructure in the preliminary demolition planning phase before those works begin. Construction, access, excavation and other activities may be restricted in this zone. No pavements (including crossovers) are to be constructed over the pipeline without consent from ATCO Gas Australia. Various pipeline safety tests may apply. The applicant is advised to contact ATCO on 9499 5272 in this regard. Anyone proposing to carry out construction or excavation works must contact 'Dial Before You Dig' (Ph 1100) to determine the location of buried gas infrastructure. Any cost of improvements identified as required to protect the existing HP gas mains within the existing Lot 72 and surrounding road reserves due to the demolition activities are to be met by the proponent.

4. In regard to Condition 5, the construction management plan shall describe how all works associated with the approval will be managed to minimise risk and shall address the following and/or include, unless otherwise agreed in writing:

    i) Prohibit the use of rippers or horizontal directional drills unless otherwise agreed by the operator of the gas transmission pipeline.

    ii) Avoid significant vibration, heavy loadings stored over the pipeline and heavy vehicles/plant crossings of the pipeline within the easement.

    iii) Endorsement by the operator of the gas transmission pipeline for any works within or crossing the relevant gas transmission easement.

    iv) The ability of the pipeline operator to access the easement at any time to facilitate prompt maintenance and repairs.

5. APA Group advises that prior to the commencement of any works within the gas transmission pipeline easement, the proponent must enter a Third Party Works Authorisation within the pipeline licensee/operator APT Parmelia Pty Ltd). Works within the easement must comply with any conditions attached to a third party works approval.

6. An early works agreement from APA is required for any assessments/approvals that require greater than 3 days assessment or supervision. Lead in times for agreements can be up to 12 weeks. Please contact APA at APAprotection@apa.com.au or 1800 103 452.

7. Any improvements within the transmission gas pipeline easement undertaken by third parties is at the risk of the proponent who will remain liable. APA will not be liable for any costs associated with the reinstatement of any vegetation and/or infrastructure constructed on the easement.

Ms Sam Fagan
Secretary
Western Australian Planning Commission

31 January 2020

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Western Australian Planning Commission

Our Ref : 21-50606-1
Your Ref : -
Enquiries : Aamon Zothner (Ph 6551 9237)

METROPOLITAN REGION SCHEME

City of Swan

APPROVAL TO COMMENCE DEVELOPMENT

Name and Address of Owner and Land on which Development Proposed:

Owner	:	Boral Bricks Western Australia Pty Ltd (Formerly Midland Brick Co Pty Ltd) (Formerly Midland Brick Co Pty Ltd) 130 Fauntleroy Avenue, Perth Airport CLOVERDALE WA 6105
Lot Number	:	160-165, 168, 169, 195-198, 166, 167, 23, 9000, 72
Location	:	-
Plan / Diagram	:	Deposited Plans 408605, 77549, 405292, Plan 9113
Volume/Folio	:	2916/634,2898/388,2905/766,1336/319,1336/320,1336/321,1336/322,1336/323,1336/324,1366/685,1366/686,1336/327,1336/328,1336/334,1336/335,1336/336,1336/337
Locality	:	Eveline Road, Somerset Street & Surrey Court, Viveash
Application Date	:	18 November 2019
Application Receipt	:	18 November 2019
Development Description	:	Demolition Works

The application for approval to commence development in accordance with the plans submitted thereto is granted subject to the following condition(s):

CONDITION(S):

1. This approval relates to the proposed demolition works in accordance with the development plans date stamped 19 November 2019 by the Department of Planning, Lands and Heritage on behalf of the Western Australian Planning Commission. It does not relate to any other development on the lot.

2. The applicant shall take appropriate preventative measures during the demolition works to ensure that no chemicals, woody debris, construction material, or soil enters Blackadder Creek, Bush Forever Area 302, the stormwater system or Swan River as a result of the works.

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ABN 35 482 341 493

3. All septic sewer systems including all tanks, pipes and associated drainage systems (soak wells or leach drains) are to be decommissioned, in accordance with the Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974, removed, filled with clean sand and compacted. Proof of decommissioning is to be provided in the form of either certification from a licenced plumber or a statutory declaration from the landowner/applicant, confirming that the site has been inspected and all septic tanks, soak wells, leach drains and any associated pipework have been removed.

4. The applicant shall take appropriate preventative measures during the demolition works to ensure no vegetation within Bush Forever area 302 is disturbed as a result of the works.

5. Prior to the commencement of works, including demolition, within the gas transmission pipeline easement or on land within 50 metres of the gas transmission pipeline, a construction management plan is to be prepared to the specifications of the APA Group. The approved construction management plan is to be implemented in its entirety to the specifications APA Group and the satisfaction of the Western Australian Planning Commission.

If the development the subject of this approval is not substantially commenced within a period of two years from the date of this letter, the approval shall lapse and be of no further effect. Where an approval has so lapsed, no development shall be carried out without the further approval of the responsible authority having first been sought and obtained.

Ms Sam Fagan
Secretary
Western Australian Planning Commission

31 January 2020

140 William Street, Perth, Western Australia 6000, Locked Bag 2506 Perth, 6001
Tel: (08) 6551 8002; Fax: (08) 6551 9001; Infoline: 1800 626 477
e-mail: info@dplh.wa.gov.au; web address http://www. dplh.wa.gov.au
ABN 35 482 341 493

Our Ref: DA-698/2019

11 February 2020

Midland Brick Company Pty Ltd
102 Great Northern Hwy
MIDDLE SWAN WA 6056

Dear Sir/Madam

DEVELOPMENT APPLICATION: DEMOLITION WORKS - VARIOUS LOTS - MIDDLE SWAN & VIVEASH

I refer to your Application for Planning Approval on the above lot received on 11 November 2019.

In accordance with the provisions of the City's *Local Planning Scheme No.17* and the *Planning and Development (Local Planning Schemes) Regulations 2015* (*Regulations*) **approval to commence development has been granted**, subject to conditions. This application has been determined by delegated authority of Council in accordance with cl.83 of the *Regulations*. Attached is the form of approval stating the conditions that must be complied with.

If an applicant is aggrieved by this Determination, there is a right of review under Part 14 of the *Planning and Development Act 2005*. An application for review should be lodged with the State Administrative Tribunal (Level 4, 12 St George Terrace, Perth) within twenty eight (28) days of the date of this determination (application may be made to the Tribunal to extend this time period). The necessary "Application for Review" forms are available from the State Administrative Tribunal.

It should be noted that this approval does not constitute a building permit.

Should you have any queries regarding this matter, please do not hesitate to contact Hannah McFeggan on 08 9278 9631.

Yours faithfully

Patricia Wojcik
Coordinator, Development Assessment & Appeals
STATUTORY PLANNING

Planning and Development Act 2005

CITY OF SWAN

Notice of Determination on Application for Planning Approval

Ref. No: DA-698/2019
Determination Date: 11 February 2020
Est. Value: $500000

Location:	VARIOUS LOTS - MIDDLE SWAN & VIVEASH		
Title (Vol/Folio):	CT-2668/413, CT-1336/319, CT-1336/322, CT-1336/323, CT-1336/324, CT-1366/685, CT-1336/334, CT-1336/335, CT-1336/336, CT-1336/337	**Plan/Diagram:**	54208
Application date:	**11 NOVEMBER 2019**	**Received on:**	**12-NOV-2019**

Description of proposed development: DEMOLITION WORKS

The application for development approval is:

☒ **Approved subject to the following conditions**

CONDITIONS

1. The approved 'Demolition Works' must comply in all respects with the attached approved plans, as dated, marked and stamped, together with any requirements and annotations detailed thereon by the City of Swan. The plans approved as part of this application form part of the development approval issued.

2. All building works to be carried out under this development approval are required to be contained within the boundaries of the subject lot.

3. Prior to a demolition permit being issued, the applicant must submit, have approved by the City of Swan and thereafter implement, noise, dust and vibration management plans to the satisfaction of the City of Swan for the proposed demolition works.

4. A Construction Management Plan shall be submitted for approval to the City of Swan prior to commencement of works. The Construction Management Plan shall address dust, noise, waste management, storage of materials, traffic management and site safety/security. The Construction Management Plan is to be complied with for the duration of the development.

5. All vegetation and trees are to be protected and retained.

6. The applicant is to ascertain the location and depth of any services that may interfere with this development. Any adjustment to these services required as part of this approval, must be arranged by the applicant prior to works commencing on the site. Any adjustment must be approved by the relevant service authorities and will be at the applicant's expense.

ADVICE TO APPLICANT

a) An appropriate management plan should be prepared to address the risks associated with potential exposure of soil contamination beneath the site.

b) This is a Development Approval issued by the City of Swan under its Local Planning Scheme No. 17. It is not a building permit or an approval to commence or carry out development under any other law. It is the responsibility of the application to obtain any other necessary approval, consents or licences required under any other law, and to commence and carry out development in accordance with all relevant laws.

c) Under the provisions of the Metropolitan Region Scheme, approval to commence development must also be obtained from the Western Australian Planning Commission (WAPC) and therefore your application has been forwarded to the Commission for its determination. Development must not be commenced until approval under the Metropolitan Region Scheme has been given, additionally to any other required approval, licence certificate or permission. The WAPC can be contacted on 6551 8002 if you wish to be advised of its progress.

d) Development may be carried out only in accordance with the details of the application as approved herein and any approved plan.

e) This approval is not an authority to ignore any constraint to development on the land, which may exist through contract or on title, such as an easement or restrictive covenant. It is the responsibility of the applicant and not the City to investigate any such constraints before commencing development. This approval will not necessarily have regard to any such constraint to development, regardless of whether or not it has been drawn to the City's attention.

f) This approval does not authorise commencement of any building and/or demolition works. In accordance with the Building Act 2011 and Building Regulations 2012, a building and/or demolition permit must be obtained prior to the commencement of any works.

g) The noise generated by activities on-site, including machinery motors or vehicles is not to exceed the levels as set out under the *Environmental Protection (Noise) Regulations 1997*.

Noisy Construction Work outside the period 7.00 am to 7.00 pm Monday to Saturday and at any time on Sundays and Public Holidays is not permitted unless a Noise Management Plan for the construction site has been approved in writing by the City.

Note 1: **If the development the subject of this approval is not substantially commenced within a period of 2 years, or another period specified in the approval after the date of the determination, the approval will lapse and be of no further effect.**

Note 2: **Where an approval has so lapsed, no development must be carried out without the further approval of the local government having first been sought and obtained.**

Note 3: **If an applicant or owner is aggrieved by this determination there is a right of review by the State Administrative Tribunal in accordance with the *Planning and Development Act 2005* Part 14. An application must be made within 28 days of the determination.**

Patricia Wojcik
Coordinator, Development Assessment & Appeals
STATUTORY PLANNING

CITY OF SWAN
APPROVED PLAN

This plan relates to the approval to commence development dated:
11 Feb 2020
No.: 1 of 2
Ref.: DA698-19

Patricia Wojcik
DELEGATED OFFICER
STATUTORY PLANNING

CITY OF SWAN
RECEIVED
11 Nov 2019

PLAN
N.T.S.

D.A. SUBMISSION

SCALE A1

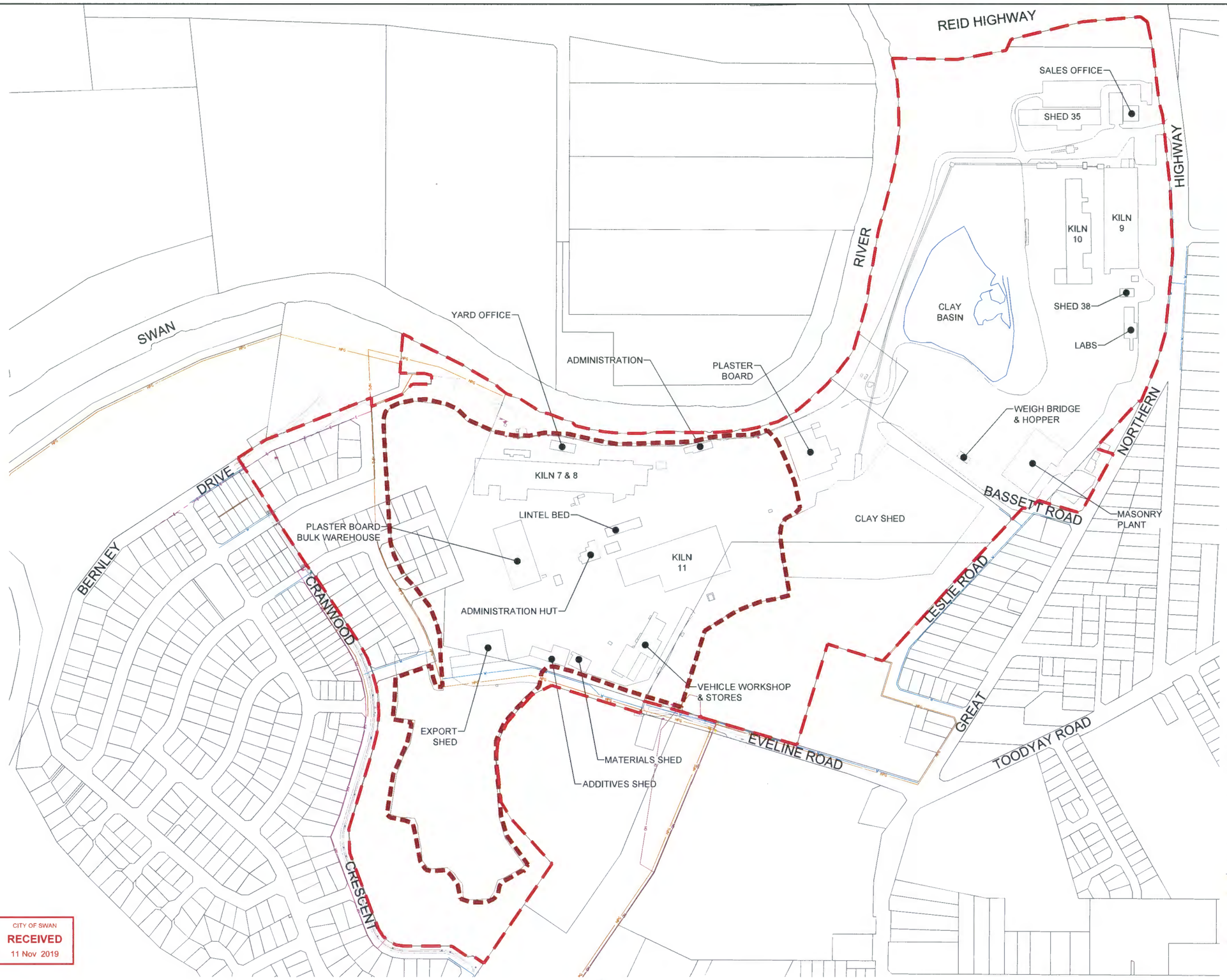
No.	DATE	DRAWN	APPROVED	AMENDMENT
A	06.11.19	RDE	CCB	ISSUED FOR COMMENTS.

CLIENT: LINC PROPERTY

DESIGNED	CHECKED	APPROVED
RDE		C.BITMEAD
DRAWN	CHECKED	DATE
RDE		06.11.19

TABEC
Civil Engineering Consultants
TABEC PTY LTD
ACN 090 779 204
14 Wickham Street, East Perth WA 6004
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

PROJECT: MIDLAND BRICK - STAGE 1 DEMOLITION
TITLE: DEMOLITION PLAN D.A. (WITH AERIAL PHOTO)
DRAWING NUMBER: 2419-00-DA-001-1
ISSUE: A



PLAN
N.T.S.

CITY OF SWAN
APPROVED PLAN
This plan relates to the approval to commence development dated:
11 Feb 2020
No.: 2 of 2
Ref.: DA698-19
Patricia Wojcik
DELEGATED OFFICER
STATUTORY PLANNING

CITY OF SWAN
RECEIVED
11 Nov 2019

NOTES

1. ALL EXISTING BUILDINGS, STRUCTURES AND HARDSTAND TO BE REMOVED TO THE EXTENT AS INSTRUCTED BY THE SUPERINTENDENT.
2. ALL TREES AND EXISTING VEGETATION MARKED FOR RETENTION MUST BE PROTECTED AND RETAINED THROUGHOUT THE DURATION OF THE WORKS.
3. ALL EXISTING SERVICES THAT ARE PRIVATE (MIDLAND BRICK) AND WITHIN WORKS BOUNDARY THAT ARE ABOVE GROUND, AT GROUND SURFACE LEVEL AND UNDER GROUND SHALL BE REMOVED AND CAPPED IN ACCORDANCE WITH RELEVANT AUTHORITY AND AUSTRALIAN STANDARDS.
4. ALL EXISTING SERVICES THAT ARE OWNED AND OPERATED BY OTHER AUTHORITIES AND WITHIN WORKS BOUNDARY, ARE TO REMAIN PROTECTED AT ALL TIMES.
5. THE CONTRACTOR SHALL PROVIDE EROSION & SEDIMENT CONTROL MEASURES THROUGHOUT THE DURATION OF THE WORKS.
6. THE CONTRACTOR SHALL PROVIDE DUST FENCING AS REQUIRED IN ACCORDANCE WITH D.E.P. 'DUST CONTROL GUIDELINES' THROUGHOUT THE DURATION OF THE WORKS.

LEGEND

- SITE BOUNDARY
- EXTENT OF DEMOLITION WORKS BOUNDARY
- D — EXISTING STORMWATER DRAINAGE
- S — EXISTING SEWER
- W — EXISTING WATER MAIN
- PM — EXISTING SEWER PRESSURE MAIN
- G — EXISTING GAS MAIN
- HPG — EXISTING HIGH PRESSURE GAS MAIN
- OF — EXISTING OPTIC FIBRE
- T — EXISTING COMMUNICATIONS
- HV — EXISTING UNDERGROUND HIGH VOLTAGE POWER
- E — EXISTING UNDERGROUND LOW VOLTAGE POWER
- EH — EXISTING OVERHEAD HIGH VOLTAGE POWER

SCALE N.T.S.

D.A. SUBMISSION

A1

No.	DATE	DRAWN	APPROVED	AMENDMENT
A	06.11.19	RDE	CCB	ISSUED FOR COMMENTS.

CLIENT: LINC PROPERTY

DESIGNED	CHECKED	APPROVED
RDE		C.BITMEAD
DRAWN	CHECKED	DATE
RDE		06.11.19

TABEC
Civil Engineering Consultants
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ACN 090 796 204
14 Wickham Street East Perth WA 6004
08 9425 5900 e: info@tabec.com.au
www.tabec.com.au

PROJECT: MIDLAND BRICK - STAGE 1 DEMOLITION

TITLE: DEMOLITION PLAN D.A.

DRAWING NUMBER: 2419-00-DA-001

ISSUE: A

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Appendix D

Local Water Management Strategy (Hyd2o Hydrology 2020)

Midland Brick, Middle Swan

Local Water Management Strategy

April 2020

Client: Linc Property

Contents

Appendices

Figures

Tables

Disclaimer

This document is published in accordance with and subject to an agreement between Hyd2o and the Client for whom it has been prepared, and is restricted to those issues that have been raised by the Client in its engagement of Hyd2o. It has been prepared using the skill and care ordinarily exercised by hydrologists in the preparation of such documents.

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.

Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by Hyd2o and the Client does so entirely at their own risk. Hyd2o denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the Client.

Executive Summary

Hyd2o was commissioned by Linc Property to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan (LSP) for land within the existing Midland Brick site in Middle Swan.

The LSP area is approximately 47 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 consists of residential lots, roads, car parking areas, public open space, and creating public amenity areas near the Swan River Foreshore and Blackadder Creek Tributary.

This LWMS addresses stormwater management of the whole of the Midland Brick site including areas outside of the LSP area to provide a comprehensive overall assessment of the existing water management system of the area 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 for the site. The site has been a brickworks site since 1946 with operations and brick sales currently operating. The site is generally characterised as having low permeability soils, good clearance to groundwater, and no known ASS risk over the majority of the site. It has an existing stormwater system which operates via a pumping based system to transfer frequently occurring events to the Blackadder Creek Tributary, with larger events also flowing to the Swan River.

The values of the Swan River are proposed to be enhanced post-development through the establishment of a foreshore reserve area. The Swan River is currently fenced off from the industrial area with industrial uses abutting the River area. Similarly, the environmental considerations and values of the Blackadder Creek tributary and the Eveline Reserve are recognised as a key consideration which have guided the hydrological design for the site.

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 this process.

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 site.

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. • Re-use of residential stormwater runoff for POS irrigation. • Re-use of brickworks industrial area stormwater runoff for dust suppression.
Water Supply	• Construction: Temporary DWER groundwater licence and use of retained stormwater via Brickworks Southern Storages • Lots: Water Corporation IWSS and rainwater tanks (optional). • POS: Stormwater harvesting and re-use scheme (15,000 kL capacity) plus supplementary groundwater Irrigation bore for supply security. • Retained Industrial: Water Corporation IWSS and stormwater harvesting via Clay Basin/Swale storage for dust suppression.
Wastewater	• Water Corporation reticulated sewerage.
Stormwater	
Design & Management Principles	• All habitable development levels to have suitable clearance above the 1% AEP flood levels of the Swan River (5.7 -6.0 mAHD) and Blackadder Creek (6.43 m AHD at 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 and stormwater harvesting scheme storage capacity, to flow to Swan River via existing outlets. • For catchments draining toward the Blackadder Creek Tributary, maintain the overall water balance at Muriel St, maintain the peak discharge at the existing southern outlet of the site to existing flows, and maintain water levels adjacent to the Threatened Ecological Community to existing levels to maintain existing hydrology and prevent waterlogging/drying. • For the remaining industrial area and its upstream external catchment, provide a flow path and operation consistent with existing practice.
Lot Scale Measures	• Soakwells sized to retain and infiltrate first 15 mm rainfall on site within sand fill. • Rainwater tanks (optional). • Water-wise landscaping to retain stormwater and minimise runoff
Street Scale Measures	• Biofiltration areas in specified locations, with additional areas identified at UWMP scale as necessary 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
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 areas for treatment of runoff from first 15mm rainfall via biolfitration, with use of treated water from frequent events diverted for stormwater harvesting. Estimated area and volume required of 0.52 ha and 1550 m^3, based on assumed 0.3m depth. • 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.

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.
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.
Implementation	
Process	• Predevelopment groundwater and surface water monitoring program in progress to be completed end of winter 2020. Final results to develop water quality targets. • Environmental Water Requirements study to be undertaken if required prior to development areas flowing to Blackadder Creek Tributary in consultation with DBCA to ensure maximum benefit in improvements to creek system. • Detailed engineering investigation and design of stormwater storage and re-use scheme infrastructure prior to UWMP for development area drainage to Swan River. • 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 transition process.

1. Introduction

Hyd2o was commissioned by Linc Property to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan (LSP) for land within the existing Midland Brick site in Middle Swan.

The LSP area is approximately 47 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 consists of residential lots, roads, car parking areas, public open space, and creating public amenity areas near the Swan River Foreshore and Blackadder Creek Tributary.

Note this LWMS addresses the whole of the Midland Brick site including areas outside of the LSP area to provide a comprehensive overall assessment of the existing water management system of the area 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 site's overarching District Water Management Strategy (DWMS) (Hyd2o, 2020a).

This 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) 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 this process.

Given the size of the site and its likely development timeframe, ongoing consultation with these stakeholders will continue as planning progresses for the site.

1.1 Planning Background

This site is currently zoned 'Industrial', 'Urban' and 'Rural' under the Metropolitan Region Scheme (2007), with an MRS amendment lodged in March 2020 for the rezoning to 'Urban' and 'Parks and Recreation' for the industrial area within the site.

The urban water management planning process for the site is shown in Table 1. This LWMS supports the proposed development of the site to an 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	Midland Brick Middle Swan 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)
- 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)
- Stormwater Management Manual for WA (Department of Water, 2007)

2. Proposed Development

The local structure plan for the site is shown in Figure 2, providing a unique opportunity for urban infill in close proximity to the Midland town centre.

The LSP area covers 47 ha of the total 83 ha site.

The proposed development consists of residential lots, roads, car parking areas, public open space, and creating public amenity areas near the Swan River Foreshore and Blackadder Creek Tributary. The proposed development also seeks to provide protection for the existing Threatened Ecological Community located adjacent to Leslie Rd.

As well as providing a vibrant and diverse residential community with a variety of housing choice and local amenities, the structure plan design aims to reconnect the river foreshore to the local community, create better and safer transport routes for existing residents and introduce new landscaped areas for public recreation.

From a stormwater management perspective, the development will seek to provide improvements in foreshore management and interaction with the Swan River, and seek to improve existing water quality management outcomes.

The development will also seek to provide hydrological improvements for the Blackadder Creek Tributary along its south eastern boundary as the site transitions from its current industrial use.

3. Existing Environment

3.1 Site Conditions

The 83 ha site is located in the suburbs of Viveash and Middle Swan in the City of Swan.

The site 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).

The site is currently utilised by Midland Brick for brick making, brick storage and commercial sales. The site has been used for brick making purposes since 1946 and is currently operational and operates under a DWER Part V Licence. The Swan River foreshore adjacent to the site comprises a relatively steep vegetated bank and is fenced on the top boundary.

Topography across the site varies between 3 mAHD and 16 mAHD. The site has been modified for industrial use to have flat areas at 5 mAHD within built up areas, falling to 3 mAHD in areas adjacent to the Swan River and bunded to heights of 16 mAHD adjacent to external development.

Figure 3 shows an aerial photograph with existing land use and topography.

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 site 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 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 locations. Test locations 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 general 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:
    - 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.
    - 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.
    - 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 mAHD and 2.9 mAHD (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.

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.

3.2.2 Contaminated Sites

Contaminated site investigations have been undertaken over the 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 recently undertaken by Emerge Associates including an assessment of biophysical characteristics for the portion of the site adjacent to the Swan River. This assessment has been used to inform the establishment of the Foreshore Reserve in the LSP, and will guide future planning of this area.

3.4 Threatened Ecological Community (TEC)

With respect to the Blackadder Creek tributary area, 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.

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 future stormwater management system. This is further discussed in Section 6.4.

An Ecological Water Requirement assessment of the Blackadder Creel Tributary area may be required by Department of Biodiversity Conservation and Attractions (DBCA) and would be undertaken as planning progresses to inform the detailed design of the stormwater management system for that area.

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 the site range from 5.7 mAHD near then downstream boundary of the site to 6.0 mAHD at the northern boundary (Figure 6, 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 site is predominately 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.

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 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 the Blackadder Creek Tributary, the 1% AEP level adjacent to the site is shown in Figure 6 and Table 2. The 1% AEP level value at the confluence of the Blackadder Creek and the Blackadder Creek Tributary near the site is shown as 6.43 mAHD.

Table 2: Watercourse Flood Levels

Watercourse	Location	1% AEP Flood Level (mAHD)
Swan River	Downstream of Site near Bernley Drive and Colyton St intersection	5.7 mAHD
Swan River	Upstream of Site near Reid Highway	6.0 mAHD
Blackadder Creek	At confluence of Blackadder Creek Tributary	6.43 mAHD

3.5.2 Existing Stormwater Management

The site has no specific Environmental Protection Act licence conditions for water control, however objectives for stormwater management are detailed in Boral (2012) 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 at the site, with plates of key locations shown in Appendix C. The function of the existing stormwater management system is summarised as follows:

- The site lies between two watercourses which receive stormwater runoff from the site; 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 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 the northern storage ponds in the north west of the 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.
- This water then flows south along the western boundary of the site before entering a further series of storages (southern storage ponds) and discharging to the Blackadder Creek Tributary.
- Flows from the Clay Shed roof area 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 Figure 6 and were mapped based on site inspections, Boral (2012) and available pipe survey data. Individual subcatchment land use breakdowns are summarised in Appendix D.

Figures 6 also details the extent of the existing area external to the site which also drains into the site. This area was mapped based on the City of Swan Intramaps and the Middle Swan Stormwater Drainage Design report (CCD Australia, 2001), and includes a catchment area of approximately 16 ha associated with Great Northern Hwy, Richardson Rd, and Leslie Rd.

With respect to the Clay Basin, the total catchment area draining to basin is estimated to be 31.7 ha, with an estimate equivalent impervious area of 19.5 ha during major events. The external catchment contributing flow to the Clay Basin area 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 was performed using XP-Storm.

The design rainfall storms modelled in XP-Storm were based on methodology in Australian Rainfall and Runoff (AR&R) (Ball et al, Australia, 2016). All design rainfall and temporal patterns where imported into the model using the ARR Data Hub. The rainfall temporal

pattern is assumed to be spatially uniform across the catchment. Storm durations ranged from 10 minutes to 168 hours and all ensembles run to determine critical design events.

Recent updates to Australian Rainfall and Runoff (Ball et al, 2016) have resulted in changes in terminology being recommended to describe design rainfalls. Annual Exceedance Probability (AEP, %) terminology has therefore been adopted to replace Average Rainfall Interval (ARI) terminology in this report as follows:

- Frequent Events : previously 1 Year ARI, replaced with 63% AEP
- Minor Events : previously 5 Year ARI, replaced with 20% AEP
- Major Events : previously 100 Year ARI, replaced with 1% AEP

Runoff coefficients adopted for modelling purposes for various events and durations are calculated in detail in Appendix D using Hyd2o's CURRV runoff rate estimator based on various individual land use characteristics.

The modelled water levels within the Clay Basin demonstrated a very good agreement to surveyed water levels in the Clay Basin when modelling the 21-24 June 2019 event (to within 2 cm), indicating a good representation of site runoff using the parameters via CURRV.

Key results of the modelled current drainage system are summarised in Figure 7 and Table 3 and described below, with more detailed results contained in Appendix D. These results should be considered a refinement of results presented in the DWMS and are based on additional survey of stormwater infrastructure and capacity, and improved topographical data:

- The estimated effective equivalent impervious area (EIA) for the total 116.6 ha catchment draining to the Swan River and Blackadder Creek Tributary is estimated to be 73.2 ha during major events.
- The maximum water level modelled in the vicinity of the existing main site pump for the 1% Annual Exceedance Probability (AEP) event was 4.69 mAHD. This is within the range of estimated 1% AEP water levels detailed in SKM (2003) for their modelled scenarios.
- The outflow level to the Swan River is at 4.29 mAHD and the estimated outflow to the River which occurs from the site for this event is 0.27 m^3/s.
- Should pumps fail and no outflow to the Swan River be possible, the model estimates a 1% Annual Exceedance Probability (AEP) event level of 4.96 mAHD, which is very similar to the annotated maximum high water mark drawn on the pump shed (refer plates Appendix C).
- While no outflow to the Swan River during the 63% AEP (1 Exceedance per Year, 1 EY) event was found to occur, both 20% AEP and 1% events were found to discharge to the river. This frequency is consistent with anecdotal field advice which indicates the previous outflow event was approximately 6 years ago.
- With respect to discharge to the Blackadder Creek tributary, outflows at the southern end of the site are constrained by a 400 mm diameter outlet. This discharges for all AEP events with flows ranging from approximately 0.20 m^3/s for the 63% AEP to 0.26 m^3/s for the 1% AEP event. Long duration events were found to be critical (24 hrs).

- Flow from the Clay Shed roof also discharges directly into the Blackadder Creek tributary further upstream of the southern outlet location and provides flows ranging from 0.33 m³/s for the 63% AEP event to 1.02 m³/s for 1%AEP (30 min critical duration). This flow is then attenuated and at the 450 mm diameter outlet from this area under Eveline Rd flow is reduced to 0.19 m³/s for the 63% AEP event to 0.27 m³/s for 1%AEP.
- At the downstream end of the Blackadder Creek Tributary at Muriel St, flow estimates were found to range from 0.28 m³/s for the 63% AEP event to 0.67 m³/s for 1%AEP. These estimates are well within the infrastructure capacity of the 900mm diameter pipe under Muriel St at this location.

Table 3: Existing Site Stormwater Management Flow Summary

Location	Flows (m³/s)		
	63% AEP Event	20% AEP Event	1% AEP Event
Clay Basin	0.05	0.06	0.07
Swan River Outflow	-	0.08	0.27
Flow to 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
Flow in Blackadder Creek Tributary at Muriel St culvert	0.28	0.45	0.67

3.5.4 Surface Water Quality

Hyd2o commenced a pre development surface water quality monitoring program in September 2019. Sampling locations are shown in Appendix E. This program has been 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), and nutrients and metals.

Surface water quality results are summarised in Table 4 for physical parameters nad 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. 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 (8.35) was marginally higher than the upper limit.

- Mean EC (µS/cm) at the Swan River downstream site was higher (16274 µS/cm) than at the upstream site (14419 µS/cm). Swan River sites were well outside the ANZECC guideline range (120 - 300 µS/cm) but this is typical of the Upper Swan Catchment of the Swan-Canning River system (DoW, 2009). Mean EC (µS/cm) at the locations within the site were well below the levels within the Swan River but outside the ANZECC guideline range, with Northern Storage Pond 4 just outside the upper limit (302 µS/cm).
- Mean TN at Swan River sites were slightly higher downstream (1.46 mg/L) than upstream (1.33 mg/L), and both sites 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 site were all within the ANZECC guideline value and long term SCWQIP target.
- Mean TP at Swan River sites were slightly higher downstream (0.10 mg/L) than upstream (0.08 mg/L), and both were slightly above the ANZECC guideline value of 0.065 mg/L but were both consistent with the SCWQIP long term target of 0.1 mg/L. Mean TP at the monitoring locations within the site were all within the ANZECC guideline value and long term SCWQIP target except for Northern Storage Pond 4 which exceeded both limits (0.13 mg/L).

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 for at Northern Storage Pond 4 where it measured within the 90% protection limit.
- Chromium was within the 90% protection limit at Swan River sites and within the 80% protection limit for all location within the site except for Northern Storage Pond 4.
- Copper was outside the 80% protection limit at all sites.
- Lead was within the 95% protection limit at Swan River sites and Northern Storage Pond 4 but outside the 80% protection limits for the Clay Basin and Southern Storage Area.
- Nickel was within the 99% protection limit for the Swan River sites and Northern Storage Pond 4 within the 95% protection limit for the Clay Basin and outside the 80% protection limit for the Southern Storage Area.
- Zinc was in the 80% protection limit for the Swan River sites and the Clay Basin but was outside the same limit for Northern Storage Pond 4 and the Southern Storage Area.
- Mercury fell within the 99% protection limit for all sites except for the Clay Basin which fell within the 95% protection limit.

Table 4: Existing Surface Water Quality

Parameter	Mean of Parameter Values						
	Swan River Upstrm	Swan River Downstrm	Clay Basin	Northern Storage Pond 4	Southern Storage Area	ANZECC	Long term SCWQIP
EC	14419	16274	743	302	384	120-300	-
pH	7.60	7.55	8.35	6.87	7.75	6.5-8.0	-
TN (mg/L)	1.33	1.46	0.69	0.51	0.7	1.2	1.0
Ammonia (mg/L)	0.17	0.19	0.05	0.03	0.05	0.32 – 2.3 (99% - 80%)	-
TP (mg/L)	0.08	0.10	0.03	0.13	0.04	0.065	0.1
FRP (mg/L)	0.03	0.04	below detect	0.01	-	0.04	-
Nitrate (mg/L)	0.53	0.6	0.2	0.07	0.59	0.017 – 17 (99% - 80%)	-
Nitrite (mg/L)	0.08	0.09	0.04	0.25	0.05	-	-

3.6 Groundwater

3.6.1 Groundwater Levels

The second edition of the Perth Groundwater Atlas (Department of Environment, 2004b) indicates the superficial aquifer base at the site is approximately -15 mAHD and indicates a saturated thickness of approximately 16 m.

Groundwater levels in the Atlas are representative of typical end of summer groundwater levels and estimate groundwater levels of 1 mAHD to 2 mAHD within the site, with groundwater flow in an easterly direction towards the Swan River.

Emerge Associates installed 10 groundwater monitoring bores within the site on 20 August, 2018. Lithological logs are including in Appendix F.

Water levels in all bores were measured monthly from Sept 2018 to Feb 2019 with monitoring recommenced in September 2019 by Hyd2o. Water quality sampling was undertaken in September 2019 and is progressing on a quarterly basis to determine baseline groundwater quality conditions.

The estimated average annual maximum groundwater levels (AAMGL) for the site are shown in Figure 8 based on this data. Hyd2o have calculated the AAMGL by adjusting levels at site bores based on the recorded level in DWER bores MM38 and GD8 on 29/10/2019 referenced to their long term historical data (Table 5). DWER bores MM38 and GD8 long-term hydrographs are provided in Appendix G. The data considered for the calculation is from the year 2000, considered representative of current climate conditions

The AAMGL for each groundwater bore based on this analysis is shown in Table 6. Perching of groundwater appears to be occurring at some bores due to their proximity to existing stormwater storage areas. This will be further examined at completion of the monitoring program after winter 2020 and groundwater mapping refined if required.

It is important to note the 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 the site.

Table 5: AAMGL for DWER Bores

Bore	Period of Record	Groundwater Level (mAHD) 21/10/2019	AAMGL 2000-2018 (mAHD)	Correction Factor (m)	MGL (mAHD)	Correction Factor (m)
MM38	1974 - 2018	20.23	20.29	+0.06	20.64	+0.41
GD8	1978-2018	4.01	4.07	+0.06	4.94	+0.94
Correction Factors for Site Bores				+0.06		+0.67

Table 6: AAMGL for Site Bores

Bore	Natural Surface (mAHD)	AAMGL (mAHD)	MaxGL (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 on a single occasion in September 2018 and Hyd2o began further monitoring in September 2019. Groundwater bore locations in the site are shown in Figure 8 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 are outlined in Table 7 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 across the site ranged from 5.53 to 7.01, with sample values ranging from below the ANZECC guideline range to within the range.
- Mean EC ranged from 190 µs/cm to 4293 µs/cm across all groundwater samples, above the ANZECC guideline range for freshwater, indicating that the groundwater is fresh to brackish (Department of Environment, 2004b).
- Across all sampling occasions, mean values for total nitrogen (TN) for each bore ranged from 0.55 mg/L to 21.08 mg/L, ranging from below to well above the ANZECC guideline value of 1.2 mg/L. It should be noted that the mean reported as 21.08 mg/L was reflective of samples collected at EMW07 and stands apart from the rest of the site bores with the next highest mean measured as 1.68 mg/L.
- Mean total phosphorous ranged from 0.07 mg/L to 0.88 mg/L across all bores, with all above the ANZECC guideline value of 0.065 mg/L.

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

- Arsenic was within the 99% protection limit across all samples.
- Cadmium was within the 95% protection limit across all samples.
- Chromium was within the 95% protection limit across all samples.
- Copper was within the 80% protection limit for all bores except EMW01, EMW04, EMW07 and EMW10.
- Lead and Nickel were within the 80% protection limit at all bores.
- Zinc was within the 80% protection limit across all bores except EMW01.
- Mercury was within the 95% protection limit at all bores.

3.7 Constraints and Opportunities

Based on the sites 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 initiatives.

Table 7: 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
EMW02	779	6.16	1.47	0.03	0.05	0.01	0.40	0.01
EMW03	2116	6.77	1.68	0.04	0.02	0.01	0.69	0.11
EMW04	658	6.64	1.15	0.02	0.05	0.01	0.75	0.01
EMW05	190	5.70	0.77	0.05	0.26	0.01	0.13	0.01
EMW06	1866	7.01	0.55	0.03	0.01	0.01	0.07	0.01
EMW07	698	5.87	21.08	0.11	16.28	0.01	0.29	0.01
EMW08	2260	5.53	1.25	0.05	0.39	0.01	0.25	0.01
EMW09	4180	6.42	1.25	1.01	0.03	0.01	0.09	0.01
EMW10	4293	5.98	0.65	0.12	0.03	0.01	0.88	0.06

4. Design Criteria & Objectives

Key design principles and criteria for the site are shown in Table 8 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 site to remain within the identified constraints and opportunities of the existing environment.

Table 8: 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) • Establishment of a secure and reliable stormwater capture, storage and reuse scheme together with 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 within road reserves and Park & Recreation Reserves 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 site 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 on site 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 on the site.

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 site 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 indicates that the superficial aquifer is fully allocated within this sub area. The deeper Leederville aquifer is also fully allocated.

An existing monthly water balance was established for the site and used to provided estimates of annual flows and water volume movements across the site at key locations, to identify opportunities and volumes available for the sustainable harvesting of stormwater for future POS irrigation use.

Modelling results are presented in Appendix H. 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 presently on average 172,000 kL/yr of water is lost from the site due to evaporation and other infiltration losses. These loses primarily occur at the existing open water storages on site, including approximately 78,000 kL/yr at the Clay Basin alone. These losses equate to approximately 56 % of the total water generated from the catchments contributing flow within the site.

Post development it is intended to implement a stormwater storage and recovery scheme to provide for long term POS irrigation requirements. This scheme would include below

ground storage of stormwater within the residential development area. The stormwater storage and recovery scheme will utilise treated water from stormwater biofiltration areas to recharge an underground storage for dedicated irrigation use. This system will be located above the regional groundwater table as a separate closed system and is not considered a Manager Aquifer Recharge scheme.

Modelling indicates stormwater harvesting to be achievable while maintaining environmental flows to the surrounding environment. This is achieved due to the existing losses being relatively large relative to future long term irrigation demands, estimated to be in the order of 38,000 kL/yr.

Water balance modelling of the post development system is detailed in Section 6.5 and Appendix H. This considers 15,000 kL/yr of stormwater re-use for POS irrigation, however considerably larger volumes are available by reducing outflows to the Swan River. Detailed engineering investigation and design of the stormwater storage and re-use scheme infrastructure will be undertaken prior to the development of areas draining to the river.

As part of a "security through diversity" approach to POS water supply options, the proponent is also continuing to identify potential groundwater licence transfer opportunities and has commenced contacting existing license holders. Upon handover of POS areas any groundwater licences will be handed over to the City of Swan.

With respect to construction water requirements, discussions with DWER's Swan Avon region have indicated temporary licences are still issued in this groundwater sub area, and a licence application has been submitted to DWER for this purpose.

Landscape masterplanning for the site prepared by UDLA 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 these areas 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 (DoW, 2007).

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, 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 proposed stormwater management system changes are shown in Figure 9, with the aim of providing a reliable POS water supply scheme for the site as well as providing stormwater quality and quality management, and staged land use transition. In broad terms the 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 to 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).
- The proposed stormwater storage and recovery scheme will utilise treated stormwater from frequently occurring events and subsoil drainage to recharge the underground storage for use during the summer irrigation period. Note it is proposed this system will be located above the regional groundwater table as a separate closed system and is therefore not considered a Manager Aquifer Recharge scheme.
- For the existing storage area adjacent to the Threatened Ecological Community (TEC) within the site, the principle of maintaining the area of inundation and water levels for various AEP events similar to 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 will be compensated and ultimately redirected to the upper reaches of the Blackadder Creek tributary as a living stream to assist in maintaining the overall existing hydrological water balance of the area.

Staging of stormwater works will be required 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. Three reports addressing the initial changes to the sites existing stormwater management system have already been completed by Hyd2o and submitted to agencies:

- Midland Brick, Middle Swan Brickworks Kiln 10 Hardstand Expansion Development Application Stormwater Management (Hyd2o, 2019a & 2020b)
- Proposed Subdivision – Cranwood Crescent, Viveash Stormwater Management, (Hyd2o, 2019b)
- Hyd2o (2020c) Midland Brick, Middle Swan Local Water Management Strategy Bridging Document, April 2020.

This LWMS is consistent with these reports. With respect to the Kiln 10 hardstand expansion, the LWMS has assumed changes to the size and operation of the Clay Basin have been undertaken in accordance with Hyd2o (2020b) recommendations.

This LWMS also considers the capacity of the downstream system of Muriel St, estimated in McDowell Affleck to be 1.057 m^3/s for the 900 mm diameter culvert at pipe full flow.

6.1 Stormwater Event Modelling

Post development stormwater modelling for the site was performed using XP-Storm.

Post development catchment areas and runoff rates are detailed in Appendix J. 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 is shown in Figure 10, showing catchment areas, flows paths, and key infrastructure details based on modelling outcomes using XP-Storm for various AEP events. Table 9 summarises the stormwater management sizing details for individual areas, with more detailed modelling results provided in Appendix K.

Note that the extent of inundation of POS areas shown in Figure 10 for various flood management events are shown to 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.

Summarising the results for individual catchments :

- Catchment A represents the largest overall catchment area of the site. This area will drain to a biofiltration swale within the POS adjacent to the foreshore reserve, Treated water will then be infiltrated for irrigation re-use. The estimated size of the biofilter area for this catchment is 2868 m^2 at 0.3m depth (860 m^3). Larger events will discharge to the Swan River via existing outlets and a further 0.2m depth will be required in the biofilter area to accommodate the safe conveyance of events up to the 1% AEP. This biofilter will also receive subsoil flows from catchments A, B and G.
- Catchment B 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 313 m^2, volume 94 m^3) within the road reserve, with larger events flowing into the vegetated/wetland area and the Blackadder Creek Tributary.
- Catchment C includes minor sections of roads which will drain externally to the site due to interfacing with existing development and infrastructure levels.
- Catchment D is the second largest catchment and flows to a biofilter and flood storage area located in POS adjacent to Jack Williamson Oval. The design of this area has been undertaken based on ensuring the 1% AEP discharge from this area is similar to the existing flow from southern area of the site which current occur as a brickworks. It is estimated the biofiltation area will be 1182 m^2 in size at 0.3m depth to provide 355 m^2 of storage, while the1% AEP area will be 1937 m^2 (1584 m^3 volume). The total POS size in this location is 3122 m^2.
- Catchment E is a small catchment adjacent to Bernley Drive. Flow from this catchment will be treated in a 3m wide biofilter (167 m^2 area, 50 m^3 volume) located within the road reserve. Larger events will flow to exist pipework in Bernley Drive, which has been modelled and found to have sufficient capacity to receive flows due to differences in the times of concentration of the respective catchments. This then drains to an existing biofilter within the Swan River foreshore area.
- Catchment F is small catchment located on the northern side of Jack Williamson oval. A biofilter (2m nominal width) within the road reserve is proposed in this area to provide 83 m^3 of storage volume (277 m^2 area required), with larger events flowing to Blackadder Creek Tributary.
- For catchment G a biofilter is proposed to be located within the road reserve with a nominal 1.2m width to provide 108 m^3 volume of storage over a 360 m^2 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 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.
- For the Clay Basin, Hyd2o (2019a & 2020b) provides details of the re-design of this storage to accommodate the Kiln 10 hardstand expansion. As previously discussed this flow will be redirected to the upper reaches of the Blackadder Creek tributary as a living stream to assist in maintaining the overall existing hydrological water balance of the area, and remove any industrial area discharge in to the Swan River.

Table 9: Stormwater Management Sizing

Catchment	A	B	C	D	E	F	G
Lots (ha)	16.09	1.42	1.47	8.29	0.84	0.61	0.84
POS/Foreshore/TEC (ha)	4.32	1.34	0.13	0.48	0.00	0.00	2.46
Road Reserve (ha)	8.19	0.89	0.31	3.38	0.48	0.79	1.03
Total Area (ha)	28.60	3.65	1.91	12.15	1.32	1.40	4.33
Equiv Imp Area (15mm event) ha	5.74	0.63	0.22	2.36	0.34	0.55	0.72
Equiv Imp Area (20% &1% AEP) ha	14.96	1.68	0.94	6.60	0.77	0.93	1.80
Storage Characteristics							
Side Slopes (v:h) Biofilter Flood Storage	0 -	0 -	- Natural	- -	0 6	0 -	0 -	0 -	- Natural
System Component and Design Approach	Biofilter in POS to stormwater reuse scheme & Swan River	Biofilter in road reserve with outlet to wetland	Wetland	Connect to existing subdivision stormwater system	Biofilter and flood storage in POS to Blackadder Creek Tributary	Biofilter in road reserve to existing stormwater system	Biofilter in road reserve to Blackadder Creek Tributary	Biofilter in road reserve to existing storage next to TEC	Existing storage next to TEC Area
Water Quality : 15 mm Event (63% AEP results shown for Natural/Wetland Storage Areas)									
Invert (mAHD)	7.5	9.5	8.75	To existing system	8.0	5.3	9.2	10.4	9.12
Flood Rise (m)	0.3	0.3	0.16		0.3	0.3	0.3	0.3	0.58
TWL (mAHD)	7.8	9.8	8.91		8.3	5.6	9.5	10.7	9.7
Volume (m^3)	860	94	260		355	50	83	108	95
TWL Area (m^2)	2868	313	1900		1182	167	277	360	670
Flood Storage: 20% AEP Event									
Invert (mAHD)	Outflow to Swan River	To wetland	8.75	To existing system	8.0	To existing system	To Blackadder Creek Tributary	To existing storage next to TEC Area	9.12
Flood Rise (m)			0.17		0.63				0.70
TWL (mAHD)			8.92		8.63				9.82
Volume (m^3)			280		794				210
TWL Area (m^2)			1930		1476				1320
Flood Storage: 1% AEP Event									
Flood Rise (m)	Outflow to Swan River	To wetland	0.19	To existing system	1.09	To existing system	To Blackadder Creek Tributary	To existing storage next to TEC Area	1.06
TWL (mAHD)			8.94		9.09				10.18
Volume (m^3)			325		1585				1050
TWL Area (m^2)			2000		1937				4110

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 locations, buffers, lot product, and subdivision layout.
  Maintenance: regular stormwater system maintenance including POS biofilter areas.
  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 improvements, POS "buffer" around TEC, native plantings.

Measures adopted represent known best management practice as detailed in the Stormwater Management Manual for Western Australia (DoW, 2007). Table 10 details a summary from the Stormwater Management Manual for Western Australia (DoW, 2007) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria.

While DoW (2007) 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).

Storm volumes for ecological protection based on water quality treatment of the 15mm event are provided in Table 9 and Figure 10. The total area required within POS, road reserves and adjacent to wetland buffers is approximately 0.52 ha. This provides approximately 1550 m^3 of storage at 0.3m depth.

Figure 11 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 10: 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 DoW (2007)

6.3 Water Balance Modelling

Based on the proposed post development stormwater management system, the site's 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 across the site at key locations.

Modelling results are summarised in Figure 12 compared to the existing site water balance, with more detailed extracts from the model contained in Appendix H.

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 be undertaken as planning for the site progresses to assess the opportunities this provides to enhance the Blackadder Creek tributary.

6.4 TEC Water Level Management Strategy

As previously 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 to existing levels to protect the TEC.

Areas of inundation post development and inundation heights relative to existing heights are shown in Figure 13. 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. 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 refinement of the stormwater design along the Blackadder Creek Tributary area will be undertaken if required following an Ecological Water Requirement assessment of the area.

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

7. Groundwater Management Strategy

7.1 Post Development Groundwater Levels

Development levels within the site are generally 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 existing buildings, 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 for the site prepared by TABEC are detailed in Appendix L on the basis of the following considerations:

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

These earthwork levels have informed the establishment of catchment boundaries for stormwater modelling in Section 6.

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 which discharge to biofiltration areas 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 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 400-800m^2, and a 0.15m clearance for lots <400 m^2. This criteria will be used as the initial basis for establishing fill requirements for the site, 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 site has been filled to confirm that permeability rates meet those used in detailed design. The 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 Identification and Investigation of Acid Sulphate Soils (DoE, 2004).

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 site.

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 will be provided during the development of the relevant UWMP's covering those specific areas. This will include the refinement of stormwater 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 is currently continuing within the site. Monthly groundwater levels and quarterly water quality are being recorded in addition to grab samples from the Swan River and sampling of existing stormwater quality within the site.

This monitoring is ongoing and scheduled for completion following winter 2020.

This information together with other previous historical monitoring data from the site will then be will analysed and used to refine predevelopment water quality estimates and water quality targets for the site.

9.2 Post Development

Department of Water (2012) indicates a minimum of 3 years post development monitoring is required, and defines post development as "from completion of first subdivision to five years after 80 per cent of the development (by land area) has been completed".

The post development monitoring program is summarised in Table 11.

Post development groundwater monitoring is proposed in 8 groundwater monitoring bores as shown in Figure 14, to provide suitable coverage of the site. Locations have been selected based on maintaining existing 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 (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, aluminium, manganese, arsenic and lead).

Surface water samples will be taken in the Swan River upstream and downstream of the site as well as within the Blackadder Creek Tributary at Bassett Rd, Eveline Rd and Muriel St. 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 each 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.

The monitoring schedule will be undertaken for a three year period consistent with usual DWER requirements. 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 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 is presented in Table 12, which will be refined following the completion of predevelopment monitoring if required.

Implementation of the post development monitoring program is the responsibility of the developer.

Where staging aspects required specific additional monitoring to be conducted, this will be appropriately detailed at UWMP stage.

Table 11: Post Development Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater level	Water level (m AHD)	6 bores within site area and 2 DWER bores	Electrical depth probe or similar	Monthly (12 occasions annually)
Groundwater quality	Physical, nutrients and heavy metals	6 bores within site area	Pumped bore sample	Quarterly (4 occasions annually)
Surface water quantity	Flow	3 locations Blackadder Creek Tributary	Visual estimate	Quarterly (4 occasions annually)
Surface water quality	Physical, nutrients and heavy metals	3 locations Blackadder Creek Tributary, 2 locations Swan River	Collected grab samples	Maximum four occasions during each annual winter monitoring period
Stormwater quantity (Local)	Flow	All storages	Visual estimate	Quarterly (4 occasions annually)
Stormwater quality (Local)	Physical, nutrients and heavy metals	All storages	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 12: Contingency Planning

Type	Criteria for Assessment	Frequency	Process & Possible Actions
Water Quality	Surface and groundwater quality significantly worse than: 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]	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. 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 13 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 site and inform the planning and design approaches for subsequent stages of development.

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

Monitoring outcomes will also be used to inform continual design and planning improvements as the development proceeds, particularly in relation to maintaining and improving the hydrology of the Blackadder Creek Tributary.

Table 13: Implementation, Roles and Responsibilities

Implementation Action	Responsibility		
	Developer	DWER / DBCA	City of Swan
Review and approval of LWMS		✓	✓
Completion of predevelopment monitoring/reporting and target establishment	✓		
Detailed engineering Investigation and design of stormwater storage and re-use scheme	✓		
Environmental Water Requirements study for Blackadder Creek Tributary (if required)	✓		
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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FIGURES

Date: 7/4/2020 Job No. H19054

Site

Local Structure Plan Area

0 125 250 375 500 Meters

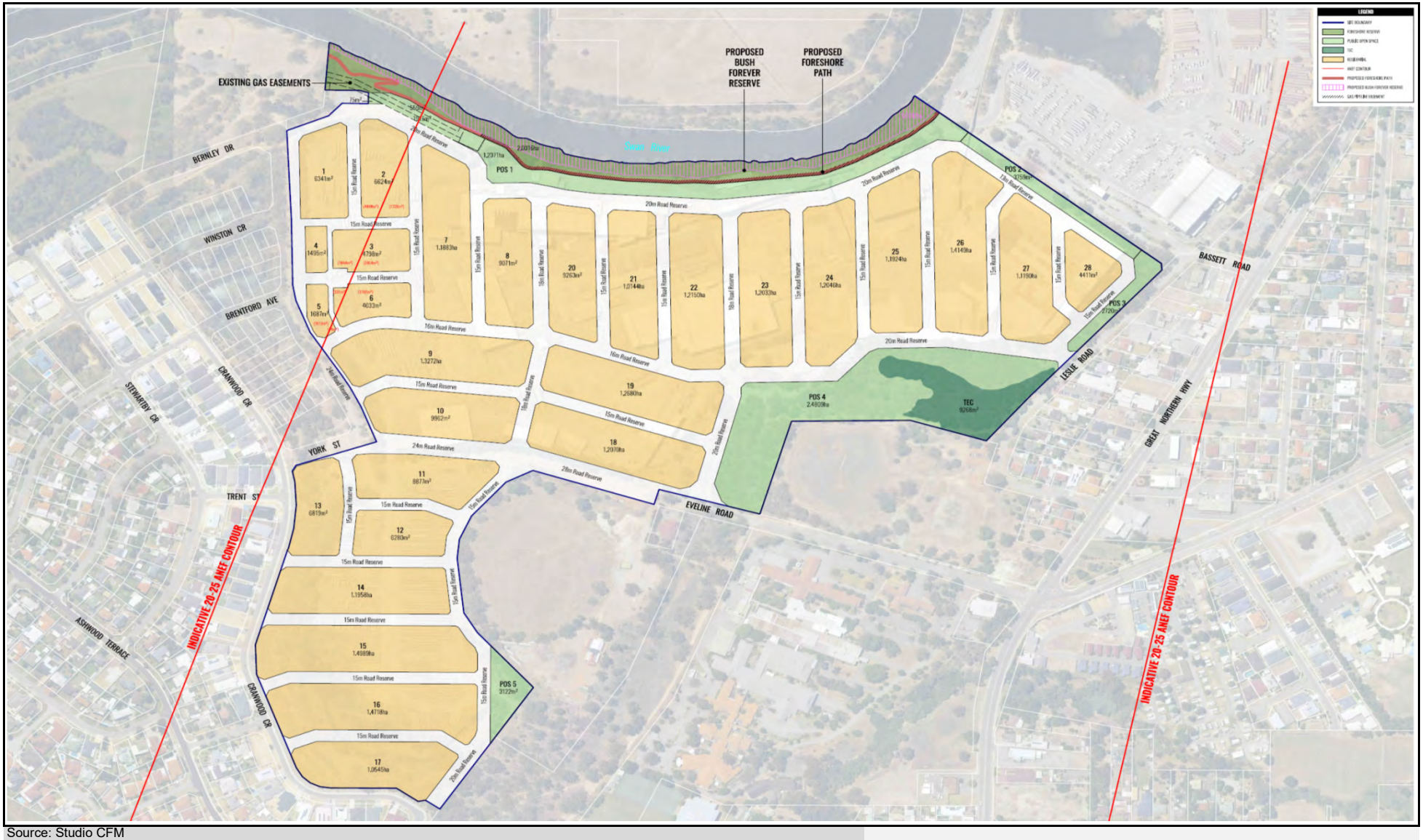
hyd2o

Midland Brick Local Water Management Strategy

Location Plan

Figure 1

Date : 4/4/2020 Job No: H19054



Source: Studio CFM

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Midland Brick Local Water Management Strategy

Local Structure Plan

Figure 2

Date: 7/4/20 Job No. H19054

LSP Area

Site

Topography (mAHD)

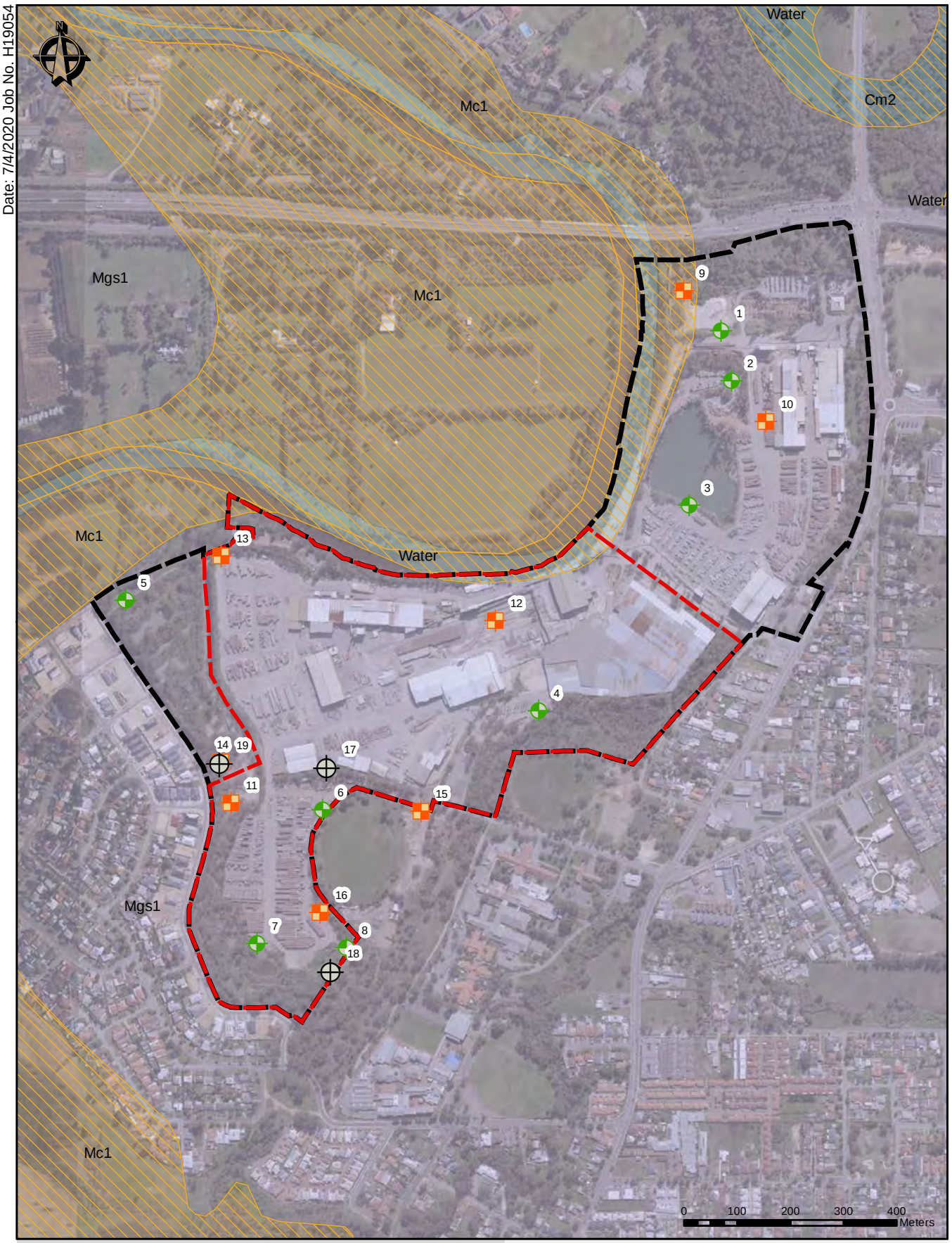
hyd2o

Midland BrickLocal Water Management Strategy

Site Conditions Plan

Figure 3

Date: 7/4/2020 Job No. H19054



Site
LSP Area
Bund/Slope Excavation
Cone Penetration Test
Test Pit

Mcs- Clayey Silt
Mgs1- Pebbly Silt
Water
High to moderate risk of ASS

hyd2o

Midland Brick Local Water Management Strategy

Environmental Geology

Figure 4

Date: 7/4/2020 Job No. H19054

Site

LSP Area

Conservation

Multiple Use

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

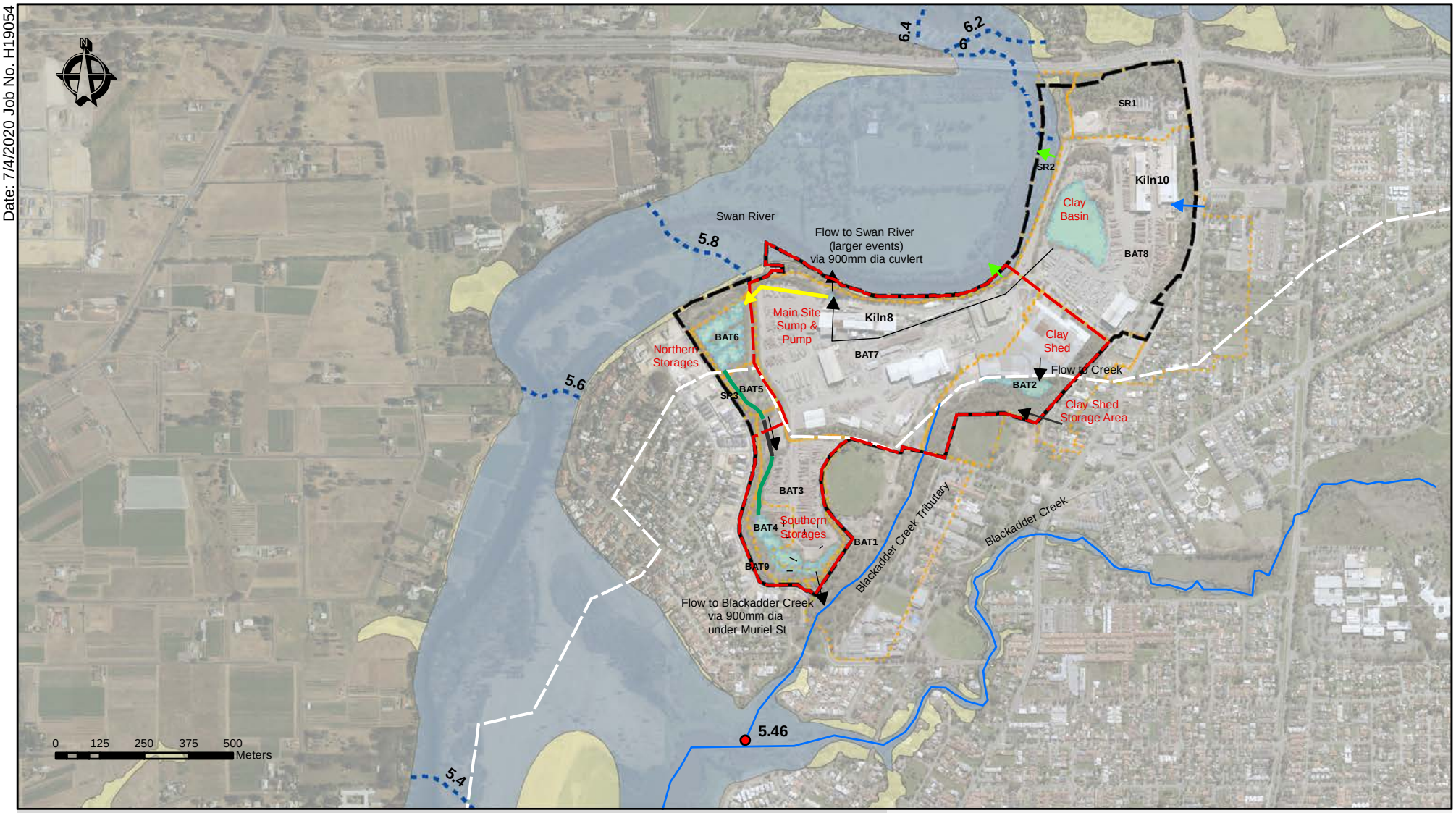
hyd2o

Midland Brick Local Water Management Strategy

Environmental Plan

Figure 5

Date: 7/4/2020 Job No. H19054



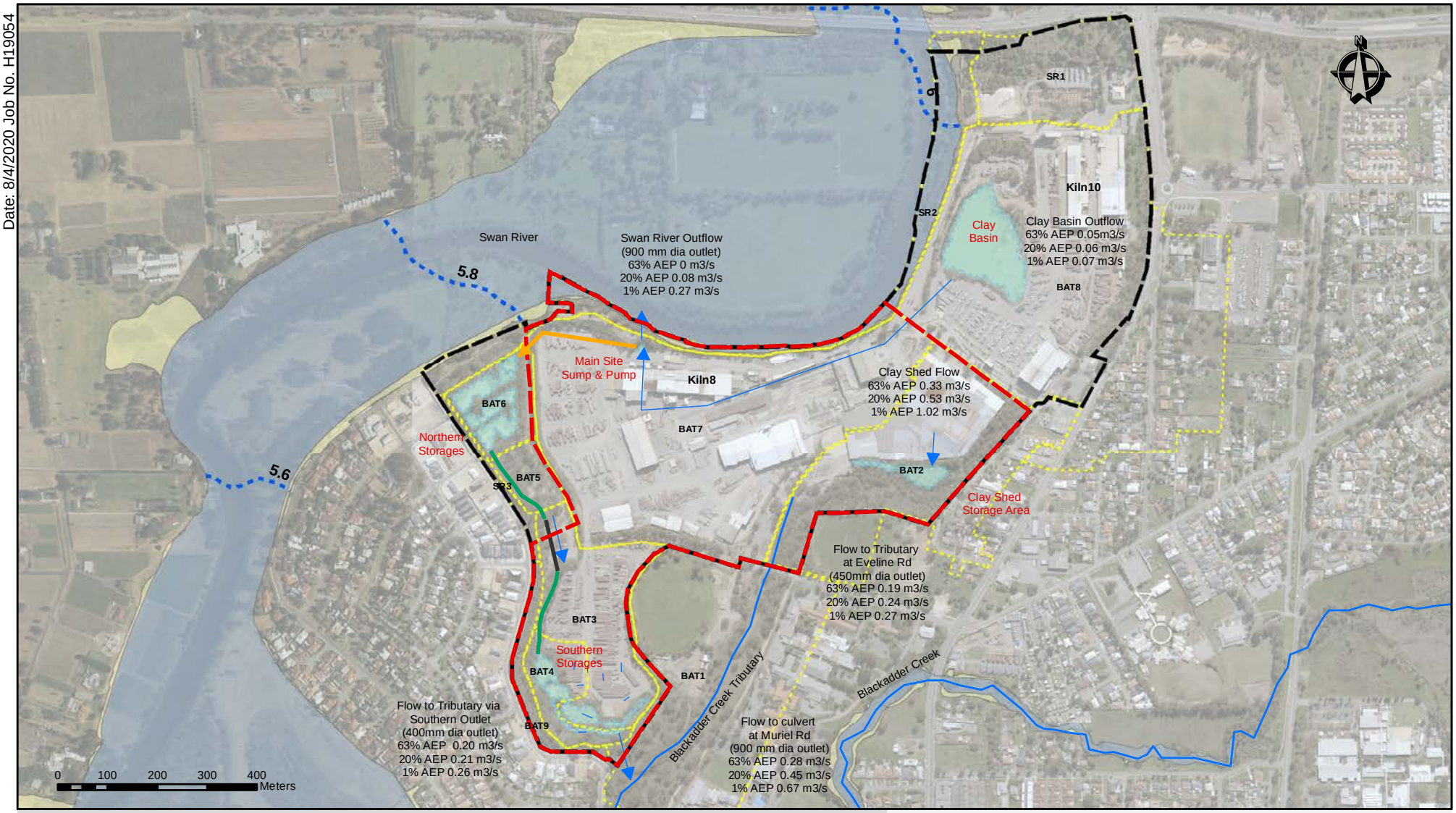
hyd2o

Midland Brick Local Water Management Strategy

Surface Water Plan

Figure 6

Date: 8/4/2020 Job No. H19054



Site
LSP Area
Subcatchment Boundaries
Existing Storages

Blackadder Creek & Tributary
Open Drain
Pipe Drain
Stormwater Flow Path (Gravity)
Stormwater Flow Path (Pumped)

Swan River 1% AEP Flood Contours
Floodway
Flood Fringe

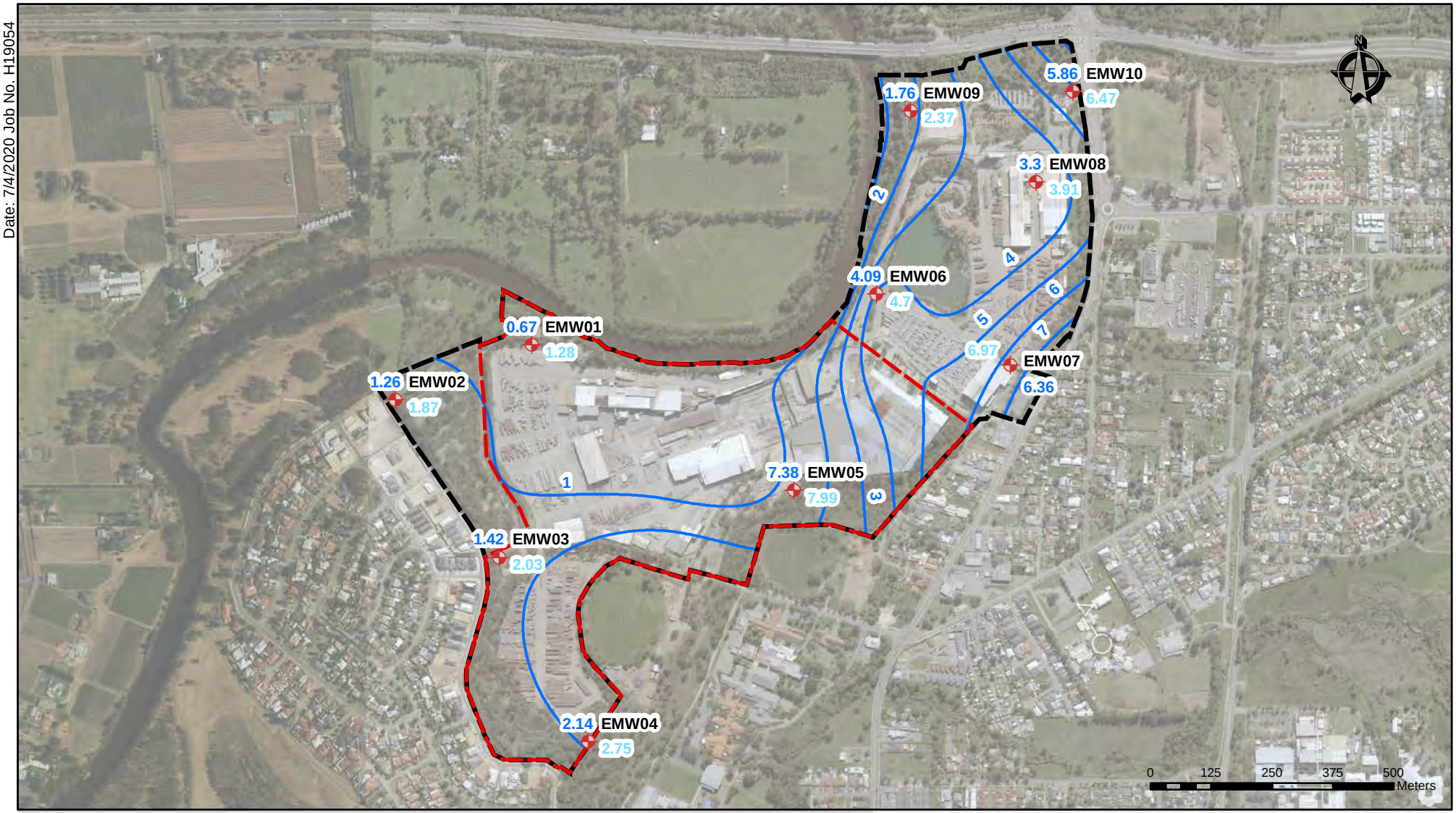
hyd2o

Midland Brick Local Water Management Strategy

Stormwater Event Modelling of Existing System

Figure 7

Date: 7/4/2020 Job No. H19054



Site

LSP Area

Groundwater Bores

AAMGL mAHD

MGL mAHD

AAMGL Contour (mAHD)

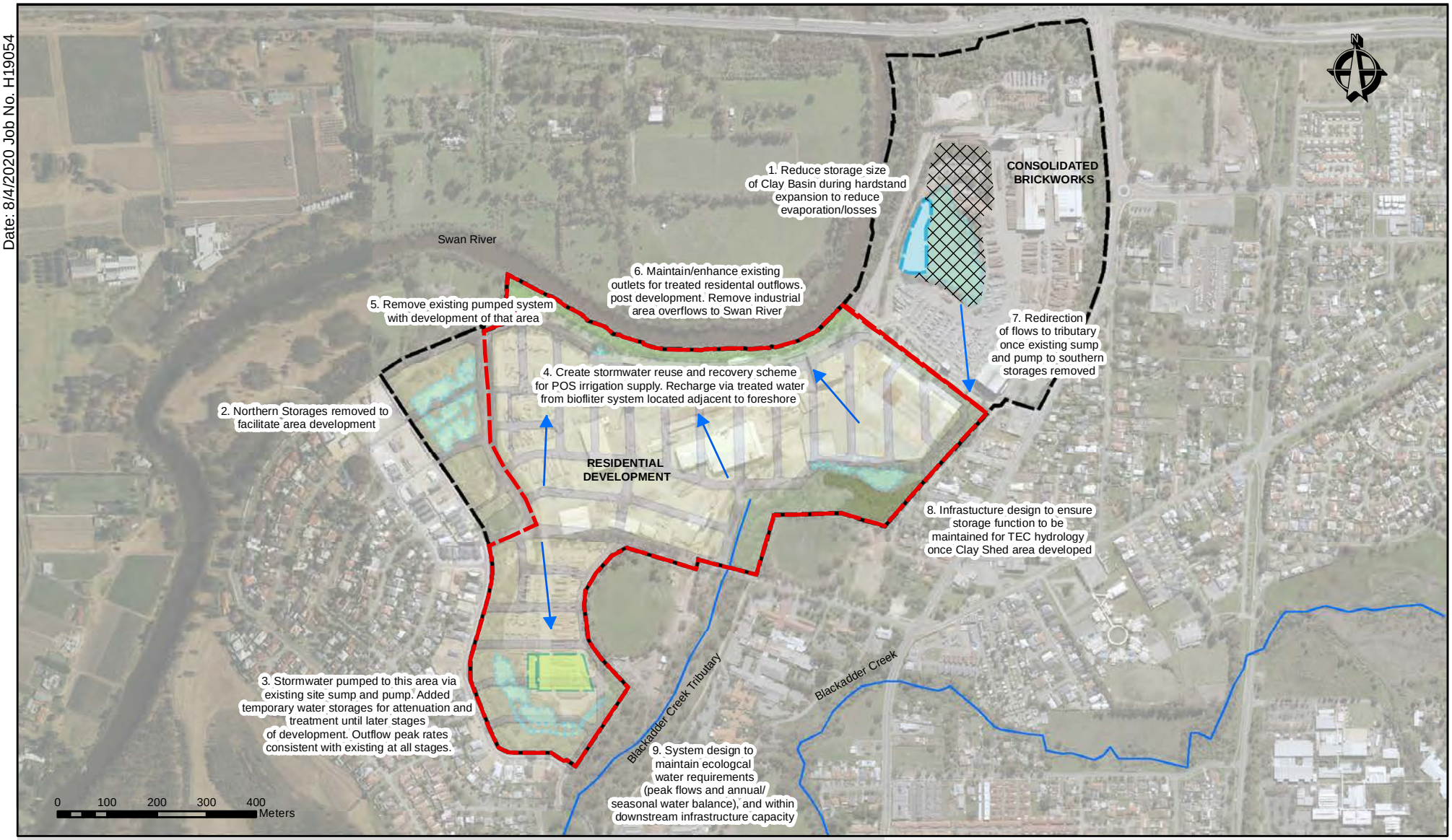
hyd2o

Midland Brick Local Water Management Strategy

Groundwater Plan

Figure 8

Date: 8/4/2020 Job No. H19054



Site
LSP Area
Hardstand Expansion
Existing Storages
Revised Clay Basin/Swale
Temporary Additional Southern Storage
Post Development Flow Paths
Blackadder Creek & Tributary

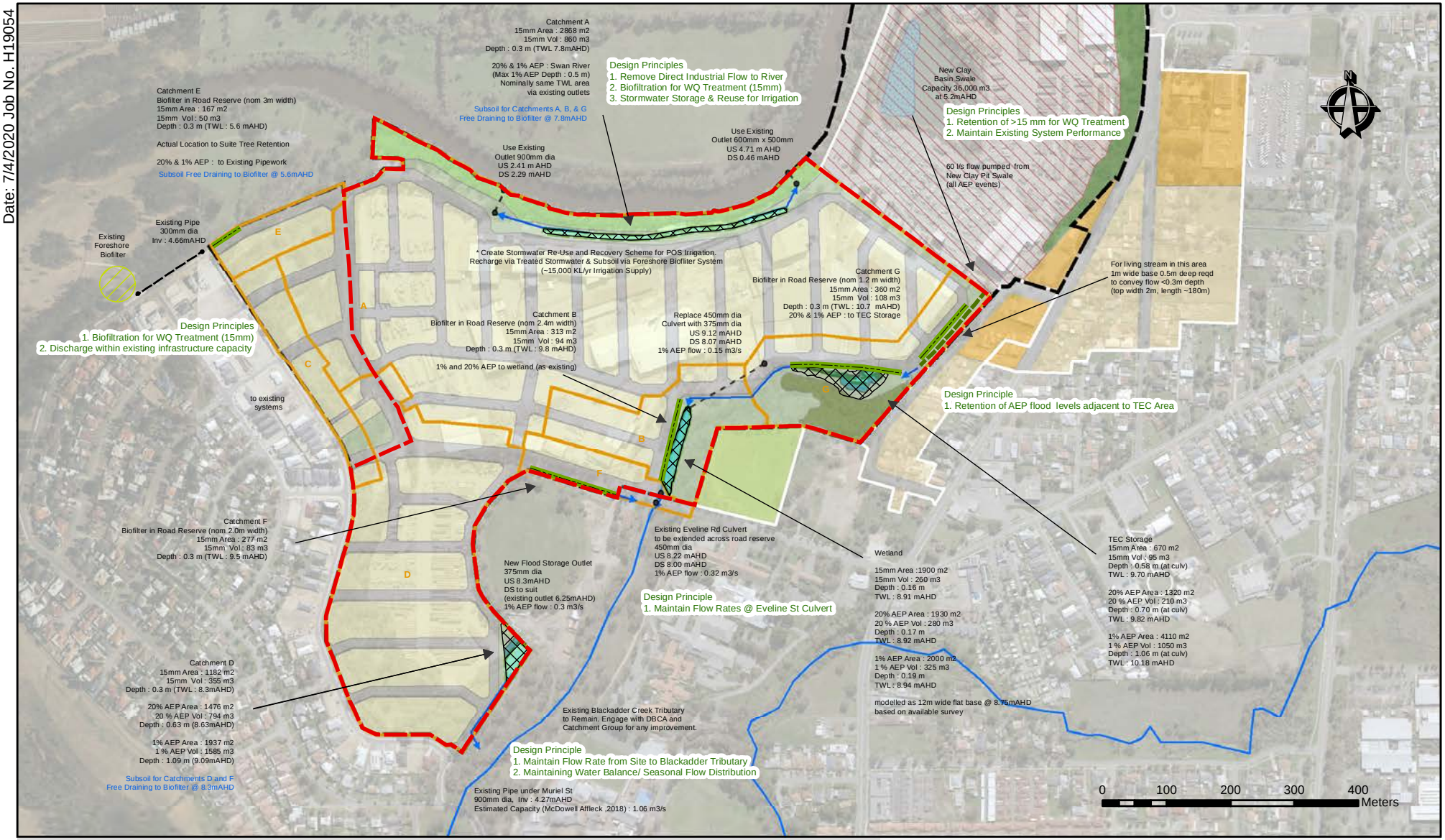
hyd2o

Midland Brick Local Water Management Strategy

Stormwater Management Changes Overview

Figure 9

Date: 7/4/2020 Job No. H19054



Site
LSP Area
Blackadder & Tributary
New Pipework
Existing Pipework

Storage 1% AEP
Storage 20% AEP
Storage 63% AEP
Living Stream
Biofilter swales in Road Reserves (15mm)

Post Dev Catchments
Lots
POS
TEC
Foreshore Res
Road

External Catchments
Hardstand
Industrial
POS
Residential
Vegetation

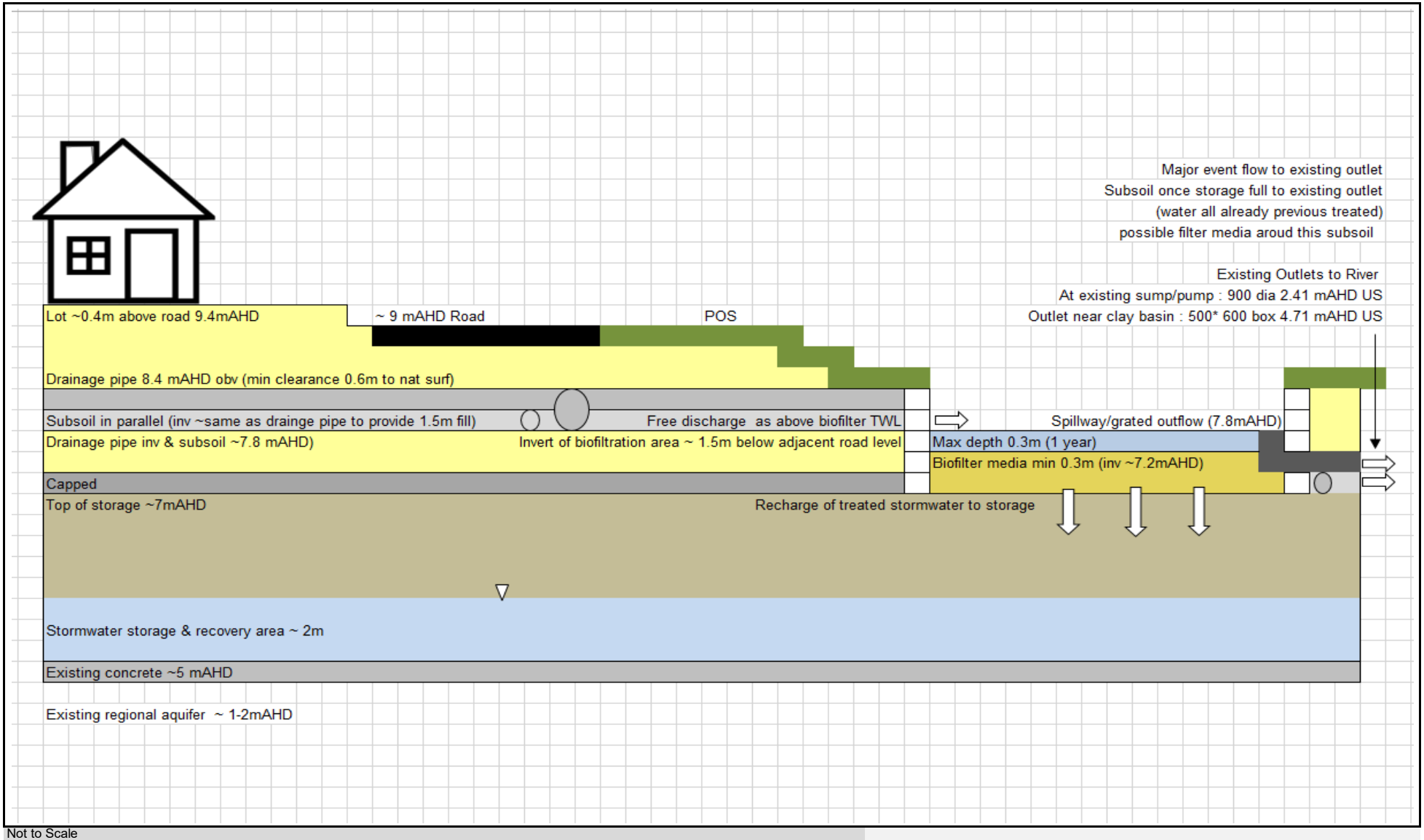
hyd2o

Midland Brick Local Water Management Strategy

Stormwater Management Event Plan

Figure 10

Date : 7/4/2020 Job No: H19054



Not to Scale

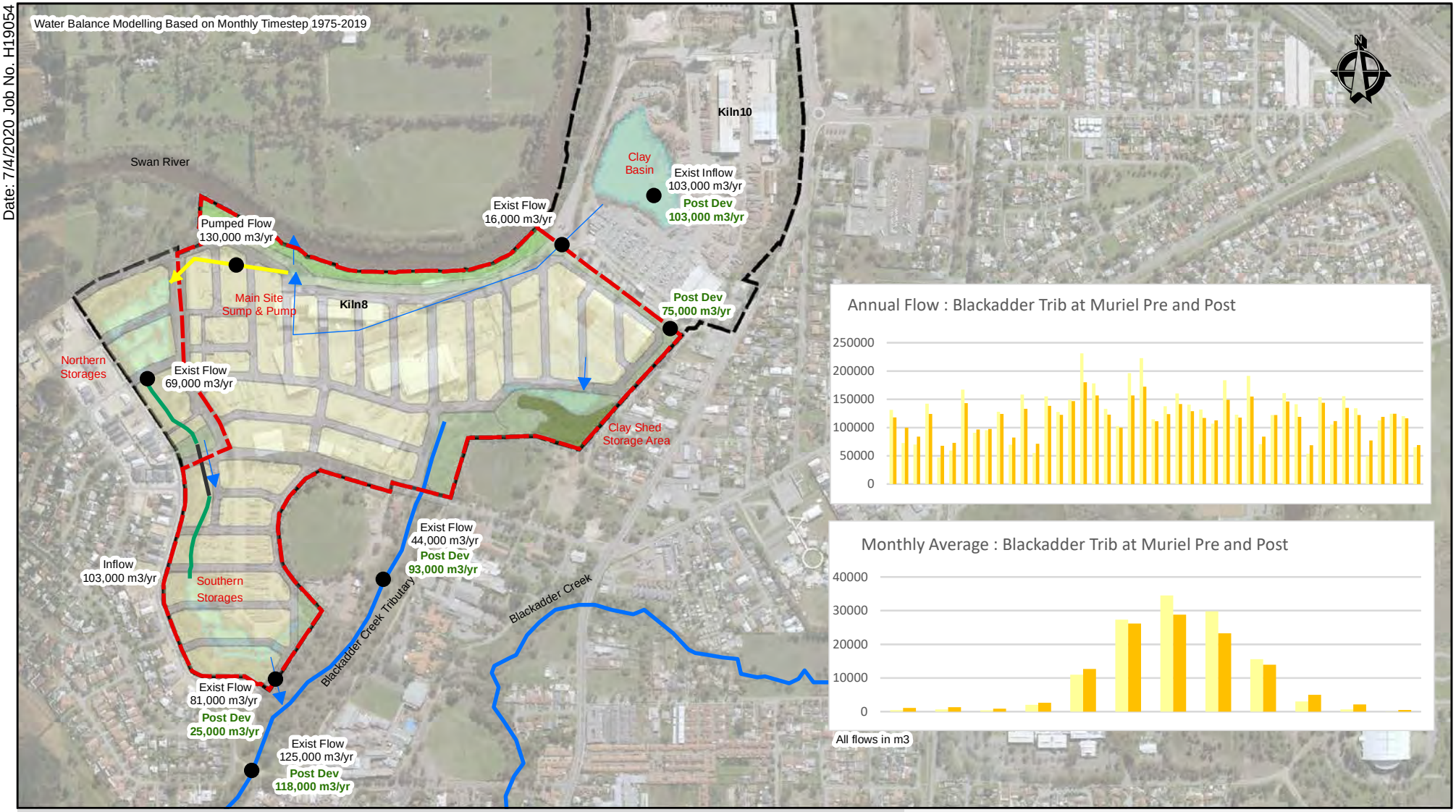
hyd$_2$o

Midland Brick LocalWater Management Strategy

Foreshore Reseve Biofilter Indicative Cross Section

Figure 11

Date: 7/4/2020 Job No. H19054



Site
LSP Area
Subcatchment Boundaries
Existing Storages

Blackadder Creek & Tributary
Open_Drain
Pipe Drain

Existing System Flows
Post Development Flow at Same Locations

Existing Stormwater Flow Path (Gravity)
Existing Stormwater Flow Path (Pumped)

0 80 160 240 320 Meters

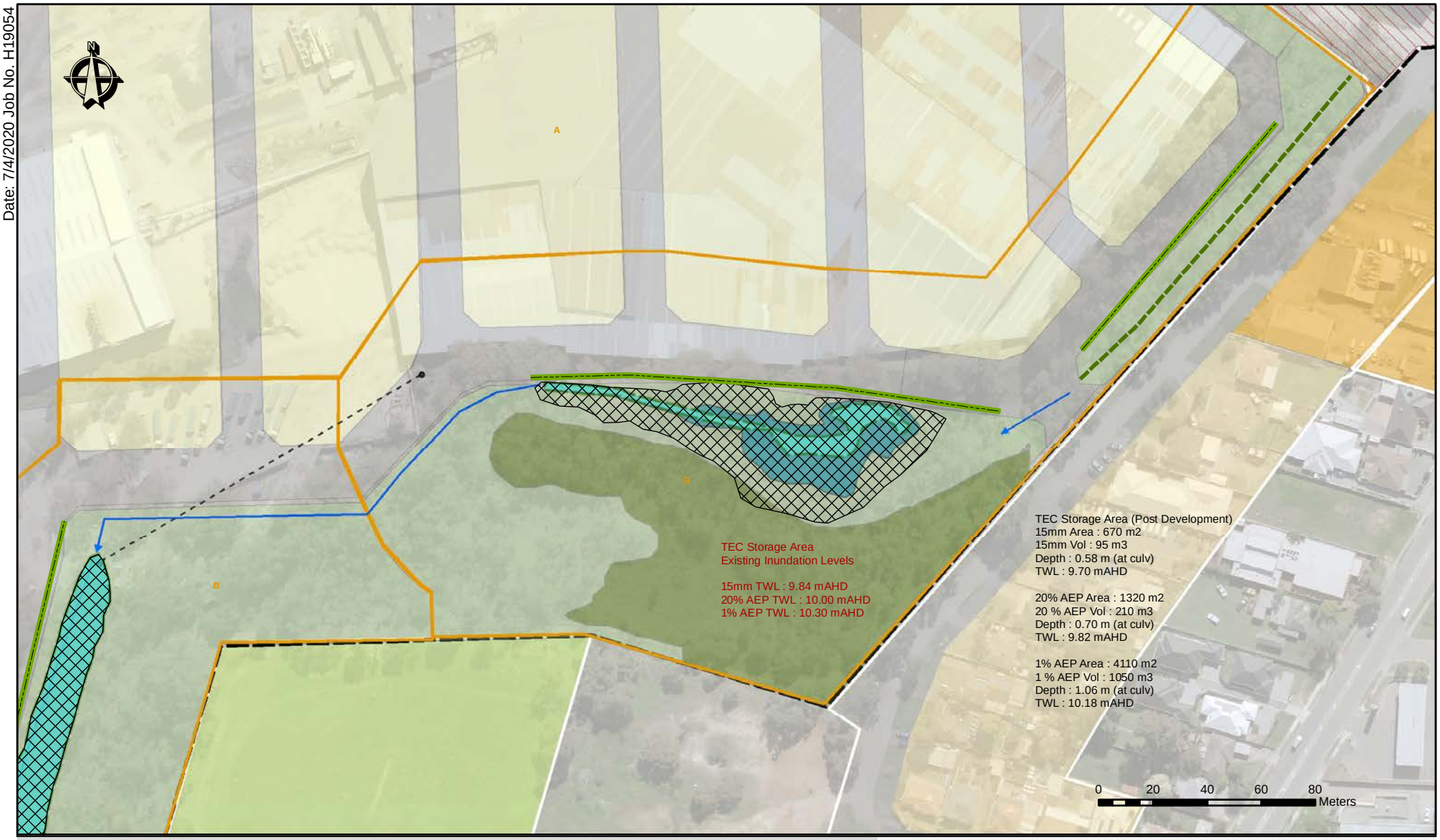
hyd2o

Midland Brick Local Water Management Strategy

Water Balance Modelling Summary

Figure 12

Date: 7/4/2020 Job No. H19054



Site
Blackadder & Tributary
New Pipework
Existing Pipework
Biofilter swales in Road Reserves (15mm)
Storage 1% AEP
Storage 20% AEP
Storage 63% AEP
Living Stream
Post Dev Catchments
Lots
POS
TEC
Road
External Catchments
Hardstand
Industrial
POS
Residential

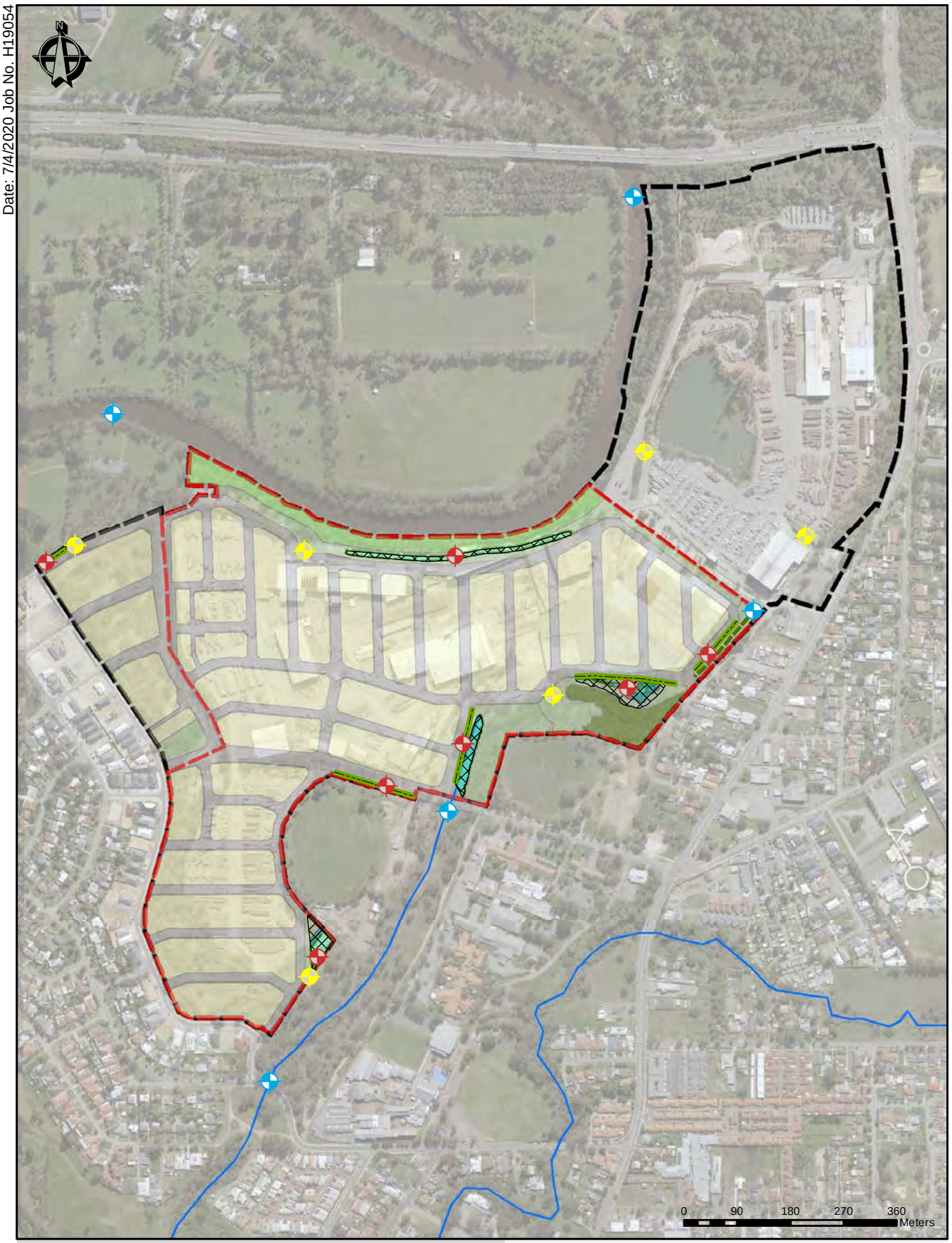
hyd2o

Midland Brick Local Water Management Strategy

Mapped TEC and Stormwater Area of Inundation

Figure 13

Date: 7/4/2020 Job No. H19054



Site

LSP Area

Groundwater Bores

Surface Water Sites

Stormwater Sites

hyd2o

Midland Brick Local Water Management Strategy

Post Development Monitoring

Figure 14

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 H
Design criteria			
Agreed design objective and source of objective		☑	Section 4, Table 8
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 3, Figures 3-8
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 & 7, 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 8, Appendices D-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, Appendix H
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 9, Figures 9 & 10, Appendix J & K
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 9, Figures 9 &10, Appendix J & K
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, 6.2, 6.4, Table 9 & 10, Figures 9, 10,& 13

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, Appendix L
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 14, Table 11 & 12
Implementation			
Developer commitments		☑	Section 10, Table 13
Roles, responsibilities, funding for implementation		☑	Section 10, Table 13
Review		☑	Section 10, Table 13

APPENDIX B
Geotechnical Report

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Project Texas
102 Great Northern Highway, Middle Swan, WA

Prepared for
Linc Property Pty Ltd

Project 96584.01
June 2019

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	96584.01	Document No.	R.001.Rev0
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Report prepared for	Linc Property Pty Ltd		
File name	96584.01.R.001.Rev0.MIDDLE SWAN, 102 Great Northern Highway		

Document status and review

Status	Prepared by	Reviewed by	Date issued
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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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FS 604853

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Douglas Partners
Geotechnics | Environment | Groundwater

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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 repot 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 general 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:
  - **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.
  - **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.

- **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:
    - 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.
    - 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:
  - 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;
  - 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);
  - Treatment of the excavated controlled fill by screening and crushing as described in Section 6.4; and
  - 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.

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

Sampling Methods

Douglas Partners

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

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

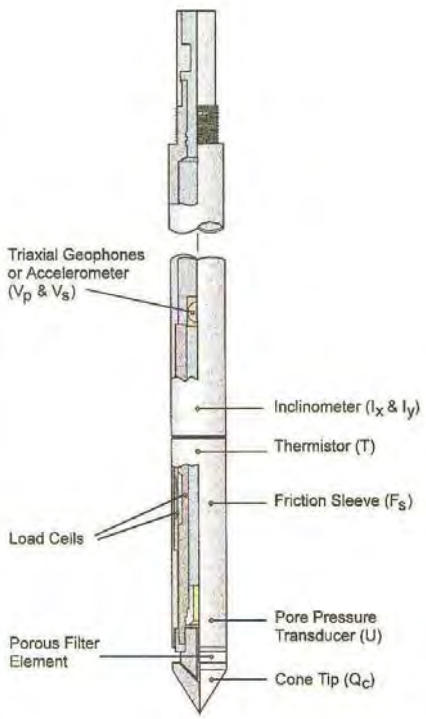


Figure 1: Cone Diagram

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)
Piezocone	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 (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

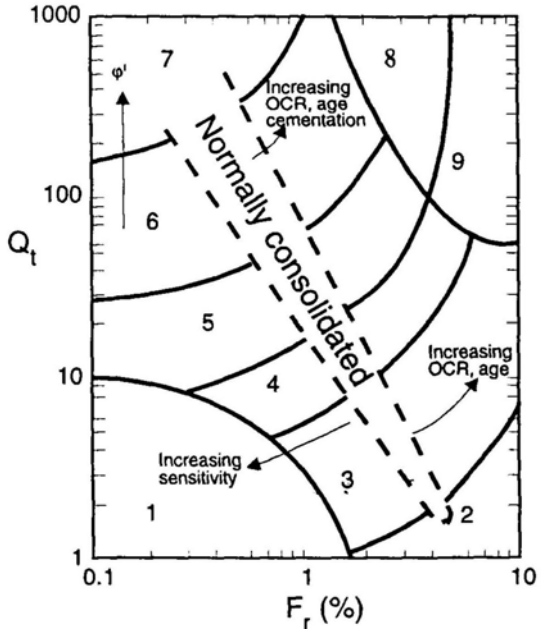


Figure 3: Soil Classification Chart

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.

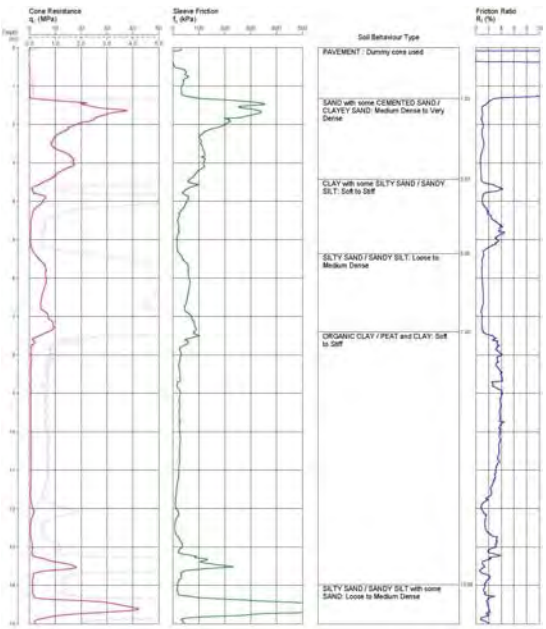


Figure 4: Sample Cone Plot

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

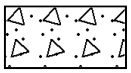
Symbols & Abbreviations

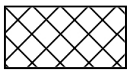
Graphic Symbols for Soil and Rock

General

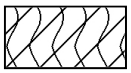

Asphalt

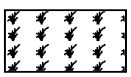

Road base

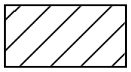

Concrete

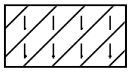

Filling

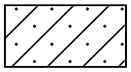
Soils


Topsoil

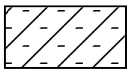

Peat

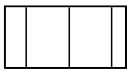

Clay

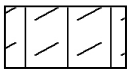

Silty clay

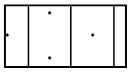

Sandy clay

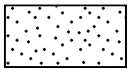

Gravelly clay

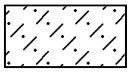

Shaly clay

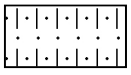

Silt


Clayey silt


Sandy silt

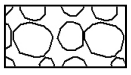

Sand

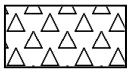

Clayey sand


Silty sand


Gravel

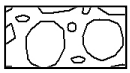

Sandy gravel


Cobbles, boulders

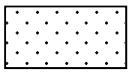

Talus

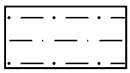
Sedimentary Rocks

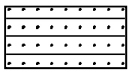

Boulder conglomerate

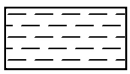

Conglomerate


Conglomeratic sandstone

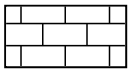

Sandstone


Siltstone

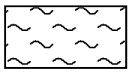

Laminite

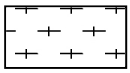

Mudstone, claystone, shale

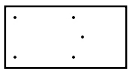

Coal


Limestone

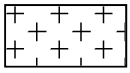
Metamorphic Rocks

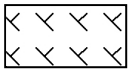

Slate, phyllite, schist

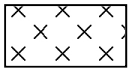

Gneiss

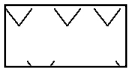

Quartzite

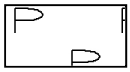
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Test Location	Easting (m)	Northing (m)
1	406463	6473965
2A	406483	6473872
3	406403	6473637
4	406120	6473251
5	405343	6473459
6	405713	6473064
7	405590	6472813
8	405758	6472805
9	406393	6474041
10	406457	6473795
11	405541	6473078
12	406038	6473420
13	405523	6473542
14	405522	6473154
15	405898	6473062
16	405709	6472872
17	405721	6473142
18	405728	6472758
19	405519	6473149

Easting and Northing in MGA Zone 50

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	Linc Property Pty Ltd
OFFICE:	Perth
DATE:	25 June 2019

Location of Tests

Proposed Residential & Industrial Development

102 Great Northern Highway, Middle Swan, WA

PROJECT No:	96584.01
DRAWING No:	1
REVISION:	A

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

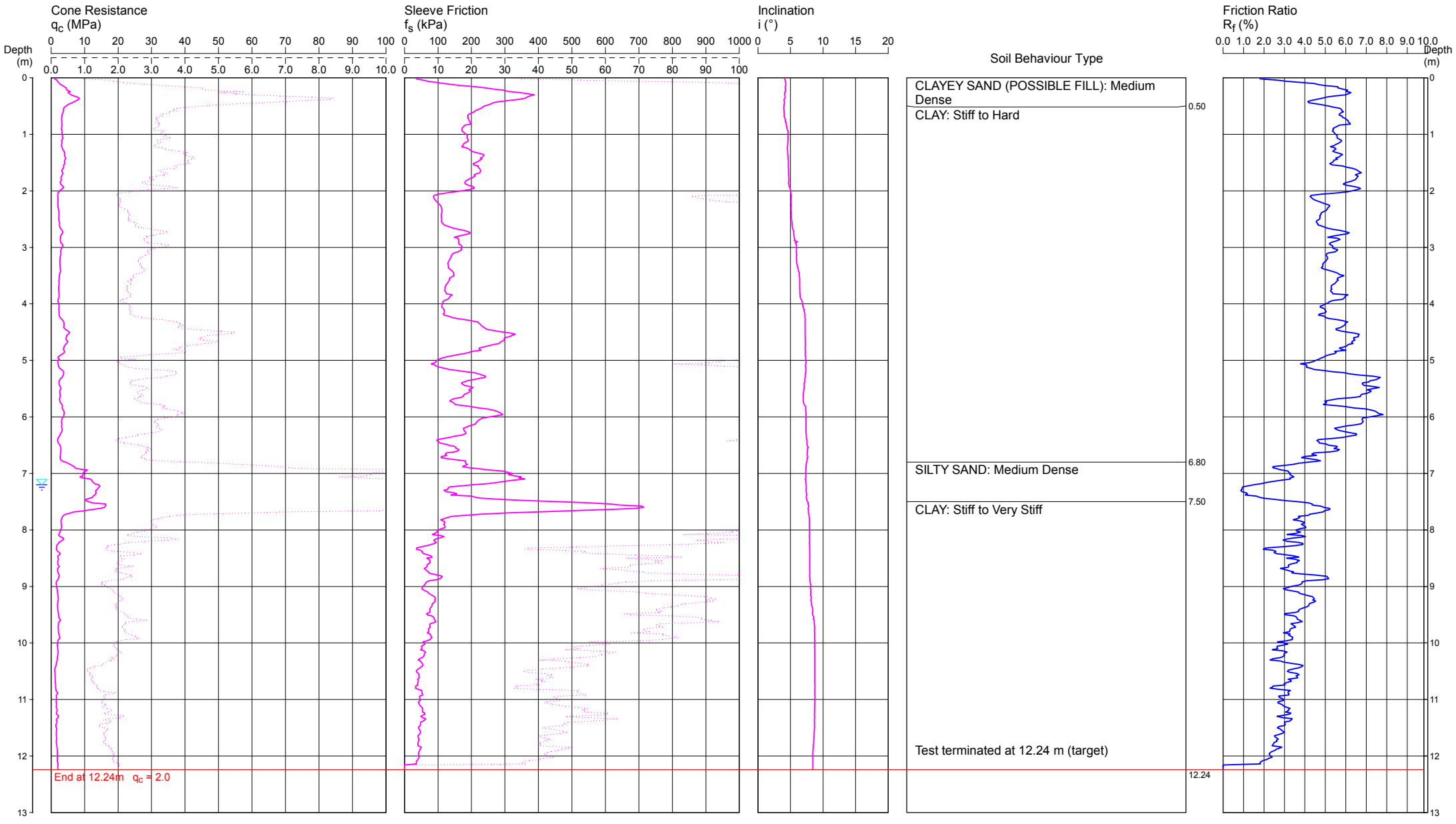
REDUCED LEVEL: 5.9 m AHD

COORDINATES: 406463E 6473965N MGA Zone 50

CPT1

DATE 21/06/2019

PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly availble LiDAR data.

Water depth after test: 7.20m depth (measured)

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

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CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd

PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan

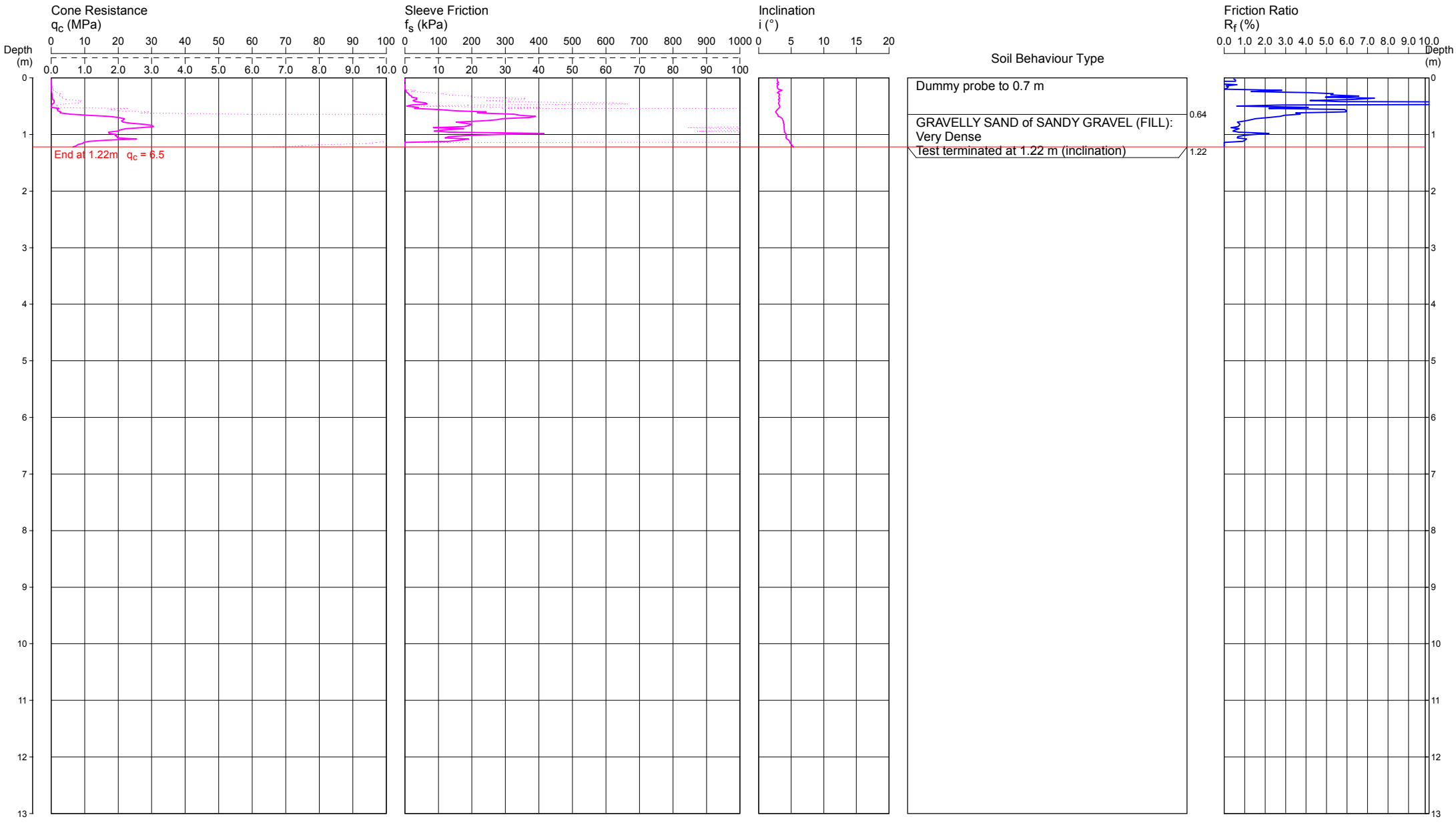
REDUCED LEVEL: 5.5 m AHD

COORDINATES: 406483E 6473872N MGA Zone 50

CPT2A

DATE 21/06/2019

PROJECT No: 96584.01



REMARKS: Surface levels estimated from publicly available LiDAR data and site observations.

File: P:\96584.01 - MIDDLE SWAN, 102 Gt Northern Highway\4.0 Field Work\CPTs\DP\96584.01 - CPT2A.CP5

Cone ID: Probedrill **Type:** EC26

ConePlot Version 5.9.2

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Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd

PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan

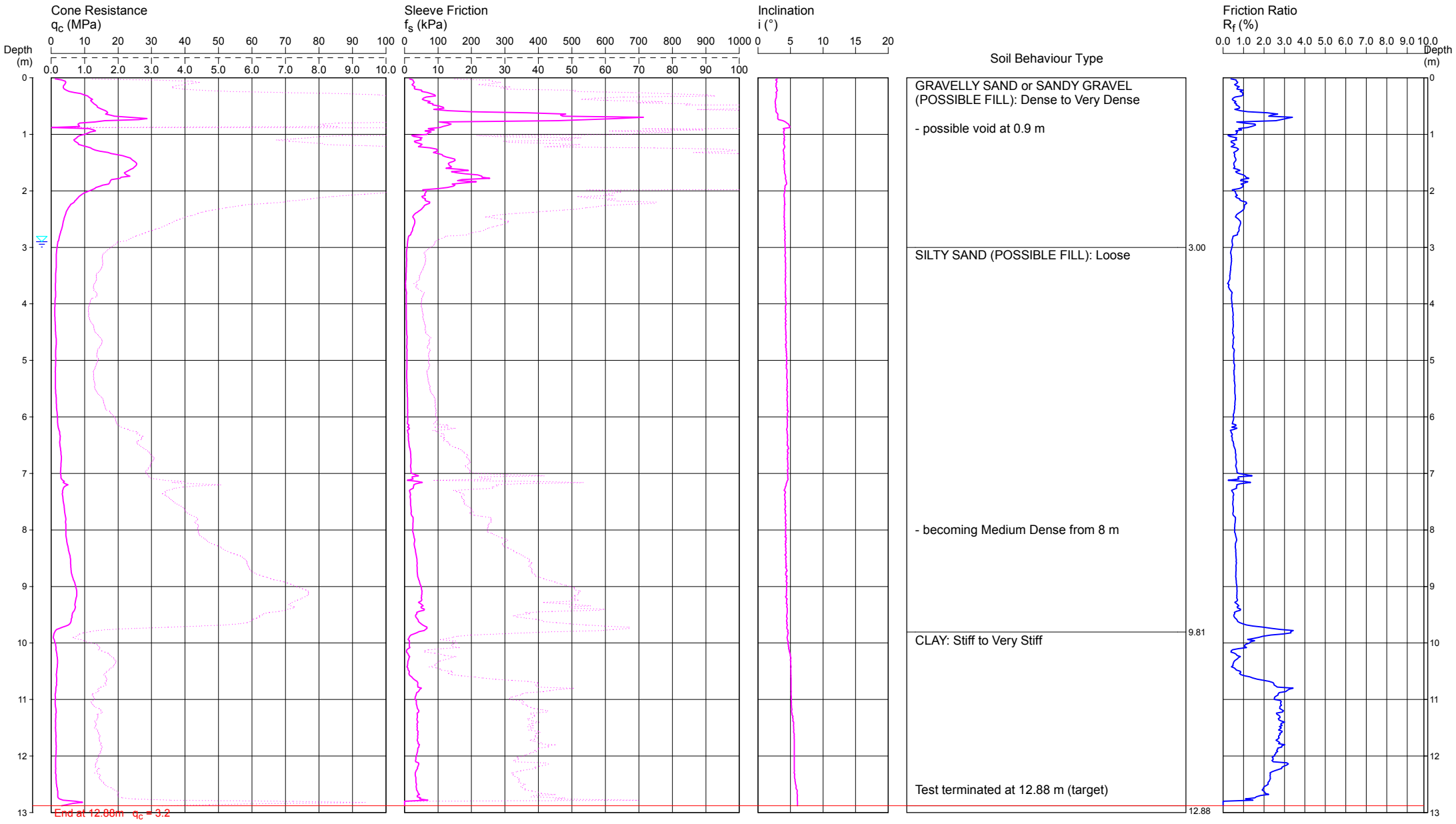
REDUCED LEVEL: 5.8 m AHD

COORDINATES: 406403E 6473637N MGA Zone 50

CPT3

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 - CPT3.CP5
Cone ID: Probedrill **Type:** EC26

Water depth after test: 2.90m depth (measured)

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CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd

PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan

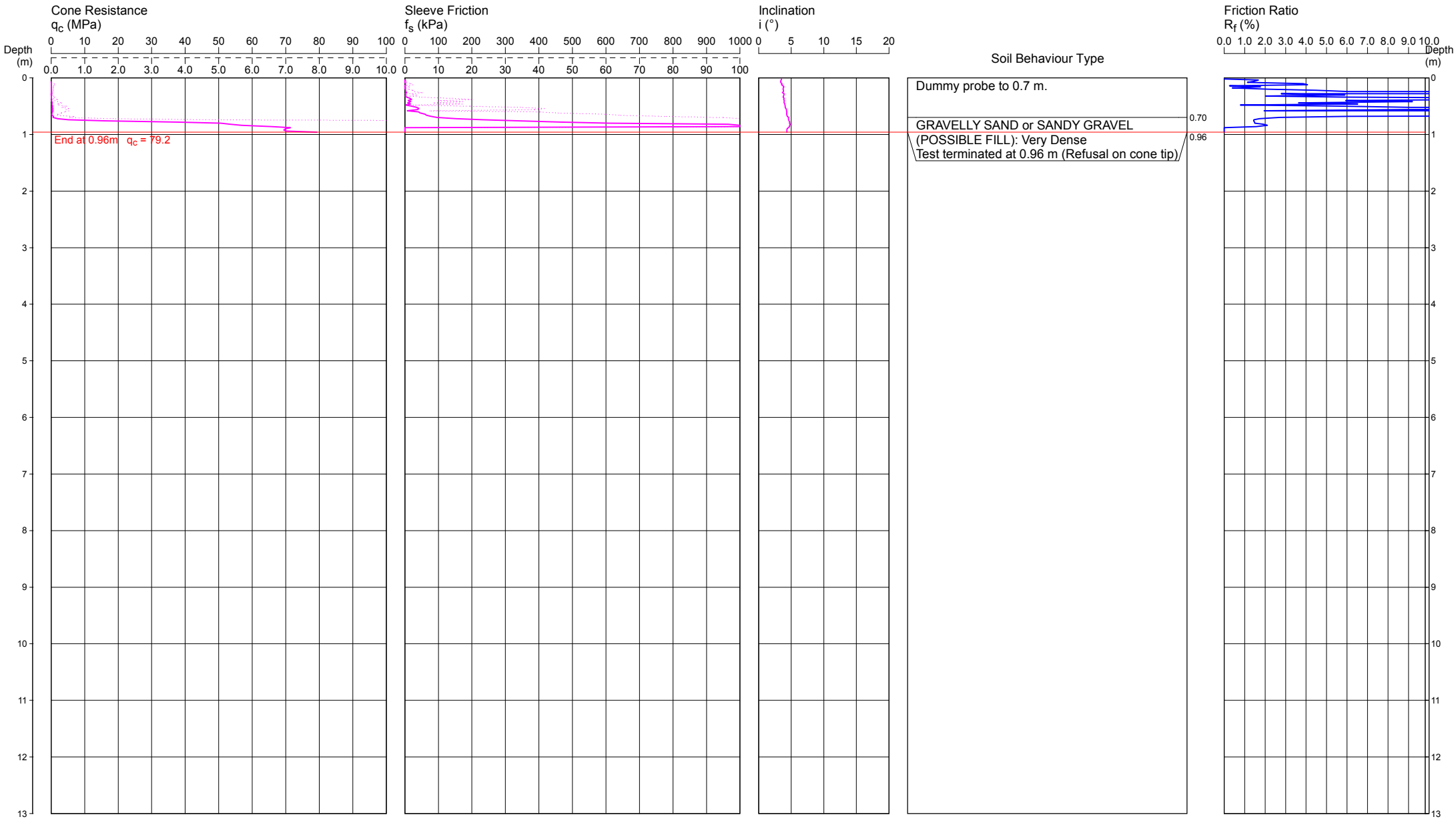
REDUCED LEVEL: 11.7 m AHD

COORDINATES: 406120E 6473251N MGA Zone 50

CPT4

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 - CPT4.CP5

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

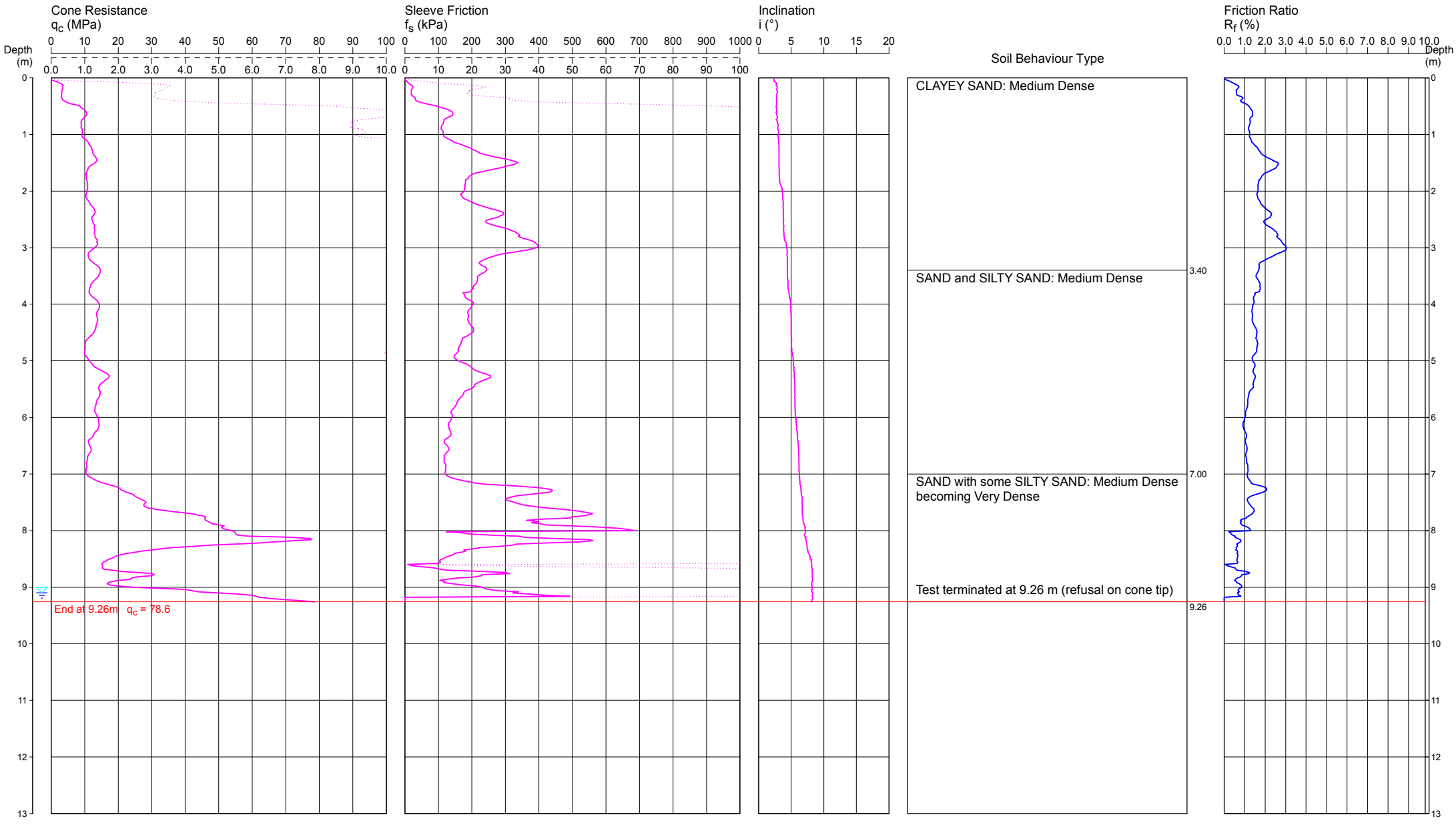
REDUCED LEVEL: 9.2 m AHD

COORDINATES: 405343E 6473459N MGA Zone 50

CPT5

DATE 21/06/2019

PROJECT No: 96584.01



REMARKS: Surface levels interpolated from publicly available LiDAR data.

Water depth after test: 9.10m depth (measured)

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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CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd

PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan

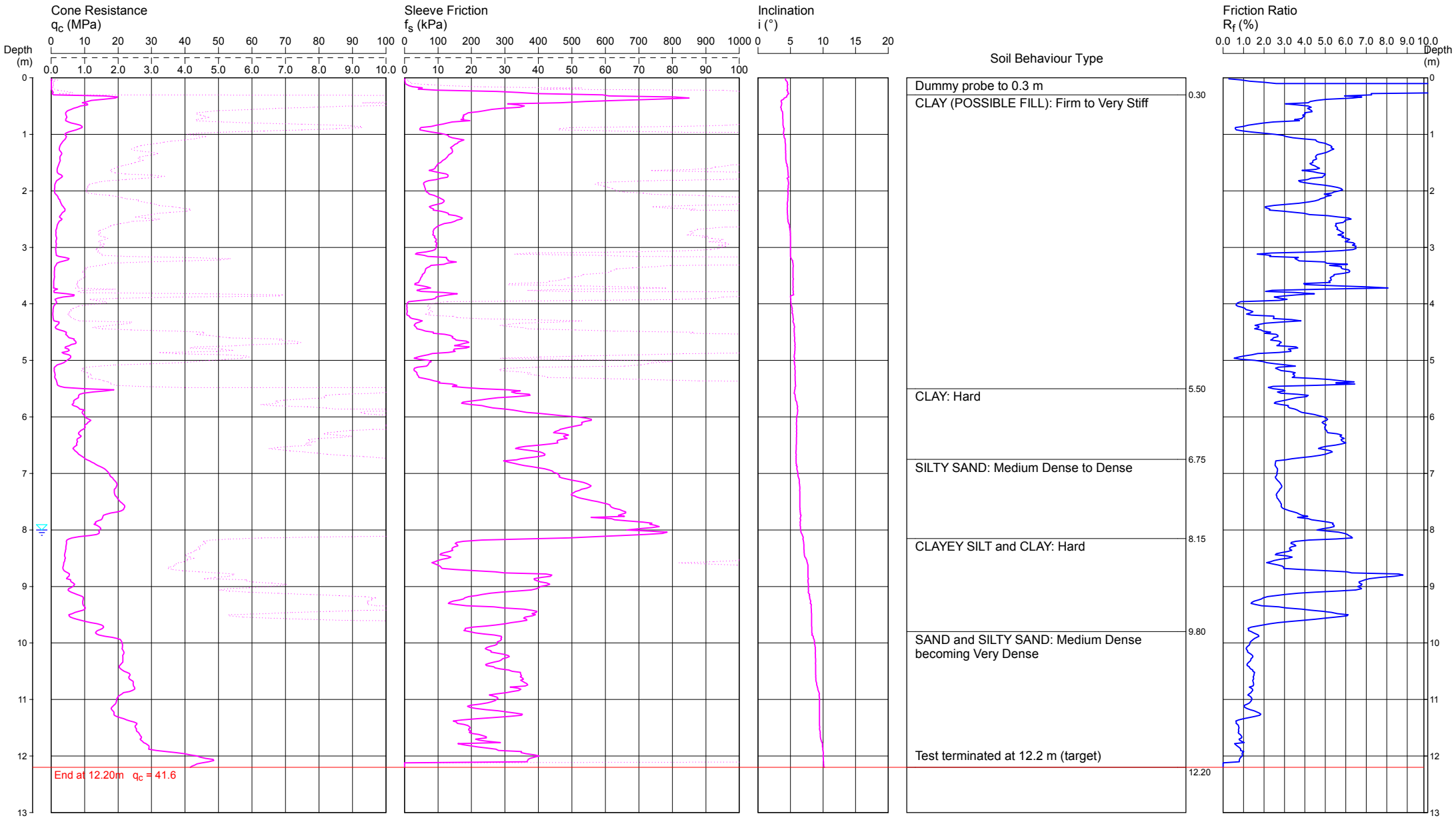
REDUCED LEVEL: 9.2 m AHD

COORDINATES: 405713E 405713N MGA Zone 50

CPT6

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

Water depth after test: 8.00m depth (measured)

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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: 8.3

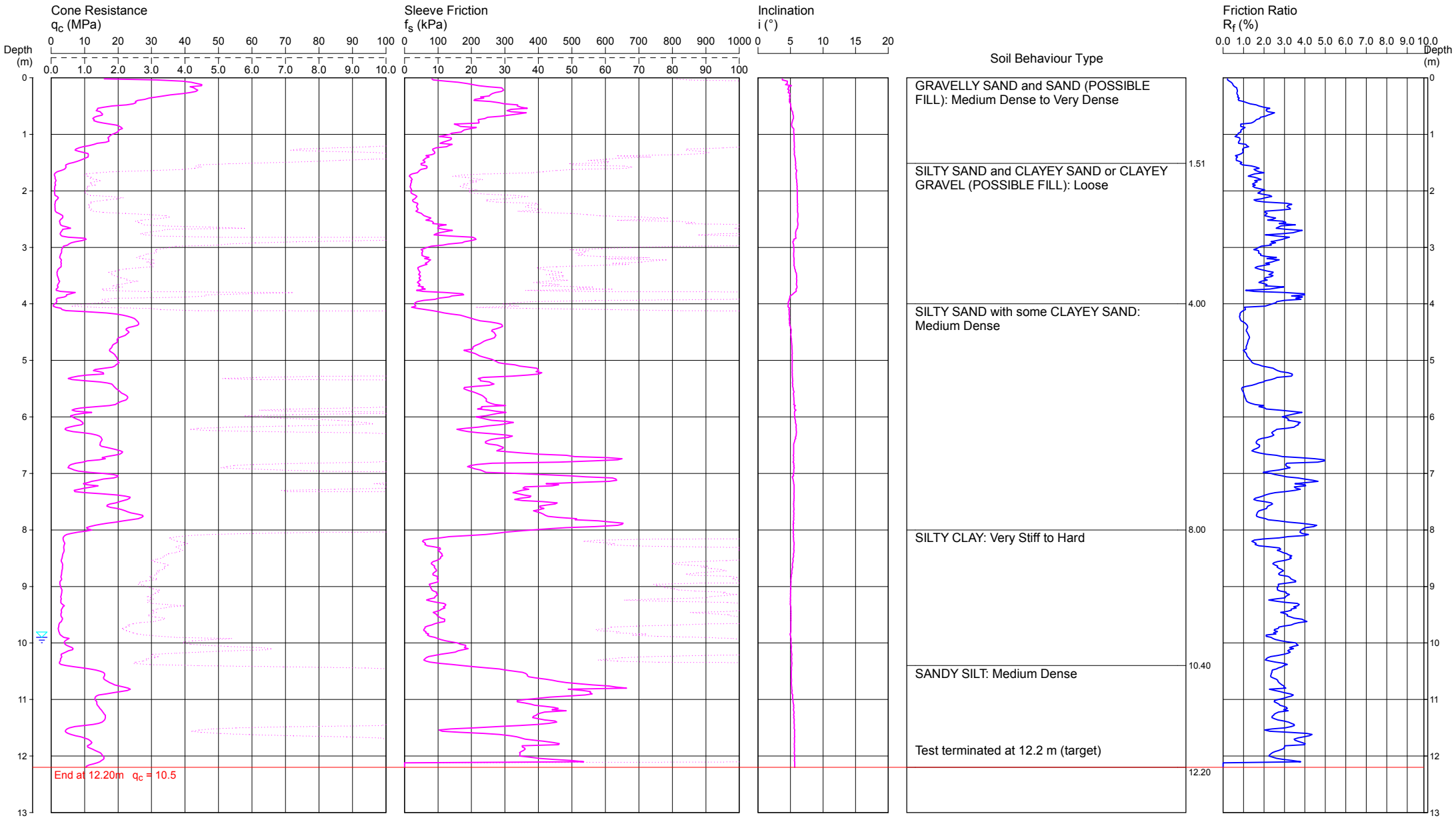
COORDINATES: 405590E 6472813N MGA Zone 50

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

Water depth after test: 9.90m depth (measured)

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CONE PENETRATION TEST

CLIENT: Linc Property Pty Ltd

PROJECT: Proposed Residential & Industrial Development

LOCATION: 102 Great Northern Highway, Middle Swan

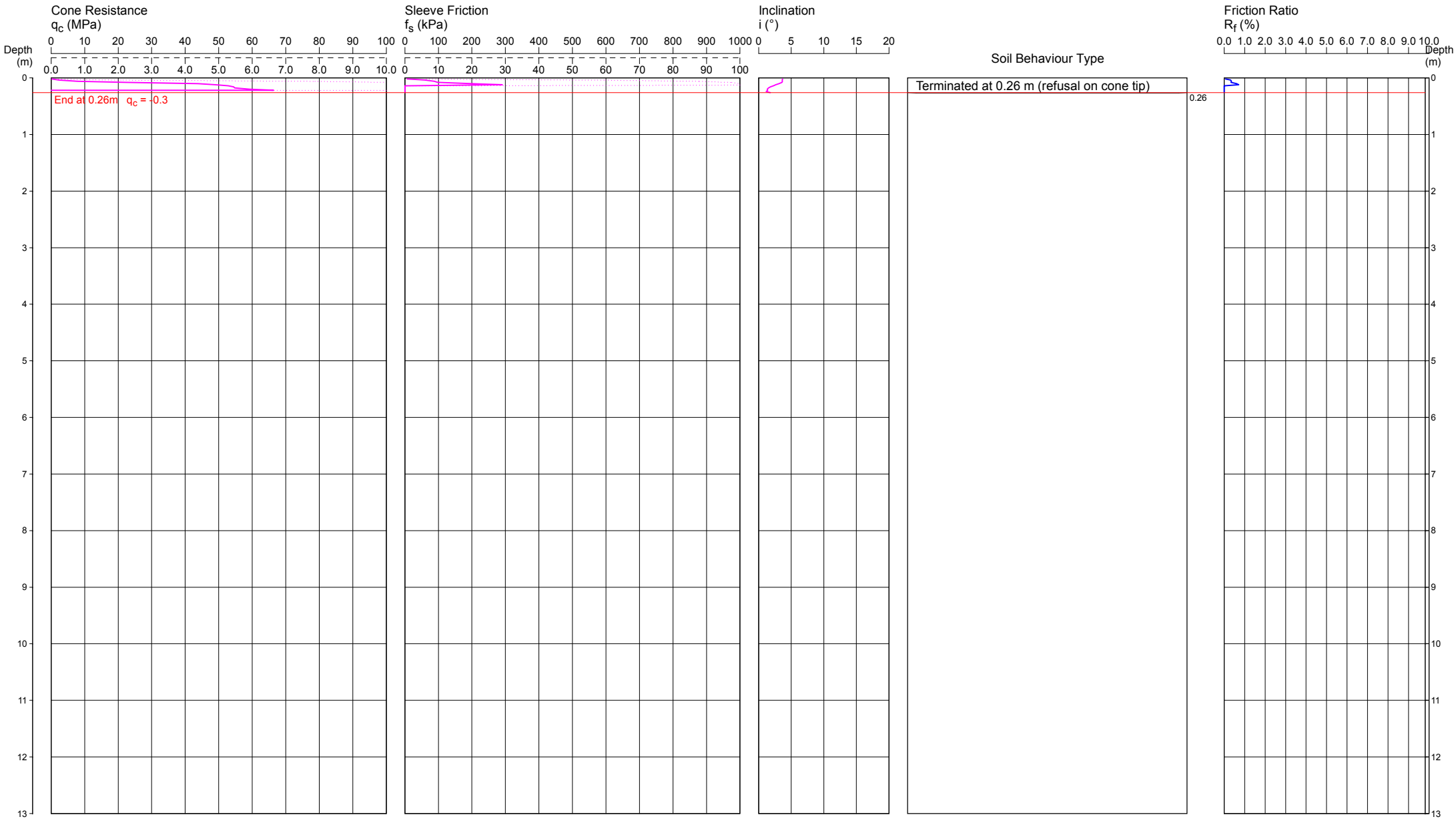
REDUCED LEVEL: 9.5 m AHD

COORDINATES: 405758E 6472805N MGA Zone 50

CPT8

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

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
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		B	0.6				
		- with brick fragments from 0.8 m to 1.0 m							
9	1	- slow digging and dry from 1.0 m							
	1.3	Pit discontinued at 1.3m (slow digging)							
8	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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
5	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			0.3		PP >600 kPa		
				B	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		
	1				0.9		PP >600 kPa		1
	1.15				1.1		PP >600 kPa		
4		Pit discontinued at 1.15m (slow digging)							
	2								
3									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
11		FILL (BRICK and GRAVELLY SAND, SP-SM) - bricks and red-brown mottled brown, fine to coarse grained gravelly sand, dry. Gravelly sand is crushed brick. Plastic and fabric observed.							
	0.55	FILL (SANDY GRAVEL, GP-GM) - yellow-brown, fine to coarse sized sandy gravel, dry. Gravel is lateritic.							
	0.75	CLAYEY SAND (CS) - hard/very dense, orange-brown mottled red-brown and grey, fine to medium grained clayey sand, dry. Hard digging.		B	1.0				1
10	1								
	1.1	SAND (SP-SC) - estimated dense, orange-brown, fine to medium grained sand with clay, dry.							
	1.5	Pit discontinued at 1.5m (slow digging)							
9	2								

5 10 15 20

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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics | Environment | Groundwater

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

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
11	0.15	FILL (SANDY GRAVEL, GS) - very dense, grey-brown, fine to coarse sized sandy gravel with cobbles, moist. Gravel and cobbles are concrete. Possible demolition debris.							>>
		Pit discontinued at 0.15m (refusal on concrete)							
10	1								
9	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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
5	0.05	FILL (TOPSOIL, SM) - dark brown, fine to medium grained silty sand, with organics, moist.							
	0.2								
	0.25	FILL (SANDY GRAVEL, GS) - very dense, red-brown, fine to coarse sized gravel, trace cobbles, moist. Gravel and cobbles are brick fragments.							
	0.4								
	0.45	FILL (GRAVELLY SAND, SP-SM) - pale brown, fine to coarse grained gravelly sand, moist. Gravel is fine to medium sized brick fragments.							
	1	FILL (GRAVELLY CLAY, CI) - red-brown gravelly clay, moist. Gravel is fine to coarse sized ferricrete and brick fragments.							1
		FILL (SANDY GRAVEL, GM) - grey, fine to coarse sandy gravel, moist. Crushed rock roadbase.							
4		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.							
	1.6	Pit discontinued at 1.6m (bricks collapsing)							
	2								
3									

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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
11	0.75	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.							
10	1.85	CLAY (CL) - red clay with sand, dry, low plasticity. Hard digging. - tree root approx. 5 cm diamter at 1 m deep.		B	1.2				
9		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	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
11		FILL (SANDY GRAVEL, GS) - very dense, red-brown, fine to coarse sized gravel, trace cobbles and boulders, moist. Gravel and cobbles are ferricrete.							
	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.		B	0.4				
10	1	- increasing sand content from 0.9 m deep		D	0.8				1
	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.							
9	2	- carpet, wood and fabric pieces from 1.8 m deep - trace brick fragments and with ferricrete cobbles and occasionale boulders from 2.2 m							2
	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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
8	0.3	FILL (SANDY GRAVEL, GS) - very dense, red-brown, fine to coarse sized gravel, trace cobbles, moist. Gravel and cobbles are brick fragments.							
	0.4	FILL (SAND, SP-SM) - blue-grey, fine to coarse grained sand with silt, moist.							
	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.							
	1	FILL (BRICKS and SAND, SP-SC) - estimated dense, brown, fine to medium grained sand with clay and bricks, moist.							
7	1.2	FILL (CLAYEY GRAVEL, GC) - blue-grey, fine to medium sized clayey gravel, moist to wet. Gravel is subangular crushed granite aggregate.							
	1.35	FILL (BRICKS and SAND, SP-SC) - estimated dense, brown, fine to medium grained sand with clay and bricks, moist.							
	1.6	FILL (GRAVELLY SANDY CLAY, CI) - grey-brown gravelly sandy clay, moist. Sand is fine to coarse grained. Gravel is fine to medium sized.							
	2	- mottled red-brown and with brick fragments up to cobble size, moist to wet from 2.0 m		B	2.5				
6	2.6	Pit discontinued at 2.6m (maximum excavator reach)							

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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
6		FILL (SANDY GRAVEL, GP-SM) - grey-brown, fine to coarse sandy gravel, moist. Gravel is brick fragments, ferricrete and granitic. Plastic tape observed.							
	0.4	Pit discontinued at 0.4m (target depth)							
5	1								
4	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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
11		FILL (SANDY CLAY, CI) - brown sandy clay with gravel, brick fragments and bricks, moist. Sand is fine to medium grained.							
	0.4	Pit discontinued at 0.4m (target depth)							
10	1								
9	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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
13	0.2	FILL (CLAY, CI) - grey clay with sand, trace gravel, moist to wet.							
		FILL (SANDY CLAY, CL) - red-brown sandy clay, trace gravel, moist, low plasticity. Sand is fine grained.							
	0.5	Pit discontinued at 0.5m (target depth)							
12	1								
11	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_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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APPENDIX C
Existing Stormwater System Plates

PLATES

PLATE 1: Blackadder Creek Tributary in vegetated area north of Eveline Rd. Broad flat area, with evidence of previous channel adjacent to road but now discontinuous

PLATE 2: Downstream end of 450mm dia Culvert under Eveline Rd. Partially blocked (50%).

PLATE 3: Driveway across Blackadder Creek Tributary downstream of Eveline Rd.

PLATE 4: 400mm dia steel culvert under driveway partially block by large tree.

PLATE 5: Blackadder Creek Tributary downstream of driveway. Broad floodplain only and no discernible flow channel

PLATE 6: Fence crossing broad flat channel of Blackadder Creek Tributary further downstream opposite LaSalle College playing fields

PLATE 7: Culvert under Muriel St at low point (approx. opposite vehicle location). Note Blackadder Creek Tributary is piped under development area immediately downstream of Muriel St.

PLATE 8: 900 mm dia pipe under Muriel St. Invert of pipe is several metres below road level.

PLATE 9: Main Site Sump and Pump. Main Electric Pump (170 l/s) located in building

PLATE 10: 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 11: Discharge from Clay Shed roof to storage area adjacent to TEC area

PLATE 12: Upstream and downstream end of 450mm concrete pipe taking compensated flow from storage area adjacent to TEC. Downstream end heavily overgrown.

PLATE 13: Storage area adjacent to TEC.

PLATE 14: 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 15: Initial northern storage pond at pumped discharge location

PLATE 16: Third northern storage pond. Shows more capacity to infiltrate stormwater in comparison to other storages in area.

PLATE 17: Existing open drain along western boundary to convey water to southern storages

PLATE 18: Initial southern storage pond

PLATE 19: Large existing southern storage area

PLATE 20: Open drain from southern storage areas to southern outlet

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

PLATE 22: Existing biofiltation area on Bernley Drive

APPENDIX D
Existing System **Stormwater Modelling**

Date: 5/4/2020 Job No. H19054

Site
Catchments

Hardstand
Industrial
POS
Public Purposes
Residential

Road
School
Stormwater
Vegetation

0 125 250 375 500 Meters

hyd2o

Midland Brick Local Water Management Strategy

Existing Catchments and Land Use Mapping

Appendix **D**

Existing Land Use Breakdown

		Internal Site Catchments				External Catchments								
Catchment	Description	Hardstand	Vegetation	Storage Area	Total	POS	Public	Vegetation	Residential	Industrial	Road	School	Total	**Total**
To Swan River - Major Events , To Blackadder Tributary - Minor Events														
BAT8	To Clay Basin Storage	17.14	1.91	1.99	21.04	0.00	0.00	0.00	5.53	3.20	1.97	0.00	10.70	**31.74**
BAT7	To Northern Storage Ponds	25.90	0.08	0.00	25.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**25.99**
To Blackadder Tributary - All Events														
BAT6	Northern Storage Ponds	0.01	0.02	2.57	2.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.60**
BAT3	To Southern Storage Ponds	5.74	0.06	0.88	6.67	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.11	**6.78**
BAT4	To Southern Storage Ponds	0.60	0.00	1.61	2.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.22**
BAT5	To Southern Storage Ponds	0.00	1.29	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.29**
BAT1	To Blackadder Creek Trib	0.01	0.00	0.00	0.01	6.25	2.77	5.52	0.00	0.00	0.38	2.83	17.75	**17.76**
BAT2	To Blackadder Creek Trib	4.47	4.80	0.00	9.27	1.88	0.00	0.00	1.34	0.77	1.13	0.00	5.12	**14.39**
BAT9	To Blackadder Creek Trib	0.00	1.14	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.14**
To Swan River - All Events														
SR1	Swan River Catchment	3.18	2.98	0.00	6.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.17**
SR2	Swan River Catchment	0.05	5.98	0.00	6.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.03**
SR3	Swan River Catchment	0.00	0.51	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.52**
Totals		**57.11**	**18.77**	**7.06**	**82.94**	**8.24**	**2.77**	**5.52**	**6.87**	**3.97**	**3.48**	**2.83**	**33.69**	**120.19**

CURRV

Calculator for Urban Runoff Rates & Volumes

23/02/2020

Project Midland Brick, Clay Basin Catchment BAT8 Calibration of Runoff Parameters for Modelling

	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	External : Residential (~600-4000m2)	5.53	Yes	1.5	10.0	2.0	0.0	1.00	60%	15	5	75	assuming large lots
2	External : Industrial	3.20	Yes	1.5	10.0	2.0	15.0	2.00	80%	60	35	5	assuming some form of on site retention/detention
3	External : Road Reserve	1.97	Yes	1.5	10.0	2.0	0.0	1.00	100%	0	70	30	standard (pervious loss model adjusted for soil type)
4	Internal : Hardstand	17.10	Yes	1.5	10.0	2.0	0.0	1.00	100%	20	40	40	assume brick stacks pervious (over half of floor space)
5	Internal : Vegetation	1.91	Yes	1.5	10.0	2.0	0.0	1.00	30%	0	5	95	standard vegetation rates applied
6	Internal : Stormwater Areas	1.99	Yes	1.5	10.0	2.0	0.0	1.00	100%	0	0	100	assuming some infiltration/bank storage occurs
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

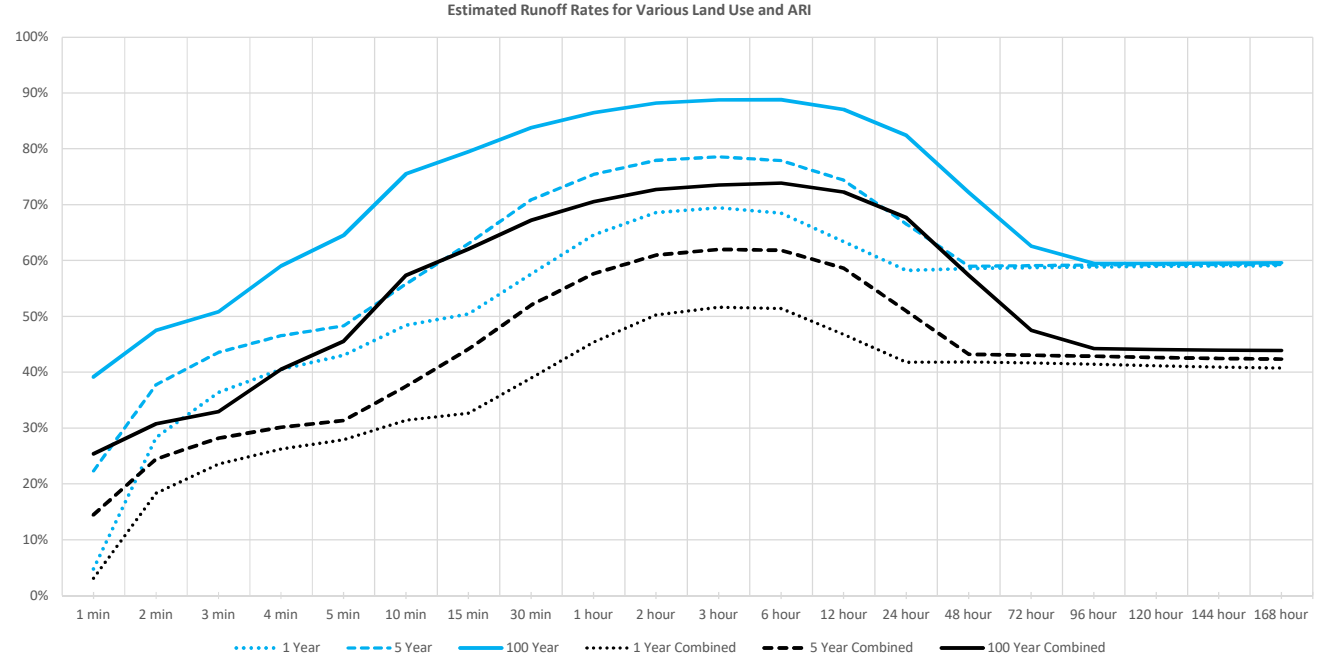
runoff rates adopted for XP-Storm model cailbration to observated June 2019 levels

runoff rates adopted for all catchments in major event modelling

Land Use Graph Selector **4**

(11 - combined total)

Internal : Hardstand



Rainfall IFD Data

Annual Exceedence Probability

	Duration	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 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

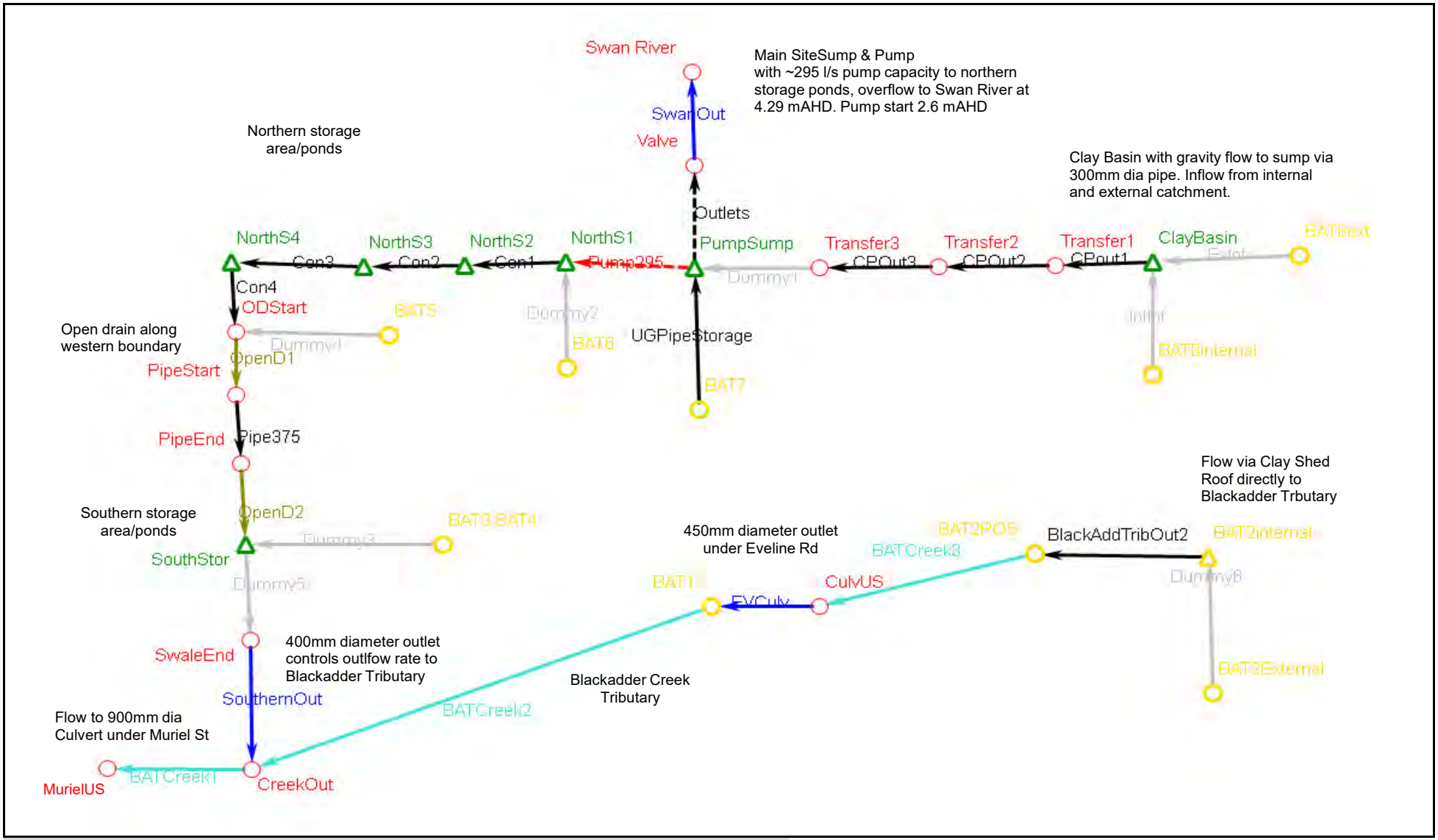
	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
Maximum of All Events							
External : Residential (~600-4000m2)	26%	29%	35%	39%	41%	44%	46%
External : Industrial	40%	43%	51%	56%	59%	63%	65%
External : Road Reserve	76%	78%	83%	85%	88%	90%	91%
Internal : Hardstand	69%	72%	79%	82%	84%	87%	89%
Internal : Vegetation	11%	13%	17%	19%	20%	22%	23%
Internal : Stormwater Areas	33%	39%	53%	60%	66%	72%	75%
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	**52%**	55%	**62%**	**66%**	69%	72%	**74%**

Event Selector	**13**	**12 hour**					
External : Residential (~600-4000m2)	18%	21%	30%	34%	37%	41%	43%
External : Industrial	38%	41%	50%	55%	59%	63%	65%
External : Road Reserve	72%	74%	80%	83%	86%	88%	90%
Internal : Hardstand	63%	67%	74%	78%	82%	85%	87%
Internal : Vegetation	5%	8%	13%	16%	18%	20%	21%
Internal : Stormwater Areas	14%	21%	40%	49%	57%	65%	70%
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	**47%**	50%	**59%**	**63%**	66%	70%	**72%**

Adopted Storm Events Runoff Rates for Existing Catchments
20% / 1% AEP Events

		Internal Site Catchments					External Catchments									Overall	
Catchment	Description	Hardstand	Vegetation	Storage Area	Total	EIA	POS	Public	Vegetation	Residential	Industrial	Road	School	Total	EIA	Total	EIA
		0.89	0.23	0.75			0.23	0.23	0.23	0.46	0.65	0.91	0.00				
To Swan River - Major Events , To Blackadder Tributary - Minor Events																	
BAT8	To Clay Basin Storage	17.14	1.91	1.99	21.04	17.18	0.00	0.00	0.00	5.53	3.20	1.97	0.00	10.70	6.42	**31.74**	**23.60**
BAT7	To Northern Storage Ponds	25.90	0.08	0.00	25.98	23.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**25.99**	**23.07**
To Blackadder Tributary - All Events																	
BAT6	Northern Storage Ponds	0.01	0.02	2.57	2.60	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.60**	**1.94**
BAT3	To Southern Storage Ponds	5.74	0.06	0.88	6.67	5.78	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.02	**6.78**	**5.80**
BAT4	To Southern Storage Ponds	0.60	0.00	1.61	2.22	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.22**	**1.74**
BAT5	To Southern Storage Ponds	0.00	1.29	0.00	1.29	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.29**	**0.30**
BAT1	To Blackadder Creek Trib	0.01	0.00	0.00	0.01	0.01	6.25	2.77	5.52	0.00	0.00	0.38	2.83	17.75	3.69	**17.76**	**3.70**
BAT2	To Blackadder Creek Trib	4.47	4.80	0.00	9.27	5.08	1.88	0.00	0.00	1.34	0.77	1.13	0.00	5.12	2.58	**14.39**	**7.66**
BAT9	To Blackadder Creek Trib	0.00	1.14	0.00	1.14	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.14**	**0.26**
To Swan River - All Events																	
SR1	Swan River Catchment	3.18	2.98	0.00	6.17	3.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.17**	**3.52**
SR2	Swan River Catchment	0.05	5.98	0.00	6.03	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**6.03**	**1.42**
SR3	Swan River Catchment	0.00	0.51	0.00	0.52	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.52**	**0.12**
TOTALS		**57.11**	**18.77**	**7.06**	**82.94**	**60.44**	**8.24**	**2.77**	**5.52**	**6.87**	**3.97**	**3.48**	**2.83**	**33.69**	**12.71**	**116.63**	**73.15**

Date: 8/4/2019 Job No H19054



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

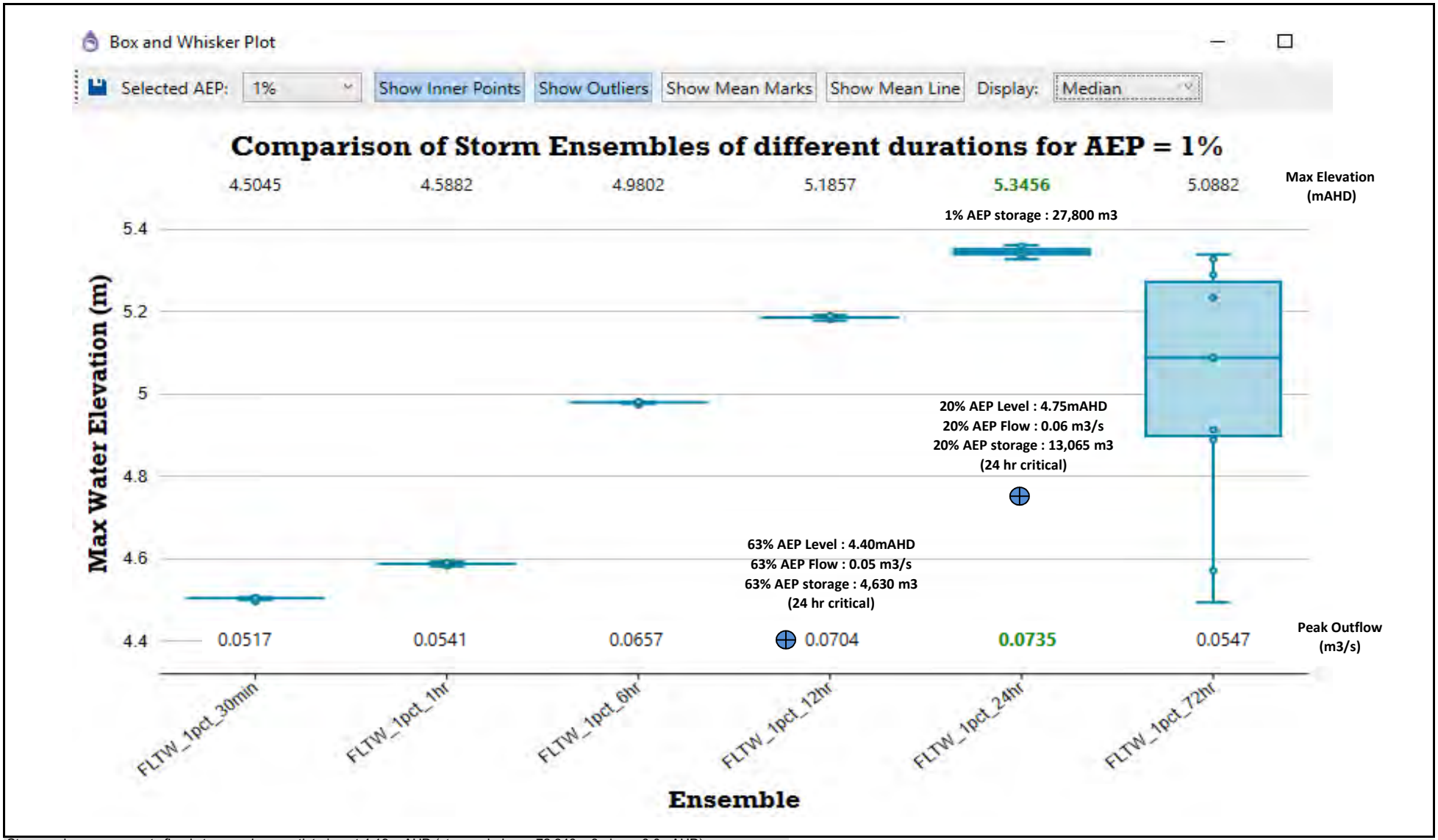
hyd$_2$o

Midland Brick Local Water Mangement Strategy

XP-Storm Conceptual Stormwater Model : Existing System

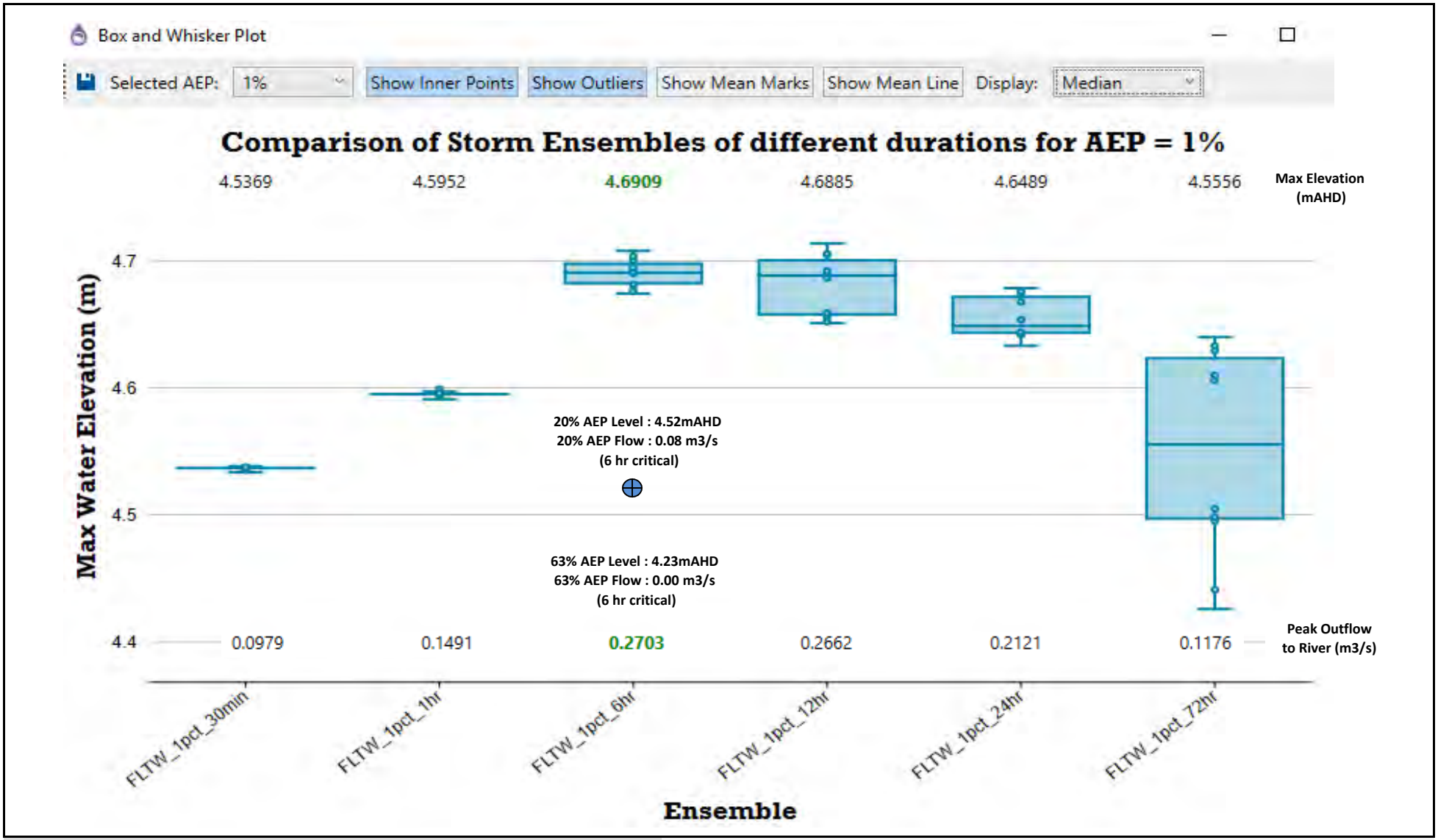
Appendix D1

Date: 8/4/2019 Job No H19054

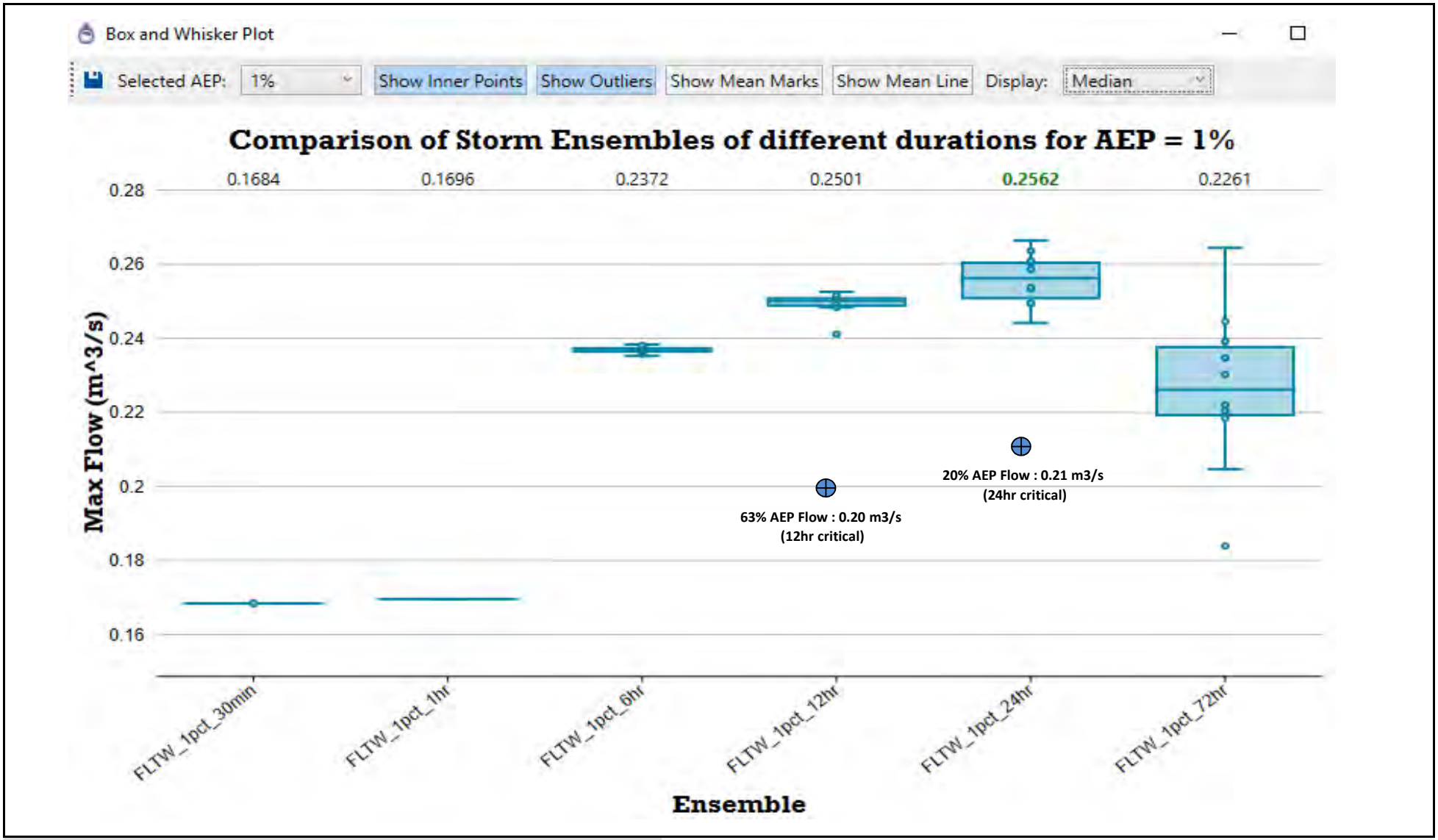


Storage shown represents flood storage above outlet pipe at 4.19 mAHD (storage below = 72,340 m3 above 0.0mAHD)

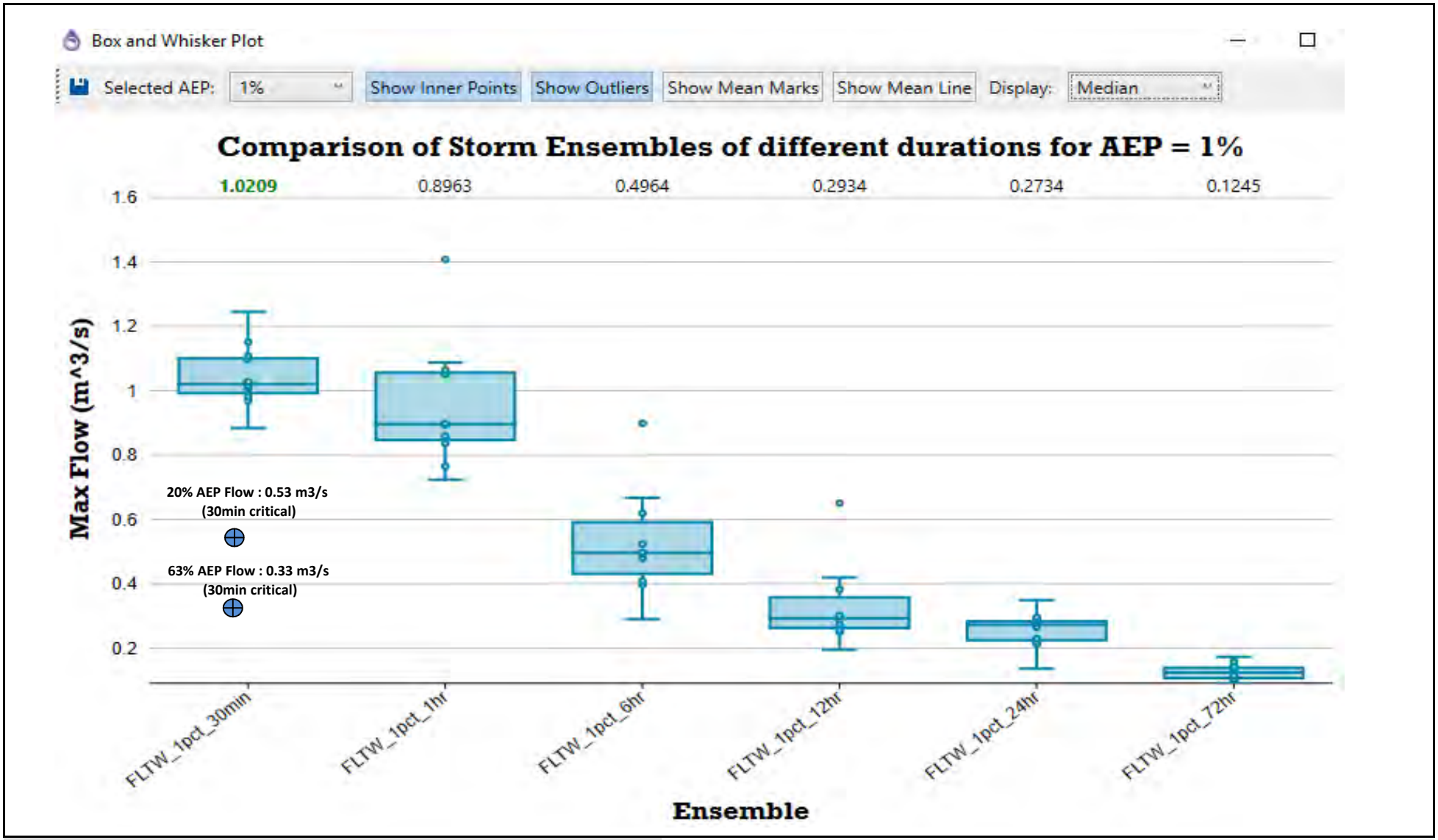
Date: 8/4/2019 Job No H19054



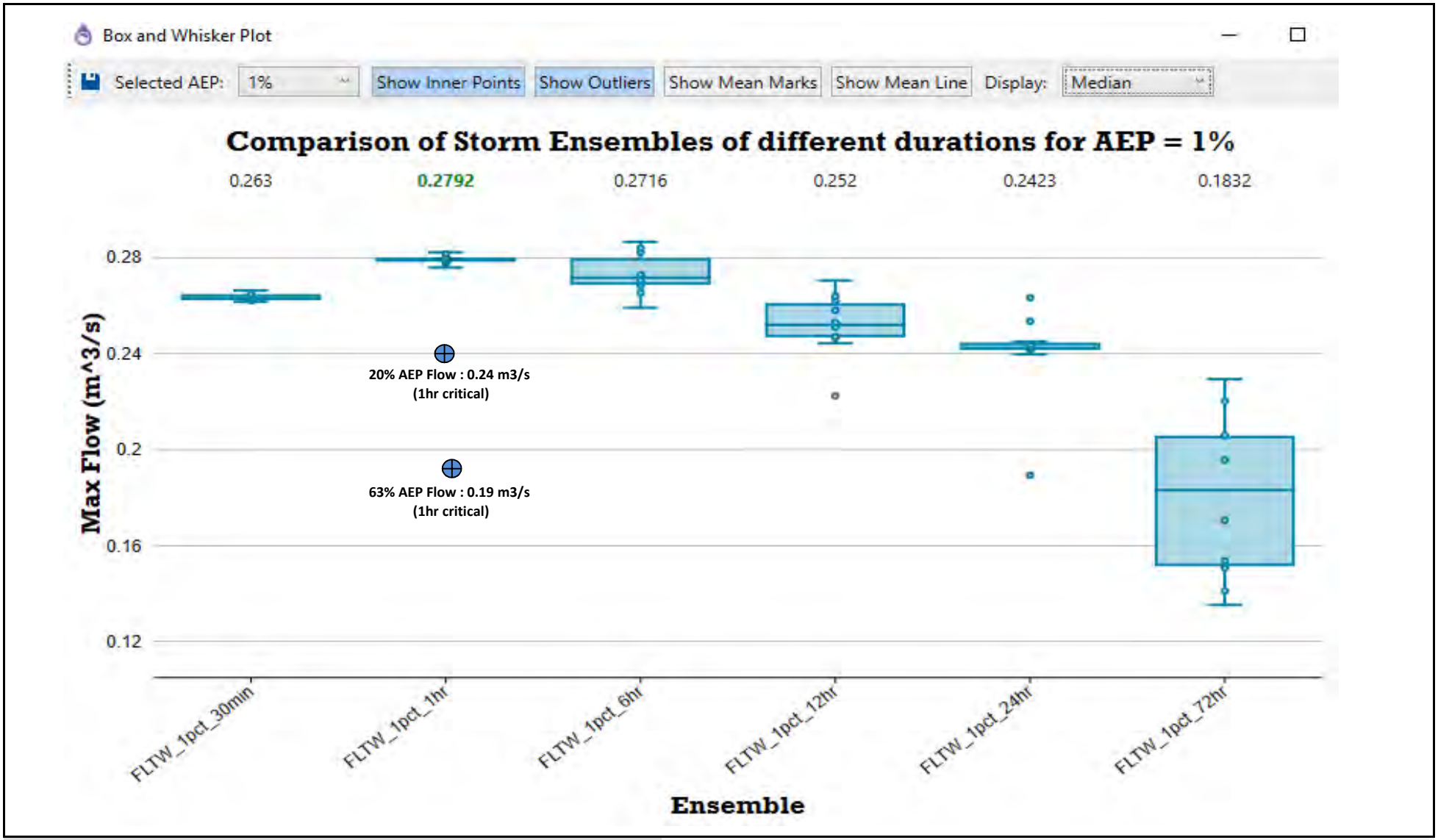
Date: 8/4/2019 Job No H19054

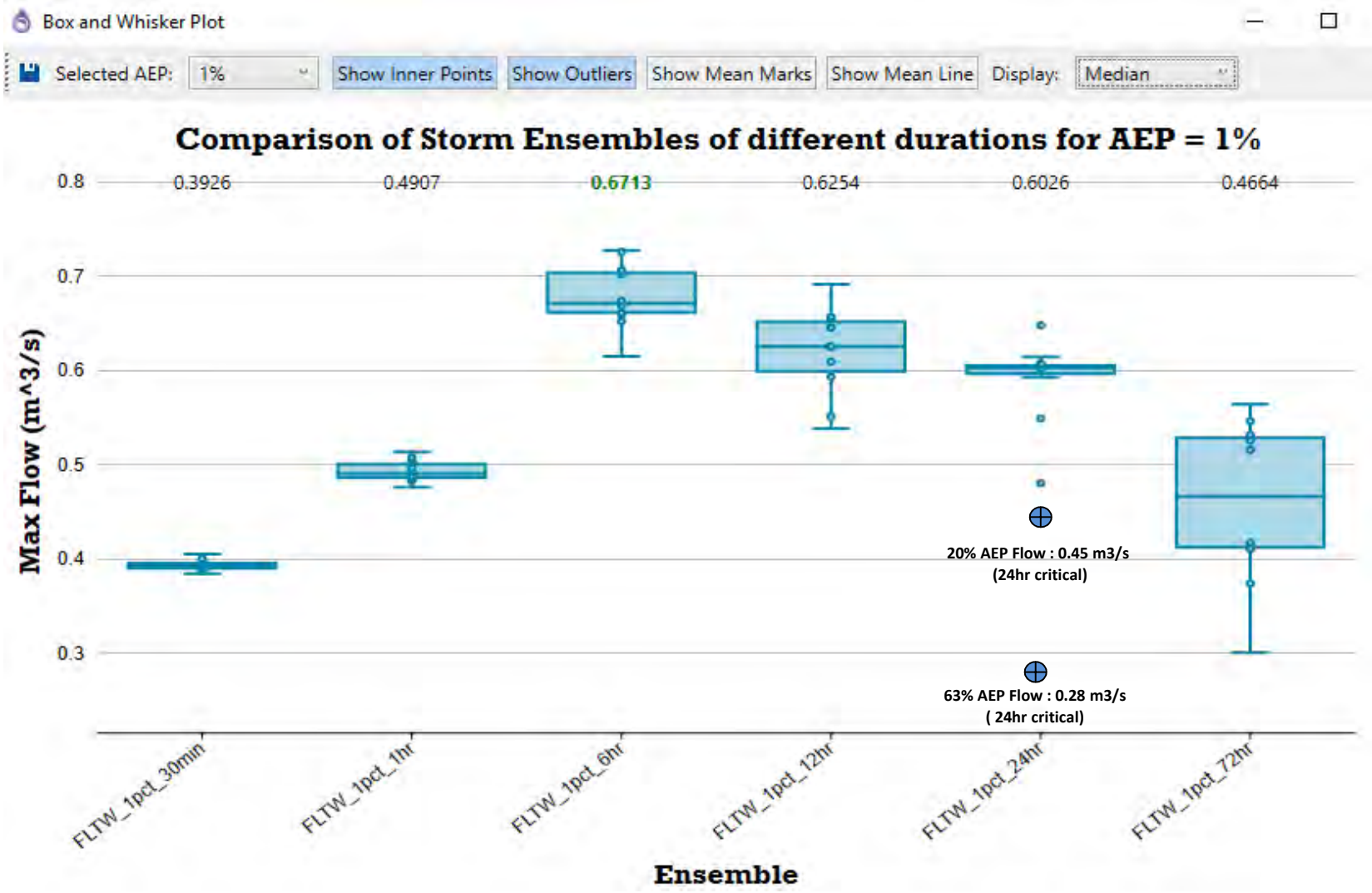


Date: 8/4/2019 Job No H19054



Date: 8/4/2019 Job No H19054




Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
0.3926
0.4907
0.6713
0.6254
0.6026
0.4664
Max Flow (m^3/s)
0.8
0.7
0.6
0.5
0.4
0.3
20% AEP Flow : 0.45 m3/s
(24hr critical)
63% AEP Flow : 0.28 m3/s
(24hr critical)
FLTW_1pct_30min
FLTW_1pct_1hr
FLTW_1pct_6hr
FLTW_1pct_12hr
FLTW_1pct_24hr
FLTW_1pct_72hr
Ensemble

APPENDIX **E**
Predevelopment Site Monitoring Data

Date: 06/04/2020 Job No. H19054

Site

Groundwater Monitoring Bores

Surface Water Monitoring Locations

hyd2o

Midland Brick, Middle Swan LWMS

Groundwater and Surface Water Monitoring Locations

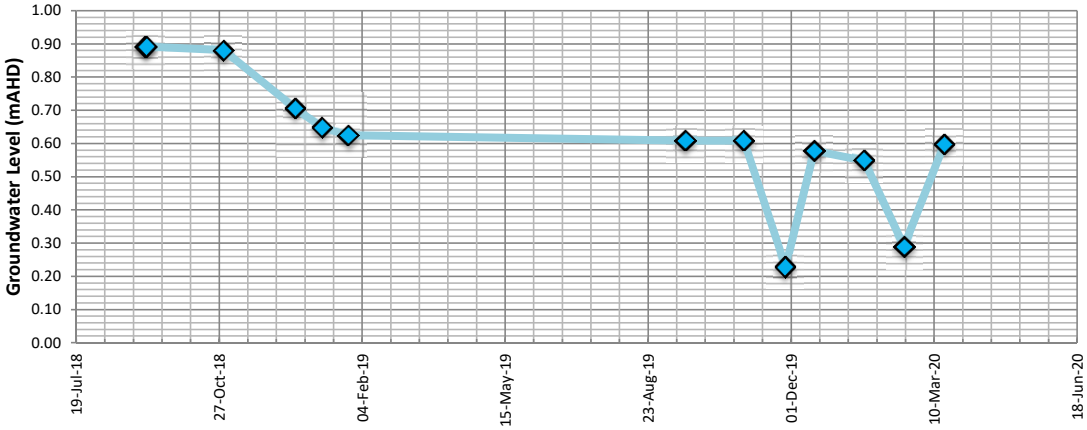
Appendix E

H19054 Midland Brick

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

				Natural Surface (mAHD)	5.60
Data Analysis Period Start Date	1/01/2004	Easting	405597	Top of Casing (m AHD)	6.05
Data Analysis Period End Date	31/12/2020	Northing	6473545	End of Hole (mAHD)	-2.10

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	5.16	0.89	4.71
6/09/2018	5.16	0.89	4.71
30/10/2018	5.17	0.88	4.72
19/12/2018	5.34	0.71	4.89
7/01/2019	5.40	0.65	4.95
25/01/2019	5.42	0.63	4.98
18/09/2019	5.44	0.61	4.99
29/10/2019	5.44	0.61	4.99
27/11/2019	5.82	0.23	5.37
17/12/2019	5.47	0.58	5.02
21/01/2020	5.50	0.55	5.05
18/02/2020	5.76	0.29	5.31
17/03/2020	5.45	0.60	5.00

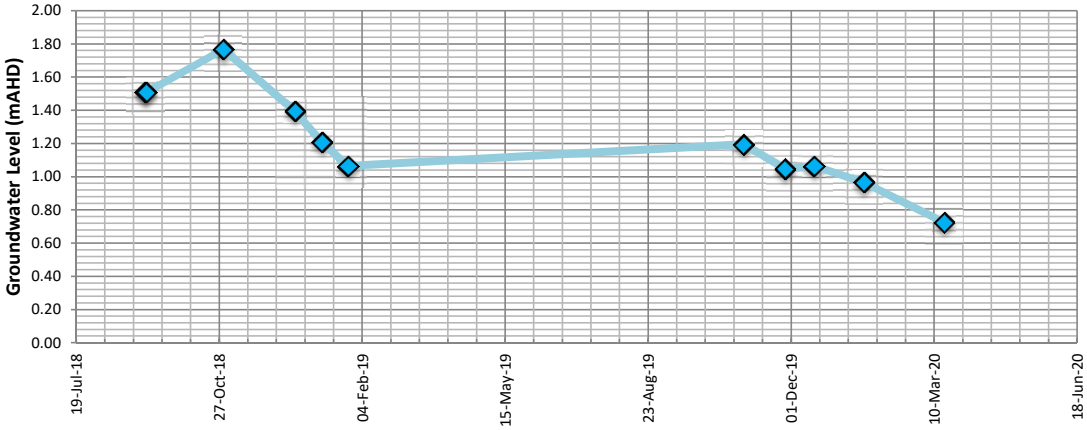
Minimum Recorded Level (mAHD)	0.229
Maximum Recorded Level (mAHD)	0.892

H19054 Midland Brick

EMW02 Groundwater Bore 2
North West Corner Outside Bund Bore

				Natural Surface (mAHD)	9.55
Data Analysis Period Start Date	1/01/2004	Easting	405317	Top of Casing (m AHD)	10.00
Data Analysis Period End Date	31/12/2020	Northing	6473432	End of Hole (mAHD)	-0.15

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	8.49	1.51	8.04
6/09/2018	8.49	1.51	8.04
30/10/2018	8.23	1.77	7.78
19/12/2018	8.60	1.39	8.16
7/01/2019	8.79	1.21	8.34
25/01/2019	8.93	1.07	8.49
29/10/2019	8.80	1.20	8.36
27/11/2019	8.95	1.05	8.51
17/12/2019	8.93	1.06	8.49
21/01/2020	9.03	0.97	8.59
17/03/2020	9.27	0.73	8.83

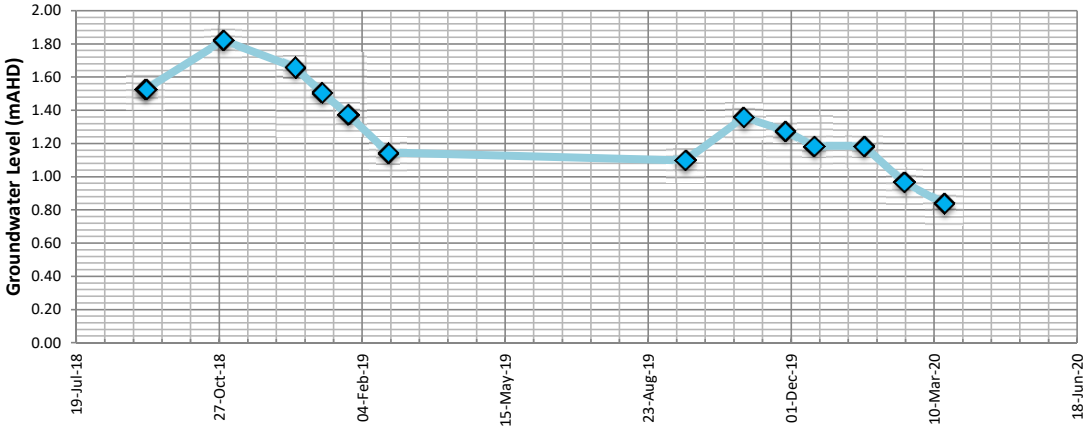
Minimum Recorded Level (mAHD)	0.725
Maximum Recorded Level (mAHD)	1.767

H19054 Midland Brick

EMW03 Groundwater Bore 3
Oval Storage Area East Bore

				Natural Surface (mAHD)	10.82
Data Analysis Period Start Date	1/01/2004	Easting	405530	Top of Casing (m AHD)	11.34
Data Analysis Period End Date	31/12/2020	Northing	6473108	End of Hole (mAHD)	-2.88

Report Date : 7/04/2020



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

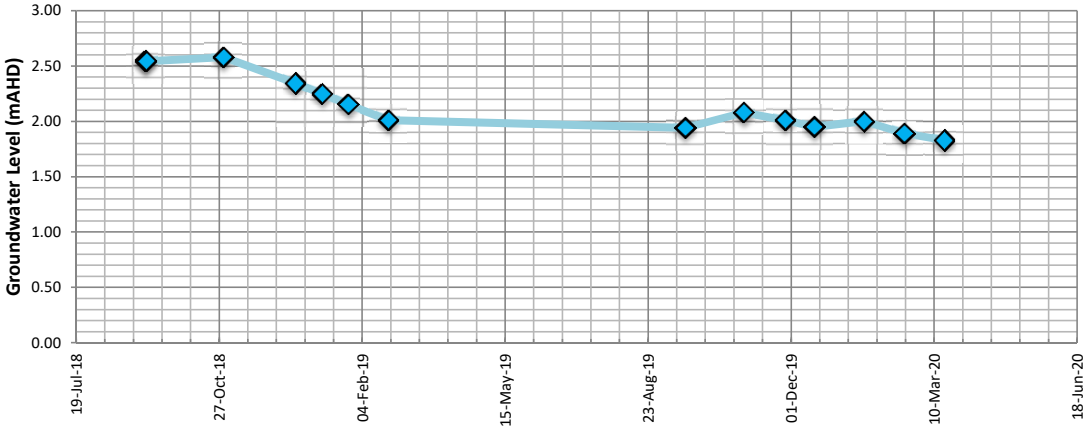
Minimum Recorded Level (mAHD)	0.837
Maximum Recorded Level (mAHD)	1.821

H19054 Midland Brick

EMW04 Groundwater Bore 4
Oval Storage Area South Bore

				Natural Surface (mAHD)	9.29
Data Analysis Period Start Date	1/01/2004	Easting	405712	Top of Casing (m AHD)	9.75
Data Analysis Period End Date	31/12/2020	Northing	6472730	End of Hole (mAHD)	0.49

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	7.21	2.54	6.75
6/09/2018	7.21	2.54	6.75
30/10/2018	7.17	2.58	6.71
19/12/2018	7.41	2.35	6.94
7/01/2019	7.50	2.25	7.04
25/01/2019	7.60	2.15	7.14
22/02/2019	7.74	2.01	7.28
18/09/2019	7.81	1.94	7.35
29/10/2019	7.67	2.08	7.21
27/11/2019	7.74	2.01	7.28
17/12/2019	7.80	1.95	7.34
21/01/2020	7.75	2.00	7.29
18/02/2020	7.86	1.89	7.40
17/03/2020	7.92	1.83	7.46

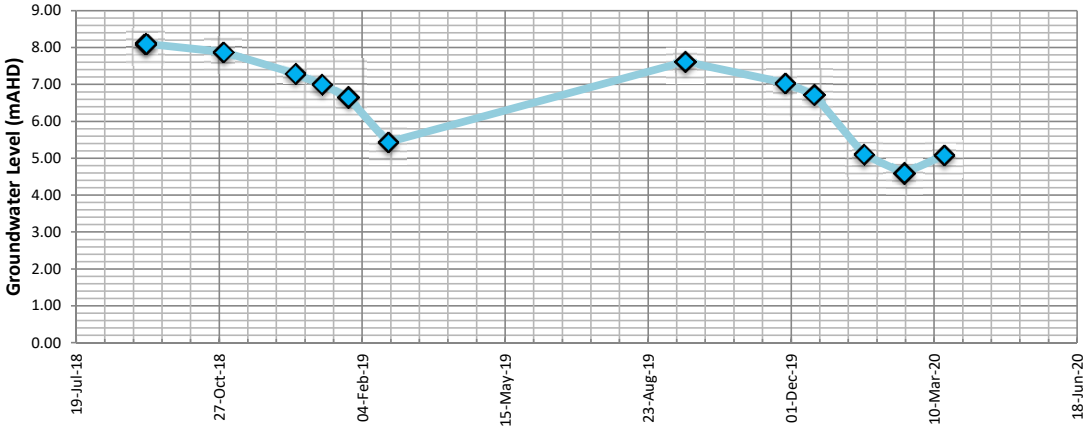
Minimum Recorded Level (mAHD)	1.831
Maximum Recorded Level (mAHD)	2.58

H19054 Midland Brick

EMW05 Groundwater Bore 5
Clay Shed Bore

				Natural Surface (mAHD)	10.96
Data Analysis Period Start Date	1/01/2004	Easting	406135	Top of Casing (m AHD)	11.39
Data Analysis Period End Date	31/12/2020	Northing	6473245	End of Hole (mAHD)	4.06

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	3.28	8.10	2.86
6/09/2018	3.28	8.10	2.86
30/10/2018	3.51	7.88	3.08
19/12/2018	4.08	7.30	3.66
7/01/2019	4.39	6.99	3.97
25/01/2019	4.73	6.66	4.31
22/02/2019	5.95	5.44	5.52
18/09/2019	3.77	7.62	3.34
27/11/2019	4.34	7.05	3.91
17/12/2019	4.66	6.73	4.23
21/01/2020	6.29	5.10	5.86
18/02/2020	6.79	4.60	6.36
17/03/2020	6.31	5.08	5.88

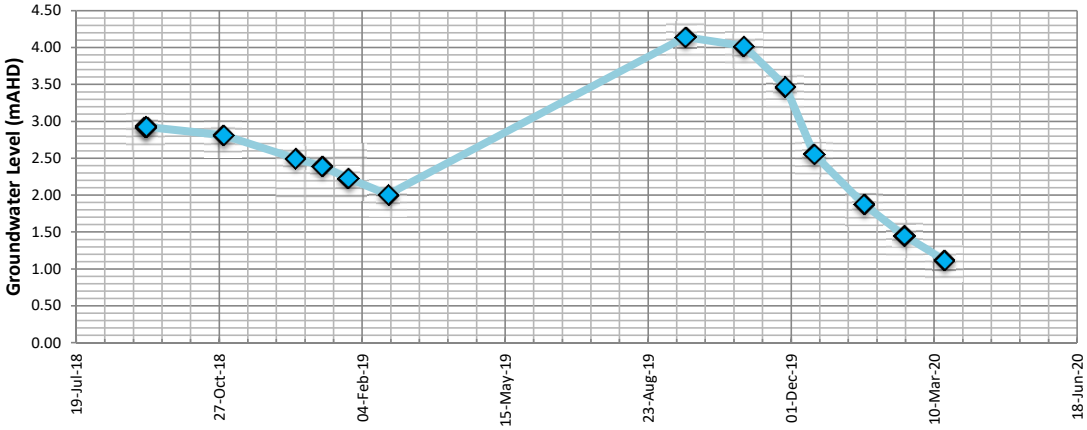
Minimum Recorded Level (mAHD)	4.596
Maximum Recorded Level (mAHD)	8.104

H19054 Midland Brick

EMW06 Groundwater Bore 6
Ticket Box / Clay Basin Bore

				Natural Surface (mAHD)	5.57
Data Analysis Period Start Date	1/01/2004	Easting	406305	Top of Casing (m AHD)	5.92
Data Analysis Period End Date	31/12/2020	Northing	6473648	End of Hole (mAHD)	-1.53

Report Date : 7/04/2020



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

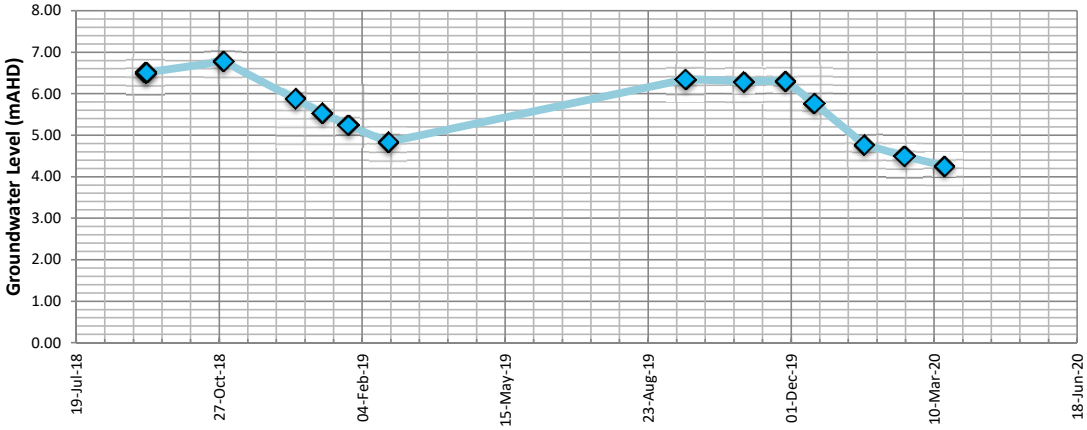
Minimum Recorded Level (mAHD)	1.124
Maximum Recorded Level (mAHD)	4.144

H19054 Midland Brick

EMW07 Groundwater Bore 7
Whitemans Bore

				Natural Surface (mAHD)	8.37
Data Analysis Period Start Date	1/01/2004	Easting	406580	Top of Casing (m AHD)	8.90
Data Analysis Period End Date	31/12/2020	Northing	6473504	End of Hole (mAHD)	1.67

Report Date : 7/04/2020



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

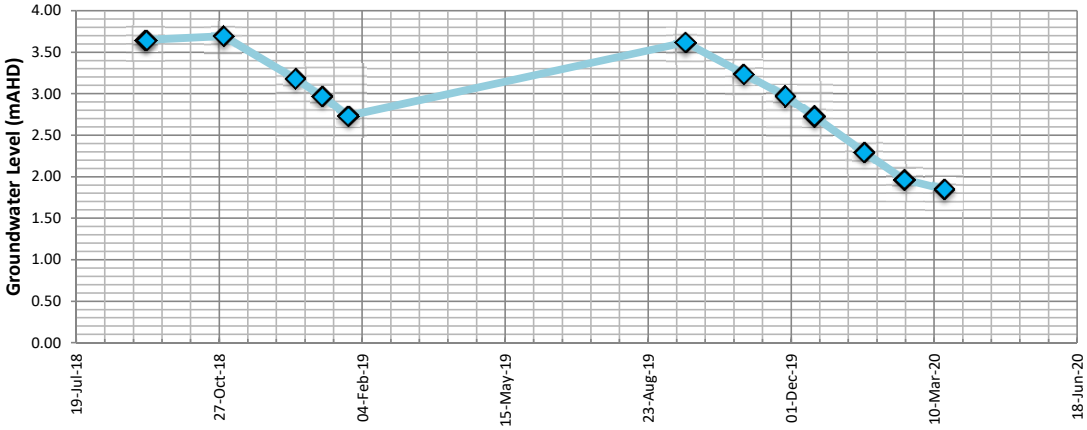
Minimum Recorded Level (mAHD)	4.26
Maximum Recorded Level (mAHD)	6.776

H19054 Midland Brick

EMW08 Groundwater Bore 8
Kilne 9 & 10 Bore (Flush Mount)

				Natural Surface (mAHD)	8.58
Data Analysis Period Start Date	1/01/2004	Easting	406632	Top of Casing (m AHD)	8.45
Data Analysis Period End Date	31/12/2020	Northing	6473879	End of Hole (mAHD)	0.08

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	4.80	3.65	4.93
6/09/2018	4.80	3.65	4.93
30/10/2018	4.76	3.69	4.89
19/12/2018	5.27	3.18	5.40
7/01/2019	5.47	2.98	5.61
25/01/2019	5.72	2.73	5.85
18/09/2019	4.83	3.62	4.96
29/10/2019	5.21	3.24	5.34
27/11/2019	5.48	2.97	5.61
17/12/2019	5.72	2.73	5.85
21/01/2020	6.15	2.30	6.28
18/02/2020	6.48	1.97	6.61
17/03/2020	6.60	1.85	6.73

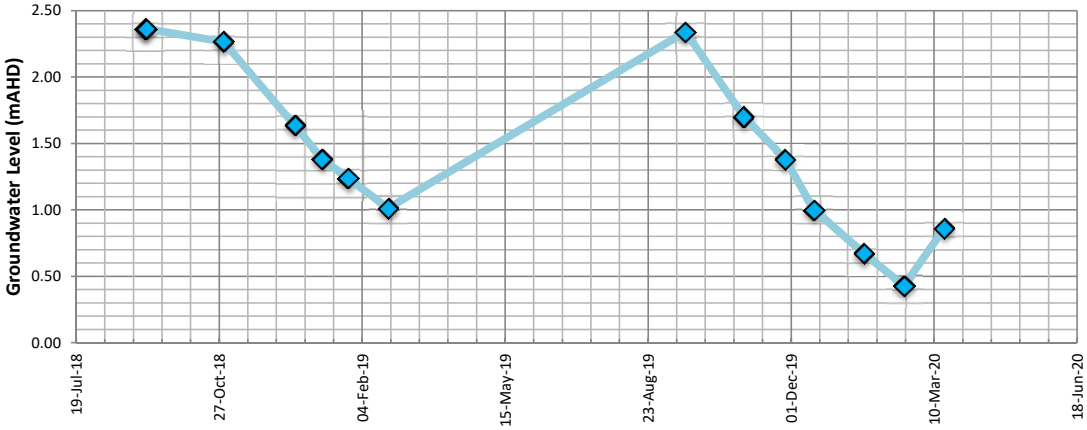
Minimum Recorded Level (mAHD)	1.849
Maximum Recorded Level (mAHD)	3.694

H19054 Midland Brick

EMW09 Groundwater Bore 9
Northern Riverside Bore

				Natural Surface (mAHD)	7.00
Data Analysis Period Start Date	1/01/2004	Easting	406375	Top of Casing (m AHD)	7.33
Data Analysis Period End Date	31/12/2020	Northing	6474025	End of Hole (mAHD)	0.80

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	4.97	2.36	4.64
6/09/2018	4.97	2.36	4.64
30/10/2018	5.07	2.27	4.73
19/12/2018	5.70	1.64	5.37
7/01/2019	5.95	1.38	5.62
25/01/2019	6.09	1.24	5.76
22/02/2019	6.32	1.01	5.99
18/09/2019	4.99	2.34	4.66
29/10/2019	5.63	1.70	5.30
27/11/2019	5.95	1.38	5.62
17/12/2019	6.33	1.00	6.00
21/01/2020	6.66	0.67	6.33
18/02/2020	6.90	0.43	6.57
17/03/2020	6.47	0.86	6.14

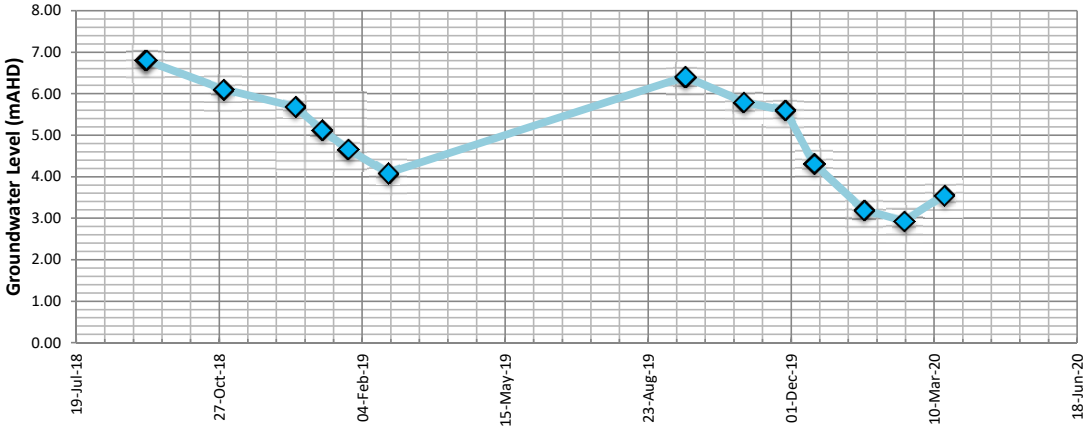
Minimum Recorded Level (mAHD)	0.431
Maximum Recorded Level (mAHD)	2.363

H19054 Midland Brick

EMW10 Groundwater Bore 10
Sales Centre Carpark Bore (Flush Mount)

				Natural Surface (mAHD)	10.35
Data Analysis Period Start Date	1/01/2004	Easting	406708	Top of Casing (m AHD)	10.58
Data Analysis Period End Date	31/12/2020	Northing	6474065	End of Hole (mAHD)	1.85

Report Date : 7/04/2020



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/09/2018	3.78	6.80	3.55
6/09/2018	3.78	6.80	3.55
30/10/2018	4.47	6.11	4.24
19/12/2018	4.90	5.69	4.67
7/01/2019	5.45	5.13	5.22
25/01/2019	5.92	4.66	5.69
22/02/2019	6.50	4.09	6.26
18/09/2019	4.17	6.41	3.94
29/10/2019	4.78	5.80	4.55
27/11/2019	4.99	5.59	4.76
17/12/2019	6.27	4.31	6.04
21/01/2020	7.38	3.20	7.15
18/02/2020	7.65	2.93	7.42
17/03/2020	7.02	3.56	6.79

Minimum Recorded Level (mAHD)	2.932
Maximum Recorded Level (mAHD)	6.798

H19054 Midland Brick

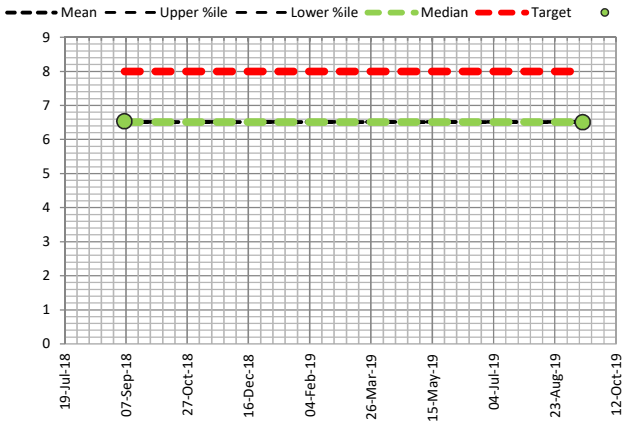
EMW01 Groundwater Bore 1
North West of Kilne 7 & 8 Bore

Easting	405597	Data Analysis Period Start Date	1/01/2004
Northing	6473545	Data Analysis Period End Date	31/12/2020

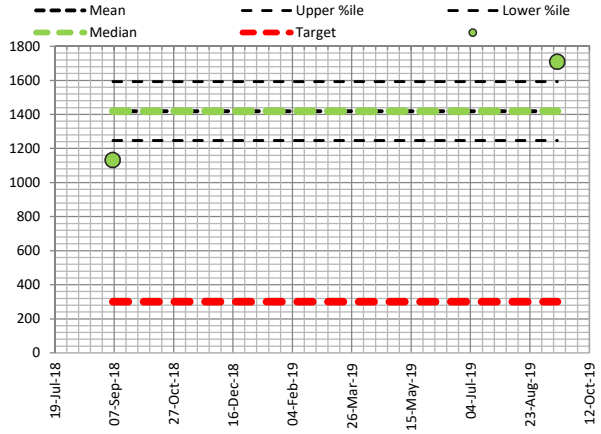
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	13	5.16	5.24	5.43	**5.44**	5.49	5.82		0
GWL mAHD	Groundwater Level	mAHD	13	0.23	0.56	0.62	**0.61**	0.81	0.89		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	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
NO_3-N	Nitrate as N	mg/L	2	0.01	0.01	0.02	**0.02**	0.03	0.04	3.40	0
NO_2-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

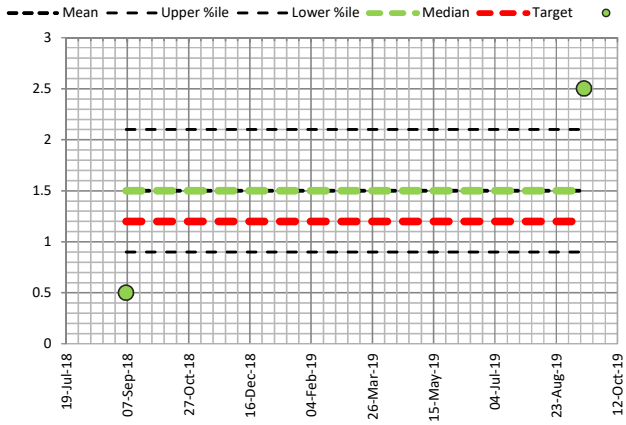
pH



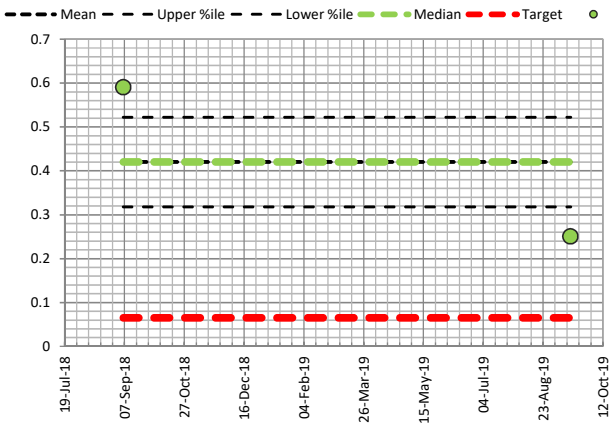
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

H19054 Midland Brick

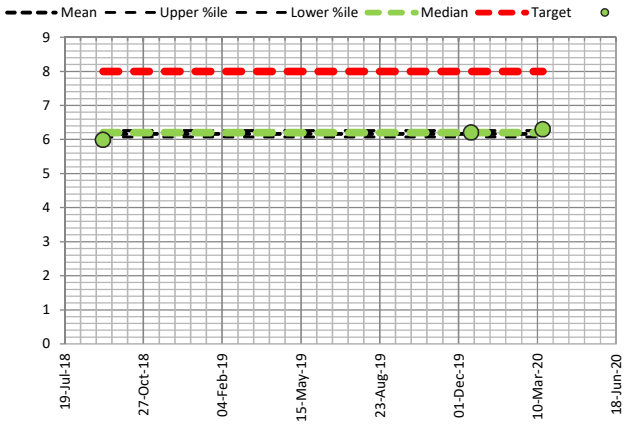
EMW02 Groundwater Bore 2
North West Corner Outside Bund Bore

Easting	405317	Data Analysis Period Start Date	1/01/2004
Northing	6473432	Data Analysis Period End Date	31/12/2020

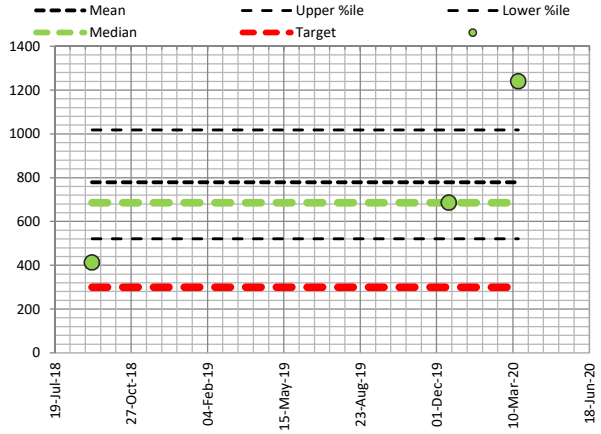
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	11	8.23	8.49	8.77	**8.80**	8.95	9.27		0
GWL mAHD	Groundwater Level	mAHD	11	0.73	1.05	1.22	**1.20**	1.51	1.77		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	3	20.10	20.98	23.07	**22.30**	25.00	26.80		0
EC	Electrical Conductivity	uS/cm	3	412.00	521.60	779.33	**686.00**	1018.40	1240.00	300.00	3
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	3	10.00	19.32	37.83	**33.30**	55.44	70.20	80.00	0
pH	pH	pH	3	5.99	6.07	6.16	**6.20**	6.26	6.30	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	0.50	0.86	1.47	**1.40**	2.06	2.50	1.20	2
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	3	0.01	0.01	0.03	**0.02**	0.05	0.08	1.43	0
NO_3-N	Nitrate as N	mg/L	3	0.04	0.05	0.05	**0.06**	0.06	0.06	3.40	0
NO_2-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	0.30	0.36	0.40	**0.44**	0.45	0.45	0.07	3
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	0.00100	**0.00100**	0.00100	0.00100	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	0.00140	0.00200	**0.00200**	0.00260	0.00300	0.00180	2
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	0.00200	0.00200	0.00300	**0.00200**	0.00380	0.00500	0.01300	0
Zn	Zinc	mg/L	3	0.00200	0.00320	0.00433	**0.00500**	0.00560	0.00600	0.01500	0
Hg	Mercury	mg/L	3	0.00005	0.00005	0.00007	**0.00005**	0.00008	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

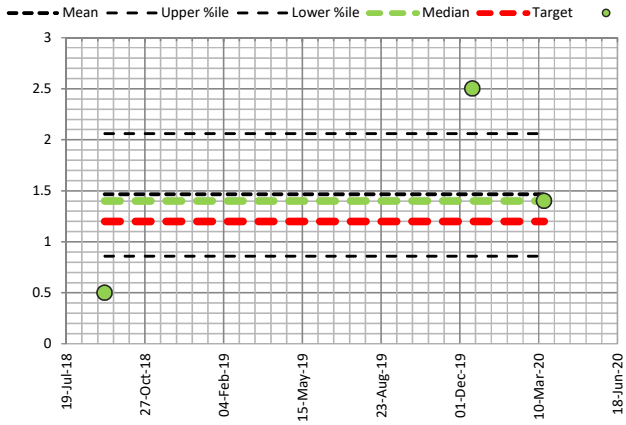
pH



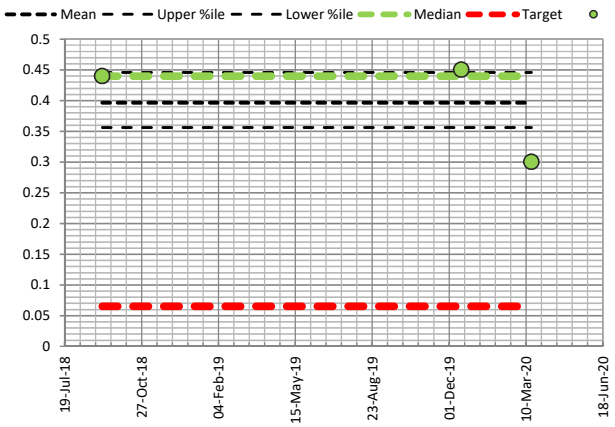
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

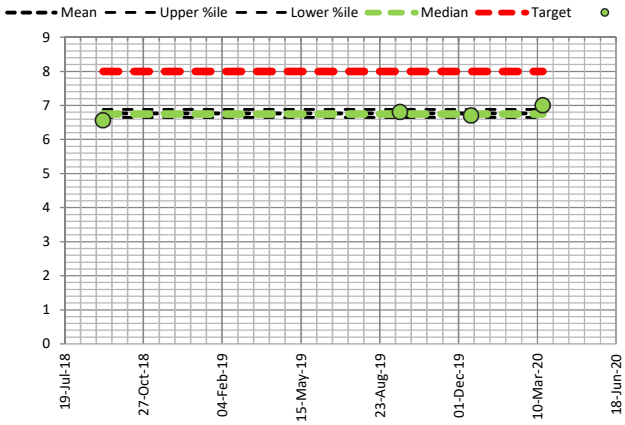
EMW03 Groundwater Bore 3
Oval Storage Area East Bore

Easting	405530	Data Analysis Period Start Date	1/01/2004
Northing	6473108	Data Analysis Period End Date	31/12/2020

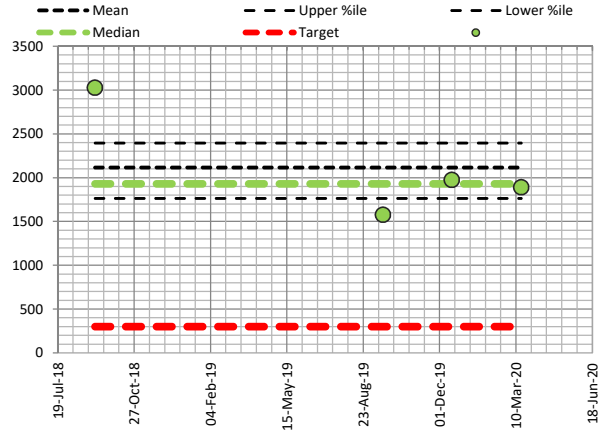
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	9.52	9.81	10.02	**10.02**	10.21	10.50		0
GWL mAHD	Groundwater Level	mAHD	14	0.84	1.13	1.32	**1.32**	1.53	1.82		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	4	21.90	21.96	23.53	**22.45**	24.66	27.30		0
EC	Electrical Conductivity	uS/cm	4	1576.00	1763.80	2116.00	**1930.50**	2394.00	3027.00	300.00	4
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	4	14.20	16.42	29.30	**26.95**	41.24	49.10	80.00	0
pH	pH	pH	4	6.56	6.64	6.77	**6.75**	6.88	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	4	0.50	0.80	1.68	**1.10**	2.32	4.00	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	4	0.01	0.01	0.04	**0.02**	0.06	0.11	1.43	0
NO_3-N	Nitrate as N	mg/L	4	0.01	0.01	0.02	**0.01**	0.03	0.05	3.40	0
NO_2-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	0.35	0.52	0.69	**0.66**	0.85	1.10	0.07	4
FRP	Filterable Reactive Phosphorous	mg/L	4	0.05	0.07	0.11	**0.09**	0.13	0.20	0.04	4
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	0.00150	**0.00100**	0.00180	0.00300	0.00180	1
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	0.00160	0.00350	**0.00350**	0.00540	0.00600	0.01300	0
Zn	Zinc	mg/L	4	0.00200	0.00200	0.00625	**0.00250**	0.00900	0.01800	0.01500	1
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

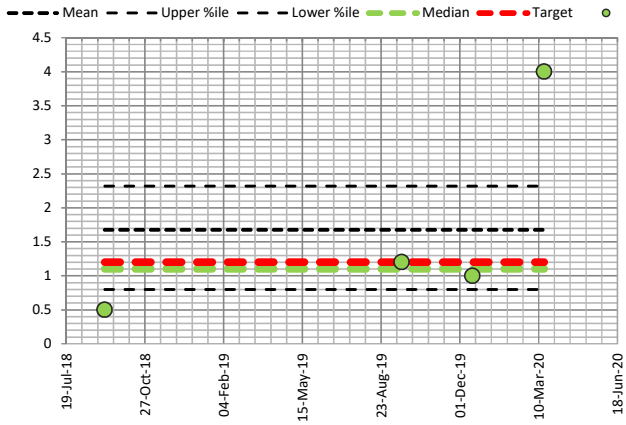
pH



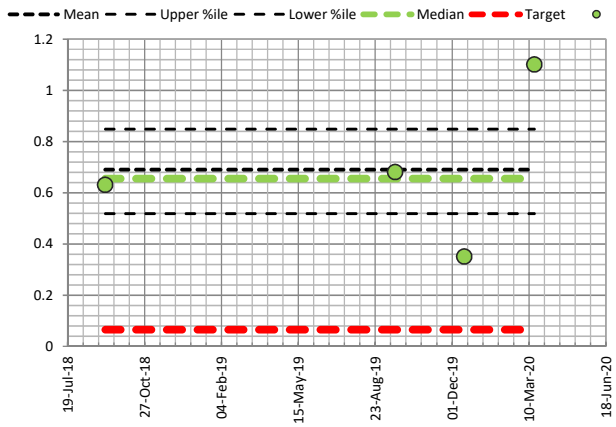
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

H19054 Midland Brick

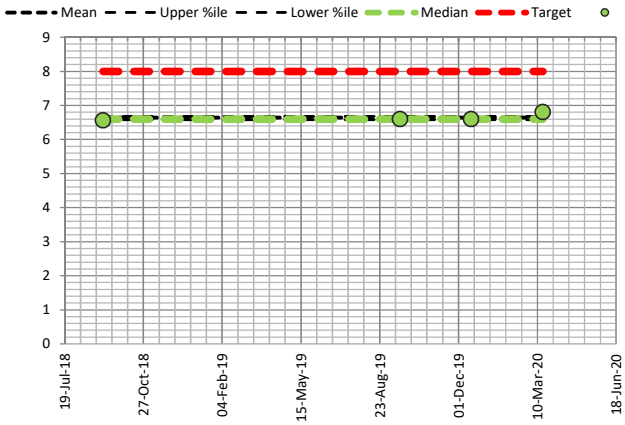
EMW04 Groundwater Bore 4
Oval Storage Area South Bore

Easting	405712	Data Analysis Period Start Date	1/01/2004
Northing	6472730	Data Analysis Period End Date	31/12/2020

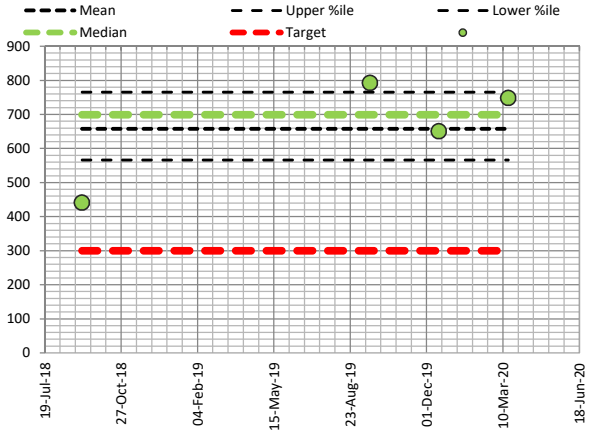
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	7.17	7.33	7.60	**7.70**	7.80	7.92		0
GWL mAHD	Groundwater Level	mAHD	14	1.83	1.95	2.15	**2.05**	2.42	2.58		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	4	20.60	20.72	22.80	**22.05**	24.58	26.50		0
EC	Electrical Conductivity	uS/cm	4	441.00	566.40	657.75	**699.00**	765.60	792.00	300.00	4
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	4	8.50	13.90	16.13	**17.75**	19.00	20.50	80.00	0
pH	pH	pH	4	6.56	6.58	6.64	**6.60**	6.68	6.80	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	0.50	0.62	1.15	**0.90**	1.58	2.30	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	4	0.01	0.01	0.02	**0.02**	0.03	0.04	1.43	0
NO_3-N	Nitrate as N	mg/L	4	0.01	0.01	0.05	**0.05**	0.09	0.10	3.40	0
NO_2-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	0.16	0.20	0.75	**0.32**	1.13	2.20	0.07	4
FRP	Filterable Reactive Phosphorous	mg/L	4	0.01	0.01	0.01	**0.01**	0.01	0.01	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	0.00475	**0.00150**	0.00720	0.01500	0.00180	2
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	0.00275	**0.00200**	0.00420	0.00600	0.01300	0
Zn	Zinc	mg/L	4	0.00200	0.00380	0.01225	**0.01000**	0.01980	0.02700	0.01500	1
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

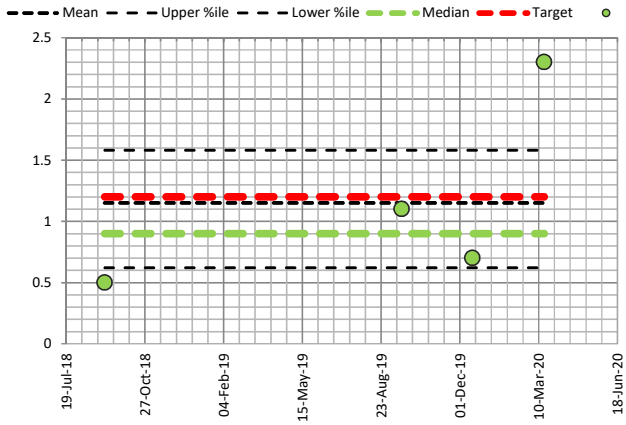
pH



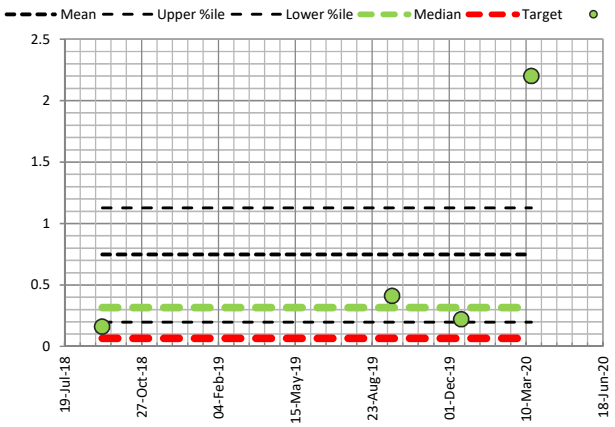
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

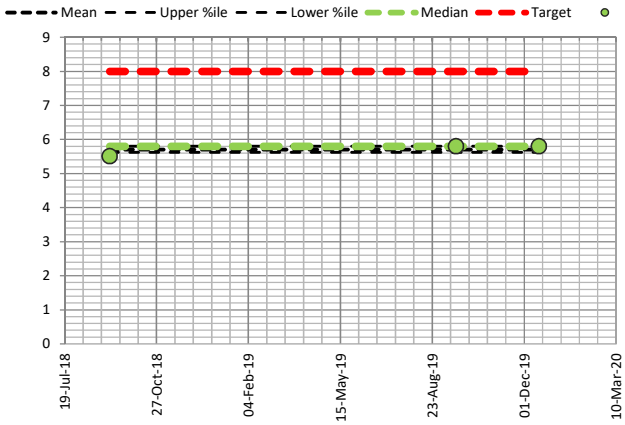
EMW05 Groundwater Bore 5
Clay Shed Bore

Easting	406135	Data Analysis Period Start Date	1/01/2004
Northing	6473245	Data Analysis Period End Date	31/12/2020

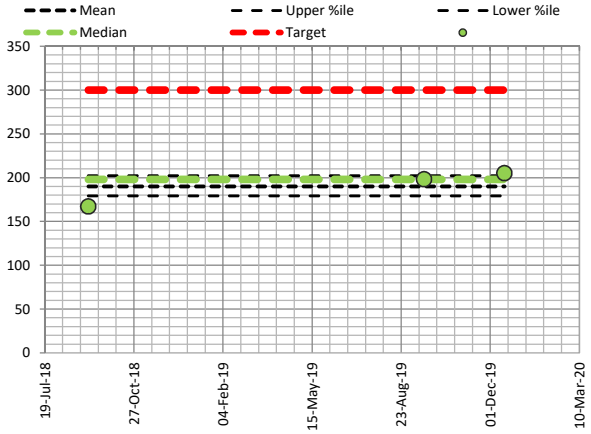
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	13	3.28	3.61	4.72	**4.39**	6.15	6.79		0
GWL mAHD	Groundwater Level	mAHD	13	4.60	5.23	6.66	**6.99**	7.77	8.10		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	3	17.90	18.50	21.40	**19.40**	23.90	26.90		0
EC	Electrical Conductivity	uS/cm	3	167.00	179.40	190.00	**198.00**	202.20	205.00	300.00	0
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	3	13.80	19.76	39.77	**28.70**	57.56	76.80	80.00	0
pH	pH	pH	3	5.51	5.63	5.70	**5.80**	5.80	5.80	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	0.50	0.54	0.77	**0.60**	0.96	1.20	1.20	0
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	3	0.02	0.03	0.05	**0.05**	0.06	0.07	1.43	0
NO_3-N	Nitrate as N	mg/L	3	0.04	0.16	0.26	**0.35**	0.38	0.40	3.40	0
NO_2-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	0.07	0.13	**0.10**	0.19	0.25	0.07	2
FRP	Filterable Reactive Phosphorous	mg/L	3	0.01	0.01	0.01	**0.01**	0.02	0.03	0.04	0
As	Arsenic	mg/L	3	0.00100	0.00100	0.00100	**0.00100**	0.00100	0.00100	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	0.00100	**0.00100**	0.00100	0.00100	0.00180	0
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	0.00100	0.00167	**0.00100**	0.00220	0.00300	0.01300	0
Zn	Zinc	mg/L	3	0.00700	0.00780	0.00967	**0.00900**	0.01140	0.01300	0.01500	0
Hg	Mercury	mg/L	3	0.00005	0.00005	0.00007	**0.00005**	0.00008	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

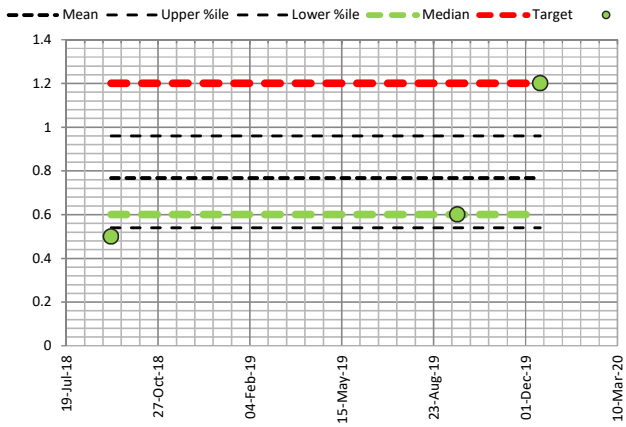
pH



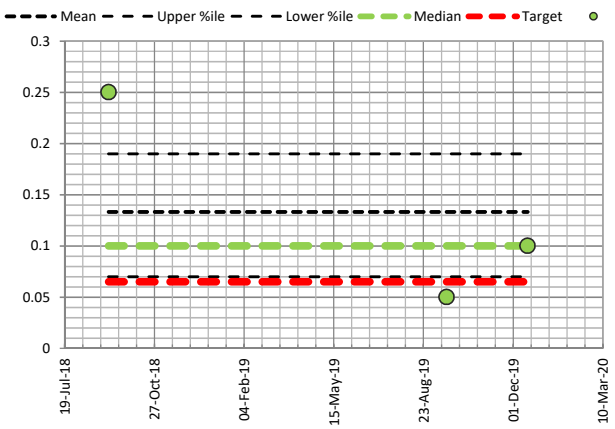
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

H19054 Midland Brick

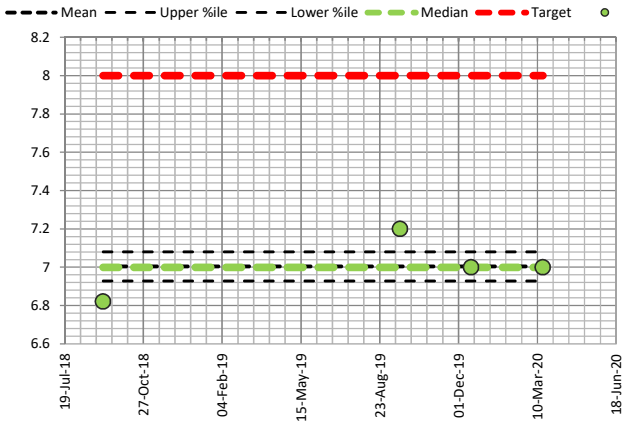
EMW06 Groundwater Bore 6
Ticket Box / Clay Basin Bore

Easting	406305	Data Analysis Period Start Date	1/01/2004
Northing	6473648	Data Analysis Period End Date	31/12/2020

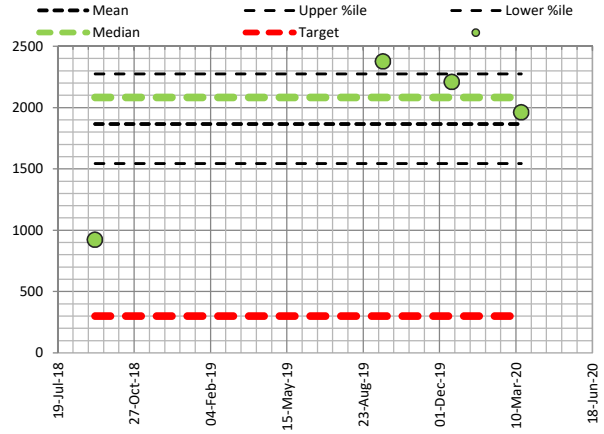
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	1.78	2.78	3.32	**3.40**	3.97	4.80		0
GWL mAHD	Groundwater Level	mAHD	14	1.12	1.96	2.60	**2.53**	3.15	4.14		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	4	18.30	18.48	21.60	**21.35**	24.62	25.40		0
EC	Electrical Conductivity	uS/cm	4	922.00	1544.80	1866.25	**2083.50**	2274.60	2376.00	300.00	4
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	4	11.00	12.02	16.80	**15.25**	20.96	25.70	80.00	0
pH	pH	pH	4	6.82	6.93	7.01	**7.00**	7.08	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	4	0.40	0.46	0.55	**0.50**	0.62	0.80	1.20	0
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	4	0.01	0.01	0.03	**0.02**	0.04	0.08	1.43	0
NO_3-N	Nitrate as N	mg/L	4	0.01	0.01	0.01	**0.01**	0.01	0.02	3.40	0
NO_2-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	0.07	**0.06**	0.08	0.12	0.07	1
FRP	Filterable Reactive Phosphorous	mg/L	4	0.01	0.01	0.01	**0.01**	0.02	0.02	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	0.00125	**0.00100**	0.00140	0.00200	0.00180	1
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	0.00160	0.00475	**0.00300**	0.00720	0.01200	0.01300	0
Zn	Zinc	mg/L	4	0.00300	0.00480	0.01100	**0.00650**	0.01540	0.02800	0.01500	1
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

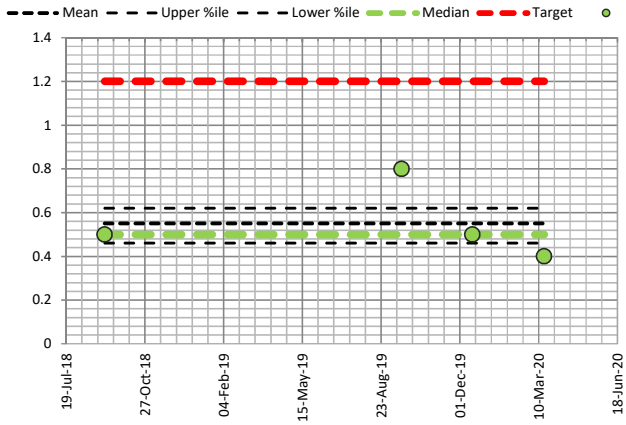
pH



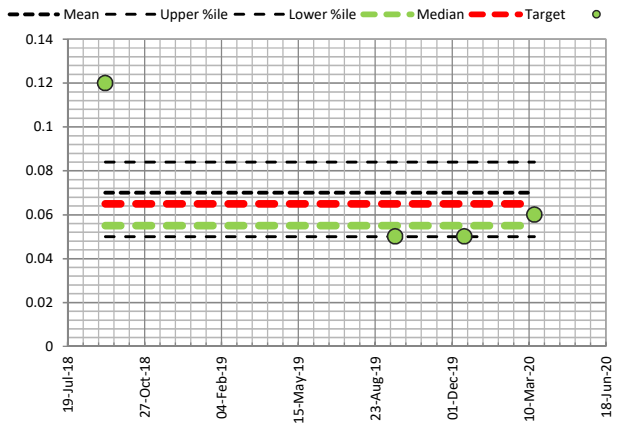
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

H19054 Midland Brick

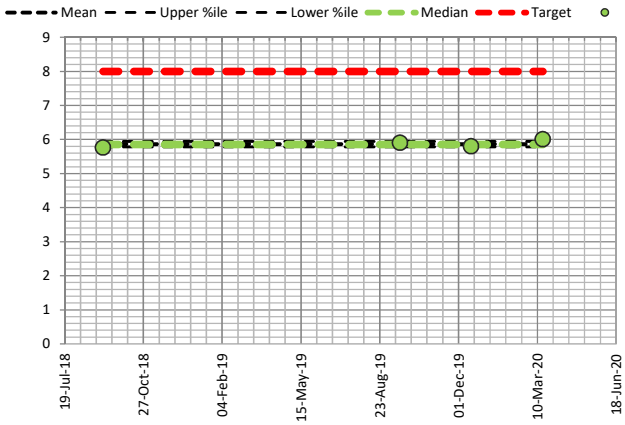
EMW07 Groundwater Bore 7
Whitemans Bore

Easting	406580	Data Analysis Period Start Date	1/01/2004
Northing	6473504	Data Analysis Period End Date	31/12/2020

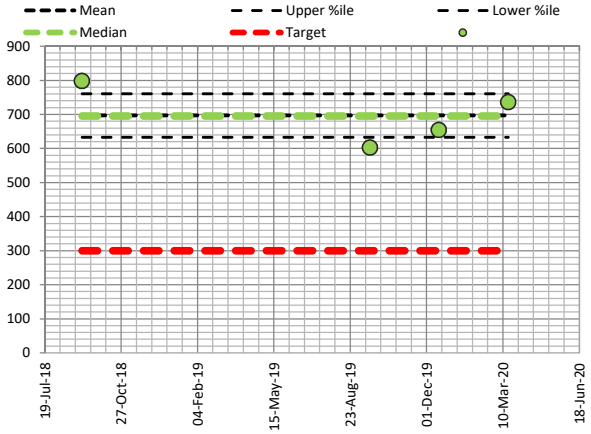
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	2.12	2.48	3.22	**3.07**	4.09	4.64		0
GWL mAHD	Groundwater Level	mAHD	14	4.26	4.81	5.68	**5.83**	6.42	6.78		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	4	20.00	20.36	23.15	**22.80**	25.80	27.00		0
EC	Electrical Conductivity	uS/cm	4	602.00	633.20	697.50	**695.00**	760.80	798.00	300.00	4
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	4	18.20	21.02	25.48	**26.40**	30.30	30.90	80.00	0
pH	pH	pH	4	5.76	5.78	5.87	**5.85**	5.94	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	4	14.00	14.00	21.08	**15.00**	25.72	40.30	1.20	4
TKN	Total Kjeldahl Nitrogen	mg/L	1	7.20	7.20	7.20	**7.20**	7.20	7.20		0
NH3-N	Ammonia as N	mg/L	4	0.01	0.01	0.11	**0.07**	0.20	0.31	1.43	0
NO_3-N	Nitrate as N	mg/L	4	10.00	10.60	16.28	**11.00**	19.84	33.10	3.40	4
NO_2-N	Nitrite as N	mg/L	4	0.01	0.01	0.01	**0.01**	0.02	0.03		0
TP	Total Phosphorous	mg/L	4	0.08	0.19	0.29	**0.31**	0.39	0.44	0.07	4
FRP	Filterable Reactive Phosphorous	mg/L	4	0.01	0.01	0.01	**0.01**	0.01	0.01	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	0.00325	**0.00150**	0.00480	0.00900	0.00180	2
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	0.00175	**0.00150**	0.00240	0.00300	0.01300	0
Zn	Zinc	mg/L	4	0.00100	0.00100	0.00975	**0.00550**	0.01680	0.02700	0.01500	1
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

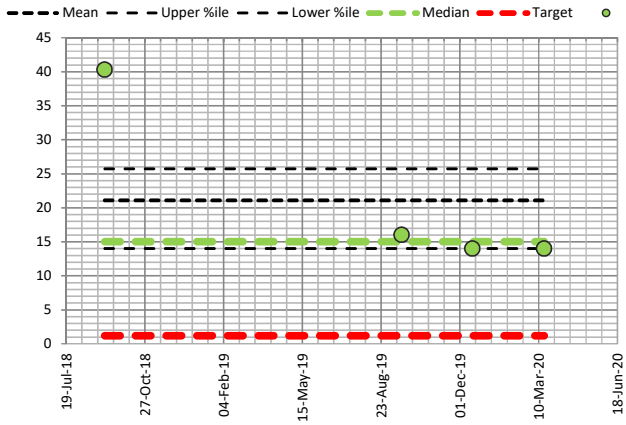
pH



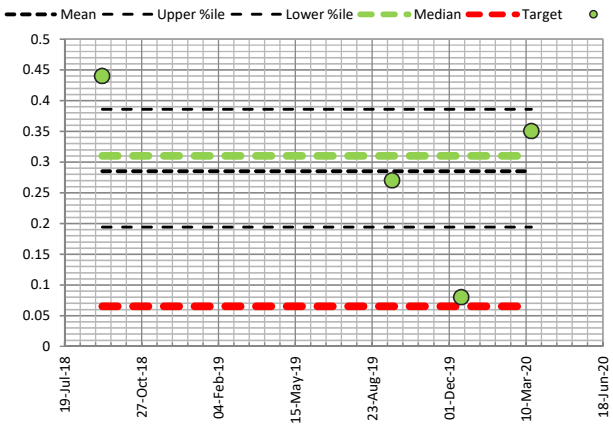
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

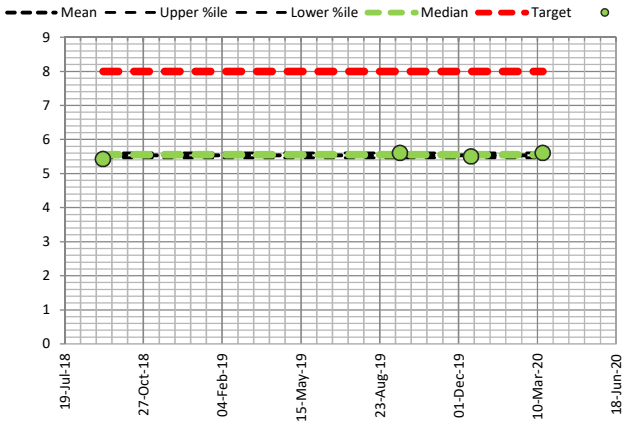
EMW08 Groundwater Bore 8
Kilne 9 & 10 Bore (Flush Mount)

Easting	406632	Data Analysis Period Start Date	1/01/2004
Northing	6473879	Data Analysis Period End Date	31/12/2020

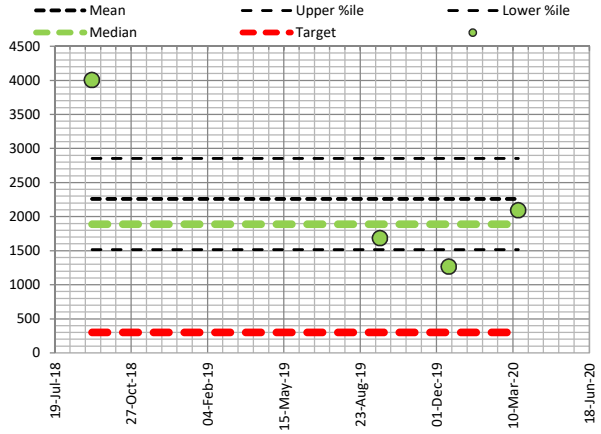
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	13	4.76	4.81	5.48	**5.47**	5.98	6.60		0
GWL mAHD	Groundwater Level	mAHD	13	1.85	2.47	2.97	**2.98**	3.64	3.69		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	4	22.30	22.90	24.25	**23.95**	25.48	26.80		0
EC	Electrical Conductivity	uS/cm	4	1266.00	1516.20	2260.25	**1886.50**	2854.80	4002.00	300.00	4
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	4	7.40	24.14	34.75	**40.70**	47.74	50.20	80.00	0
pH	pH	pH	4	5.42	5.47	5.53	**5.55**	5.60	5.60	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	0.50	0.86	1.25	**1.15**	1.60	2.20	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	4	0.01	0.01	0.05	**0.02**	0.08	0.15	1.43	0
NO_3-N	Nitrate as N	mg/L	4	0.03	0.05	0.39	**0.22**	0.67	1.10	3.40	0
NO_2-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	0.25	**0.16**	0.42	0.65	0.07	2
FRP	Filterable Reactive Phosphorous	mg/L	4	0.01	0.01	0.01	**0.01**	0.02	0.02	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	0.00125	**0.00100**	0.00140	0.00200	0.00180	1
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	0.00160	0.00300	**0.00200**	0.00400	0.00700	0.01300	0
Zn	Zinc	mg/L	4	0.00300	0.00420	0.00725	**0.00750**	0.01040	0.01100	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

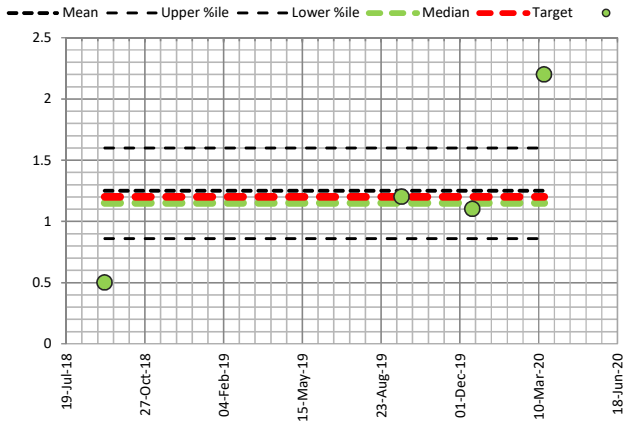
pH



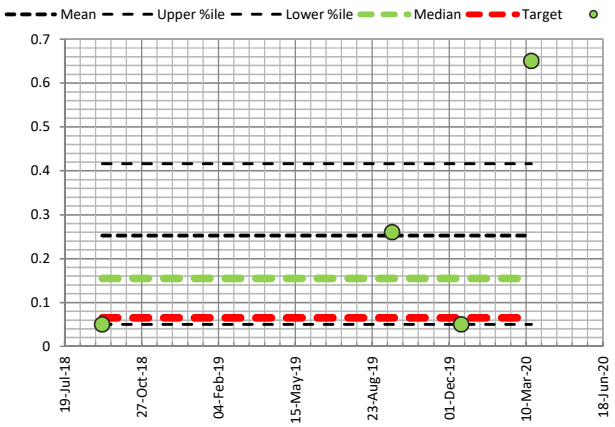
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

H19054 Midland Brick

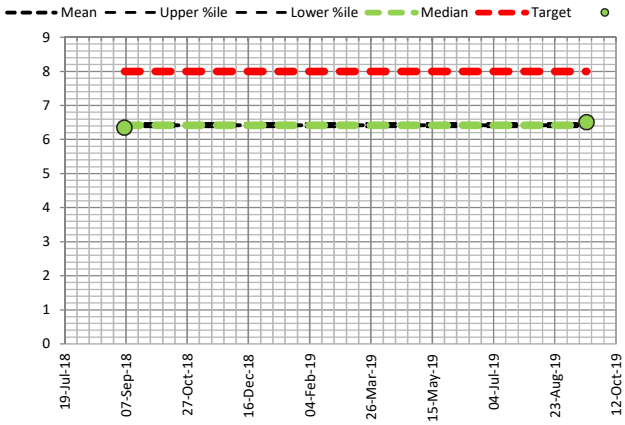
EMW09 Groundwater Bore 9
Northern Riverside Bore

Easting	406375	Data Analysis Period Start Date	1/01/2004
Northing	6474025	Data Analysis Period End Date	31/12/2020

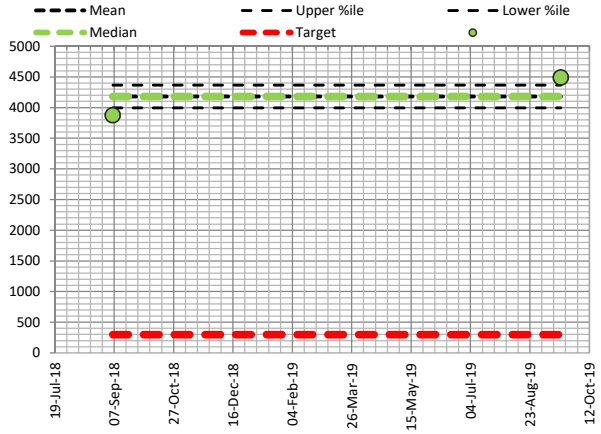
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	4.97	5.04	5.86	**5.95**	6.39	6.90		0
GWL mAHD	Groundwater Level	mAHD	14	0.43	0.95	1.48	**1.38**	2.30	2.36		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	2	21.40	21.42	21.45	**21.45**	21.48	21.50		0
EC	Electrical Conductivity	uS/cm	2	3871.00	3994.40	4179.50	**4179.50**	4364.60	4488.00	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	5.60	7.62	10.65	**10.65**	13.68	15.70	80.00	0
pH	pH	pH	2	6.34	6.37	6.42	**6.42**	6.47	6.50	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	2	0.70	0.92	1.25	**1.25**	1.58	1.80	1.20	1
TKN	Total Kjeldahl Nitrogen	mg/L	1	1.80	1.80	1.80	**1.80**	1.80	1.80		0
NH3-N	Ammonia as N	mg/L	2	0.43	0.66	1.01	**1.01**	1.35	1.58	1.43	1
NO_3-N	Nitrate as N	mg/L	2	0.03	0.03	0.03	**0.03**	0.03	0.04	3.40	0
NO_2-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	0.06	0.09	**0.09**	0.11	0.12	0.07	1
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	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	0.00120	0.00150	**0.00150**	0.00180	0.00200	0.00180	1
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	0.00200	0.00200	0.00200	**0.00200**	0.00200	0.00200	0.01300	0
Zn	Zinc	mg/L	2	0.00600	0.00600	0.00600	**0.00600**	0.00600	0.00600	0.01500	0
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

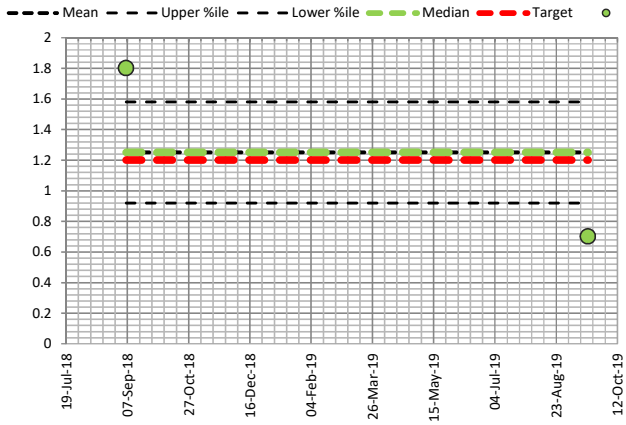
pH



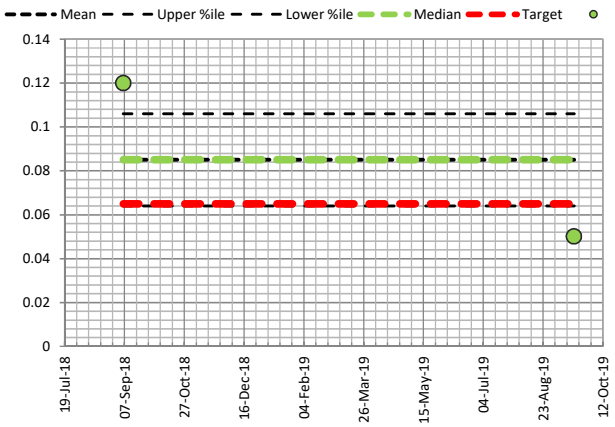
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

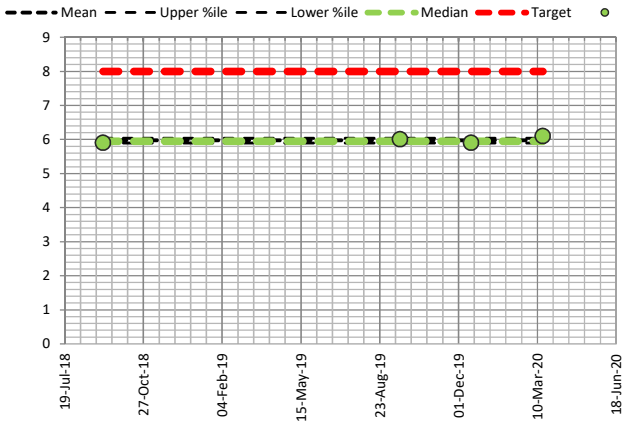
EMW10 Groundwater Bore 10
Sales Centre Carpark Bore (Flush Mount)

Easting	406708	Data Analysis Period Start Date	1/01/2004
Northing	6474065	Data Analysis Period End Date	31/12/2020

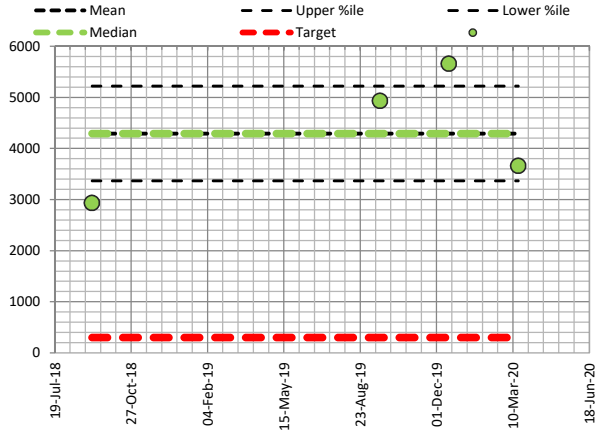
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	14	3.78	4.35	5.50	**5.22**	6.71	7.65		0
GWL mAHD	Groundwater Level	mAHD	14	2.93	3.88	5.08	**5.36**	6.23	6.80		0
SWL	Surface Water Level	m	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	4	19.70	20.30	22.20	**21.05**	23.64	27.00		0
EC	Electrical Conductivity	uS/cm	4	2929.00	3365.80	4293.00	**4293.00**	5220.20	5657.00	300.00	4
DO	Dissolved Oxygen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
DO %	Dissolved Oxygen	%	4	23.70	23.88	32.73	**31.55**	41.10	44.10	80.00	0
pH	pH	pH	4	5.90	5.90	5.98	**5.95**	6.04	6.10	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	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	0.40	0.40	0.65	**0.45**	0.82	1.30	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	4	0.09	0.10	0.12	**0.12**	0.13	0.15	1.43	0
NO_3-N	Nitrate as N	mg/L	4	0.01	0.01	0.03	**0.02**	0.04	0.06	3.40	0
NO_2-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	0.12	0.21	0.88	**0.35**	1.33	2.70	0.07	4
FRP	Filterable Reactive Phosphorous	mg/L	4	0.03	0.05	0.06	**0.06**	0.07	0.07	0.04	3
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	0.00450	**0.00300**	0.00740	0.01100	0.00180	2
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	0.00400	0.00460	0.00625	**0.00650**	0.00800	0.00800	0.01300	0
Zn	Zinc	mg/L	4	0.00900	0.01020	0.02000	**0.01600**	0.02820	0.03900	0.01500	2
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

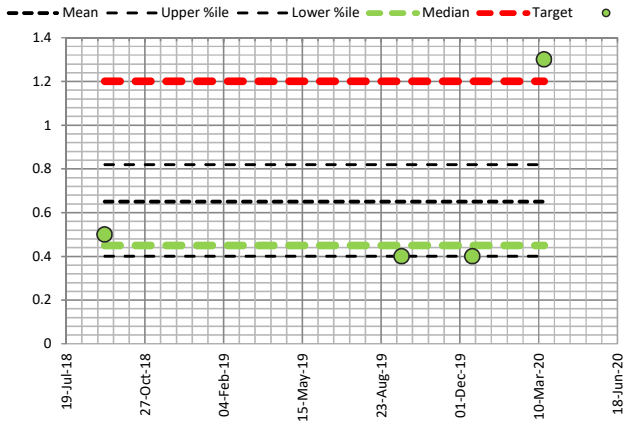
pH



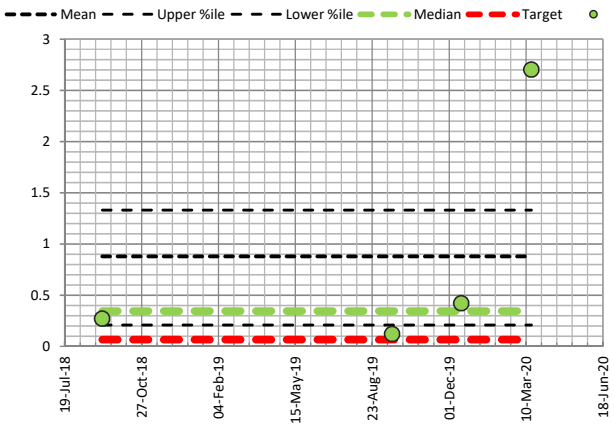
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

H19054 Midland Brick

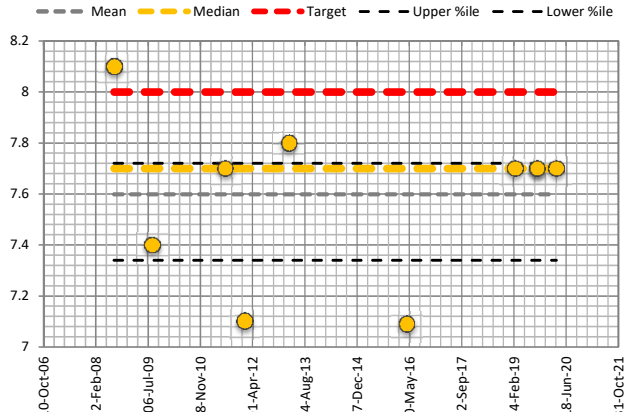
Swan River Sites
Swan River Upstream Site

Data Analysis Period Start Date	1/01/2004
Data Analysis Period End Date	31/12/2020

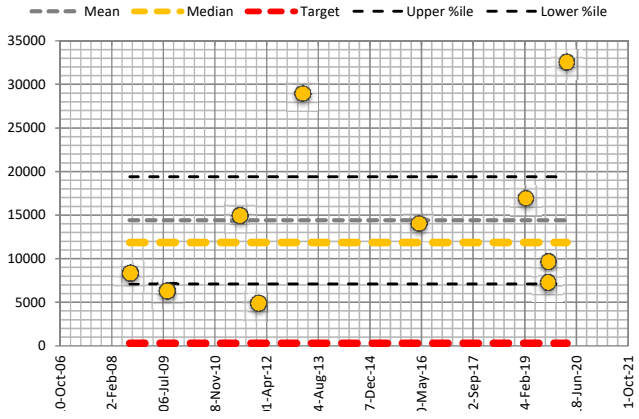
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
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	2	20.20	20.86	21.85	**21.85**	22.84	23.50		0
EC	Electrical Conductivity	uS/cm	10	4900.00	7108.60	14419.40	**11869.50**	19400.00	32612.00	300.00	10
DO	Dissolved Oxygen	mg/L	6	3.16	4.20	7.12	**7.57**	9.90	10.30		0
DO %	Dissolved Oxygen	%	2	46.30	46.66	47.20	**47.20**	47.74	48.10	80.00	0
pH	pH	pH	10	7.09	7.34	7.60	**7.70**	7.72	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	8	0.89	0.94	1.33	**1.20**	1.64	2.20	1.20	4
TKN	Total Kjeldahl Nitrogen	mg/L	6	0.80	1.10	1.78	**1.70**	2.70	2.70		0
NH3-N	Ammonia as N	mg/L	6	0.05	0.06	0.17	**0.09**	0.36	0.40	1.43	0
NO_3-N	Nitrate as N	mg/L	9	0.01	0.04	0.53	**0.07**	0.95	2.25	3.40	0
NO_2-N	Nitrite as N	mg/L	6	0.01	0.01	0.08	**0.05**	0.09	0.25		0
TP	Total Phosphorous	mg/L	10	0.01	0.03	0.08	**0.08**	0.12	0.23	0.07	6
FRP	Filterable Reactive Phosphorous	mg/L	5	0.01	0.01	0.03	**0.02**	0.05	0.08	0.04	2
As	Arsenic	mg/L	12	0.00100	0.00120	0.00400	**0.00450**	0.00500	0.01000	0.09400	0
Cd	Cadmium	mg/L	12	0.00010	0.00010	0.00113	**0.00050**	0.00090	0.00500	0.00040	7
Cr	Chromium	mg/L	11	0.00050	0.00100	0.00495	**0.00500**	0.00500	0.02500		0
Cu	Copper	mg/L	12	0.00050	0.00120	0.00504	**0.00400**	0.00500	0.02500	0.00180	9
Pb	Lead	mg/L	12	0.00050	0.00100	0.00288	**0.00250**	0.00500	0.00500	0.00560	0
Ni	Nickel	mg/L	12	0.00100	0.00200	0.00558	**0.00500**	0.00500	0.02500	0.01300	1
Zn	Zinc	mg/L	12	0.00200	0.00920	0.01925	**0.01900**	0.02500	0.05000	0.01500	6
Hg	Mercury	mg/L	11	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

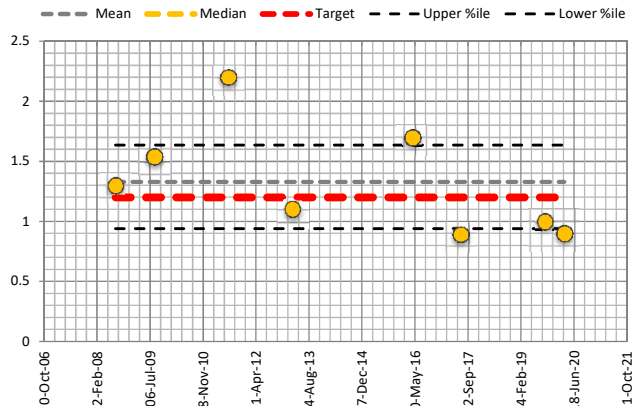
pH



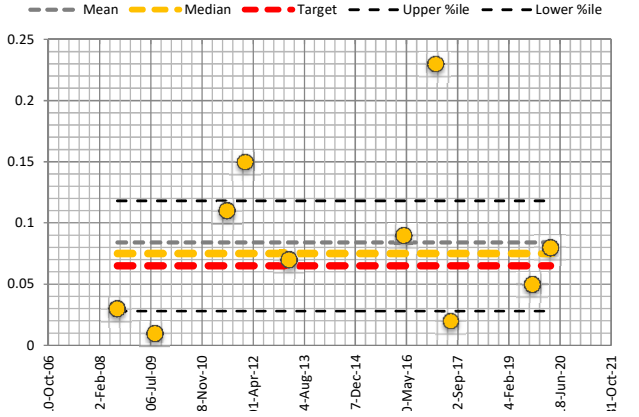
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

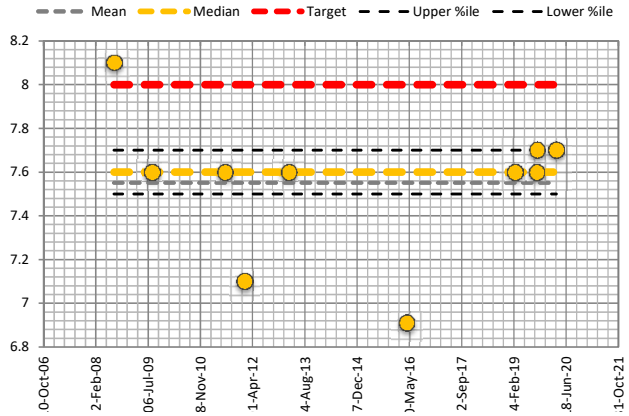
Swan River Sites
Swan River Downstream Site

Data Analysis Period Start Date	1/01/2004
Data Analysis Period End Date	31/12/2020

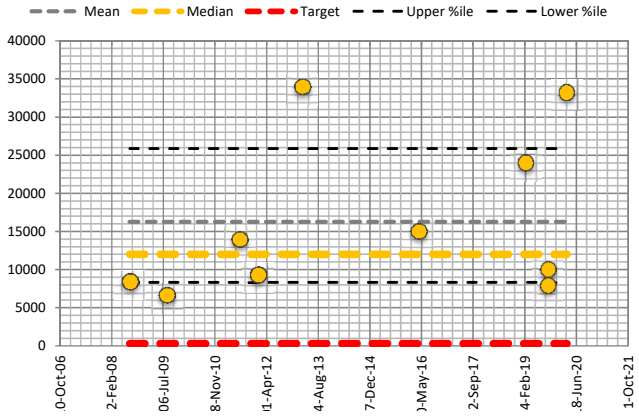
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
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	2	19.60	20.38	21.55	**21.55**	22.72	23.50		0
EC	Electrical Conductivity	uS/cm	10	6675.00	8320.00	16273.90	**12005.00**	25858.40	34000.00	300.00	10
DO	Dissolved Oxygen	mg/L	6	2.85	4.50	6.73	**6.82**	9.20	10.20		0
DO %	Dissolved Oxygen	%	2	37.50	38.70	40.50	**40.50**	42.30	43.50	80.00	0
pH	pH	pH	10	6.91	7.50	7.55	**7.60**	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	8	0.90	0.99	1.46	**1.40**	1.88	2.30	1.20	5
TKN	Total Kjeldahl Nitrogen	mg/L	6	0.85	1.40	1.96	**1.85**	2.80	3.00		0
NH3-N	Ammonia as N	mg/L	6	0.05	0.07	0.19	**0.09**	0.39	0.43	1.43	0
NO_3-N	Nitrate as N	mg/L	9	0.02	0.05	0.60	**0.10**	0.98	2.68	3.40	0
NO_2-N	Nitrite as N	mg/L	6	0.01	0.01	0.09	**0.05**	0.13	0.30		0
TP	Total Phosphorous	mg/L	10	0.03	0.03	0.10	**0.08**	0.15	0.23	0.07	6
FRP	Filterable Reactive Phosphorous	mg/L	5	0.01	0.02	0.04	**0.04**	0.07	0.08	0.04	3
As	Arsenic	mg/L	12	0.00100	0.00100	0.00375	**0.00450**	0.00500	0.01000	0.09400	0
Cd	Cadmium	mg/L	12	0.00010	0.00010	0.00113	**0.00050**	0.00090	0.00500	0.00040	7
Cr	Chromium	mg/L	11	0.00050	0.00100	0.00495	**0.00500**	0.00500	0.02500		0
Cu	Copper	mg/L	12	0.00050	0.00200	0.00504	**0.00400**	0.00500	0.02500	0.00180	10
Pb	Lead	mg/L	12	0.00050	0.00100	0.00296	**0.00300**	0.00500	0.00500	0.00560	0
Ni	Nickel	mg/L	12	0.00100	0.00220	0.00567	**0.00500**	0.00500	0.02500	0.01300	1
Zn	Zinc	mg/L	12	0.00100	0.00520	0.01883	**0.02300**	0.02500	0.05000	0.01500	7
Hg	Mercury	mg/L	11	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

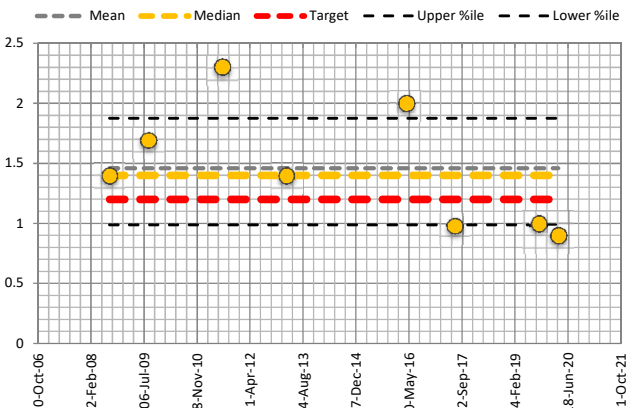
pH



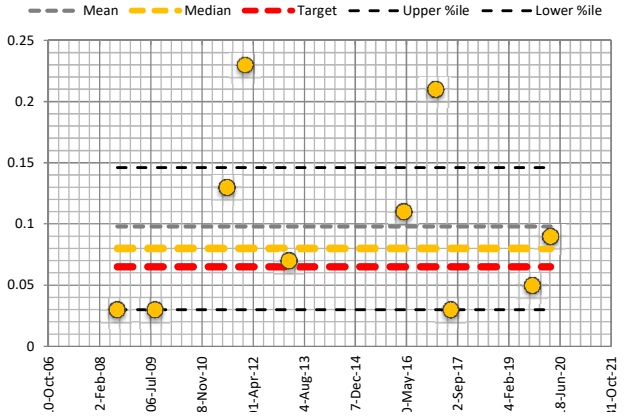
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

SW6 Surface Water Site 6

MB : Clay Basin

Easting

Northing

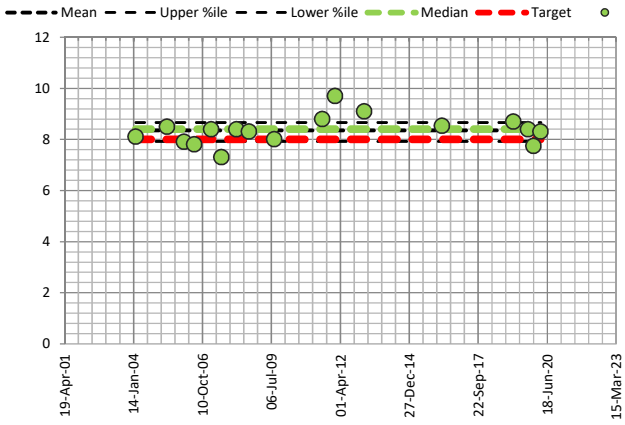
Data Analysis Period Start Date: 1/01/2004

Data Analysis Period End Date: 31/12/2020

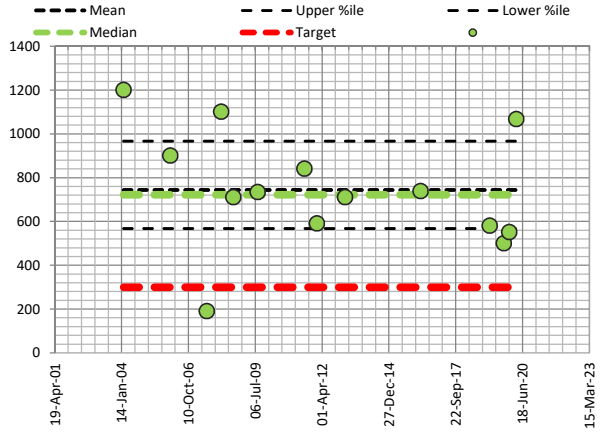
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
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	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	0	0.00	0.000	0.000	**0.000**	0.000	0.000		0
T	Temperature	°C	2	24.40	25.22	26.45	**26.45**	27.68	28.50		0
EC	Electrical Conductivity	uS/cm	14	190.00	568.40	743.57	**722.00**	966.80	1200.00	300.00	13
DO	Dissolved Oxygen	mg/L	12	6.10	7.70	8.64	**8.60**	9.65	11.20		0
DO %	Dissolved Oxygen	%	2	60.40	71.92	89.20	**89.20**	106.48	118.00	80.00	1
pH	pH	pH	17	7.30	7.92	8.35	**8.40**	8.67	9.70	8.00	12
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	15	0.30	0.40	0.69	**0.60**	0.91	1.30	1.20	1
TKN	Total Kjeldahl Nitrogen	mg/L	6	0.53	0.53	0.70	**0.68**	0.88	0.90		0
NH3-N	Ammonia as N	mg/L	12	0.01	0.01	0.05	**0.04**	0.07	0.16	1.43	0
NO_3-N	Nitrate as N	mg/L	16	0.01	0.05	0.20	**0.05**	0.20	1.60	3.40	0
NO_2-N	Nitrite as N	mg/L	7	0.01	0.01	0.04	**0.05**	0.05	0.06		0
TP	Total Phosphorous	mg/L	17	0.01	0.01	0.03	**0.02**	0.05	0.09	0.07	2
FRP	Filterable Reactive Phosphorous	mg/L	5	0.00	0.00	0.00	**0.01**	0.01	0.01	0.04	0
As	Arsenic	mg/L	20	0.00100	0.00100	0.00185	**0.00100**	0.00200	0.00500	0.09400	0
Cd	Cadmium	mg/L	20	0.00010	0.00010	0.00155	**0.00055**	0.00500	0.00500	0.00040	10
Cr	Chromium	mg/L	19	0.00010	0.00100	0.01590	**0.00300**	0.05000	0.05000		0
Cu	Copper	mg/L	20	0.00010	0.00100	0.01451	**0.00100**	0.05000	0.05000	0.00180	9
Pb	Lead	mg/L	20	0.00010	0.00100	0.00951	**0.00100**	0.00500	0.05000	0.00560	3
Ni	Nickel	mg/L	20	0.00100	0.00100	0.00990	**0.00300**	0.00560	0.05000	0.01300	3
Zn	Zinc	mg/L	20	0.00100	0.00500	0.02255	**0.00900**	0.05000	0.11000	0.01500	6
Hg	Mercury	mg/L	19	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

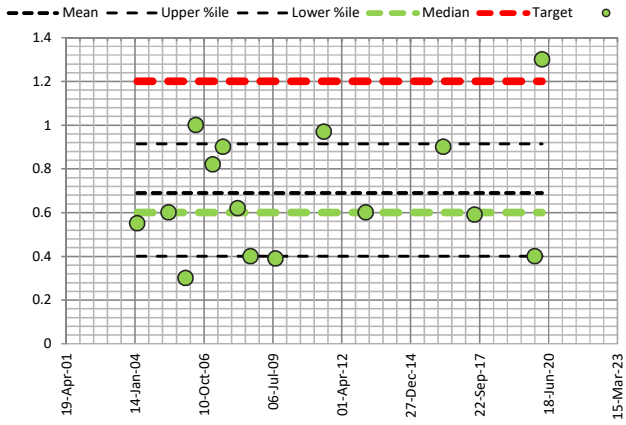
pH



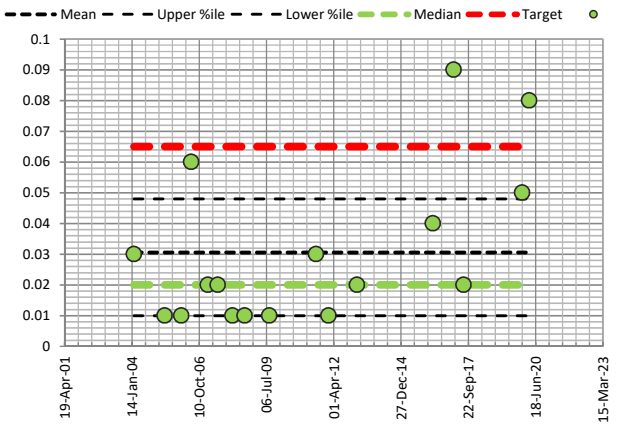
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

SW7 Surface Water Site 7

MB : Northern Storage Pond 4

Easting

Northing

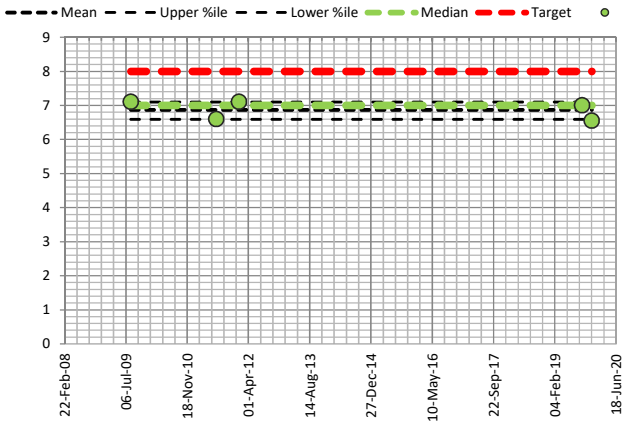
Data Analysis Period Start Date: 1/01/2004

Data Analysis Period End Date: 31/12/2020

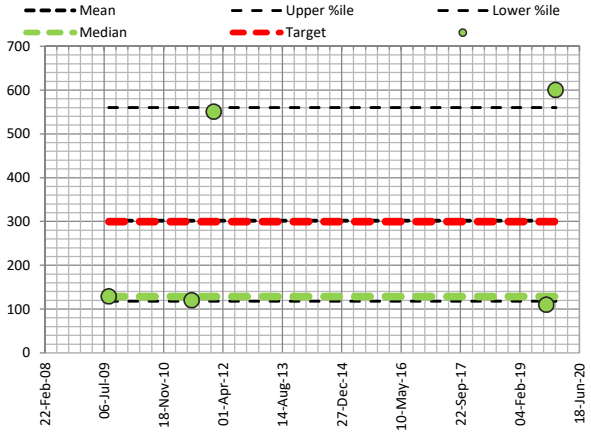
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
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	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	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
NO_3-N	Nitrate as N	mg/L	4	0.01	0.01	0.07	**0.03**	0.11	0.20	3.40	0
NO_2-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

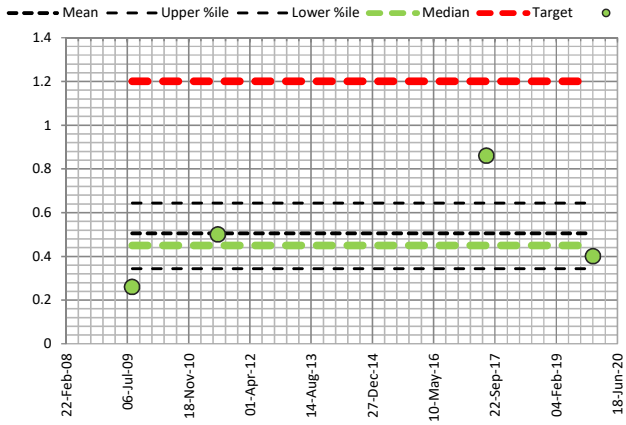
pH



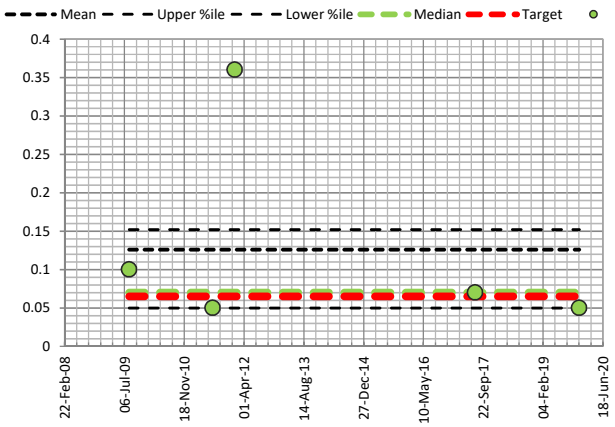
Electrical Conductivity



Total Nitrogen



Total Phosphorous



H19054 Midland Brick

SW10 Surface Water Site 10

MB : Southern Storage Area

Easting

Northing

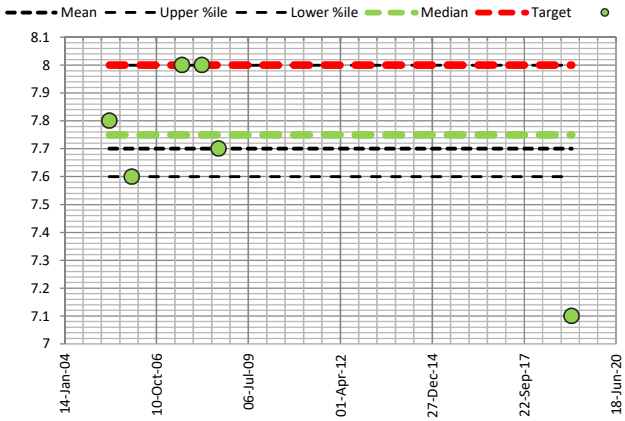
Data Analysis Period Start Date: 1/01/2004

Data Analysis Period End Date: 31/12/2020

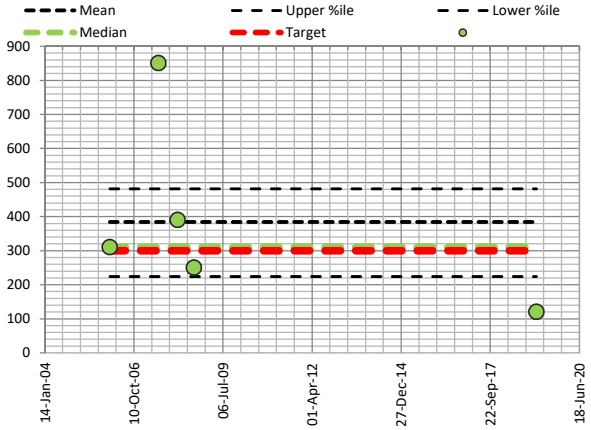
Report Date : 7/04/2020

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 90%	Times Exceeded
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	0.000	0.000	**0.000**	0.000	0.000		0
SWF	Flow Estimate	m³/s	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	5	120.00	224.00	384.00	**310.00**	482.00	850.00	300.00	3
DO	Dissolved Oxygen	mg/L	4	7.00	7.66	8.58	**8.55**	9.48	10.20		0
DO %	Dissolved Oxygen	%	0	0.00	0.00	0.00	**0.00**	0.00	0.00	80.00	0
pH	pH	pH	6	7.10	7.60	7.70	**7.75**	8.00	8.00	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	5	0.18	0.44	0.70	**0.71**	1.02	1.10	1.20	0
TKN	Total Kjeldahl Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH3-N	Ammonia as N	mg/L	5	0.01	0.01	0.05	**0.06**	0.07	0.10	1.43	0
NO_3-N	Nitrate as N	mg/L	5	0.05	0.05	0.59	**0.05**	0.63	2.70	3.40	0
NO_2-N	Nitrite as N	mg/L	2	0.05	0.05	0.05	**0.05**	0.05	0.05		0
TP	Total Phosphorous	mg/L	5	0.02	0.02	0.04	**0.04**	0.05	0.06	0.07	0
FRP	Filterable Reactive Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.04	0
As	Arsenic	mg/L	6	0.00100	0.00100	0.00183	**0.00100**	0.00200	0.00500	0.09400	0
Cd	Cadmium	mg/L	6	0.00010	0.00100	0.00218	**0.00100**	0.00500	0.00500	0.00040	5
Cr	Chromium	mg/L	5	0.00500	0.00500	0.02760	**0.02800**	0.05000	0.05000		0
Cu	Copper	mg/L	6	0.00100	0.00500	0.02100	**0.01000**	0.05000	0.05000	0.00180	5
Pb	Lead	mg/L	6	0.00100	0.00500	0.01933	**0.00500**	0.05000	0.05000	0.00560	2
Ni	Nickel	mg/L	6	0.00100	0.00500	0.01933	**0.00500**	0.05000	0.05000	0.01300	2
Zn	Zinc	mg/L	6	0.00900	0.01300	0.03850	**0.02950**	0.05000	0.10000	0.01500	4
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

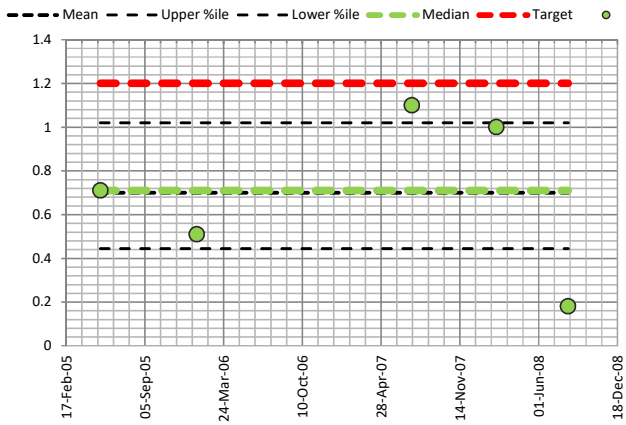
pH



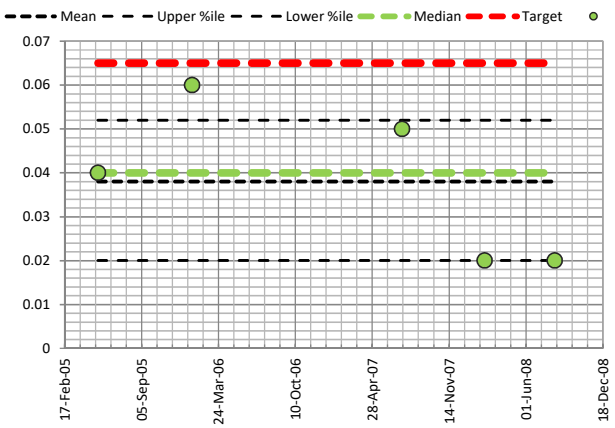
Electrical Conductivity



Total Nitrogen



Total Phosphorous



FieldDAE

Field Data Analysis & Evaluation System

FieldDAE
Field Data Analysis & Evaluation System

Water Quality Monitoring Data

note blue shaded cells represent result less than limit of detection

Date	Site	Monitored By	Monitoring Comment	GWL bToC mBToC	GWL mAHD mAHD	SWL m	SWF m³/s	T °C	EC uS/cm	DO mg/L	DO % %	pH pH	ORP mV	TUR NTU	TSS mg/L	TN mg/L	TKN mg/L	NH3-N mg/L	NO_3-N mg/L	NO_2-N mg/L	TP mg/L	FRP mg/L	As mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Pb mg/L	Ni mg/L	Zn mg/L	Hg mg/L	TDS mg/L
15/02/2004	SW6	Midland Brick							1200			8.10				0.550			0.200		0.030		0.005	0.005	0.05	0.05	0.05	0.05	0.05	0.00005	
15/05/2005	SW10	Midland Brick								7.00		7.80				0.710		0.010	2.700		0.040		0.005	0.005	0.05	0.05	0.05	0.05	0.1	0.00005	
15/05/2005	SW6	Midland Brick								8.50		8.50				0.600		0.013	0.500		0.010		0.005	0.005	0.05	0.05	0.05	0.05	0.05	0.00005	
15/01/2006	SW10	Midland Brick							310			7.60				0.510		0.005	0.050		0.060		0.001	0.005	0.05	0.05	0.05	0.05	0.05	0.0001	
15/01/2006	SW6	Midland Brick							900			7.90				0.300		0.005	0.050		0.010		0.001	0.005	0.05	0.05	0.05	0.05	0.05	0.0001	
15/06/2006	SW12	Midland Brick								6.80		7.00				0.900		0.093	0.098		0.060		0.002	0.005	0.05	0.05	0.005	0.025	0.45	0.0001	
15/06/2006	SW6	Midland Brick								11.20		7.80				1.000		0.072	0.050		0.060		0.001	0.005	0.05	0.05	0.005	0.005	0.05	0.0001	
15/02/2007	SW12	Midland Brick								8.10		7.80				0.690		0.005	0.050		0.050		0.001	0.005	0.05	0.05	0.005	0.005	0.05	0.0001	
15/02/2007	SW6	Midland Brick								8.60		8.40				0.820		0.005	0.050		0.020		0.001	0.005	0.05	0.05	0.005	0.005	0.05	0.0008	
15/07/2007	SW10	Midland Brick							850	9.00		8.00				1.100		0.058	0.110		0.050		0.001	0.001	0.028	0.01	0.005	0.005	0.04	0.00005	
15/07/2007	SW6	Midland Brick							190	7.50		7.30				0.900		0.024	1.600		0.020		0.001	0.001	0.024	0.01	0.005	0.008	0.11	0.00005	
15/02/2008	SW10	Midland Brick							390	8.10		8.00				1.000		0.061	0.050	0.050	0.020		0.001	0.001	0.005	0.01	0.005	0.005	0.019	0.00005	
15/02/2008	SW6	Midland Brick							1100	9.30		8.40				0.620		0.008	0.050	0.050	0.010		0.001	0.001	0.005	0.01	0.005	0.005	0.01	0.00005	
15/08/2008	SW10	Midland Brick							250	10.20		7.70				0.180		0.100	0.050	0.050	0.020		0.002	0.001	0.005	0.005	0.005	0.005	0.013	0.00005	
15/08/2008	SW6	Midland Brick							710	9.80		8.30				0.400		0.100	0.080	0.050	0.010		0.002	0.001	0.005	0.005	0.005	0.005	0.01	0.00005	
15/08/2008	SW8	Midland Brick							8300	10.30		8.10				1.300		0.100	1.700	0.050	0.030		0.004	0.005	0.025	0.025	0.004	0.025	0.05	0.00005	
15/08/2008	SW9	Midland Brick							8400	10.20		8.10				1.400		0.100	1.800	0.050	0.030		0.004	0.005	0.025	0.025	0.004	0.025	0.05	0.00005	
15/08/2009	SW12	Midland Brick							95	4.91		7.50				0.390			0.200		0.080		0.002	0.001	0.005	0.005	0.005	0.022	0.043	0.00005	
15/08/2009	SW6	Midland Brick							734	8.59		8.00				0.390			0.200		0.010		0.002	0.001	0.005	0.005	0.005	0.005	0.01	0.00005	
15/08/2009	SW7	Midland Brick							129	4.32		7.10				0.260			0.200		0.100		0.002	0.001	0.005	0.005	0.005	0.034	0.053	0.00005	
15/08/2009	SW8	Midland Brick							6343	8.53		7.40				1.540			2.250		0.010		0.01	0.001	0.005	0.005	0.005	0.008	0.029	0.00005	
15/08/2009	SW9	Midland Brick							6675	8.54		7.60				1.690			2.680		0.030		0.01	0.001	0.005	0.005	0.005	0.008	0.01	0.00005	
15/07/2011	SW11	Midland Brick							270	1.00		7.00				2.30	2.20		0.073		7.700		0.003	0.0001	0.001	0.001	0.001	0.003	0.002	0.00005	
15/07/2011	SW13	Midland Brick							110	4.20		6.50				0.62	0.59		0.025		0.070		0.001	0.0001	0.001	0.001	0.001	0.004	0.075	0.00005	
15/07/2011	SW6	Midland Brick							840	6.10		8.80				0.97	0.77		0.200		0.030		0.002	0.0001	0.003	0.001	0.001	0.001	0.009	0.00005	
15/07/2011	SW7	Midland Brick							120	4.10		6.60				0.50	0.48		0.017		0.050		0.001	0.0001	0.001	0.001	0.001	0.006	0.066	0.00005	
15/07/2011	SW8	Midland Brick							15000	9.90		7.70				2.20	1.80		0.450		0.110		0.005	0.0005	0.005	0.005	0.005	0.005	0.013	0.00005	
15/07/2011	SW9	Midland Brick							14000	9.20		7.60				2.30	1.90		0.440		0.130		0.005	0.0005	0.005	0.005	0.005	0.005	0.005	0.00005	
15/01/2012	SW13	Midland Brick							210	7.10		6.30					1.30				0.080		0.004	0.0003	0.001	0.004	0.001	0.017	0.62	0.00005	
15/01/2012	SW6	Midland Brick							590	8.50		9.70					0.53				0.010		0.002	0.0001	0.003	0.001	0.001	0.001	0.009	0.00005	
15/01/2012	SW7	Midland Brick							550	4.80		7.10					3.00				0.360		0.005	0.0001	0.007	0.009	0.005	0.007	0.14	0.00005	
15/01/2012	SW8	Midland Brick							4900	4.20		7.10					2.70				0.150		0.004	0.0001	0.001	0.003	0.001	0.003	0.013	0.00005	
15/01/2012	SW9	Midland Brick							9300	4.50		7.10					2.80				0.230		0.001	0.0001	0.001	0.003	0.002	0.003	0.028	0.00005	
15/03/2013	SW6	Midland Brick							710	6.70		9.10				0.60	0.58		0.014		0.020		0.004	0.0001	0.001	0.001	0.001	0.001	0.009	0.00005	
15/03/2013	SW8	Midland Brick							29000	6.60		7.80				1.10	1.10		0.005		0.070		0.002	0.0001	0.001	0.001	0.001	0.002	0.005	0.00005	
15/03/2013	SW9	Midland Brick							34000	5.10		7.60				1.40	1.40		0.019		0.070		0.002	0.0001	0.001	0.002	0.001	0.002	0.005	0.00005	
15/04/2016	SW11	Midland Brick							161	0.87		5.95				1.70	1.70	0.550	0.050	0.050	0.370	0.054	0.001	0.0001	0.0001	0.0001	0.0001	0.006	0.005	0.00005	
15/04/2016	SW13	Midland Brick							221	0.29		7.03				2.30	2.30	0.050	0.050	0.050	0.670	0.084	0.001	0.0001	0.0001	0.0001	0.0001	0.003	0.005	0.00005	
15/04/2016	SW6	Midland Brick							738	9.74		8.53				0.90	0.88	0.050	0.050	0.050	0.040	0.002	0.002	0.0001	0.0001	0.0001	0.0001	0.001	0.005	0.00005	
15/04/2016	SW8	Midland Brick							14059	3.16		7.09				1.70	1.60	0.360	0.070	0.050	0.090	0.013	0.005	0.0005	0.0005	0.0005	0.0005	0.005	0.025	0.00005	
15/04/2016	SW9	Midland Brick							15062	2.85		6.91				2.00	1.80	0.390	0.090	0.050	0.110	0.044	0.005	0.0005	0.0005	0.0005	0.0005	0.005	0.025	0.00005	
15/02/2017	SW11	Midland Brick															0.69	0.050	0.050	0.050	0.100	0.005	0.001	0.001	0.001	0.001	0.001	0.004	0.008	0.00005	
15/02/2017	SW14	Midland Brick															1.10	0.060	0.050	0.050	0.240	0.005	0.003	0.001	0.002	0.002	0.001	0.006	0.03	0.00005	
15/02/2017	SW6	Midland Brick															0.90	0.050	0.050	0.050	0.090	0.006	0.002	0.001	0.001	0.001	0.001	0.001	0.005	0.00005	
15/02/2017	SW8	Midland Brick															2.70	0.400	0.050	0.250	0.230	0.079	0.005	0.005	0.005	0.005	0.005	0.005	0.025	0.00005	
15/02/2017	SW9	Midland Brick															3.00	0.430	0.050	0.300	0.210	0.082	0.005	0.005	0.005	0.005	0.005	0.005	0.025	0.00005	
15/07/2017	SW11	Midland Brick														0.51	0.47	0.050	0.050	0.050	0.030	0.005	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	0.00005	
15/07/2017	SW6	Midland Brick														0.59	0.53	0.050	0.050	0.060	0.020	0.005	0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.00005	
15/07/2017	SW7	Midland Brick														0.86	0.36	0.050	0.050	0.500	0.070	0.005	0.001	0.0001	1	2	0.001	0.001	0.028	0.00005	
15/07/2017	SW8	Midland Brick														0.89	0.80	0.050	0.050	0.090	0.020	0.005	0.005	0.0005	0.005	0.005	0.005	0.005	0.025	0.00005	
15/07/2017	SW9	Midland Brick														0.98	0.85	0.050	0.050	0.130	0.030	0.008	0.005	0.0005	0.005	0.005	0.005	0.005	0.025	0.00005	
15/02/2018	SW11	Midland Brick																					0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.00005	
15/02/2018	SW12	Midland Brick																					0.002	0.0001	0.001	0.001	0.001	0.002	0.01	0.00005	
15/02/2018	SW13	Midland Brick																					0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.00005	
15/02/2018	SW14	Midland Brick																					0.002	0.0001	0.001	0.001	0.001	0.002	0.005	0.00005	
15/02/2018	SW6	Midland Brick																					0.001	0.0001	0.001	0.001	0.001	0.001	0.005	0.00005	
15/02/2018	SW7	Midland Brick																					0.002	0.0001	0.001	0.001	0.001	0.002	0.006	0.00005	
15/02/2018	SW8	Midland Brick																					0.005	0.0005	0.005	0.005	0.005	0.005	0.025	0.00005	
15/02/2018	SW9	Midland Brick																					0.005	0.0005	0.005	0.005	0.005	0.005	0.025	0.00005	
5/09/2018	EMW01	Emerge		5.16	0.9																										
5/09/2018	EMW02	Emerge		8.49	1.5																										
5/09/2018	EMW03	Emerge		9.81	1.53																										
5/09/2018	EMW04	Emerge		7.21	2.54																										
5/09/2018	EMW05	Emerge		3.28	8.10																										
5/09/2018	EMW06	Emerge		3.00	2.93																										
5/09/2018	EMW07	Emerge		2.39	6.52																										
5/09/2018	EMW08	Emerge		4.80	3.65																										
5/09/2018	EMW09	Emerge		4.97	2.36																										
5/09/2018	EMW10	Emerge		3.78	6.80																										
6/09/2018	EMW01	Emerge		5.16	0.89			22.1	1131		13.4	6.53				0.50	0.50	0.260	0.040	0.01	0.590	0.020	0.001	0.0001	0.001	0.265	0.017	0.012	0.329	0.000	
6/09/2018	EMW02	Emerge		8.49	1.51			20.10	412		70.2	5.99				0.50	0.50	0.080	0.060	0.01	0.440	0.010	0.001	0.000	0.001	0.002	0.001	0.002	0.005	0.000	

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Date	Site	Monitored By	Monitoring Comment	GWL bToC mBToC	GWL mAHD mAHD	SWL m	SWF m³/s	T °C	EC uS/cm	DO mg/L	DO % %	pH pH	ORP mV	TUR NTU	TSS mg/L	TN mg/L	TKN mg/L	NH3-N mg/L	NO_3-N mg/L	NO_2-N mg/L	TP mg/L	FRP mg/L	As mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Pb mg/L	Ni mg/L	Zn mg/L	Hg mg/L	TDS mg/L
6/09/2018	EMW03	Emerge		9.81	1.53			21.90	3027		49.1	6.56				0.50	0.50	0.110	0.050	0.01	0.630	0.080	0.001	0.000	0.001	0.003	0.001	0.005	0.018	0.000	
6/09/2018	EMW04	Emerge		7.21	2.54			20.60	441		20.5	6.56				0.50	0.50	0.040	0.090	0.01	0.160	0.010	0.001	0.000	0.001	0.002	0.001	0.001	0.005	0.000	
6/09/2018	EMW05	Emerge		3.28	8.10			17.90	167		76.8	5.51				0.50	0.50	0.050	0.350	0.01	0.250	0.01	0.001	0.000	0.001	0.001	0.001	0.001	0.007	0.000	
6/09/2018	EMW06	Emerge		3.00	2.93			18.60	922		12.7	6.82				0.50	0.50	0.080	0.01	0.01	0.120	0.020	0.001	0.000	0.001	0.001	0.001	0.001	0.007	0.000	
6/09/2018	EMW07	Emerge		2.39	6.5			20.0	798		22.9	5.8				40.30	7.20	0.310	33.100	0.030	0.440	0.010	0.001	0.000	0.001	0.002	0.001	0.002	0.01	0.000	
6/09/2018	EMW08	Emerge		4.80	3.7			23.3	4002		7.4	5.4				0.50	0.50	0.150	0.060	0.01	0.05	0.020	0.001	0.000	0.001	0.001	0.001	0.007	0.01	0.000	
6/09/2018	EMW09	Emerge		4.97	2.4			21.5	3871		5.6	6.3				1.80	1.80	1.580	0.030	0.01	0.120	0.01	0.001	0.000	0.001	0.001	0.001	0.002	0.006	0.000	
6/09/2018	EMW10	Emerge		3.78	6.8			19.7	2929		23.7	5.9				0.50	0.50	0.110	0.010	0.01	0.270	0.060	0.001	0.000	0.001	0.001	0.001	0.008	0.011	0.000	
30/10/2018	EMW01	Emerge		5.17	0.88																										
30/10/2018	EMW02	Emerge		8.23	1.77																										
30/10/2018	EMW03	Emerge		9.52	1.82																										
30/10/2018	EMW04	Emerge		7.17	2.58																										
30/10/2018	EMW05	Emerge		3.51	7.88																										
30/10/2018	EMW06	Emerge		3.11	2.81																										
30/10/2018	EMW07	Emerge		2.12	6.78																										
30/10/2018	EMW08	Emerge		4.76	3.69																										
30/10/2018	EMW09	Emerge		5.07	2.27																										
30/10/2018	EMW10	Emerge		4.47	6.11																										
19/12/2018	EMW01	Emerge		5.34	0.71																										
19/12/2018	EMW02	Emerge		8.60	1.39																										
19/12/2018	EMW03	Emerge		9.68	1.66																										
19/12/2018	EMW04	Emerge		7.41	2.35																										
19/12/2018	EMW05	Emerge		4.08	7.30																										
19/12/2018	EMW06	Emerge		3.42	2.50																										
19/12/2018	EMW07	Emerge		3.02	5.88																										
19/12/2018	EMW08	Emerge		5.27	3.18																										
19/12/2018	EMW09	Emerge		5.70	1.64																										
19/12/2018	EMW10	Emerge		4.90	5.69																										
7/01/2019	EMW01	Emerge		5.40	0.65																										
7/01/2019	EMW02	Emerge		8.79	1.21																										
7/01/2019	EMW03	Emerge		9.83	1.51																										
7/01/2019	EMW04	Emerge		7.50	2.25																										
7/01/2019	EMW05	Emerge		4.39	6.99																										
7/01/2019	EMW06	Emerge		3.53	2.40																										
7/01/2019	EMW07	Emerge		3.37	5.53																										
7/01/2019	EMW08	Emerge		5.47	2.98																										
7/01/2019	EMW09	Emerge		5.95	1.38																										
7/01/2019	EMW10	Emerge		5.45	5.13																										
25/01/2019	EMW01	Emerge		5.42	0.63																										
25/01/2019	EMW02	Emerge		8.93	1.07																										
25/01/2019	EMW03	Emerge		9.96	1.38																										
25/01/2019	EMW04	Emerge		7.60	2.15																										
25/01/2019	EMW05	Emerge		4.73	6.66																										
25/01/2019	EMW06	Emerge		3.69	2.23																										
25/01/2019	EMW07	Emerge		3.66	5.24																										
25/01/2019	EMW08	Emerge		5.72	2.73																										
25/01/2019	EMW09	Emerge		6.09	1.24																										
25/01/2019	EMW10	Emerge		5.92	4.66																										
15/02/2019	SW11	MB Master							470			7.50											0.001	0.0001	0.001	0.001	0.001	0.007	0.012		
15/02/2019	SW6	MB Master							580			8.70											0.001	0.0001	0.001	0.001	0.001	0.005	0.005		
15/02/2019	SW8	MB Master							17000			7.70											0.001	0.0001	0.001	0.002	0.001	0.001	0.009		
15/02/2019	SW9	MB Master							24000			7.60											0.001	0.0001	0.001	0.002	0.001	0.001	0.021		
22/02/2019	EMW03	Emerge		10.19	1.15																										
22/02/2019	EMW04	Emerge		7.74	2.01																										
22/02/2019	EMW05	Emerge		5.95	5.44																										
22/02/2019	EMW06	Emerge		3.91	2.01																										
22/02/2019	EMW07	Emerge		4.06	4.84																										
22/02/2019	EMW09	Emerge		6.32	1.01																										
22/02/2019	EMW10	Emerge		6.50	4.09																										
15/09/2019	SW10	MB Master							120			7.10											0.001	0.0001		0.001	0.001	0.001	0.009	0.00005	
15/09/2019	SW11	MB Master							210			7.20											0.001	0.0001		0.001	0.001	0.015	0.025	0.00005	
15/09/2019	SW6	MB Master							500			8.40											0.001	0.0001		0.001	0.001	0.001	0.005	0.00005	
15/09/2019	SW7	MB Master							110			7.00											0.001	0.0001		0.001	0.001	0.002	0.005	0.00005	
15/09/2019	SW8	MB Master							7300			7.70											0.001	0.0001		0.001	0.001	0.001	0.002	0.00005	
15/09/2019	SW9	MB Master							8000			7.60											0.001	0.0001		0.001	0.001	0.001	0.001	0.00005	
18/09/2019	EMW01	ASM & SS		5.44	0.61			20.80	1708		22.4	6.50				2.50		0.013	0.005	0.005	0.250	0.033	0.001	0.0001	0.001	0.001	0.001	0.003	0.001	0.00005	
18/09/2019	EMW02*	ASM & SS	Root Blockage																												
18/09/2019	EMW03	ASM & SS		10.24	1.10			22.00	1576		14.2	6.80				1.20		0.013	0.010	0.005	0.680	0.200	0.001	0.0001	0.001	0.001	0.001	0.001	0.002	0.00005	
18/09/2019	EMW04	ASM & SS		7.81	1.94			20.80	792		17.5	6.60				1.10		0.022	0.100	0.005	0.410	0.011	0.001	0.0001	0.001	0.001	0.001	0.001	0.015	0.00005	
18/09/2019	EMW05	ASM & SS		3.77	7.62			19.40	198		28.7	5.80				0.60		0.016	0.400	0.005	0.050	0.006	0.001	0.0001	0.001	0.001	0.001	0.001	0.013	0.00005	
18/09/2019	EMW06	ASM & SS		1.78	4.14			18.30	2376		25.7	7.20				0.80		0.018	0.022	0.005	0.050	0.010	0.001	0.0001	0.001	0.002	0.001	0.004	0.028	0.00005	
18/09/2019	EMW07	ASM & SS		2.55	6.35			20.60	602		29.9	5.90				16.00		0.130	11.000	0.005	0.270	0.006	0.001	0.0001	0.001	0.009	0.001	0.003	0.027	0.00005	
18/09/2019	EMW08	ASM & SS		4.83	3.62			22.30	1683		35.3	5.60				1.20		0.012	0.380	0.005	0.260	0.005	0.001	0.0001	0.001	0.001	0.001	0.002	0.011	0.00005	
18/09/2019	EMW09	ASM & SS		4.99	2.34			21.40	4488		15.7	6.50				0.70		0.430	0.035	0.010	0.050	0.008	0.001	0.0001	0.001	0.002	0.001	0.002	0.006	0.00005	

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Date	Site	Monitored By	Monitoring Comment	GWL bToC mBToC	GWL mAHD mAHD	SWL m	SWF m³/s	T °C	EC uS/cm	DO mg/L	DO % %	pH pH	ORP mV	TUR NTU	TSS mg/L	TN mg/L	TKN mg/L	NH3-N mg/L	NO_3-N mg/L	NO_2-N mg/L	TP mg/L	FRP mg/L	As mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Pb mg/L	Ni mg/L	Zn mg/L	Hg mg/L	TDS mg/L
18/09/2019	EMW10	ASM & SS		4.17	6.41			20.70	4929		39.1	6.00				0.40		0.150	0.028	0.005	0.120	0.073	0.001	0.0001	0.001	0.005	0.001	0.004	0.021	0.00005	
18/09/2019	SW1	ASM & SS						20.20	9680		46.3	7.70				1.00		0.079	0.130	0.006	0.050	0.020	0.001	0.0001	0.001	0.003	0.001	0.002	0.01	0.00005	
18/09/2019	SW2	ASM & SS						19.60	10010		43.5	7.70				1.00		0.072	0.140	0.006	0.050	0.019	0.001	0.0001	0.001	0.002	0.001	0.003	0.006	0.00005	
29/10/2019	EMW01	ASM & SS		5.44	0.6																										
29/10/2019	EMW02	ASM & SS	Root Blockage cleared	8.80	1.20																										
29/10/2019	EMW03	ASM & SS		9.98	1.36																										
29/10/2019	EMW04	ASM & SS		7.67	2.08																										
29/10/2019	EMW05*	ASM & SS		4.07	5.7																										
29/10/2019	EMW06	ASM & SS		1.90	4.0																										
29/10/2019	EMW07	ASM & SS		2.60	6.3																										
29/10/2019	EMW08	ASM & SS		5.21	3.2																										
29/10/2019	EMW09	ASM & SS		5.63	1.70																										
29/10/2019	EMW10	ASM & SS		4.78	5.80																										
27/11/2019	EMW01	ASM & SS	Dry	5.82	0.23																										
27/11/2019	EMW02	ASM & SS		8.95	1.05																										
27/11/2019	EMW03	ASM & SS		10.06	1.28																										
27/11/2019	EMW04	ASM & SS		7.74	2.01																										
27/11/2019	EMW05	ASM & SS		4.34	7.05																										
27/11/2019	EMW06	ASM & SS		2.45	3.47																										
27/11/2019	EMW07	ASM & SS		2.59	6.31																										
27/11/2019	EMW08	ASM & SS		5.48	2.97																										
27/11/2019	EMW09	ASM & SS		5.95	1.38																										
27/11/2019	EMW10	ASM & SS		4.99	5.6																										
27/11/2019	MM38	ASM & SS		1.93	20.09																										
3/12/2019	SW4	ASM & SS						26.60	516	5.16	64.7	7.30		0.7		0.50		0.008	0.013	0.005	0.050	0.005	0.001	0.0001	0.001	0.001	0.001	0.001	0.006	0.00005	336
3/12/2019	SW6	ASM & SS						28.50	551	9.11	118.0	7.74		8.1		0.40		0.005	0.005	0.005	0.050	0.005	0.001	0.0001	0.001	0.001	0.001	0.001	0.003	0.00005	358
3/12/2019	SW7	ASM & SS						27.20	600	6.45	81.7	6.55		-0.3		0.40		0.009	0.010	0.005	0.050	0.005	0.001	0.0001	0.001	0.001	0.001	0.001	0.006	0.00005	387
17/12/2019	EMW01	SS and SO	Dry	5.47	0.58																										
17/12/2019	EMW02	SS and SO	Recorded level adjusted up 1m believed in error	8.93	1.06			26.80	686		10.0	6.20				2.50		0.017	0.062	0.005	0.450	0.010	0.001	0.0001	0.001	0.001	0.001	0.005	0.006	0.00005	
17/12/2019	EMW03	SS and SO		10.15	1.19			27.30	1972		36.0	6.70				1.00		0.025	0.005	0.005	0.350	0.090	0.001	0.0001	0.001	0.001	0.001	0.006	0.003	0.00005	
17/12/2019	EMW04	SS and SO		7.80	1.95			26.50	650		18.0	6.60				0.70		0.008	0.013	0.005	0.220	0.007	0.001	0.0001	0.001	0.001	0.001	0.006	0.002	0.00005	
17/12/2019	EMW05	SS and SO		4.66	6.73			26.90	205		13.8	5.80				1.20		0.072	0.035	0.005	0.100	0.025	0.001	0.0001	0.001	0.001	0.001	0.003	0.009	0.00005	
17/12/2019	EMW06	SS and SO		3.37	2.55			25.40	2207		11.0	7.00				0.50		0.005	0.005	0.005	0.050	0.012	0.001	0.0001	0.001	0.001	0.001	0.012	0.006	0.00005	
17/12/2019	EMW07	SS and SO		3.12	5.78			27.00	654		30.9	5.80				14.00		0.005	11.000	0.005	0.080	0.013	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.00005	
17/12/2019	EMW08	SS and SO		5.72	2.73			26.80	1266		46.1	5.50				1.10		0.005	1.100	0.005	0.050	0.018	0.001	0.0001	0.001	0.001	0.001	0.002	0.005	0.00005	
17/12/2019	EMW09	SS and SO		6.33	1.00																										
17/12/2019	EMW10	SS and SO		6.27	4.31			27.00	5657		24.0	5.90				0.40		0.120	0.005	0.005	0.420	0.058	0.001	0.0001	0.001	0.001	0.001	0.008	0.009	0.00005	
17/12/2019	MM38	SS and SO		2.13	19.89																										
21/01/2020	EMW01	SS and SO	Dry	5.50	0.55																										
21/01/2020	EMW02	SS and SO		9.03	0.97																										
21/01/2020	EMW03	SS and SO		10.15	1.19																										
21/01/2020	EMW04	SS and SO		7.75	2.00																										
21/01/2020	EMW05	SS and SO	Dry	6.29	5.10																										
21/01/2020	EMW06	SS and SO		4.05	1.87																										
21/01/2020	EMW07	SS and SO		4.12	4.78																										
21/01/2020	EMW08	SS and SO		6.15	2.30																										
21/01/2020	EMW09	SS and SO	Dry	6.66	0.67																										
21/01/2020	EMW10	SS and SO		7.38	3.20																										
21/01/2020	MM38	SS and SO		2.36	19.66																										
18/02/2020	EMW01	SS	Dry	5.76	0.29																										
18/02/2020	EMW03	SS		10.37	0.97																										
18/02/2020	EMW04	SS		7.86	1.89																										
18/02/2020	EMW05	SS	Dry	6.79	4.60																										
18/02/2020	EMW06	SS		4.47	1.45																										
18/02/2020	EMW07	SS		4.40	4.50																										
18/02/2020	EMW08	SS		6.48	1.97																										
18/02/2020	EMW09	SS	Dry	6.90	0.43																										
18/02/2020	EMW10	SS		7.65	2.93																										
18/02/2020	MM38	SS		2.55	19.47																										
17/03/2020	EMW01	SS and SO	Dry	5.45	0.60																										
17/03/2020	EMW02	SS and SO		9.27	0.73			22.30	1240		33.3	6.30				1.40		0.005	0.042	0.005	0.300	0.005	0.001	0.0001	0.001	0.003	0.001	0.002	0.002	0.00005	
17/03/2020	EMW03	SS and SO	Dark black/blue colour from suspended solids	10.50	0.84			22.90	1889		17.9	7.00				4.00		0.014	0.005	0.005	1.100	0.054	0.001	0.0001	0.001	0.001	0.001	0.002	0.002	0.00005	
17/03/2020	EMW04	SS and SO		7.92	1.83			23.30	748		8.5	6.80				2.30		0.005	0.009	0.005	2.200	0.005	0.001	0.0001	0.001	0.015	0.001	0.003	0.027	0.00005	
17/03/2020	EMW05	SS and SO	Dry	6.31	5.08																										
17/03/2020	EMW06	SS and SO		4.80	1.12			24.10	1960		17.8	7.00				0.40		0.016	0.010	0.005	0.060	0.005	0.001	0.0001	0.001	0.001	0.001	0.002	0.003	0.00005	
17/03/2020	EMW07	SS and SO		4.64	4.26			25.00	736		18.2	6.00				14.00		0.005	10.000	0.005	0.350	0.006	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.00005	
17/03/2020	EMW08	SS and SO		6.60	1.85			24.60	2090		50.2	5.60				2.20		0.036	0.032	0.005	0.650	0.005	0.001	0.0001	0.001	0.002	0.001	0.001	0.003	0.00005	
17/03/2020	EMW09	SS and SO	Dry	6.47	0.86																										
17/03/2020	EMW10	SS and SO		7.02	3.56			21.40	3657		44.1	6.10				1.30		0.092	0.061	0.005	2.700	0.033	0.001	0.0001	0.001	0.011	0.001	0.005	0.039	0.00005	
17/03/2020	MM38	SS and SO																													
17/03/2020	SW1	SS and SO						23.50	32612		48.1	7.70				0.90		0.059	0.033	0.010	0.080	0.042									
17/03/2020	SW2	SS and SO						23.50	33292		37.5	7.70				0.90		0.078	0.100	0.011	0.090	0.064									
17/03/2020	SW6	SS and SO						24.40	1067		60.4	8.30				1.30		0.160	0.008	0.005	0.080	0.005	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.00005	

APPENDIX **F**
Lithological Logs

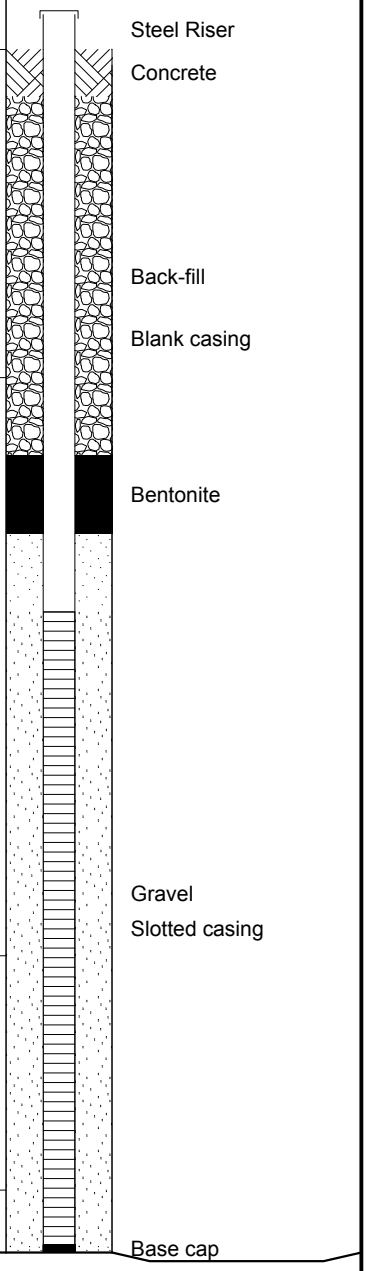
Well ID: EMW01

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
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

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0			0.0m: SANDY UNCONTROLLED FILL: light brown/grey, fine to medium grained, low plasticity, brown mottling, trace organics.	Dry To Moist
1	5			
2	4		2.1m: GRAVELLY CLAY: light brown, low plasticity.	Dry To Moist
3	3			
4	2			
5	1			
6	0		5.8m: SANDY CLAY: light brown, low plasticity.	Moist To Wet
7	-1			
	-2		7.3m: CLAY: light brown, medium plasticity.	Moist

Total drilled depth: 7.7 mBGL



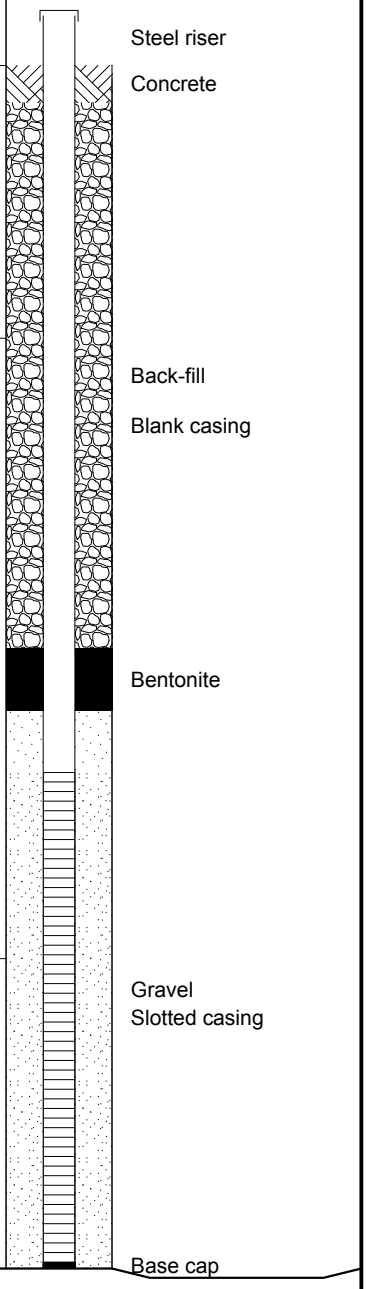
COMMENTS: Water was observed at 5.80 mBGL during well install. Standing water level recorded in September 2018 was 4.708 mBGL

Well ID: EMW02

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
SURVEY SOURCE: Surveyed
EASTING: 405316.678
NORTHING: 6473431.581
PROJECTION: MGA, GDA94
ELEVATION (GROUND): 9.6 mAHD
ELEVATION (TOP OF CASING): 10.0 mAHD
CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0	9		0.0m: SANDY CLAY: dark red/orange, fine to medium grained, low plasticity, orange mottling.	Dry To Moist
2	7		2.2m: CLAYEY SAND: light brown, fine grained, low plasticity, fine grained sands.	Dry To Moist
7	2		7.2m: SANDY CLAY: light brown, fine grained, low plasticity, water bearing layer commencing.	Moist To Wet
9.7	0		Total drilled depth: 9.7 mBGL	



COMMENTS: Water was observed at 7.2 mBGL during well install.Standing water level recorded in September 2018 was 8.041 mBGL

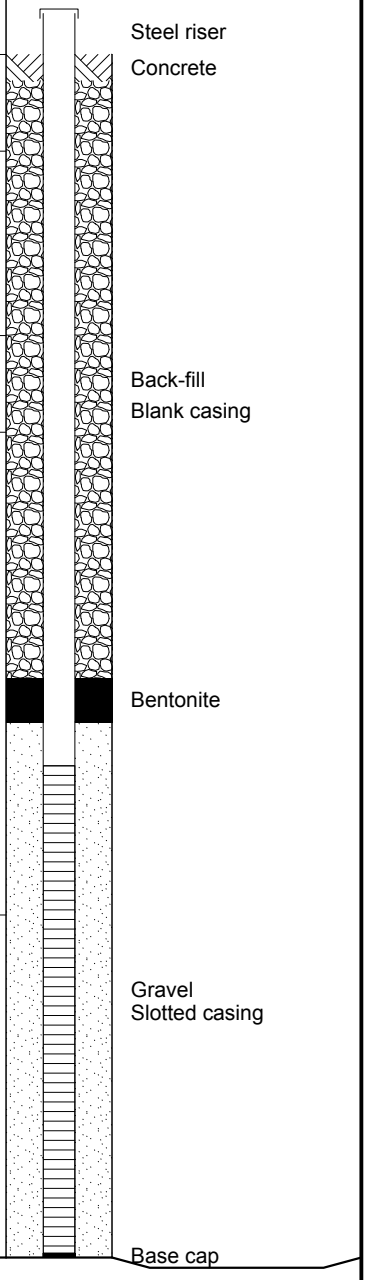
Well ID: EMW03

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Auger
LOGGED BY: MM
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

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0			0.0m: UNCONTROLLED FILL: dark grey, plastic, brick, bluemetal.	
1	10		1.1m: SANDY CLAY: dark red/brown, fine to medium grained, low plasticity, orange mottling.	Dry To Moist
2	9			
3	8		3.2m: CLAYEY SAND: dark red/brown, fine grained, low plasticity, fine sands with charcoal fines.	Moist
4	7			
5	6		4.3m: SANDY CLAY: light brown, fine grained, low plasticity, firm to stiff layer, slow penetration.	Dry
6	5			
7	4			
8	3			
9	2			
10	1		9.8m: CLAYEY SAND: light brown, fine to coarse grained, medium plasticity, soft to firm, water bearing layer encountered .	Wet
11	0			
12	-1			
13	-2			

Total drilled depth: 13.7 mBGL



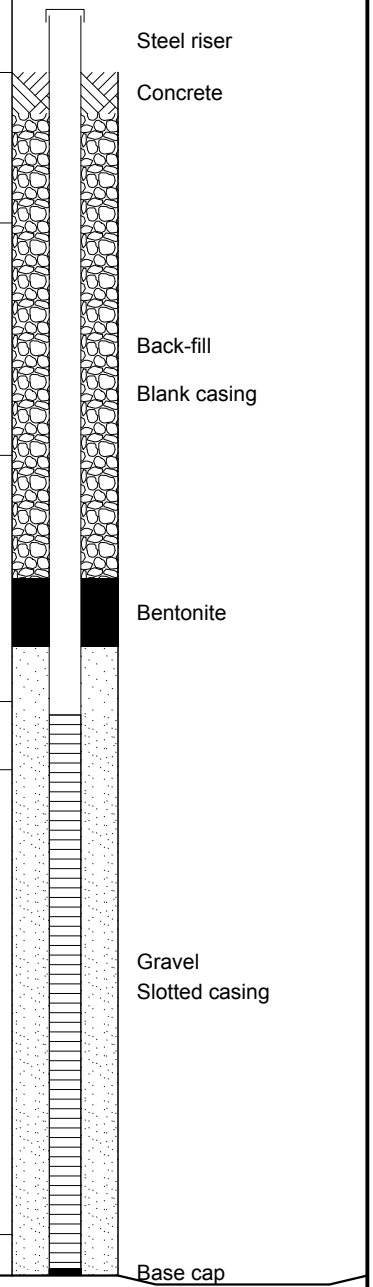
COMMENTS: Water was observed at 10.00 mBGL during well install. Standing water level recorded in September 2018 was 9.291 mBGL

Well ID: EMW04

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
SURVEY SOURCE: Surveyed
EASTING: 405712.103
NORTHING: 6472730.410
PROJECTION: MGA, GDA94
ELEVATION (GROUND): 9.3 mAHD
ELEVATION (TOP OF CASING): 9.8 mAHD
CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0	9		0.0m: SANDY CLAYEY UNCONTROLLED FILL: dark brown/grey, brick and bitumen rubble, plastics, unable to sonic core due to rubble.	Dry To Moist
1	8		1.1m: CLAY: dark brown, medium plasticity.	Moist
2	7			
3	6		2.8m: SANDY CLAY: light brown, low plasticity, firm to stiff layer, slow to gradual penetration.	Dry
4	5			
5	4		4.6m: GRAVELLY CLAY: dark brown/purple, medium plasticity, purple mottling.	Moist
6	3		5.1m: CLAYEY SAND: light brown, fine to coarse grained, low plasticity, water bearing layer.	Wet
7	2			
8	1		8.5m: SANDY CLAY: light brown/red, medium plasticity, more clays at depth.	Wet
			Total drilled depth: 8.8 mBGL	



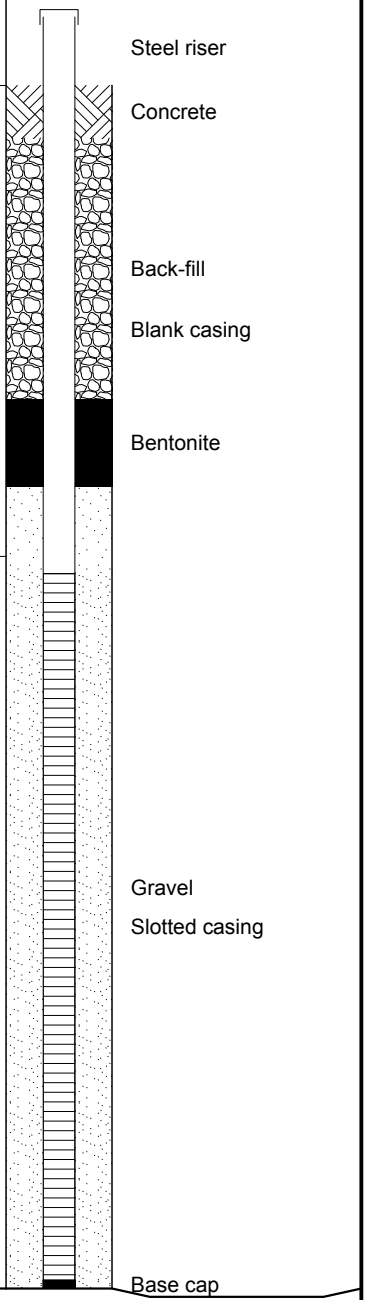
COMMENTS: water was observed at 5.10 mBGL during well install. Standing water level recorded in September 2018 was 6.808 mBGL.

Well ID: EMW05

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
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

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0			0.0m: SANDY CLAY: dark brown/red, fine to coarse grained, low plasticity, red mottling, soft to firm layer.	Moist
1	10			
2	9			
3	8		2.7m: CLAYEY SAND: light brown/yellow, fine to coarse grained, low plasticity, water bearing layer encounteted , prodominately sands, becomingore clay based at 7.0 mBGL.	Wet
4	7			
5	6			
6	5			



Total drilled depth: 6.9 mBGL

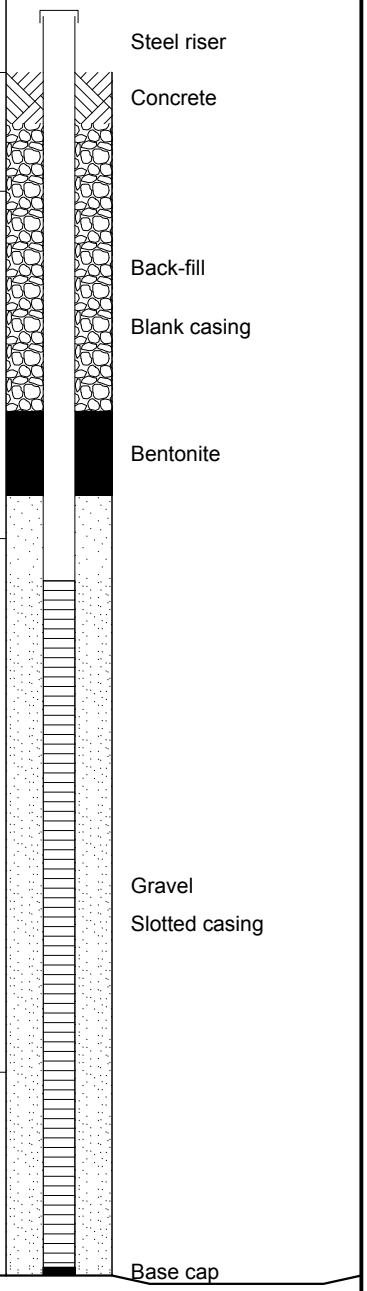
COMMENTS: water was observed at 3.10 mBGL during well install. Standing water level recorded in September 2018 was 2.856 mBGL

Well ID: EMW06

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
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

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0	5		0.0m: UNCONTROLLED FILL: dark grey/red, fine to coarse grained, brown mottling, bricks, organics, bluemetal.	Dry To Moist
1	4		0.7m: GRAVELLY CLAY: dark brown, fine to medium grained, firm to stiff clays.	Moist
2	3			
3	2		2.8m: CLAYEY SAND: light brown, fine to coarse grained, water bearing zone at 3.1mbgs.	Wet
4	1			
5	0			
6	-1		5.9m: CLAY: dark grey, heavy clays.	Moist To Wet
7			Total drilled depth: 7.1 mBGL	



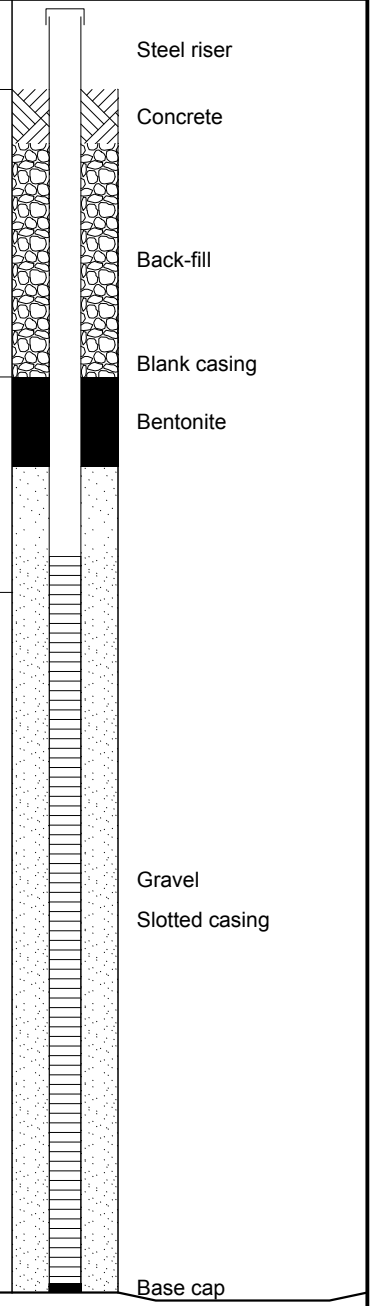
COMMENTS: water was observed at 3.1 mBGL during well install. Standing water level recorded in September 2018 was 2.643 mBGL

Well ID: EMW07

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
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

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0	8		0.0m: GRAVELLY CLAYEY SAND: light brown, fine to coarse grained, low plasticity.	Moist
1	7		1.6m: CLAYEY SAND: light brown/red, fine to coarse grained, medium plasticity, water bearing layer at 2.5m.	Wet
2	6			
3	5		2.8m: CLAYEY SAND: light brown, fine to coarse grained, low plasticity.	Wet
4	4			
5	3			
6	2			



Total drilled depth: 6.7 mBGL

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

Well ID: EMW08

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
SURVEY SOURCE: Surveyed
EASTING: 406362.335
NORTHING: 6473878.785
PROJECTION: MGA, GDA94
ELEVATION (GROUND): 8.6 mAHD
ELEVATION (TOP OF CASING): 8.4 mAHD
CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT	WELL CONSTRUCTION
0	8		0.0m: BITUMEN. 0.1m: ROAD BASE: limestone. 0.3m: SANDY CLEAN FILL: light grey/white, fine to medium grained, fill sands encompassing ADF UST.	Dry To Moist	Flush mount Concrete
1	7				Back-fill
2	6				Blank casing
3	5		3.1m: CLAYEY SAND: light brown, fine to coarse grained, low plasticity, soft clays, water bearing layer at 3.1mbgs. 3.5m: SANDY CLAY: dark brown/grey, medium plasticity, firm to stiff clays slow penetration.	Moist Moist	Bentonite
4	4		4.2m: CLAY: dark green, medium plasticity.	Wet	
5	3				Gravel Slotted casing
6	2				
7	1				
8			Total drilled depth: 8.5 mBGL		Base cap

COMMENTS: Water was observed at 3.10 mBGL during well install. Standing water level recorded in September 2018 was 4.930 mBGL

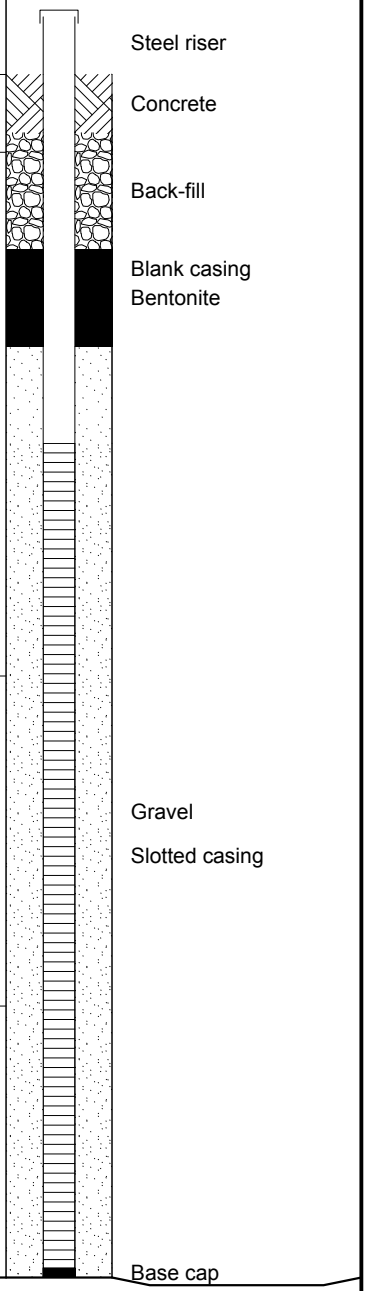
Well ID: EMW09

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
SURVEY SOURCE: Surveyed
EASTING: 406374.876
NORTHING: 6474025.215
PROJECTION: MGA, GDA94
ELEVATION (GROUND): 7.0 mAHD
ELEVATION (TOP OF CASING): 7.3 mAHD
CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0	7		0.0m: CLAYEY UNCONTROLLED FILL: light brown, medium plasticity, orange mottling, plastic, brick rubble, trace gravels.	Dry To Moist
			0.4m: GRAVELLY CLAY: dark brown, low plasticity, natural layer.	Moist
1	6			
2	5			
3	4			
			3.1m: CLAY: dark grey, low plasticity, slight , river loam/organic odour, soft clays at 4 mBGL, water bearing layer between 3.5m to 7.0 mBGL	Moist
4	3			
5	2		4.8m: SANDY CLAY: light grey, fine to coarse grained, low plasticity.	Wet
6	1			

Total drilled depth: 6.2 mBGL



COMMENTS: Water was observed at 4.80 mBGL during well install. Standing water level recorded in September 2018 was 4.637 mBGL

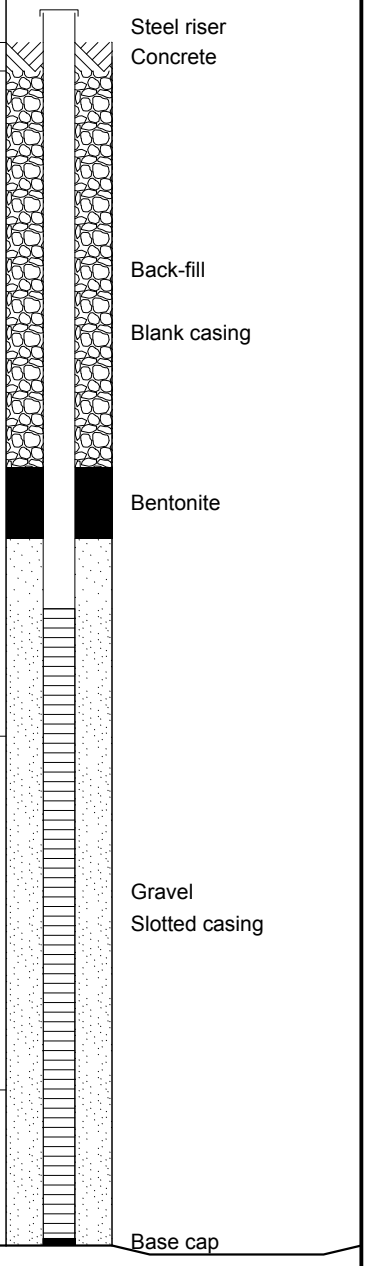
Well ID: EMW10

PROJECT NUMBER: EP18-062(01)
CLIENT: Boral Limited
PROJECT NAME: Boral Midland Groundwater Assessment
PROJECT LOCATION: 102 Great Northern Highway Midvale

DATE INSTALLED: 20/08/2018
DRILLING CONTRACTOR: Strataprobe
DRILLING METHOD: Sonic
LOGGED BY: MM
SURVEY SOURCE: Surveyed
EASTING: 406708.721
NORTHING: 6474065.385
PROJECTION: MGA, GDA94
ELEVATION (GROUND): 10.4 mAHD
ELEVATION (TOP OF CASING): 10.6 mAHD
CASING DIAMETER: 50 mm

DEPTH (mBGL)	DEPTH (mAHD)	GRAPHIC LOG	MATERIAL DESCRIPTION	MOISTURE CONTENT
0	10		0.0m: ROAD BASE: light orange, gravel roadbase	
			0.2m: CLAY: light brown, high plasticity, grey mottling, firm to stiff, gradual penetration.	Dry
1	9			
2	8			
3	7			
4	6			
5	5		4.9m: SANDY GRAVELLY CLAY: dark brown, medium plasticity, grey mottling, soft, superficial aquifer.	Moist To Wet
6	4			
7	3		7.4m: CLAY: light brown, medium plasticity, minimal fines within clay material.	Moist
8	2			

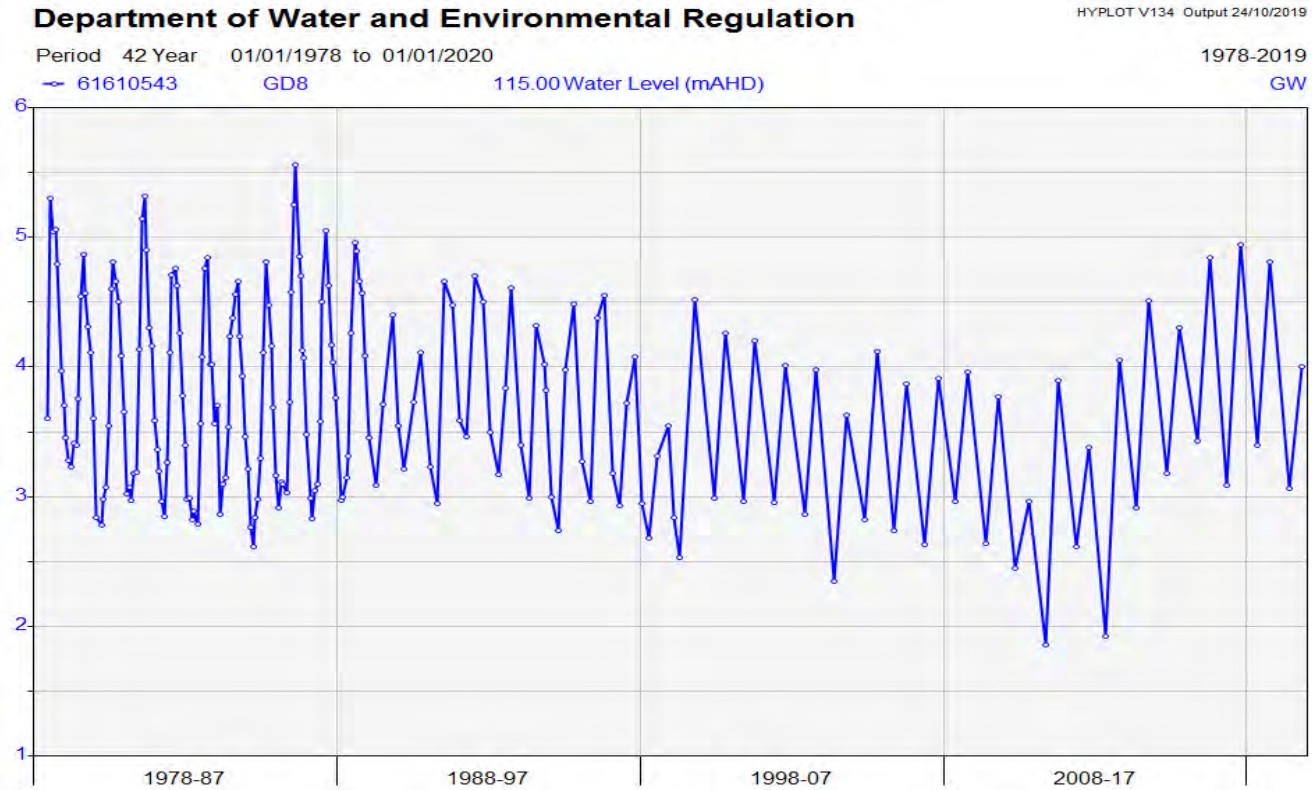
Total drilled depth: 8.5 mBGL

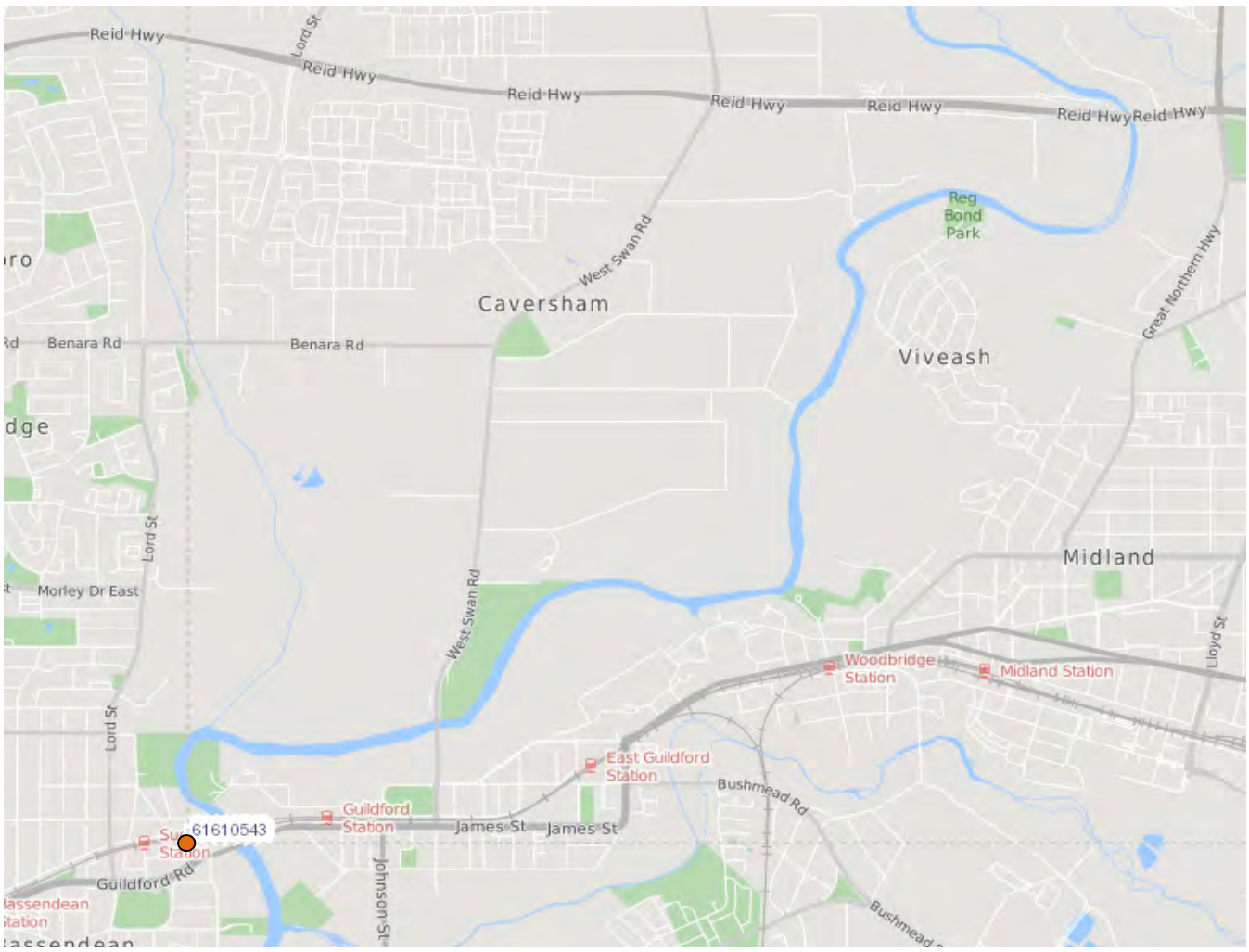


COMMENTS: Water was observed at 4.00 mBGL during well install. Standing water level recorded in September 2018 was 3.552 mBGL

APPENDIX G
DWER Groundwater Monitoring Data

Date :5/4/2020 Job No. H19054





Source: Department of Water and Environmental Regulation (2020)

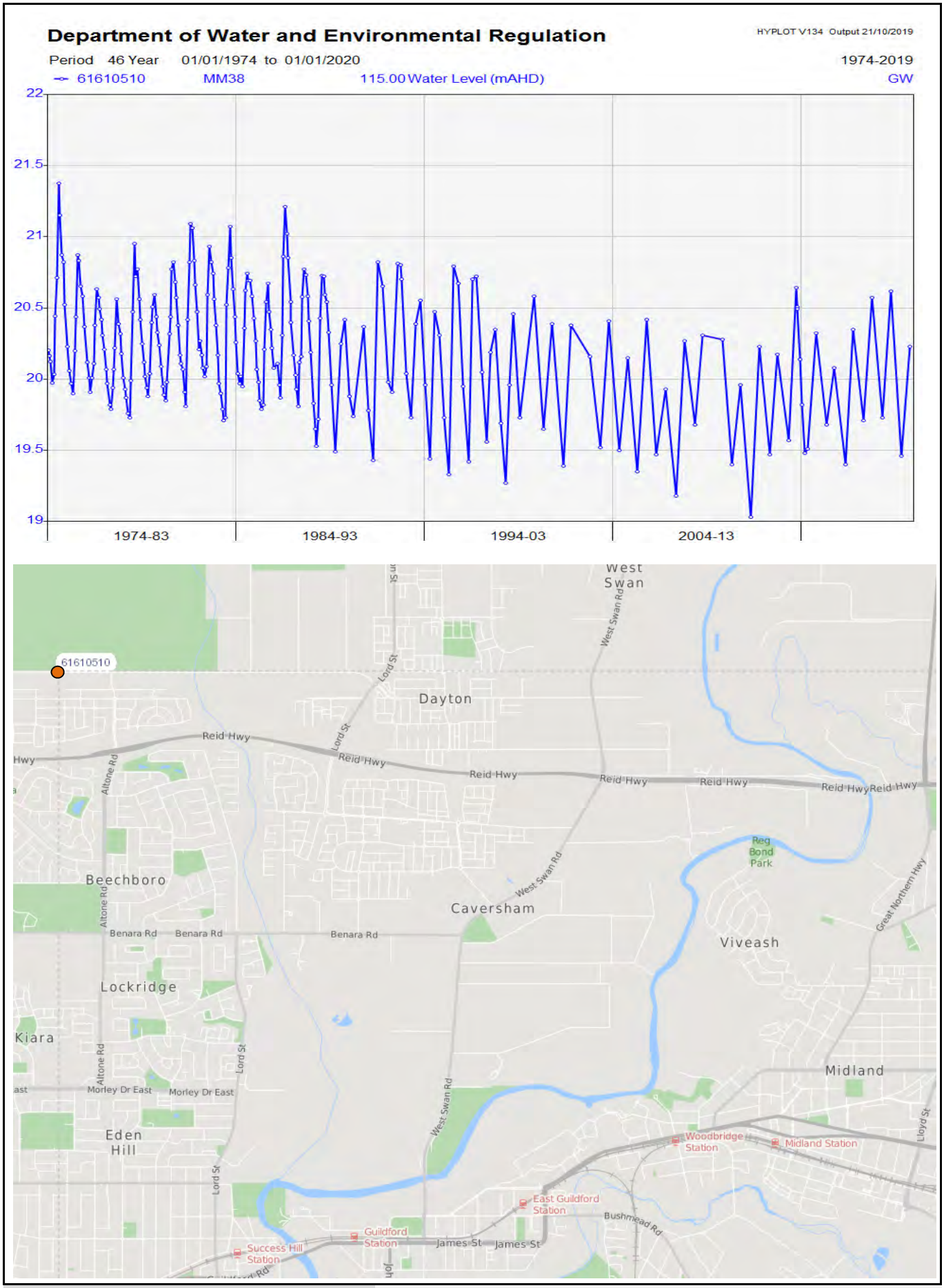
hyd$_2$o

Midland Brick Local Water Management Strategy

DWER Bore Hydrographs : GD8

Appendix G1

Date :5/4/2020 Job No. H19054



Source: Department of Water and Environmental Regulation (2020)

hyd2o

Midland Brick Local Water Management Strategy

DWER Bore Hydrographs : MM388

Appendix G2

APPENDIX **H**
Water Balance Modelling

Midland Brick

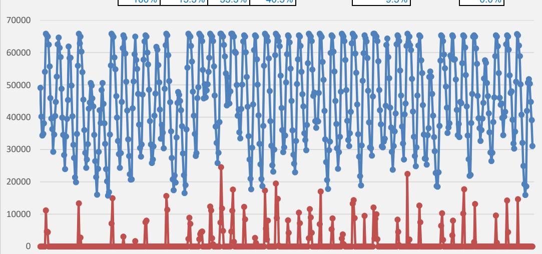
Existing Water Balance Model

Modelling Start Year	1975
Modelling Start Month	1
Rainfall Multiplier	1.00

Total Flow (kL/yr)	306132	
Catchment 1 (kL/yr)	102752	33.6%
Catchment 2 (kL/yr)	114443	37.4%
Catchment 3 (kL/yr)	34448	11.3%
Catchment 4 (kL/yr)	54490	17.8%
Total Evaporation	67889	22.2%
Total Demand	9768	3.2%
Total Loss	103915	33.9%
BA Trib Outflow	125470	41.0%
Average Outflow l/s	4.0	

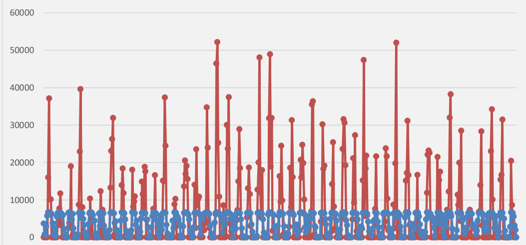
Clay Basin

Inflow	Outflow	Evap	Loss	Demand	Supplied	Empty
102752	15756	36237	41633	9768	9768	0
100%	15.3%	35.3%	40.5%		9.5%	0.0%



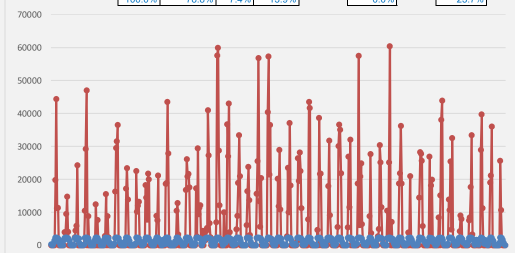
North Storage

Inflow	Outflow	Evap	Loss	Demand	Supplied	Empty
130199	68533	13926	47962	0	0	73
100.0%	52.6%	10.7%	36.8%		0.0%	13.5%



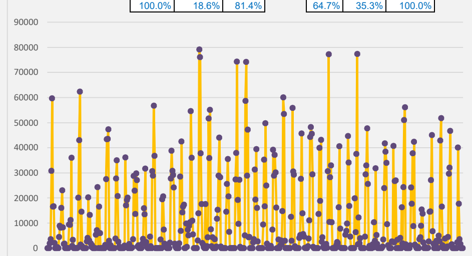
South Storage

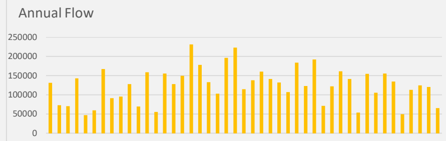
Inflow	Outflow	Evap	Loss	Demand	Supplied	Empty
102981	81119	7587	14320	0	0	128
100.0%	78.8%	7.4%	13.9%		0.0%	23.7%

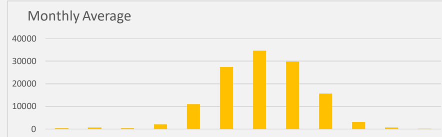


BA Trib Flow

Cshed	Evap	Outflow	South	Cshed	Outflow
54490	10139	44351	81119	44351	125470
100.0%	18.6%	81.4%	64.7%	35.3%	100.0%







Year	Mth	Rain (mm)	Adj Rain (mm)	Evap (mm)	Dust Supp kL	Recycl Plant kL	Resid /POS kL	Constr kL	Catch 1 Hstand ha	Catch 1 Roof ha	Catch 1 External ha	Catch 2 Indust ha	Catch 2 Resid ha	Catch 3 Indust ha	Catch 3 Resid ha	Catch 4 Local/ CShed ha	Catch 4 Other ha	Extra Bore kL
					1.00	0.00	0.00	0.00										0
					Demands				Water Sources, Catchment Areas, & Runoff									
									55%	85%	25%	55%	30%	55%	30%	85%	15%	
1975	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	2	0.0	0.0	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	3	12.8	12.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	4	39.4	39.4	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	5	55.6	55.6	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	6	146.8	146.8	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	7	201.2	201.2	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	8	76.8	76.8	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	9	79.0	79.0	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	10	44.0	44.0	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	11	18.6	18.6	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1975	12	1.4	1.4	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	1	23.4	23.4	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	2	35.7	35.7	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	3	0.4	0.4	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	4	72.2	72.2	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	5	73.6	73.6	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	6	63.8	63.8	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	7	90.4	90.4	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	8	114.8	114.8	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	9	65.6	65.6	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	10	38.5	38.5	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	11	46.9	46.9	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1976	12	4.2	4.2	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	1	6.4	6.4	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	2	20.0	20.0	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	3	4.8	4.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	4	0.0	0.0	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	5	99.0	99.0	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	6	67.7	67.7	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	7	73.7	73.7	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	8	159.2	159.2	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	9	23.3	23.3	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	10	59.1	59.1	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	11	1.4	1.4	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1977	12	0.0	0.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	2	23.2	23.2	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	3	0.8	0.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	4	15.9	15.9	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	5	132.4	132.4	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	6	183.4	183.4	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	7	203.1	203.1	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	8	27.2	27.2	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	9	84.2	84.2	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	10	27.4	27.4	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	11	20.3	20.3	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1978	12	10.0	10.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	2	4.4	4.4	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	3	12.8	12.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	4	48.3	48.3	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	5	61.4	61.4	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	6	107.5	107.5	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	7	46.0	46.0	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	8	81.6	81.6	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	9	36.9	36.9	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	10	23.7	23.7	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	11	39.0	39.0	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1979	12	0.0	0.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	2	11.5	11.5	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	3	0.0	0.0	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	4	83.6	83.6	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	5	63.6	63.6	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	6	119.3	119.3	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	7	3.6	3.6	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	8	107.9	107.9	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	9	58.1	58.1	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	10	5.5	5.5	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	11	11.6	11.6	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1980	12	13.6	13.6	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	2	18.2	18.2	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	3	7.0	7.0	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	4	31.0	31.0	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	5	152.2	152.2	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	6	184.7	184.7	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	7	160.2	160.2	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	8	146.7	146.7	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	9	47.6	47.6	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	10	15.7	15.7	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	11	38.4	38.4	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1981	12	12.1	12.1	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	1	22.0	22.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	2	6.0	6.0	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	3	20.0	20.0	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	4	0.0	0.0	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	5	58.8	58.8	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	6	141.4	141.4	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	7	155.2	155.2	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	8	96.6	96.6	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	9	45.2	45.2	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	10	26.2	26.2	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	11	2.4	2.4	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1982	12	5.0	5.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	1	0.8	0.8	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	2	16.3	16.3	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	3	3.8	3.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	4	15.8	15.8	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	5	23.0	23.0	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	6	181.8	181.8	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	7	93.6	93.6	50.4	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	8	102.0	102.0	73.1	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	9	100.4	100.4	92.4	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	10	8.6	8.6	135.2	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	11	45.0	45.0	185.6	1071	3857	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1983	12	16.8	16.8	254.5	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1984	1	0.8	0.8	274.7	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1984	2	3.6	3.6	236.0	1000	3600	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1984	3	29.2	29.2	202.4	1107	3986	6333	833	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1984	4	59.6	59.6	114.2	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1984	5	143.4	143.4	74.8	554	1329	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0
1984	6	114.4	114.4	52.9	536	1286	0	0	19.2	1.8	10.7	29.9	0.0	9.0	0.0	4.5	26.7	0

Year	Mth	Catch 1 Hstand kL	Catch 1 Roof kL	Catch 1 External kL	Catch 2 Indust kL	Catch 2 Resid kL	Catch 3 Indust kL	Catch 3 Resid kL	Catch 4 CShed kL	Catch 4 Other kL	Clay Basin Inflow kL	Vol kL	Outflow kL	Level m	Area m2	Evap kL	Demand kL	Used kL	End Stor kL	Level m
												1313					814		Stor Loss	
		6124	887	1551	9537	0	2871	0	2218	2323	8563	72575 MaxV				3020	814	5147	7%	
																			60000	
1975	1	0	0	0	0	0	0	0	0	0	0	60000	0	3.6	22152	6085	1107	7192	49112	3.10
1975	2	0	0	0	0	0	0	0	0	0	0	49112	0	3.1	20885	4930	1000	5930	40159	2.60
1975	3	1352	196	342	2105	0	634	0	490	513	1890	42049	0	2.7	19575	3963	1107	5070	34391	2.30
1975	4	4161	603	1054	6479	0	1950	0	1507	1578	5817	40208	0	2.6	19223	2196	536	2732	34853	2.40
1975	5	5871	851	1487	9143	0	2752	0	2127	2227	8209	43062	0	2.8	19927	1490	554	2043	38148	2.50
1975	6	15502	2246	3927	24141	0	7267	0	5615	5879	21675	59823	0	3.6	22152	1172	536	1708	54047	3.30
1975	7	21247	3078	5382	33087	0	9959	0	7696	8058	29707	83754	11179	4.2	23438	1181	554	12914	65881	3.90
1975	8	8110	1175	2054	12630	0	3802	0	2938	3076	11340	77221	4646	4.2	23438	1713	554	6912	65387	3.80
1975	9	8342	1209	2113	12992	0	3911	0	3022	3164	11664	77051	4476	4.2	23438	2166	536	7178	64982	3.80
1975	10	4646	673	1177	7236	0	2178	0	1683	1762	6497	71479	0	4.1	23302	3151	1107	4258	62515	3.70
1975	11	1964	285	498	3059	0	921	0	711	745	2746	65261	0	3.8	22658	4206	1071	5278	55785	3.40
1975	12	148	21	37	230	0	69	0	54	56	207	55992	0	3.4	21645	5509	1107	6616	45919	3.00
1976	1	2471	358	626	3848	0	1158	0	895	937	3455	49374	0	3.1	20885	5737	1107	6844	39553	2.60
1976	2	3770	546	955	5871	0	1767	0	1366	1430	5271	44824	0	2.9	20279	4787	1000	5787	36305	2.40
1976	3	42	6	11	66	0	20	0	15	16	59	36364	0	2.4	18519	3749	1107	4856	29302	2.10
1976	4	7624	1105	1931	11873	0	3574	0	2762	2892	10660	39963	0	2.6	19223	2196	536	2732	34625	2.40
1976	5	7772	1126	1969	12104	0	3643	0	2815	2948	10867	45492	0	2.9	20279	1516	554	2070	40383	2.70
1976	6	6737	976	1707	10492	0	3158	0	2440	2555	9420	49803	0	3.1	20885	1105	536	1641	44790	2.90
1976	7	9546	1383	2418	14866	0	4475	0	3458	3621	13348	58138	0	3.5	21898	1104	554	1657	52527	3.30
1976	8	12123	1756	3071	18879	0	5683	0	4391	4598	16950	69477	0	4.0	23165	1693	554	2246	62525	3.70
1976	9	6927	1004	1755	10788	0	3247	0	2509	2627	9686	72210	0	4.1	23302	2153	536	2689	64655	3.80
1976	10	4066	589	1030	6331	0	1906	0	1473	1542	5685	70340	0	4.1	23302	3151	1107	4258	61456	3.70
1976	11	4953	718	1255	7713	0	2322	0	1794	1878	6925	68380	0	4.0	23165	4300	1071	5372	58598	3.50
1976	12	444	64	112	691	0	208	0	161	168	620	59218	0	3.6	22152	5638	1107	6745	48800	3.10
1977	1	676	98	171	1052	0	317	0	245	256	945	49745	0	3.1	20885	5737	1107	6844	39898	2.60
1977	2	2112	306	535	3289	0	990	0	765	801	2953	42851	0	2.8	19927	4704	1000	5704	34547	2.30
1977	3	507	73	128	789	0	238	0	184	192	709	35256	0	2.4	18519	3749	1107	4856	28272	2.00
1977	4	0	0	0	0	0	0	0	0	0	0	28272	0	2.0	17110	1955	536	2490	23977	1.70
1977	5	10454	1515	2648	16281	0	4901	0	3787	3965	14617	38594	0	2.6	19223	1437	554	1991	34041	2.30
1977	6	7149	1036	1811	11133	0	3351	0	2590	2711	9996	44037	0	2.9	20279	1073	536	1609	39458	2.60
1977	7	7783	1128	1971	12120	0	3648	0	2819	2952	10882	50340	0	3.2	21138	1065	554	1619	45311	2.90
1977	8	16812	2436	4259	26180	0	7880	0	6089	6376	23506	68816	0	4.0	23165	1693	554	2246	61910	3.70
1977	9	2460	356	623	3832	0	1153	0	891	933	3440	65350	0	3.8	22658	2094	536	2629	58330	3.50
1977	10	6241	904	1581	9719	0	2925	0	2261	2367	8726	67057	0	3.9	22911	3099	1107	4206	58451	3.50
1977	11	148	21	37	230	0	69	0	54	56	207	58658	0	3.5	21898	4065	1071	5137	49775	3.10
1977	12	0	0	0	0	0	0	0	0	0	0	49775	0	3.1	20885	5316	1107	6423	40318	2.70
1978	1	0	0	0	0	0	0	0	0	0	0	40318	0	2.7	19575	5377	1107	6484	31465	2.20
1978	2	2450	355	621	3815	0	1148	0	887	929	3425	34891	0	2.4	18519	4371	1000	5371	27453	2.00
1978	3	84	12	21	132	0	40	0	31	32	118	27571	0	2.0	17110	3464	1107	4571	21390	1.60
1978	4	1679	243	425	2615	0	787	0	608	637	2348	23738	0	1.7	16004	1828	536	2364	19878	1.50
1978	5	13981	2026	3542	21773	0	6554	0	5064	5303	19549	39427	0	2.6	19223	1437	554	1991	34815	2.40
1978	6	19367	2806	4906	30160	0	9078	0	7015	7345	27079	61894	0	3.7	22405	1186	536	1721	55961	3.40
1978	7	21447	3107	5433	33400	0	10053	0	7769	8134	29988	85949	13374	4.2	23438	1181	554	15109	65881	3.90
1978	8	2872	416	728	4473	0	1346	0	1040	1089	4016	69897	0	4.0	23165	1693	554	2246	62915	3.70
1978	9	8892	1288	2252	13847	0	4168	0	3221	3372	12432	75348	2773	4.2	23438	2166	536	5474	64982	3.80
1978	10	2893	419	733	4506	0	1356	0	1048	1097	4046	69028	0	4.0	23165	3133	1107	4240	60253	3.60
1978	11	2144	311	543	3338	0	1005	0	776	813	2997	63250	0	3.7	22405	4159	1071	5231	53958	3.30
1978	12	1056	153	268	1645	0	495	0	383	401	1477	55435	0	3.4	21645	5509	1107	6616	45401	2.90
1979	1	0	0	0	0	0	0	0	0	0	0	45401	0	2.9	20279	5570	1107	6678	36013	2.40
1979	2	465	67	118	724	0	218	0	168	176	650	36663	0	2.5	18871	4454	1000	5454	29024	2.10
1979	3	1352	196	342	2105	0	634	0	490	513	1890	30914	0	2.2	17814	3606	1107	4713	24366	1.80
1979	4	5100	739	1292	7943	0	2391	0	1847	1934	7131	31498	0	2.2	17814	2035	536	2571	26902	1.90
1979	5	6484	939	1642	10097	0	3039	0	2349	2459	9066	35968	0	2.4	18519	1384	554	1938	31648	2.20
1979	6	11352	1645	2876	17678	0	5321	0	4112	4305	15872	47520	0	3.0	20632	1092	536	1628	42680	2.80
1979	7	4858	704	1231	7565	0	2277	0	1760	1842	6792	49472	0	3.1	20885	1053	554	1606	44515	2.90
1979	8	8617	1248	2183	13419	0	4039	0	3121	3268	12048	56563	0	3.4	21645	1582	554	2135	50618	3.20
1979	9	3897	565	987	6068	0	1827	0	1411	1478	5448	56066	0	3.4	21645	2000	536	2536	49783	3.10
1979	10	2503	363	634	3897	0	1173	0	907	949	3499	53283	0	3.3	21392	2893	1107	4000	45833	2.90
1979	11	4118	597	1043	6414	0	1931	0	1492	1562	5758	51591	0	3.2	21138	3924	1071	4996	43334	2.80
1979	12	0	0	0	0	0	0	0	0	0	0	43334	0	2.8	19927	5072	1107	6179	34554	2.30
1980	1	0	0	0	0	0	0	0	0	0	0	34554	0	2.3	18166	4990	1107	6097	26465	1.90
1980	2	1214	176	308	1891	0	569	0	440	461	1698	28163	0	2.0	17110	4039	1000	5039	21506	1.60
1980	3	0	0	0	0	0	0	0	0	0	0	21506	0	1.6	15636	3165	1107	4272	16027	1.20
1980	4	8828	1279	2236	13748	0	4138	0	3198	3348	12344	28370	0	2.0	17110	1955	536	2490	24068	1.80
1980	5	6716	973	1701	10459	0	3148	0	2433	2547	9391	33459	0	2.3	18166	1358	554	1912	29339	2.10
1980	6	12598	1825	3191	19619	0	5905	0	4563	4778	17615	46954	0	3.0	20632	1092	536	1628	42153	2.80
1980	7	380	55	96	592	0	178	0	138	144	532	42685	0	2.8	19927	1004	554	1558	38248	2.50
1980	8	11394	1651	2886	17744	0	5341	0	4127	4321	15931	54179	0	3.3	21392	1563	554	2117	48418	3.10
1980	9	6135	889	1554	9555	0	2876	0	2222	2327	8578	56997	0	3.5	21898	2023	536	2559	50627	3.20
1980	10	581	84	147	904	0	272	0	210	220	812	51439	0	3.2	21138	2859	1107	3966	44150	2.90
1980	11	1225	177	310	1908	0	574	0	444	465	1713	45863	0	2.9	20279	3765	1071	4836	38155	2.50
1980	12	1436	208	364	2237	0	673	0	520	545	2008	40163	0	2.6	19223	4893	1107	6000	31772	2.20
1981	1	0	0	0	0	0	0	0	0	0	0	31772	0	2.2	17814	4893	1107	6000	23967	1.70
1981	2	1922	278	487	2993	0	901	0	696	729	2687	26655	0	1.9	16741	3952	1000	4952	20184	1.50
1981	3	739	107	187	1151	0	347	0	268	280	1034	21217	0	1.6	15636	3165	1107	4272	15759	1.20
1981	4	3274	474	829	5098	0	1535	0	1186	1242	4577	20336	0	1.5	15267	1744	536	2280	16792	1.30
1981	5	16072	2329	4071	25029	0	7534	0	5822	6096	22472	39264	0	2.6	19223	1437	554	1991	34665	2.40
1981	6	19504	2826	4941	30374	0	9143	0	7065	7397	27271	61936	0	3.7	22405	1186	536	1721	55999	3.40
1981	7	16917	2451	4285	26345	0	7930	0	6128	6416	23654	79653	7078	4.2	23438	1181	554	8813	65881	3.90
1981	8	15492	2245	3924	24125	0	7262	0	5611	5875	21660	87542	14967	4.2	23438	1713	554	17233	65387	3.80
1981	9	5027	728	1273	7828	0	2356	0	1821	1906	7028	72415	0	4.1	23302	2153	536	2689	64845	3.80
1981	10	1658	240	420	2582	0	777	0	601	629	2318	67164	0	3.9	22911	3099	1107	4206	58551	3.50
1981	11	4055	588	1027	6315	0	1901	0	1469	1538	5670	64221	0	3.8	22658	4206	1071	5278	54817	3.40
1981	12	1278	185	324	1990	0	599	0	463	485	1787	56603	0	3.4	21645	5509	1107	6616	46488	3.00
1982	1	2323	337	589	3618	0	1089	0	842	881	3248	49736	0	3.1	20885	5737	1107	6844	39890	2.60
1982	2	634	92	161	987	0	297	0	230	240	886	40776	0	2.7	19575	4621	1000	5621	32695	2.20
1982	3	2112	306	535	3289	0	990	0	765	801	2953	35648	0	2.4	18519	3749	1107	4856	28636	2.00
1982	4	0	0	0	0	0	0	0	0	0	0	28636	0	2.0	17110	1955	536	2490	24316	1.80
1982	5	6209	900	1573	9670	0	2911	0	2249	2355	8682	32997	0	2.3	18166	1358	554	1912	28910	2.00
1982	6	14932	2163	3782	23253	0	6999	0	5409	5663	20878	49787	0	3.1	20885	1105	536	1641	44776	2.90
1982	7	16389	2375	4152	25523	0	7682	0	5936	6216	22915	67692	0	3.9	22911	1155	554	1708	61364	3.70
1982	8	10201	1478	2584	15886	0	4782	0	3695	3869	14263	75627	3052	4.2	23438	1713	554	5319	65387	3.80
1982	9	4773	692	1209	7433	0	2237	0	1729	1810	6674	72061	0	4.1	23302	2153	536	2689	64516	3.80
1982	10	2767	401	701	4309	0	1297	0	1002	1049	3868	68384	0	4.0	23165	3133	1107	4240	59654	3.60
1982	11	253	37	64	395	0	119	0	92	96	354	60009	0	3.6	22152	4112	1071	5184	50987	3.20
1982	12	528	77	134	822	0	248	0	191	200	738	51726	0	3.2	21138	5380	1107	6487	42072	2.70
1983	1	84	12	21	132	0	40	0	31	32	118	42190	0	2.8	19927	5474	1107	6581	33116	2.30
1983	2	1721	249	436	2681	0	807	0	623	653	2407	35523	0	2.4	18519	4371	1000	5371	28041	2.00
1983	3	401	58	102	625	0	188	0	145	152	561	28602	0	2.0	17110	3464	1107	4571	22349	1.60
1983	4	1668	242	423	2598	0	782	0	604	633	2333	24682	0	1.8	16373	1870	536	2406	20717	1.50
1983	5	2429	352	615	3782	0	1139	0	880	921	3396	24113	0	1.8	16373	1224	554	1778	20772	1.50
1983	6	19198	2782	4863	29897	0	8999	0	6954	7281	26843	47614	0	3.0	20632	1092	536	1628	42768	2.80
1983	7	9884	1432	2504	15393	0	4633	0	3580	3749	13820	56588	0	3.4	21645	1091	554	1644	51097	3.20
1983	8	10771	1561	2729	16774	0	5049	0	3902	4085	15060	66158	0	3.9	22911	1674	554	2228	59455	3.60
1983	9	10602	1536	2686	16511	0	4970	0	3840	4021	14824	74279	1704	4.2	23438	2166	536	4405	64982	3.80
1983	10	908	132	230	1414	0	426	0	329	344	1270	66252	0	3.9	22911	3099	1107	4206	57703	3.50
1983	11	4752	689	1204	7400	0	2228	0	1721	1802	6644	64348	0	3.8	22658	4206	1071	5278	54935	3.40
1983	12	1774	257	449	2763	0	832	0	643	673	2481	57415	0	3.5	21898	5574	1107	6681	47183	3.00
1984	1	84	12	21	132	0	40	0	31	32	118	47301	0	3.0	20632	5667	1107	6774	37690	2.50
1984	2	380	55	96	592	0	178	0	138	144	532	38222	0	2.5	18871	4454	1000	5454	30474	2.10
1984	3	3084	447	781	4802	0	1445	0	1117	1169	4311	34785	0	2.4	18519	3749	1107	4856	27834	2.00
1984	4	6294	912	1594	9801	0	2950	0	2280	2387	8800	36634	0	2.5	18871	2156	536	2692	31567	2.20
1984	5	15143	2194	3836	23582	0	7098	0	5485	5743	21173	52740	0	3.3	21392	1599	554	2153	47046	3.00
1984	6	12081	1750	3060	18813	0	5663	0	4376	4582	16891	63937	0	3.8	22658	1199	536	1735	57848	3.50

Year	Mth	Northern Storages Inflow kL	Vol kL	Outflow kL	Level m	Area m2	Evap kL	Demand kL	Used kL	End Stor kL	Level m	Southern Storages Inflow kL	Vol kL	Outflow kL	Level m	Area m2	Evap kL	Demand kL	Used kL	End Stor (kl)	Level m	Blackadder Creek Tributary Clay Shed kL	Evap kL	Clay ShedOut kL	South StorOut kL	Total Flow kL
			5711					0		Stor Loss			6760					0		Stor Loss			Area			
		10850	13800 MaxV				1160	0	6872	50%		8582	5000 MaxV				632	0	7392	50%		4541	10000	3696	6760	10456
										10000										2000						
1975	1	0	10000	0	1.1	9200	2527	0	2527	3736	0.40	0	2000	0	0.4	5240	1439	0	1439	280	0.05	0	2747	0	0	0
1975	2	0	3736	0	0.4	9200	2172	0	2172	782	0.05	0	280	0	0.1	4155	280	0	280	0	0.00	0	2360	0	0	0
1975	3	2105	2887	0	0.3	9200	1862	0	1862	512	0.05	634	634	0	0.1	4310	634	0	634	0	0.00	1002	2024	0	0	0
1975	4	6479	6992	0	0.8	9200	1051	0	1051	2970	0.30	1950	1950	0	0.4	5085	581	0	581	685	0.10	3085	1142	1943	0	1943
1975	5	9143	12114	0	1.3	9200	688	0	688	5713	0.60	2752	3437	0	0.7	6015	450	0	450	1494	0.25	4353	748	3606	0	3606
1975	6	24141	29854	16054	1.5	9200	487	0	16541	6657	0.70	23321	24814	19814	1.0	7100	376	0	20190	2312	0.45	11494	529	10965	19814	30780
1975	7	44266	50923	37123	1.5	9200	464	0	37586	6668	0.70	47082	49394	44394	1.0	7100	358	0	44752	2321	0.45	15754	504	15250	44394	59644
1975	8	17276	23944	10144	1.5	9200	672	0	10816	6564	0.70	13945	16266	11266	1.0	7100	519	0	11785	2241	0.40	6013	731	5283	11266	16549
1975	9	17468	24032	10232	1.5	9200	850	0	11082	6475	0.70	14142	16383	11383	1.0	7100	656	0	12039	2172	0.40	6186	924	5262	11383	16644
1975	10	7236	13711	0	1.5	9200	1244	0	1244	6233	0.65	2178	4350	0	0.9	6635	897	0	897	1726	0.30	3445	1352	2093	0	2093
1975	11	3059	9292	0	1.0	9200	1708	0	1708	3792	0.40	921	2647	0	0.5	5550	1030	0	1030	808	0.15	1456	1856	0	0	0
1975	12	230	4022	0	0.4	9200	2342	0	2342	840	0.05	69	878	0	0.2	4465	878	0	878	0	0.00	110	2545	0	0	0
1976	1	3848	4688	0	0.5	9200	2527	0	2527	1081	0.10	1158	1158	0	0.2	4620	1158	0	1158	0	0.00	1832	2747	0	0	0
1976	2	5871	6952	0	0.8	9200	2172	0	2172	2390	0.25	1767	1767	0	0.4	5085	1200	0	1200	283	0.05	2795	2360	435	0	435
1976	3	66	2456	0	0.3	9200	1862	0	1862	297	0.00	20	303	0	0.1	4155	303	0	303	0	0.00	31	2024	0	0	0
1976	4	11873	12170	0	1.3	9200	1051	0	1051	5559	0.60	3574	3574	0	0.7	6170	705	0	705	1435	0.25	5653	1142	4511	0	4511
1976	5	12104	17663	3863	1.5	9200	688	0	4551	6556	0.70	7506	8941	3941	1.0	7100	531	0	4472	2235	0.40	5763	748	5015	3941	8956
1976	6	10492	17048	3248	1.5	9200	487	0	3735	6657	0.70	6406	8641	3641	1.0	7100	376	0	4016	2312	0.45	4996	529	4466	3641	8107
1976	7	14866	21523	7723	1.5	9200	464	0	8187	6668	0.70	12198	14510	9510	1.0	7100	358	0	9868	2321	0.45	7078	504	6574	9510	16084
1976	8	18879	25547	11747	1.5	9200	672	0	12419	6564	0.70	17430	19751	14751	1.0	7100	519	0	15270	2241	0.40	8989	731	8258	14751	23009
1976	9	10788	17352	3552	1.5	9200	850	0	4402	6475	0.70	6799	9040	4040	1.0	7100	656	0	4696	2172	0.40	5136	924	4212	4040	8252
1976	10	6331	12806	0	1.4	9200	1244	0	1244	5781	0.60	1906	4078	0	0.8	6480	876	0	876	1601	0.30	3015	1352	1662	0	1662
1976	11	7713	13494	0	1.5	9200	1708	0	1708	5893	0.60	2322	3922	0	0.8	6325	1174	0	1174	1374	0.25	3672	1856	1816	0	1816
1976	12	691	6584	0	0.7	9200	2342	0	2342	2121	0.20	208	1582	0	0.3	4930	1255	0	1255	164	0.00	329	2545	0	0	0
1977	1	1052	3173	0	0.3	9200	2527	0	2527	323	0.00	317	480	0	0.1	4155	480	0	480	0	0.00	501	2747	0	0	0
1977	2	3289	3612	0	0.4	9200	2172	0	2172	720	0.05	990	990	0	0.2	4465	990	0	990	0	0.00	1566	2360	0	0	0
1977	3	789	1510	0	0.2	9200	1510	0	1510	0	0.00	238	238	0	0.0	4000	238	0	238	0	0.00	376	2024	0	0	0
1977	4	0	0	0	0.0	9200	0	0	0	0	0.00	0	0	0	0.0	4000	0	0	0	0	0.00	0	1142	0	0	0
1977	5	16281	16281	2481	1.5	9200	688	0	3168	6556	0.70	7381	7381	2381	1.0	7100	531	0	2912	2235	0.40	7752	748	7004	2381	9385
1977	6	11133	17689	3889	1.5	9200	487	0	4376	6657	0.70	7241	9475	4475	1.0	7100	376	0	4851	2312	0.45	5301	529	4772	4475	9247
1977	7	12120	18777	4977	1.5	9200	464	0	5440	6668	0.70	8625	10937	5937	1.0	7100	358	0	6295	2321	0.45	5771	504	5267	5937	11204
1977	8	26180	32849	19049	1.5	9200	672	0	19721	6564	0.70	26929	29250	24250	1.0	7100	519	0	24769	2241	0.40	12465	731	11735	24250	35985
1977	9	3832	10396	0	1.1	9200	850	0	850	4773	0.50	1153	3394	0	0.7	6015	556	0	556	1419	0.25	1824	924	900	0	900
1977	10	9719	14492	692	1.5	9200	1244	0	1936	6278	0.65	3617	5036	36	1.0	7100	960	0	996	2020	0.40	4628	1352	3275	36	3311
1977	11	230	6508	0	0.7	9200	1708	0	1708	2400	0.25	69	2089	0	0.4	5240	973	0	973	558	0.10	110	1856	0	0	0
1977	12	0	2400	0	0.3	9200	2342	0	2342	29	0.00	0	558	0	0.1	4310	558	0	558	0	0.00	0	2545	0	0	0
1978	1	0	29	0	0.0	9200	29	0	29	0	0.00	0	0	0	0.0	4000	0	0	0	0	0.00	0	2747	0	0	0
1978	2	3815	3815	0	0.4	9200	2172	0	2172	822	0.05	1148	1148	0	0.2	4620	1091	0	1091	29	0.00	1817	2360	0	0	0
1978	3	132	953	0	0.1	9200	953	0	953	0	0.00	40	69	0	0.0	4000	69	0	69	0	0.00	63	2024	0	0	0
1978	4	2615	2615	0	0.3	9200	1051	0	1051	782	0.05	787	787	0	0.2	4465	510	0	510	138	0.00	1245	1142	103	0	103
1978	5	21773	22555	8755	1.5	9200	688	0	9443	6556	0.70	15309	15447	10447	1.0	7100	531	0	10978	2235	0.40	10367	748	9619	10447	20067
1978	6	30160	36716	22916	1.5	9200	487	0	23403	6657	0.70	31995	34229	29229	1.0	7100	376	0	29605	2312	0.45	14360	529	13831	29229	43060
1978	7	46773	53430	39630	1.5	9200	464	0	40094	6668	0.70	49683	51996	46996	1.0	7100	358	0	47353	2321	0.45	15903	504	15399	46996	62394
1978	8	4473	11141	0	1.2	9200	672	0	672	5234	0.55	1346	3667	0	0.7	6170	451	0	451	1608	0.30	2130	731	1399	0	1399
1978	9	16619	21854	8054	1.5	9200	850	0	8904	6475	0.70	12222	13830	8830	1.0	7100	656	0	9486	2172	0.40	6593	924	5669	8830	14499
1978	10	4506	10981	0	1.2	9200	1244	0	1244	4868	0.50	1356	3528	0	0.7	6170	834	0	834	1347	0.25	2145	1352	793	0	793
1978	11	3338	8207	0	0.9	9200	1708	0	1708	3249	0.35	1005	2352	0	0.5	5395	1002	0	1002	675	0.10	1589	1856	0	0	0
1978	12	1645	4894	0	0.5	9200	2342	0	2342	1276	0.10	495	1170	0	0.2	4620	1170	0	1170	0	0.00	783	2545	0	0	0
1979	1	0	1276	0	0.1	9200	1276	0	1276	0	0.00	0	0	0	0.0	4000	0	0	0	0	0.00	0	2747	0	0	0
1979	2	724	724	0	0.1	9200	724	0	724	0	0.00	218	218	0	0.0	4000	218	0	218	0	0.00	345	2360	0	0	0
1979	3	2105	2105	0	0.2	9200	1862	0	1862	121	0.00	634	634	0	0.1	4310	634	0	634	0	0.00	1002	2024	0	0	0
1979	4	7943	8064	0	0.9	9200	1051	0	1051	3507	0.35	2391	2391	0	0.5	5395	616	0	616	887	0.15	3782	1142	2639	0	2639
1979	5	10097	13604	0	1.5	9200	688	0	688	6458	0.70	3039	3927	0	0.8	6325	473	0	473	1727	0.30	4808	748	4060	0	4060
1979	6	17678	24136	10336	1.5	9200	487	0	10823	6657	0.70	15658	17384	12384	1.0	7100	376	0	12760	2312	0.45	8417	529	7888	12384	20273
1979	7	7565	14221	421	1.5	9200	464	0	885	6668	0.70	2698	5010	10	1.0	7100	358	0	368	2321	0.45	3602	504	3098	10	3108
1979	8	13419	20087	6287	1.5	9200	672	0	6960	6564	0.70	10326	12648	7648	1.0	7100	519	0	8166	2241	0.40	6389	731	5658	7648	13306
1979	9	6068	12632	0	1.4	9200	850	0	850	5891	0.60	1827	4067	0	0.8	6480	599	0	599	1734	0.30	2889	924	1965	0	1965
1979	10	3897	9788	0	1.1	9200	1244	0	1244	4272	0.45	1173	2907	0	0.6	5705	772	0	772	1068	0.20	1856	1352	503	0	503
1979	11	6414	10686	0	1.2	9200	1708	0	1708	4489	0.45	1931	2998	0	0.6	5705	1059	0	1059	970	0.15	3054	1856	1197	0	1197
1979	12	0	4489	0	0.5	9200	2342	0	2342	1074	0.10	0	970	0	0.2	4465	970	0	970	0	0.00	0	2545	0	0	0
1980	1	0	1074	0	0.1	9200	1074	0	1074	0	0.00	0	0	0	0.0	4000	0	0	0	0	0.00	0	2747	0	0	0
1980	2	1891	1891	0	0.2	9200	1891	0	1891	0	0.00	569	569	0	0.1	4310	569	0	569	0	0.00	900	2360	0	0	0
1980	3	0	0	0	0.0	9200	0	0	0	0	0.00	0	0	0	0.0	4000	0	0	0	0	0.00	0	2024	0	0	0
1980	4	13748	13748	0	1.5	9200	1051	0	1051	6349	0.65	4138	4138	0	0.8	6480	740	0	740	1699	0.30	6546	1142	5403	0	5403
1980	5	10459	16808	3008	1.5	9200	688	0	3695	6556	0.70	6156	7855	2855	1.0	7100	531	0	3385	2235	0.40	4980	748	4232	2855	7087
1980	6	19619	26175	12375	1.5	9200	487	0	12862	6657	0.70	18280	20515	15515	1.0	7100	376	0	15891	2312	0.45	9341	529	8812	15515	24327
1980	7	592	7249	0	0.8	9200	464	0	464	3392	0.35	178	2490	0	0.5	5395	272	0	272	1109	0.20	282	504	0	0	0
1980	8	17744	21137	7337	1.5	9200	672	0	8009	6564	0.70	12678	13787	8787	1.0	7100	519	0	9306	2241	0.40	8449	731	7718	8787	16505
1980	9	9555	16118	2318	1.5	9200	850	0	3168	6475	0.70	5194	7435	2435	1.0	7100	656	0	3091	2172	0.40	4549	924	3625	2435	6060
1980	10	904	7379	0	0.8	9200	1244	0	1244	3068	0.30	272	2444	0	0.5	5395	730	0	730	857	0.15	431	1352	0	0	0
1980	11	1908	4975	0	0.5	9200	1708	0	1708	1634	0.15	574	1432	0	0.3	4775	886	0	886	273	0.05	908	1856	0	0	0
1980	12	2237	3870	0	0.4	9200	2342	0	2342	764	0.05	673	946	0	0.2	4465	946	0	946	0	0.00	1065	2545	0	0	0
1981	1	0	764	0	0.1	9200	764	0	764	0	0.00	0	0	0	0.0	4000	0	0	0	0	0.00	0	2747	0	0	0
1981	2	2993	2993	0	0.3	9200	2172	0	2172	411	0.00	901	901	0	0.2	4465	901	0	901	0	0.00	1425	2360	0	0	0
1981	3	1151	1562	0	0.2	9200	1562	0	1562	0	0.00	347	347	0	0.1	4155	347	0	347	0	0.00	548	2024	0	0	0
1981	4	5098	5098	0	0.6	9200	1051	0	1051	2023	0.20	1535	1535	0	0.3	4930	563	0	563	486	0.05	2427	1142	1285	0	1285
1981	5	25029	27053	13253	1.5	9200	688	0	13941	6556	0.70	20787	21272	16272	1.0	7100	531	0	16803	2235	0.40	11917	748	11170	16272	27442
1981	6	30374	36930	23130	1.5	9200	487	0	23617	6657	0.70	32273	34507	29507	1.0	7100	376	0	29883	2312	0.45	14462	529	13933	29507	43440
1981	7	33423	40079	26279	1.5	9200	464	0	26743	6668	0.70	34209	36521	31521	1.0	7100	358	0	31879	2321	0.45	12544	504	12040	31521	43561
1981	8	39091	45760	31960	1.5	9200	672	0	32632	6564	0.70	39221	41542	36542	1.0	7100	519	0	37061	2241	0.40	11487	731	10756	36542	47298
1981	9	7828	14392	592	1.5	9200	850	0	1442	6475	0.70	2948	5188	188	1.0	7100	656	0	844	2172	0.40	3727	924	2803	188	2991
1981	10	2582	9057	0	1.0	9200	1244	0	1244	3906	0.40	777	2949	0	0.6	5705	772	0	772	1089	0.20	1229	1352	0	0	0
1981	11	6315	10221	0	1.1	9200	1708	0	1708	4257	0.45	1901	2990	0	0.6	5705	1059	0	1059	965	0.15	3007	1856	1150	0	1150
1981	12	1990	6246	0	0.7	9200	2342	0	2342	1952	0.20	599	1564	0	0.3	4930	1255	0	1255	155	0.00	947	2545	0	0	0
1982	1	3618	5570	0	0.6	9200	2527	0	2527	1522	0.15	1089	1244	0	0.2	4620	1244	0	1244	0	0.00	1723	2747	0	0	0
1982	2	987	2508	0	0.3	9200	2172	0	2172	168	0.00	297	297	0	0.1	4155	297	0	297	0	0.00	470	2360	0	0	0
1982	3	3289	3457	0	0.4	9200	1862	0	1862	797	0.05	990	990	0	0.2	4465	904	0	904	43	0.00	1566	2024	0	0	0
1982	4	0	797	0	0.1	9200	797	0	797	0	0.00	0	43	0	0.0	4000	43	0	43	0	0.00	0	1142	0	0	0
1982	5	9670	9670	0	1.1	9200	688	0	688	4491	0.45	2911	2911	0	0.6	5705	427	0	427	1242	0.20	4604	748	3856	0	3856
1982	6	23253	27744	13944	1.5	9200	487	0	14431	6657	0.70	20943	22186	17186	1.0	7100	376	0	17561	2312	0.45	11072	529	10542	17186	27728
1982	7	25523	32179	18379	1.5	9200	464	0	18843	6668	0.70	26062	28374	23374	1.0	7100	358	0	23732	2321	0.45	12152	504	11648	23374	35022
1982	8	18938	25606	11806	1.5	9200	672	0	12479	6564	0.70	16588	18909	13909	1.0	7100	519	0	14428	2241	0.40	7564	731	6833	13909	20742
1982	9	7433	13997	197	1.5	9200	850	0	1047	6475	0.70	2434	4675	0	0.9	6790	627	0	627	2024	0.40	3539	924	2615	0	2615
1982	10	4309	10784	0	1.2	9200	1244	0	1244	4770	0.50	1297	3321	0	0.7	6015	813	0	813	1254	0.25	2051	1352	699	0	699
1982	11	395	5164	0	0.6	9200	1708	0	1708	1728	0.15	119	1372	0	0.3	4775	886	0	886	243	0.00	188	1856	0	0	0
1982	12	822	2550	0	0.3	9200	2342	0	2342	104	0.00	248	490	0	0.1	4155	490	0	490	0	0.00	392	2545	0	0	0
1983	1	132	236	0	0.0	9200	236	0	236	0	0.00	40	40	0	0.0	4000	40	0	40	0	0.00	63	2747	0	0	0
1983	2	2681	2681	0	0.3	9200	2172	0	2172	254	0.00	807	807	0	0.2	4465	807	0	807	0	0.00	1276	2360	0	0	0
1983	3	625	879	0	0.1	9200	879	0	879	0	0.00	188	188	0	0.0	4000	188	0	188	0	0.00	298	2024	0	0	0
1983	4	2598	2598	0	0.3	9200	1051	0	1051	774	0.05	782	782	0	0.2	4465	510	0	510	136	0.00	1237	1142	95	0	95
1983	5	3782	4556	0	0.5	9200	688	0	688	1934	0.20	1139	1275	0	0.3	4775	357	0	357	459	0.05	1801	748	1053	0	1053
1983	6	29897	31831	18031	1.5	9200	487	0	18518	6657	0.70	27030	27489	22489	1.0	7100	376	0	22865	2312	0.45	14235	529	13706	22489	36195
1983	7	15393	22049	8249	1.5	9200	464	0	8713	6668	0.70	12882	15194	10194	1.0	7100	358	0	10552	2321	0.45	7329	504	6825	10194	17019
1983	8	16774	23442	9642	1.5	9200	672	0	10314	6564	0.70	14691	17012	12012	1.0	7100	519	0	12531	2241	0.40	7987	731	7256	12012	19268
1983	9	18214	24778	10978	1.5	9200	850	0	11828	6475	0.70	15948	18189	13189	1.0	7100	656	0	13845	2172	0.40	7861	924	6937	13189	20126
1983	10	1414	7889	0	0.9	9200	1244	0	1244	3323	0.35	426	2598	0	0.5	5550	751	0	751	924	0.15	673	1352	0	0	0
1983	11	7400	10723	0	1.2	9200	1708	0	1708	4507	0.45	2228	3151	0	0.6	5860	1088	0	1088	1032	0.20	3524	1856	1667	0	1667
1983	12	2763	7270	0	0.8	9200	2342	0	2342	2464	0.25	832	1863	0	0.4	5085	1294	0	1294	284	0.05	1315	2545	0	0	0
1984	1	132	2596	0	0.3	9200	2527	0	2527	34	0.00	40	324	0	0.1	4155	324	0	324	0	0.00	63	2747	0	0	0
1984	2	592	626	0	0.1	9200	626	0	626	0	0.00	178	178	0	0.0	4000	178	0	178	0	0.00	282	2360	0	0	0
1984	3	4802	4802	0	0.5	9200	1862	0	1862	1470	0.15	1445	1445	0	0.3	4775	967	0	967	239	0.00	2286	2024	262	0	262
1984	4	9801	11271	0	1.2	9200	1051	0	1051	5110	0.55	2950	3190	0	0.6	5860	669	0	669	1260	0.25	4667	1142	3524	0	3524
1984	5	23582	28692	14892	1.5	9200	688	0	15580	6556	0.70	21990	23250	18250	1.0	7100	531	0	18781	2235	0.40	11228	748	10481	18250	28731
1984	6	18813	25369	11569	1.5	9200	487	0	12056	6657	0.70	17232	19467	14467	1.0	7100	376	0	14842	2312	0.45	8958	529	8428	14467	22895

Midland Brick

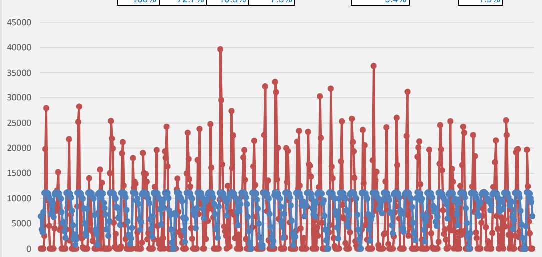
Water Balance Model Ultimate

Add Northern Aquifer/Remove Jack Wiliamson Catchments 2&3 & Clay Shed to Residential Clay Swale Outlfow to BA Trib

Modelling Start Year	1975	
Modelling Start Month	1	
Rainfall Multiplier	1.00	
Total Flow (kL/yr)	217682	
Catchment 1 (kL/yr)	102752	47.2%
Catchment 2 (kL/yr)	50732	23.3%
Catchment 3 (kL/yr)	24635	11.3%
Catchment 4 (kL/yr)	39563	18.2%
Total Evaporation	19527	9.0%
Total Demand	47768	21.9%
Total Loss	18403	8.5%
BA Trib Outflow	118425	54.4%
Average Outflow l/s	3.8	

Clay Swale DIVERTED

Inflow	Outflow	Evap	Loss	Demand	Supplied	Empty
102752	74673	10772	7727	9768	9654	10
100%	72.7%	10.5%	7.5%		9.4%	1.9%

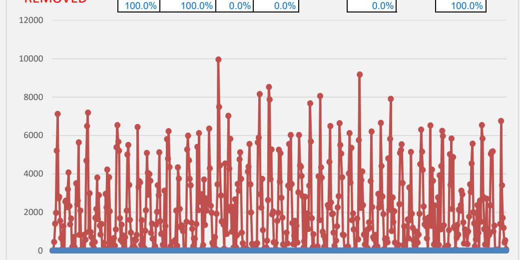


North Storage AQUIFER/SWAN

Inflow	Outflow	Evap	Loss	Demand	Supplied	Empty
87423	39341	0	10676	38000	37320	26
100.0%	45.0%	0.0%	12.2%		42.7%	4.8%

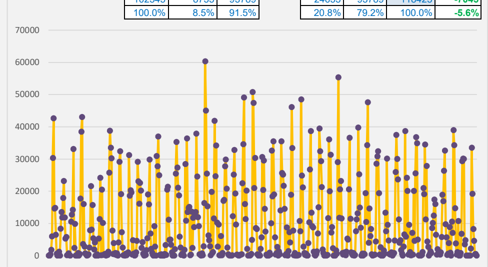
South Storage REMOVED

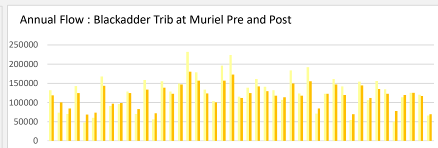
Inflow	Outflow	Evap	Loss	Demand	Supplied	Empty
24635	24635	0	0	0	0	540
100.0%	100.0%	0.0%	0.0%		0.0%	100.0%

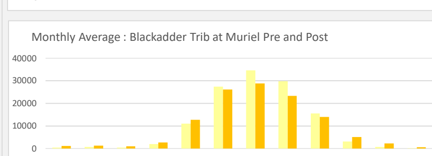


BA Trib Flow

Cshed	Evap	Outflow	South	Cshed	Outflow	Increase
102545	8755	93789	24635	93789	118425	-7045
100.0%	8.5%	91.5%	20.8%	79.2%	100.0%	-5.6%







Demands / Water Sources, Catchment Areas, & Runoff

Year	Mth	Rain (mm)	Adj Rain (mm)	Evap (mm)	Dust Supp kL	Recycl Plant kL	Resid /POS kL	Constr kL	Catch 1 Hstand ha	Catch 1 Roof ha	Catch 1 External ha	Catch 2 Indust ha	Catch 2 Resid ha	Catch 3 Indust ha	Catch 3 Resid ha	Catch 4 Local/ CShed ha	Catch 4 Other ha	Extra Bore kL
					1.00	0.00	1.00	0.00										Vol 25000
									55%	85%	25%	55%	30%	55%	30%	30%	15%	
1975	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1975	2	0.0	0.0	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1975	3	12.8	12.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1975	4	39.4	39.4	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1975	5	55.6	55.6	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1975	6	146.8	146.8	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1975	7	201.2	201.2	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1975	8	76.8	76.8	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1975	9	79.0	79.0	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1975	10	44.0	44.0	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1975	11	18.6	18.6	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1975	12	1.4	1.4	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1976	1	23.4	23.4	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1976	2	35.7	35.7	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1976	3	0.4	0.4	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1976	4	72.2	72.2	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1976	5	73.6	73.6	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1976	6	63.8	63.8	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1976	7	90.4	90.4	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1976	8	114.8	114.8	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1976	9	65.6	65.6	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1976	10	38.5	38.5	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1976	11	46.9	46.9	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1976	12	4.2	4.2	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1977	1	6.4	6.4	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1977	2	20.0	20.0	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1977	3	4.8	4.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1977	4	0.0	0.0	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1977	5	99.0	99.0	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1977	6	67.7	67.7	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1977	7	73.7	73.7	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1977	8	159.2	159.2	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1977	9	23.3	23.3	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1977	10	59.1	59.1	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1977	11	1.4	1.4	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1977	12	0.0	0.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1978	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1978	2	23.2	23.2	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1978	3	0.8	0.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1978	4	15.9	15.9	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1978	5	132.4	132.4	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1978	6	183.4	183.4	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1978	7	203.1	203.1	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1978	8	27.2	27.2	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1978	9	84.2	84.2	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1978	10	27.4	27.4	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1978	11	20.3	20.3	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1978	12	10.0	10.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1979	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1979	2	4.4	4.4	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1979	3	12.8	12.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1979	4	48.3	48.3	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1979	5	61.4	61.4	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1979	6	107.5	107.5	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1979	7	46.0	46.0	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1979	8	81.6	81.6	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1979	9	36.9	36.9	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1979	10	23.7	23.7	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1979	11	39.0	39.0	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1979	12	0.0	0.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1980	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1980	2	11.5	11.5	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1980	3	0.0	0.0	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1980	4	83.6	83.6	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1980	5	63.6	63.6	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1980	6	119.3	119.3	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1980	7	3.6	3.6	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1980	8	107.9	107.9	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1980	9	58.1	58.1	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1980	10	5.5	5.5	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1980	11	11.6	11.6	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1980	12	13.6	13.6	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1981	1	0.0	0.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1981	2	18.2	18.2	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1981	3	7.0	7.0	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1981	4	31.0	31.0	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1981	5	152.2	152.2	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1981	6	184.7	184.7	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1981	7	160.2	160.2	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1981	8	146.7	146.7	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1981	9	47.6	47.6	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1981	10	15.7	15.7	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1981	11	38.4	38.4	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1981	12	12.1	12.1	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1982	1	22.0	22.0	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1982	2	6.0	6.0	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1982	3	20.0	20.0	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1982	4	0.0	0.0	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1982	5	58.8	58.8	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1982	6	141.4	141.4	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1982	7	155.2	155.2	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1982	8	96.6	96.6	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1982	9	45.2	45.2	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1982	10	26.2	26.2	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1982	11	2.4	2.4	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1982	12	5.0	5.0	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1983	1	0.8	0.8	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1983	2	16.3	16.3	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1983	3	3.8	3.8	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1983	4	15.8	15.8	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1983	5	23.0	23.0	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1983	6	181.8	181.8	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1983	7	93.6	93.6	50.4	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1983	8	102.0	102.0	73.1	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1983	9	100.4	100.4	92.4	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1983	10	8.6	8.6	135.2	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1983	11	45.0	45.0	185.6	1071	3857	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1983	12	16.8	16.8	254.5	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1984	1	0.8	0.8	274.7	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1984	2	3.6	3.6	236.0	1000	3600	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1984	3	29.2	29.2	202.4	1107	3986	6333	833	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	4167
1984	4	59.6	59.6	114.2	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1984	5	143.4	143.4	74.8	554	1329	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0
1984	6	114.4	114.4	52.9	536	1286	0	0	19.2	1.8	10.7	0.0	24.3	0.0	11.8	5.6	26.7	0

Runoff / Clay Swale

Year	Mth	Catch 1 Hstand kL	Catch 1 Roof kL	Catch 1 External kL	Catch 2 Indust kL	Catch 2 Resid kL	Catch 3 Indust kL	Catch 3 Resid kL	Catch 4 CShed kL	Catch 4 Other kL	Clay Swale Inflow kL	Vol kL	Outflow kL	Level m	Area m2	Evap kL	Demand kL	Used kL	End Stor kL	Level m
													6223				805	Stor Loss		
		6124	887	1551	0	4228	0	2053	974	2323	8563		12950	MaxV		898	814	7925	7%	
																			9747	
1975	1	0	0	0	0	0	0	0	0	0	0	9747	0	1.8	6186	1699	1107	2806	6455	1.20
1975	2	0	0	0	0	0	0	0	0	0	0	6455	0	1.2	5668	1338	1000	2338	3829	0.70
1975	3	1352	196	342	0	933	0	453	215	513	1890	5719	0	1.1	5582	1130	1107	2237	3238	0.60
1975	4	4161	603	1054	0	2872	0	1395	662	1578	5817	9055	0	1.6	6012	687	536	1223	7284	1.30
1975	5	5871	851	1487	0	4053	0	1968	934	2227	8209	15494	2544	2.3	6625	495	554	3593	11068	2.00
1975	6	15502	2246	3927	0	10702	0	5197	2466	5879	21675	32743	19793	2.3	6625	351	536	20679	11219	2.00
1975	7	21247	3078	5382	0	14667	0	7122	3380	8058	29707	40926	27976	2.3	6625	334	554	28864	11218	2.00
1975	8	8110	1175	2054	0	5599	0	2719	1290	3076	11340	22558	9608	2.3	6625	484	554	10645	11078	2.00
1975	9	8342	1209	2113	0	5759	0	2797	1327	3164	11664	22743	9793	2.3	6625	612	536	10941	10976	1.90
1975	10	4646	673	1177	0	3208	0	1558	739	1762	6497	17473	4523	2.3	6625	896	1107	6526	10181	1.80
1975	11	1964	285	498	0	1356	0	658	312	745	2746	12927	0	2.2	6537	1214	1071	2285	9897	1.80
1975	12	148	21	37	0	102	0	50	24	56	207	10104	0	1.8	6186	1574	1107	2682	6903	1.30
1976	1	2471	358	626	0	1706	0	828	393	937	3455	10358	0	1.8	6186	1699	1107	2806	7023	1.30
1976	2	3770	546	955	0	2603	0	1264	600	1430	5271	12294	0	2.2	6537	1543	1000	2543	9068	1.60
1976	3	42	6	11	0	29	0	14	7	16	59	9127	0	1.6	6012	1217	1107	2324	6327	1.20
1976	4	7624	1105	1931	0	5263	0	2556	1213	2892	10660	16987	4037	2.3	6625	757	536	5330	10841	1.90
1976	5	7772	1126	1969	0	5365	0	2605	1236	2948	10867	21708	8758	2.3	6625	495	554	9807	11068	2.00
1976	6	6737	976	1707	0	4651	0	2259	1072	2555	9420	20488	7538	2.3	6625	351	536	8424	11219	2.00
1976	7	9546	1383	2418	0	6590	0	3200	1519	3621	13348	24567	11617	2.3	6625	334	554	12504	11218	2.00
1976	8	12123	1756	3071	0	8369	0	4064	1929	4598	16950	28168	15218	2.3	6625	484	554	16256	11078	2.00
1976	9	6927	1004	1755	0	4782	0	2322	1102	2627	9686	20764	7814	2.3	6625	612	536	8962	10976	1.90
1976	10	4066	589	1030	0	2807	0	1363	647	1542	5685	16661	3711	2.3	6625	896	1107	5714	10181	1.80
1976	11	4953	718	1255	0	3419	0	1660	788	1878	6925	17105	4155	2.3	6625	1230	1071	6457	9903	1.80
1976	12	444	64	112	0	306	0	149	71	168	620	10523	0	1.9	6273	1597	1107	2704	7272	1.30
1977	1	676	98	171	0	467	0	227	108	256	945	8217	0	1.5	5926	1628	1107	2735	5099	1.00
1977	2	2112	306	535	0	1458	0	708	336	801	2953	8052	0	1.5	5926	1399	1000	2399	5257	1.00
1977	3	507	73	128	0	350	0	170	81	192	709	5966	0	1.1	5582	1130	1107	2237	3468	0.70
1977	4	0	0	0	0	0	0	0	0	0	0	3468	0	0.7	5242	599	536	1135	2170	0.40
1977	5	10454	1515	2648	0	7217	0	3505	1663	3965	14617	16787	3837	2.3	6625	495	554	4886	11068	2.00
1977	6	7149	1036	1811	0	4935	0	2397	1137	2711	9996	21064	8114	2.3	6625	351	536	9000	11219	2.00
1977	7	7783	1128	1971	0	5373	0	2609	1238	2952	10882	22101	9151	2.3	6625	334	554	10039	11218	2.00
1977	8	16812	2436	4259	0	11606	0	5636	2675	6376	23506	34724	21774	2.3	6625	484	554	22812	11078	2.00
1977	9	2460	356	623	0	1699	0	825	391	933	3440	14519	1569	2.3	6625	612	536	2717	10976	1.90
1977	10	6241	904	1581	0	4308	0	2092	993	2367	8726	19702	6752	2.3	6625	896	1107	8755	10181	1.80
1977	11	148	21	37	0	102	0	50	24	56	207	10387	0	1.9	6273	1165	1071	2236	7581	1.40
1977	12	0	0	0	0	0	0	0	0	0	0	7581	0	1.4	5839	1486	1107	2593	4638	0.90
1978	1	0	0	0	0	0	0	0	0	0	0	4638	0	0.9	5412	1487	1107	2594	1902	0.30
1978	2	2450	355	621	0	1691	0	821	390	929	3425	5327	0	1.0	5497	1298	1000	2298	2817	0.50
1978	3	84	12	21	0	58	0	28	13	32	118	2936	0	0.5	5074	1027	1107	2134	745	0.10
1978	4	1679	243	425	0	1159	0	563	267	637	2348	3093	0	0.6	5158	589	536	1125	1830	0.30
1978	5	13981	2026	3542	0	9652	0	4687	2224	5303	19549	21379	8429	2.3	6625	495	554	9478	11068	2.00
1978	6	19367	2806	4906	0	13370	0	6492	3081	7345	27079	38147	25197	2.3	6625	351	536	26083	11219	2.00
1978	7	21447	3107	5433	0	14806	0	7190	3412	8134	29988	41207	28257	2.3	6625	334	554	29144	11218	2.00
1978	8	2872	416	728	0	1983	0	963	457	1089	4016	15234	2284	2.3	6625	484	554	3322	11078	2.00
1978	9	8892	1288	2252	0	6138	0	2981	1415	3372	12432	23511	10561	2.3	6625	612	536	11708	10976	1.90
1978	10	2893	419	733	0	1997	0	970	460	1097	4046	15022	2072	2.3	6625	896	1107	4075	10181	1.80
1978	11	2144	311	543	0	1480	0	719	341	813	2997	13178	228	2.3	6625	1230	1071	2529	9903	1.80
1978	12	1056	153	268	0	729	0	354	168	401	1477	11380	0	2.0	6361	1619	1107	2726	8048	1.50
1979	1	0	0	0	0	0	0	0	0	0	0	8048	0	1.5	5926	1628	1107	2735	4941	0.90
1979	2	465	67	118	0	321	0	156	74	176	650	5591	0	1.0	5497	1298	1000	2298	3063	0.60
1979	3	1352	196	342	0	933	0	453	215	513	1890	4953	0	0.9	5412	1096	1107	2203	2557	0.50
1979	4	5100	739	1292	0	3521	0	1710	811	1934	7131	9689	0	1.7	6099	697	536	1232	7864	1.40
1979	5	6484	939	1642	0	4476	0	2174	1032	2459	9066	16930	3980	2.3	6625	495	554	5029	11068	2.00
1979	6	11352	1645	2876	0	7837	0	3806	1806	4305	15872	26940	13990	2.3	6625	351	536	14877	11219	2.00
1979	7	4858	704	1231	0	3353	0	1628	773	1842	6792	18011	5061	2.3	6625	334	554	5949	11218	2.00
1979	8	8617	1248	2183	0	5949	0	2889	1371	3268	12048	23266	10316	2.3	6625	484	554	11354	11078	2.00
1979	9	3897	565	987	0	2690	0	1306	620	1478	5448	16527	3577	2.3	6625	612	536	4725	10976	1.90
1979	10	2503	363	634	0	1728	0	839	398	949	3499	14475	1525	2.3	6625	896	1107	3528	10181	1.80
1979	11	4118	597	1043	0	2843	0	1381	655	1562	5758	15939	2989	2.3	6625	1230	1071	5290	9903	1.80
1979	12	0	0	0	0	0	0	0	0	0	0	9903	0	1.8	6186	1574	1107	2682	6716	1.20
1980	1	0	0	0	0	0	0	0	0	0	0	6716	0	1.2	5668	1557	1107	2664	3768	0.70
1980	2	1214	176	308	0	838	0	407	193	461	1698	5466	0	1.0	5497	1298	1000	2298	2947	0.60
1980	3	0	0	0	0	0	0	0	0	0	0	2947	0	0.6	5158	1044	1107	2151	740	0.10
1980	4	8828	1279	2236	0	6094	0	2959	1404	3348	12344	13084	134	2.3	6625	757	536	1426	10841	1.90
1980	5	6716	973	1701	0	4636	0	2251	1068	2547	9391	20232	7282	2.3	6625	495	554	8331	11068	2.00
1980	6	12598	1825	3191	0	8697	0	4223	2004	4778	17615	28683	15733	2.3	6625	351	536	16619	11219	2.00
1980	7	380	55	96	0	262	0	127	60	144	532	11751	0	2.1	6449	325	554	879	10111	1.80
1980	8	11394	1651	2886	0	7866	0	3820	1813	4321	15931	26043	13093	2.3	6625	484	554	14130	11078	2.00
1980	9	6135	889	1554	0	4235	0	2057	976	2327	8578	19657	6707	2.3	6625	612	536	7855	10976	1.90
1980	10	581	84	147	0	401	0	195	92	220	812	11788	0	2.1	6449	872	1107	1979	9122	1.60
1980	11	1225	177	310	0	846	0	411	195	465	1713	10835	0	1.9	6273	1165	1071	2236	7997	1.50
1980	12	1436	208	364	0	991	0	481	228	545	2008	10005	0	1.8	6186	1574	1107	2682	6811	1.30
1981	1	0	0	0	0	0	0	0	0	0	0	6811	0	1.3	5753	1580	1107	2687	3835	0.70
1981	2	1922	278	487	0	1327	0	644	306	729	2687	6522	0	1.2	5668	1338	1000	2338	3891	0.70
1981	3	739	107	187	0	510	0	248	118	280	1034	4925	0	0.9	5412	1096	1107	2203	2532	0.50
1981	4	3274	474	829	0	2260	0	1097	521	1242	4577	7109	0	1.3	5753	657	536	1193	5502	1.00
1981	5	16072	2329	4071	0	11095	0	5388	2557	6096	22472	27974	15024	2.3	6625	495	554	16073	11068	2.00
1981	6	19504	2826	4941	0	13465	0	6538	3103	7397	27271	38339	25389	2.3	6625	351	536	26275	11219	2.00
1981	7	16917	2451	4285	0	11679	0	5671	2691	6416	23654	34873	21923	2.3	6625	334	554	22810	11218	2.00
1981	8	15492	2245	3924	0	10694	0	5193	2465	5875	21660	32878	19928	2.3	6625	484	554	20966	11078	2.00
1981	9	5027	728	1273	0	3470	0	1685	800	1906	7028	18107	5157	2.3	6625	612	536	6304	10976	1.90
1981	10	1658	240	420	0	1145	0	556	264	629	2318	13294	344	2.3	6625	896	1107	2347	10181	1.80
1981	11	4055	588	1027	0	2799	0	1359	645	1538	5670	15850	2900	2.3	6625	1230	1071	5202	9903	1.80
1981	12	1278	185	324	0	882	0	428	203	485	1787	11690	0	2.1	6449	1641	1107	2749	8315	1.50
1982	1	2323	337	589	0	1604	0	779	370	881	3248	11564	0	2.0	6361	1747	1107	2854	8100	1.50
1982	2	634	92	161	0	437	0	212	101	240	886	8986	0	1.6	6012	1419	1000	2419	6107	1.10
1982	3	2112	306	535	0	1458	0	708	336	801	2953	9060	0	1.6	6012	1217	1107	2324	6264	1.20
1982	4	0	0	0	0	0	0	0	0	0	0	6264	0	1.2	5668	648	536	1183	4725	0.90
1982	5	6209	900	1573	0	4287	0	2082	988	2355	8682	13407	457	2.3	6625	495	554	1506	11068	2.00
1982	6	14932	2163	3782	0	10308	0	5006	2376	5663	20878	31946	18996	2.3	6625	351	536	19882	11219	2.00
1982	7	16389	2375	4152	0	11314	0	5494	2607	6216	22915	34135	21185	2.3	6625	334	554	22072	11218	2.00
1982	8	10201	1478	2584	0	7042	0	3420	1623	3869	14263	25481	12531	2.3	6625	484	554	13569	11078	2.00
1982	9	4773	692	1209	0	3295	0	1600	759	1810	6674	17752	4802	2.3	6625	612	536	5950	10976	1.90
1982	10	2767	401	701	0	1910	0	927	440	1049	3868	14844	1894	2.3	6625	896	1107	3898	10181	1.80
1982	11	253	37	64	0	175	0	85	40	96	354	10535	0	1.9	6273	1165	1071	2236	7718	1.40
1982	12	528	77	134	0	365	0	177	84	200	738	8456	0	1.5	5926	1508	1107	2615	5432	1.00
1983	1	84	12	21	0	58	0	28	13	32	118	5550	0	1.0	5497	1510	1107	2617	2728	0.50
1983	2	1721	249	436	0	1188	0	577	274	653	2407	5134	0	1.0	5497	1298	1000	2298	2638	0.50
1983	3	401	58	102	0	277	0	135	64	152	561	3199	0	0.6	5158	1044	1107	2151	975	0.20
1983	4	1668	242	423	0	1152	0	559	265	633	2333	3308	0	0.6	5158	589	536	1125	2030	0.40
1983	5	2429	352	615	0	1677	0	814	386	921	3396	5426	0	1.0	5497	411	554	965	4149	0.80
1983	6	19198	2782	4863	0	13253	0	6436	3054	7281	26843	30992	18042	2.3	6625	351	536	18928	11219	2.00
1983	7	9884	1432	2504	0	6823	0	3313	1572	3749	13820	25039	12089	2.3	6625	334	554	12977	11218	2.00
1983	8	10771	1561	2729	0	7436	0	3611	1714	4085	15060	26278	13328	2.3	6625	484	554	14366	11078	2.00
1983	9	10602	1536	2686	0	7319	0	3554	1687	4021	14824	25902	12952	2.3	6625	612	536	14100	10976	1.90
1983	10	908	132	230	0	627	0	304	144	344	1270	12246	0	2.1	6449	872	1107	1979	9548	1.70
1983	11	4752	689	1204	0	3281	0	1593	756	1802	6644	16192	3242	2.3	6625	1230	1071	5543	9903	1.80
1983	12	1774	257	449	0	1225	0	595	282	673	2481	12384	0	2.2	6537	1664	1107	2771	8940	1.60
1984	1	84	12	21	0	58	0	28	13	32	118	9058	0	1.6	6012	1651	1107	2759	5859	1.10
1984	2	380	55	96	0	262	0	127	60	144	532	6390	0	1.2	5668	1338	1000	2338	3769	0.70
1984	3	3084	447	781	0	2129	0	1034	491	1169	4311	8080	0	1.5	5926	1200	1107	2307	5369	1.00
1984	4	6294	912	1594	0	4345	0	2110	1001	2387	8800	14169	1219	2.3	6625	757	536	2512	10841	1.90
1984	5	15143	2194	3836	0	10454	0	5076	2409	5743	21173	32014	19064	2.3	6625	495	554	20113	11068	2.00
1984	6	12081	1750	3060	0	8340	0	4050	1922	4582	16891	27959	15009	2.3	6625	351	536	15896	11219	2.00

Northern Storages Removed - To Stormwater Reuse and Swan River / Southern Storage - Removed / Blackadder Creek Tributary

Year	Mth	N Inflow kL	N Vol kL	N Outflow kL	N Level m	N Area m2	N Evap kL	N Demand kL	N Used kL	N End Stor kL	N Level m	S Inflow kL	S Vol kL	S Outflow kL	S Level m	S Area m2	S Evap kL	S Demand kL	S Used kL	S End Stor (kl)	S Level m	Clay Shed kL	Evap kL	Clay ShedOut kL	South StorOut kL	Total Flow kL
				3278			Evap N	3110	Stor Loss					2053			Evap N	0	Stor Loss					Area		
		7285		15000	MaxV		0	3167	6388	10%		2053		0	MaxV		0	0	2053	0%		8545	10000	7816	2053	9869
										0										0						
1975	1	4167	4167	0	0.6	75000	0	6333	4167	0	0.00	0	0	0	0.0	20000	0	0	0	0	0.00	0	2747	0	0	0
1975	2	4167	4167	0	0.6	75000	0	6333	4167	0	0.00	0	0	0	0.0	20000	0	0	0	0	0.00	0	2360	0	0	0
1975	3	5315	5315	0	0.7	75000	0	6333	5315	0	0.00	453	453	453	0.0	20000	0	0	453	0	0.00	513	2024	0	453	453
1975	4	3534	3534	0	0.5	75000	0	0	0	3181	0.40	1395	1395	1395	0.0	20000	0	0	1395	0	0.00	1578	1142	436	1395	1830
1975	5	4987	8168	0	1.1	75000	0	0	0	7351	0.95	1968	1968	1968	0.0	20000	0	0	1968	0	0.00	4771	748	4023	1968	5991
1975	6	13168	20519	5519	2.0	75000	0	0	5519	13500	1.75	5197	5197	5197	0.0	20000	0	0	5197	0	0.00	25672	529	25143	5197	30340
1975	7	18048	31548	16548	2.0	75000	0	0	16548	13500	1.75	7122	7122	7122	0.0	20000	0	0	7122	0	0.00	36034	504	35530	7122	42653
1975	8	6889	20389	5389	2.0	75000	0	0	5389	13500	1.75	2719	2719	2719	0.0	20000	0	0	2719	0	0.00	12684	731	11953	2719	14671
1975	9	7086	20586	5586	2.0	75000	0	0	5586	13500	1.75	2797	2797	2797	0.0	20000	0	0	2797	0	0.00	12957	924	12033	2797	14829
1975	10	8113	21613	6613	2.0	75000	0	6333	12947	7800	1.00	1558	1558	1558	0.0	20000	0	0	1558	0	0.00	6285	1352	4932	1558	6490
1975	11	5835	13635	0	1.8	75000	0	6333	6333	6572	0.85	658	658	658	0.0	20000	0	0	658	0	0.00	745	1856	0	658	658
1975	12	4292	10864	0	1.4	75000	0	6333	6333	4077	0.50	50	50	50	0.0	20000	0	0	50	0	0.00	56	2545	0	50	50
1976	1	6266	10343	0	1.4	75000	0	6333	6333	3609	0.45	828	828	828	0.0	20000	0	0	828	0	0.00	937	2747	0	828	828
1976	2	7369	10978	0	1.5	75000	0	6333	6333	4180	0.55	1264	1264	1264	0.0	20000	0	0	1264	0	0.00	1430	2360	0	1264	1264
1976	3	4203	8383	0	1.1	75000	0	6333	6333	1844	0.20	14	14	14	0.0	20000	0	0	14	0	0.00	16	2024	0	14	14
1976	4	6476	8321	0	1.1	75000	0	0	0	7489	0.95	2556	2556	2556	0.0	20000	0	0	2556	0	0.00	6929	1142	5786	2556	8342
1976	5	6602	14090	0	1.9	75000	0	0	0	12681	1.65	2605	2605	2605	0.0	20000	0	0	2605	0	0.00	11706	748	10959	2605	13564
1976	6	5723	18404	3404	2.0	75000	0	0	3404	13500	1.75	2259	2259	2259	0.0	20000	0	0	2259	0	0.00	10093	529	9564	2259	11823
1976	7	8109	21609	6609	2.0	75000	0	0	6609	13500	1.75	3200	3200	3200	0.0	20000	0	0	3200	0	0.00	15237	504	14733	3200	17933
1976	8	10298	23798	8798	2.0	75000	0	0	8798	13500	1.75	4064	4064	4064	0.0	20000	0	0	4064	0	0.00	19816	731	19085	4064	23149
1976	9	5884	19384	4384	2.0	75000	0	0	4384	13500	1.75	2322	2322	2322	0.0	20000	0	0	2322	0	0.00	10442	924	9518	2322	11840
1976	10	7620	21120	6120	2.0	75000	0	6333	12453	7800	1.00	1363	1363	1363	0.0	20000	0	0	1363	0	0.00	5252	1352	3900	1363	5263
1976	11	8374	16174	1174	2.0	75000	0	6333	7507	7800	1.00	1660	1660	1660	0.0	20000	0	0	1660	0	0.00	6034	1856	4177	1660	5838
1976	12	4543	12343	0	1.6	75000	0	6333	6333	5409	0.70	149	149	149	0.0	20000	0	0	149	0	0.00	168	2545	0	149	149
1977	1	4741	10150	0	1.4	75000	0	6333	6333	3435	0.45	227	227	227	0.0	20000	0	0	227	0	0.00	256	2747	0	227	227
1977	2	5961	9395	0	1.3	75000	0	6333	6333	2756	0.35	708	708	708	0.0	20000	0	0	708	0	0.00	801	2360	0	708	708
1977	3	4597	7353	0	1.0	75000	0	6333	6333	918	0.10	170	170	170	0.0	20000	0	0	170	0	0.00	192	2024	0	170	170
1977	4	0	918	0	0.1	75000	0	0	0	826	0.10	0	0	0	0.0	20000	0	0	0	0	0.00	0	1142	0	0	0
1977	5	8880	9706	0	1.3	75000	0	0	0	8736	1.15	3505	3505	3505	0.0	20000	0	0	3505	0	0.00	7802	748	7054	3505	10559
1977	6	6073	14808	0	2.0	75000	0	0	0	13328	1.75	2397	2397	2397	0.0	20000	0	0	2397	0	0.00	10825	529	10296	2397	12693
1977	7	6611	19938	4938	2.0	75000	0	0	4938	13500	1.75	2609	2609	2609	0.0	20000	0	0	2609	0	0.00	12103	504	11599	2609	14208
1977	8	14280	27780	12780	2.0	75000	0	0	12780	13500	1.75	5636	5636	5636	0.0	20000	0	0	5636	0	0.00	28150	731	27419	5636	33055
1977	9	2090	15590	590	2.0	75000	0	0	590	13500	1.75	825	825	825	0.0	20000	0	0	825	0	0.00	2502	924	1578	825	2403
1977	10	9468	22968	7968	2.0	75000	0	6333	14301	7800	1.00	2092	2092	2092	0.0	20000	0	0	2092	0	0.00	9119	1352	7767	2092	9859
1977	11	4292	12092	0	1.6	75000	0	6333	6333	5183	0.65	50	50	50	0.0	20000	0	0	50	0	0.00	56	1856	0	50	50
1977	12	4167	9350	0	1.2	75000	0	6333	6333	2715	0.35	0	0	0	0.0	20000	0	0	0	0	0.00	0	2545	0	0	0
1978	1	4167	6881	0	0.9	75000	0	6333	6333	493	0.05	0	0	0	0.0	20000	0	0	0	0	0.00	0	2747	0	0	0
1978	2	6248	6741	0	0.9	75000	0	6333	6333	367	0.00	821	821	821	0.0	20000	0	0	821	0	0.00	929	2360	0	821	821
1978	3	4238	4605	0	0.6	75000	0	6333	4605	0	0.00	28	28	28	0.0	20000	0	0	28	0	0.00	32	2024	0	28	28
1978	4	1426	1426	0	0.2	75000	0	0	0	1284	0.15	563	563	563	0.0	20000	0	0	563	0	0.00	637	1142	0	563	563
1978	5	11876	13160	0	1.8	75000	0	0	0	11844	1.55	4687	4687	4687	0.0	20000	0	0	4687	0	0.00	13732	748	12984	4687	17671
1978	6	16451	28295	13295	2.0	75000	0	0	13295	13500	1.75	6492	6492	6492	0.0	20000	0	0	6492	0	0.00	32542	529	32013	6492	38505
1978	7	18218	31718	16718	2.0	75000	0	0	16718	13500	1.75	7190	7190	7190	0.0	20000	0	0	7190	0	0.00	36391	504	35887	7190	43077
1978	8	2440	15940	940	2.0	75000	0	0	940	13500	1.75	963	963	963	0.0	20000	0	0	963	0	0.00	3374	731	2643	963	3606
1978	9	7553	21053	6053	2.0	75000	0	0	6053	13500	1.75	2981	2981	2981	0.0	20000	0	0	2981	0	0.00	13933	924	13009	2981	15989
1978	10	6624	20124	5124	2.0	75000	0	6333	11458	7800	1.00	970	970	970	0.0	20000	0	0	970	0	0.00	3169	1352	1817	970	2787
1978	11	5988	13788	0	1.8	75000	0	6333	6333	6709	0.85	719	719	719	0.0	20000	0	0	719	0	0.00	1041	1856	0	719	719
1978	12	5064	11772	0	1.6	75000	0	6333	6333	4895	0.65	354	354	354	0.0	20000	0	0	354	0	0.00	401	2545	0	354	354
1979	1	4167	9062	0	1.2	75000	0	6333	6333	2456	0.30	0	0	0	0.0	20000	0	0	0	0	0.00	0	2747	0	0	0
1979	2	4561	7017	0	0.9	75000	0	6333	6333	615	0.05	156	156	156	0.0	20000	0	0	156	0	0.00	176	2360	0	156	156
1979	3	5315	5930	0	0.8	75000	0	6333	5930	0	0.00	453	453	453	0.0	20000	0	0	453	0	0.00	513	2024	0	453	453
1979	4	4333	4333	0	0.6	75000	0	0	0	3899	0.50	1710	1710	1710	0.0	20000	0	0	1710	0	0.00	1934	1142	792	1710	2502
1979	5	5508	9407	0	1.3	75000	0	0	0	8466	1.10	2174	2174	2174	0.0	20000	0	0	2174	0	0.00	6439	748	5692	2174	7865
1979	6	9643	18109	3109	2.0	75000	0	0	3109	13500	1.75	3806	3806	3806	0.0	20000	0	0	3806	0	0.00	18296	529	17767	3806	21572
1979	7	4126	17626	2626	2.0	75000	0	0	2626	13500	1.75	1628	1628	1628	0.0	20000	0	0	1628	0	0.00	6903	504	6399	1628	8028
1979	8	7320	20820	5820	2.0	75000	0	0	5820	13500	1.75	2889	2889	2889	0.0	20000	0	0	2889	0	0.00	13584	731	12854	2889	15742
1979	9	3310	16810	1810	2.0	75000	0	0	1810	13500	1.75	1306	1306	1306	0.0	20000	0	0	1306	0	0.00	5055	924	4131	1306	5437
1979	10	6293	19793	4793	2.0	75000	0	6333	11126	7800	1.00	839	839	839	0.0	20000	0	0	839	0	0.00	2474	1352	1122	839	1961
1979	11	7665	15465	465	2.0	75000	0	6333	6798	7800	1.00	1381	1381	1381	0.0	20000	0	0	1381	0	0.00	4551	1856	2695	1381	4075
1979	12	4167	11967	0	1.6	75000	0	6333	6333	5070	0.65	0	0	0	0.0	20000	0	0	0	0	0.00	0	2545	0	0	0
1980	1	4167	9237	0	1.2	75000	0	6333	6333	2613	0.30	0	0	0	0.0	20000	0	0	0	0	0.00	0	2747	0	0	0
1980	2	5198	7811	0	1.0	75000	0	6333	6333	1330	0.15	407	407	407	0.0	20000	0	0	407	0	0.00	461	2360	0	407	407
1980	3	4167	5497	0	0.7	75000	0	6333	5497	0	0.00	0	0	0	0.0	20000	0	0	0	0	0.00	0	2024	0	0	0
1980	4	7499	7499	0	1.0	75000	0	0	0	6749	0.85	2959	2959	2959	0.0	20000	0	0	2959	0	0.00	3482	1142	2339	2959	5299
1980	5	5705	12454	0	1.7	75000	0	0	0	11209	1.45	2251	2251	2251	0.0	20000	0	0	2251	0	0.00	9829	748	9082	2251	11333
1980	6	10701	21910	6910	2.0	75000	0	0	6910	13500	1.75	4223	4223	4223	0.0	20000	0	0	4223	0	0.00	20511	529	19981	4223	24205
1980	7	323	13823	0	1.8	75000	0	0	0	12441	1.65	127	127	127	0.0	20000	0	0	127	0	0.00	144	504	0	127	127
1980	8	9679	22119	7119	2.0	75000	0	0	7119	13500	1.75	3820	3820	3820	0.0	20000	0	0	3820	0	0.00	17414	731	16683	3820	20503
1980	9	5212	18712	3712	2.0	75000	0	0	3712	13500	1.75	2057	2057	2057	0.0	20000	0	0	2057	0	0.00	9034	924	8110	2057	10167
1980	10	4660	18160	3160	2.0	75000	0	6333	9493	7800	1.00	195	195	195	0.0	20000	0	0	195	0	0.00	220	1352	0	195	195
1980	11	5207	13007	0	1.7	75000	0	6333	6333	6006	0.80	411	411	411	0.0	20000	0	0	411	0	0.00	465	1856	0	411	411
1980	12	5387	11393	0	1.5	75000	0	6333	6333	4554	0.60	481	481	481	0.0	20000	0	0	481	0	0.00	545	2545	0	481	481
1981	1	4167	8720	0	1.2	75000	0	6333	6333	2148	0.25	0	0	0	0.0	20000	0	0	0	0	0.00	0	2747	0	0	0
1981	2	5799	7948	0	1.1	75000	0	6333	6333	1453	0.15	644	644	644	0.0	20000	0	0	644	0	0.00	729	2360	0	644	644
1981	3	4795	6247	0	0.8	75000	0	6333	6247	0	0.00	248	248	248	0.0	20000	0	0	248	0	0.00	280	2024	0	248	248
1981	4	2781	2781	0	0.4	75000	0	0	0	2503	0.30	1097	1097	1097	0.0	20000	0	0	1097	0	0.00	1242	1142	99	1097	1197
1981	5	13652	16155	1155	2.0	75000	0	0	1155	13500	1.75	5388	5388	5388	0.0	20000	0	0	5388	0	0.00	21120	748	20372	5388	25760
1981	6	16568	30068	15068	2.0	75000	0	0	15068	13500	1.75	6538	6538	6538	0.0	20000	0	0	6538	0	0.00	32786	529	32257	6538	38795
1981	7	14370	27870	12870	2.0	75000	0	0	12870	13500	1.75	5671	5671	5671	0.0	20000	0	0	5671	0	0.00	28339	504	27835	5671	33506
1981	8	13159	26659	11659	2.0	75000	0	0	11659	13500	1.75	5193	5193	5193	0.0	20000	0	0	5193	0	0.00	25804	731	25073	5193	30266
1981	9	4270	17770	2770	2.0	75000	0	0	2770	13500	1.75	1685	1685	1685	0.0	20000	0	0	1685	0	0.00	7063	924	6139	1685	7824
1981	10	5575	19075	4075	2.0	75000	0	6333	10408	7800	1.00	556	556	556	0.0	20000	0	0	556	0	0.00	973	1352	0	556	556
1981	11	7611	15411	411	2.0	75000	0	6333	6744	7800	1.00	1359	1359	1359	0.0	20000	0	0	1359	0	0.00	4438	1856	2582	1359	3941
1981	12	5252	13052	0	1.7	75000	0	6333	6333	6047	0.80	428	428	428	0.0	20000	0	0	428	0	0.00	485	2545	0	428	428
1982	1	6140	12187	0	1.6	75000	0	6333	6333	5268	0.70	779	779	779	0.0	20000	0	0	779	0	0.00	881	2747	0	779	779
1982	2	4705	9973	0	1.3	75000	0	6333	6333	3276	0.40	212	212	212	0.0	20000	0	0	212	0	0.00	240	2360	0	212	212
1982	3	5961	9236	0	1.2	75000	0	6333	6333	2613	0.30	708	708	708	0.0	20000	0	0	708	0	0.00	801	2024	0	708	708
1982	4	0	2613	0	0.3	75000	0	0	0	2352	0.30	0	0	0	0.0	20000	0	0	0	0	0.00	0	1142	0	0	0
1982	5	5274	7626	0	1.0	75000	0	0	0	6863	0.90	2082	2082	2082	0.0	20000	0	0	2082	0	0.00	2812	748	2064	2082	4146
1982	6	12684	19547	4547	2.0	75000	0	0	4547	13500	1.75	5006	5006	5006	0.0	20000	0	0	5006	0	0.00	24659	529	24130	5006	29135
1982	7	13921	27421	12421	2.0	75000	0	0	12421	13500	1.75	5494	5494	5494	0.0	20000	0	0	5494	0	0.00	27400	504	26896	5494	32390
1982	8	8665	22165	7165	2.0	75000	0	0	7165	13500	1.75	3420	3420	3420	0.0	20000	0	0	3420	0	0.00	16400	731	15669	3420	19089
1982	9	4054	17554	2554	2.0	75000	0	0	2554	13500	1.75	1600	1600	1600	0.0	20000	0	0	1600	0	0.00	6612	924	5688	1600	7289
1982	10	6517	20017	5017	2.0	75000	0	6333	11350	7800	1.00	927	927	927	0.0	20000	0	0	927	0	0.00	2944	1352	1591	927	2519
1982	11	4382	12182	0	1.6	75000	0	6333	6333	5264	0.70	85	85	85	0.0	20000	0	0	85	0	0.00	96	1856	0	85	85
1982	12	4615	9879	0	1.3	75000	0	6333	6333	3191	0.40	177	177	177	0.0	20000	0	0	177	0	0.00	200	2545	0	177	177
1983	1	4238	7429	0	1.0	75000	0	6333	6333	987	0.10	28	28	28	0.0	20000	0	0	28	0	0.00	32	2747	0	28	28
1983	2	5629	6615	0	0.9	75000	0	6333	6333	254	0.00	577	577	577	0.0	20000	0	0	577	0	0.00	653	2360	0	577	577
1983	3	4508	4761	0	0.6	75000	0	6333	4761	0	0.00	135	135	135	0.0	20000	0	0	135	0	0.00	152	2024	0	135	135
1983	4	1417	1417	0	0.2	75000	0	0	0	1276	0.15	559	559	559	0.0	20000	0	0	559	0	0.00	633	1142	0	559	559
1983	5	2063	3339	0	0.4	75000	0	0	0	3005	0.40	814	814	814	0.0	20000	0	0	814	0	0.00	921	748	174	814	988
1983	6	16307	19312	4312	2.0	75000	0	0	4312	13500	1.75	6436	6436	6436	0.0	20000	0	0	6436	0	0.00	25323	529	24794	6436	31229
1983	7	8396	21896	6896	2.0	75000	0	0	6896	13500	1.75	3313	3313	3313	0.0	20000	0	0	3313	0	0.00	15838	504	15334	3313	18647
1983	8	9149	22649	7649	2.0	75000	0	0	7649	13500	1.75	3611	3611	3611	0.0	20000	0	0	3611	0	0.00	17414	731	16683	3611	20294
1983	9	9006	22506	7506	2.0	75000	0	0	7506	13500	1.75	3554	3554	3554	0.0	20000	0	0	3554	0	0.00	16973	924	16049	3554	19604
1983	10	4938	18438	3438	2.0	75000	0	6333	9771	7800	1.00	304	304	304	0.0	20000	0	0	304	0	0.00	344	1352	0	304	304
1983	11	8203	16003	1003	2.0	75000	0	6333	7337	7800	1.00	1593	1593	1593	0.0	20000	0	0	1593	0	0.00	5044	1856	3188	1593	4781
1983	12	5674	13474	0	1.8	75000	0	6333	6333	6426	0.85	595	595	595	0.0	20000	0	0	595	0	0.00	673	2545	0	595	595
1984	1	4238	10665	0	1.4	75000	0	6333	6333	3898	0.50	28	28	28	0.0	20000	0	0	28	0	0.00	32	2747	0	28	28
1984	2	4490	8388	0	1.1	75000	0	6333	6333	1849	0.20	127	127	127	0.0	20000	0	0	127	0	0.00	144	2360	0	127	127
1984	3	6786	8635	0	1.2	75000	0	6333	6333	2071	0.25	1034	1034	1034	0.0	20000	0	0	1034	0	0.00	1169	2024	0	1034	1034
1984	4	5346	7418	0	1.0	75000	0	0	0	6676	0.85	2110	2110	2110	0.0	20000	0	0	2110	0	0.00	3606	1142	2464	2110	4573
1984	5	12863	19539	4539	2.0	75000	0	0	4539	13500	1.75	5076	5076	5076	0.0	20000	0	0	5076	0	0.00	24808	748	24060	5076	29136
1984	6	10262	23762	8762	2.0	75000	0	0	8762	13500	1.75	4050	4050	4050	0.0	20000	0	0	4050	0	0.00	19591	529	19062	4050	23112

APPENDIX I
Landscape Masterplan

DRAFT

LEGEND

POS 1 RIVER FORESHORE POS
A LINEAR GREEN SPACE WITH AN EMBANKMENT OFFERING VIEWS ACROSS THE RIVER, ACTIVATED NODES WITH DIVERSE USES AND A NUMBER OF PATHWAYS TO SUPPORT TRAVEL TO AND THROUGH THE SPACE.

POS 2 GREEN CORRIDOR
A TREE LINED NORTH/SOUTH LINK THAT PROVIDES NOISE ATTENUATION, SUPPORTS PEDESTRIAN AND FAUNA MOVEMENT BETWEEN EXISTING RESERVES AND THE RIVER.

POS 3 GREEN CORRIDOR
OPEN TURF, DUAL USE PATH, FAUNA TRAIL & HABITAT WITH A MEANDERING 'LIVING STREAM'.

POS 4 RETAINED BUSHLAND
PROTECTION OF EXISTING QUALITY VEGETATION, WITH PATHS, MINOR SEATING NODES AND INTERPRETIVE SIGNAGE.

POS 5 NEIGHBOURHOOD POS
SMALL NEIGHBOURHOOD POS WITH PASSIVE RECREATION OPPORTUNITIES FOR ADJACENT RESIDENTS.

Ⓐ GREEN LINK (EXISTING & PROPOSED TREES)
A VEGETATED LINEAR GREEN LINK THAT RETAINS EXISTING HEALTHY TREES AND REINFORCES WITH LOCAL SPECIES THAT SUPPORT NORTH/SOUTH FAUNA MOVEMENT.

Ⓑ GREEN LINK (PROPOSED TREES)
A STRONG TREE LINED AND VEGETATED LINEAR CONNECTION, REINFORCED WITH LOCAL SPECIES THAT SUPPORT NORTH/SOUTH FAUNA MOVEMENT.

Ⓒ ACTIVE RECREATION NODE
ACTIVE RECREATION, INCLUSIVE OF ELEMENTS SUCH AS, EXERCISE EQUIPMENT, SEATING AND SHADE.

Ⓓ PASSIVE NODE
SEATING, SHADE AND INTEGRATED ART.

Ⓔ CENTRAL ACTIVITY NODE
DECK TO PROVIDE SEATING OPPORTUNITY AND VIEWS ACROSS THE RIVER. INFRASTRUCTURE TO INCLUDE RIVER FORESHORE PLAYGROUND, OPPORTUNITY FOR FOOD TRUCKS, LARGE COMMUNAL SEATING SPACES AND END OF TRIP FACILITIES.

Ⓕ EXERCISE NODE
OUTDOOR EXERCISE EQUIPMENT AND BIKE MAINTENANCE.

FOCAL POINT (ART/ SIGNAGE/ FEATURE TREE) AT END OF GREEN LINK BOULEVARD, TO ACT AS WAYFINDING BEACON DRAWING VISITORS TO FORESHORE.

BUSH FOREVER BOUNDARY

BIOFILTRATION SWALE

Carpark
PSP to connect to existing pathway along foreshore.
Existing gas easements
Future PSP - Subject to Approvals
Green Link Connection to River
SWAN RIVER
River Embankment
POS 1
POS 2
Indicative Parking to Verge
Catchment A Drainage Swale Meandering through Foreshore POS.
Retained Building
Catchment G - Drainage Swale
POS 3
Culvert under road to allow passage for small fauna and **water flow.**
POS 4
RETAINED BUSHLAND
T.E.C
Catchment G
CRANWOOD CRES
Existing Trees Retained
Catchment B (wetland) drainage swale *Stormwater to be captured and 'sheet' across site.*
GT NORTHERN HWY
JACK WILLIAMSON OVAL
Culvert under road to allow passage for small fauna and **water flow.**
EVELINE RD
Eveline Reserve
POS 5
Catchment D Retention Basin

Internal road layout is indicative only.

MIDLAND BRICK
INDICATIVE LANDSCAPE MASTERPLAN

udla pty. ltd. www.udla.com.au p: +61 8 9336 7577 Level 1A, 3-5 Josephson St, Fremantle, 6160.

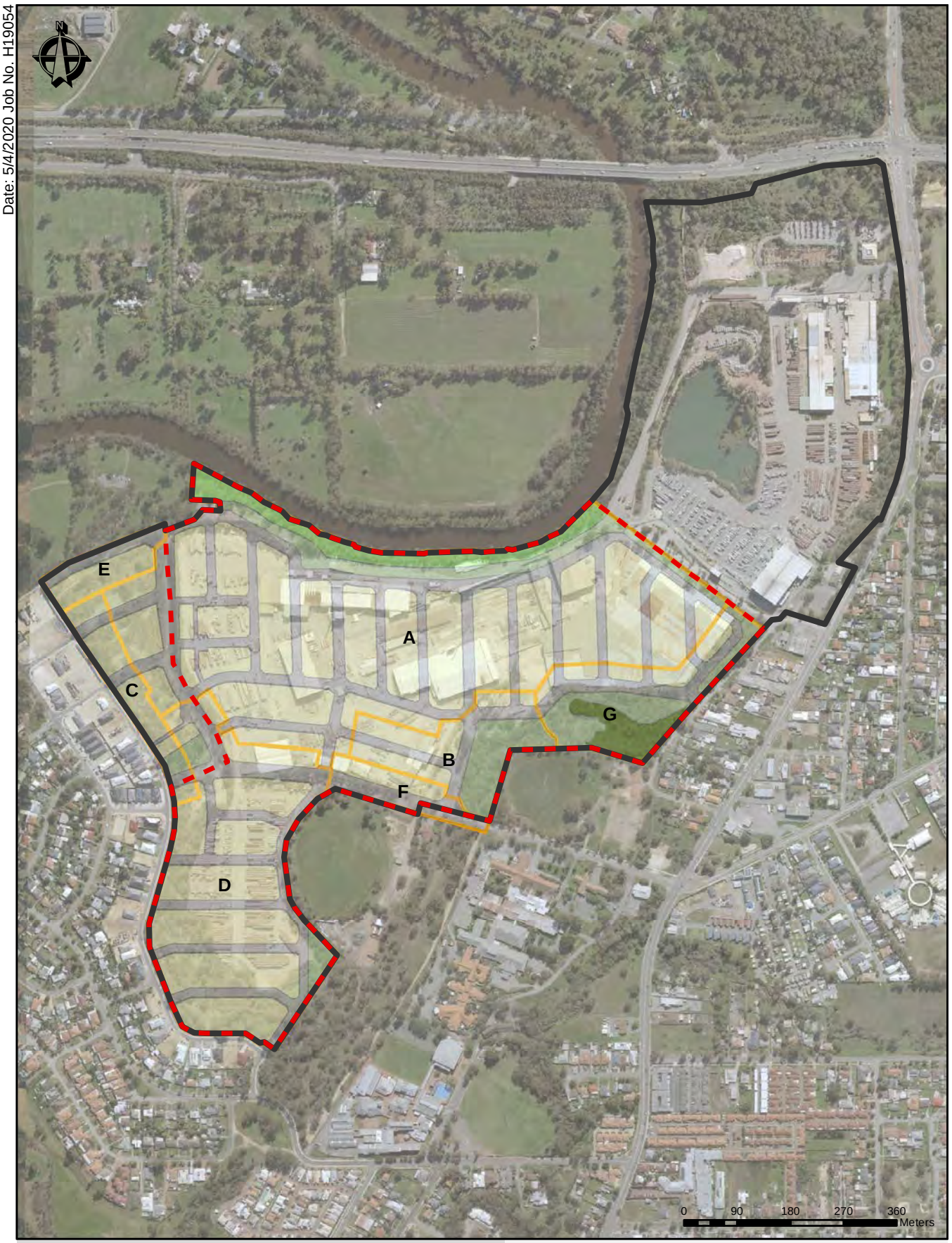
udla
NEW IDEAS THROUGH SHARED DESIGN-THINKING

N

PROJECT NAME:	CLIENT:	DRAWN:	SCALE:	ISSUE DATE:	REVISION:
Midland Brick	Linc	KT	1:4000 @A3	April 2020	H

APPENDIX J
Post Development Catchments & Runoff Rate Estimation

Date: 5/4/2020 Job No. H19054



LSP

Site

Landuse

- Foreshore Res
- Lots
- POS
- Roads
- TEC
- Post Development Catchments

hyd2o

Midland Brick Local Water Management Strategy

Post Development LandUse & Catchments

Appendix J

Post Development Catchment Land Use Breakdown

Area in ha

	Lots	POS/Foreshore	Roads	TEC	Total
A	16.09	4.32	8.19	0.00	28.61
B	1.42	1.34	0.89	0.00	3.66
C	1.47	0.13	0.31	0.00	1.91
D	8.29	0.48	3.38	0.00	12.15
E	0.84	0.00	0.48	0.00	1.32
F	0.61	0.00	0.79	0.00	1.40
G	0.84	0.45	1.03	2.01	4.33
Total	29.56	6.72	15.07	2.01	53.37

CURRV

Calculator for Urban Runoff Rates & Volumes
8/04/2020

Project Midland Brick, Post Development LSP Area Model

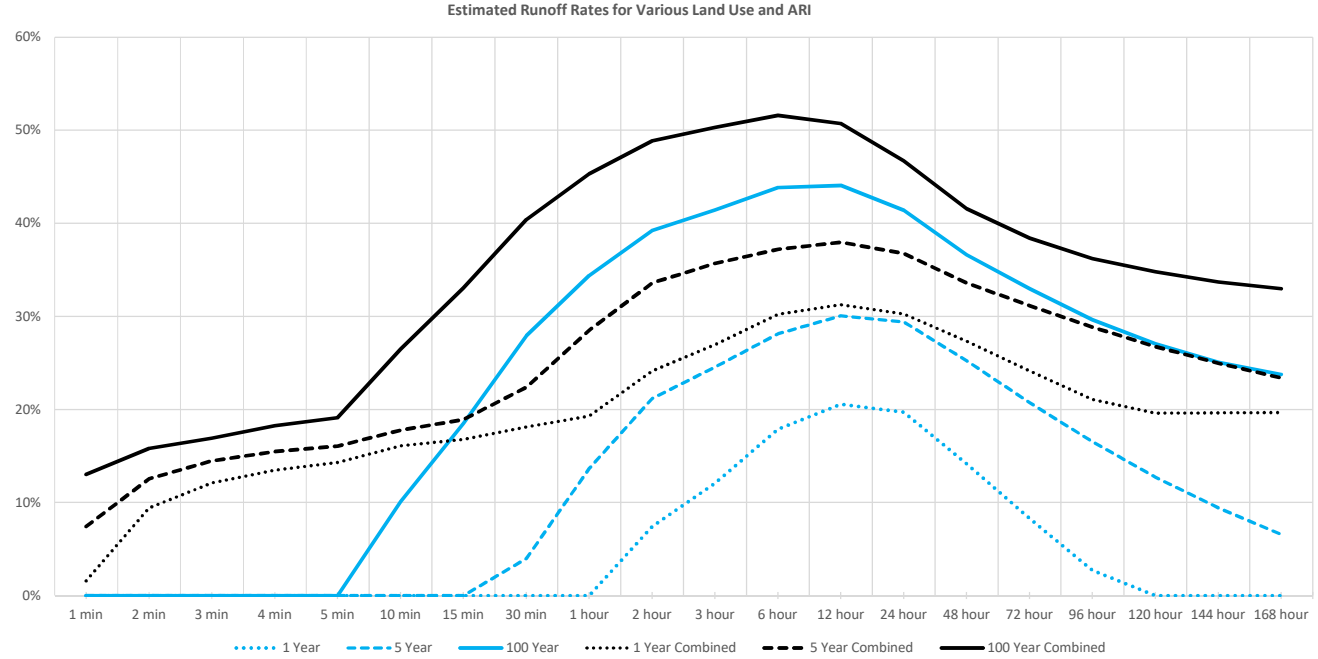
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	Empty (days)	AR&R EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	Residential Lots	29.6	Yes	1.5	20.0	4.0	15.0	1.00	60%	65	22	13	
2	Roads	15.1	Yes	1.5	20.0	4.0	0.0	1.00	100%	0	70	30	
3	TEC	2.0	Yes	1.5	10.0	2.0	0.0	1.00	30%	0	0	100	
4	POS/Foreshore	6.7	Yes	1.5	10.0	2.0	0.0	1.00	30%	0	5	95	
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



Rainfall IFD Data
Annual Exceedence Probability

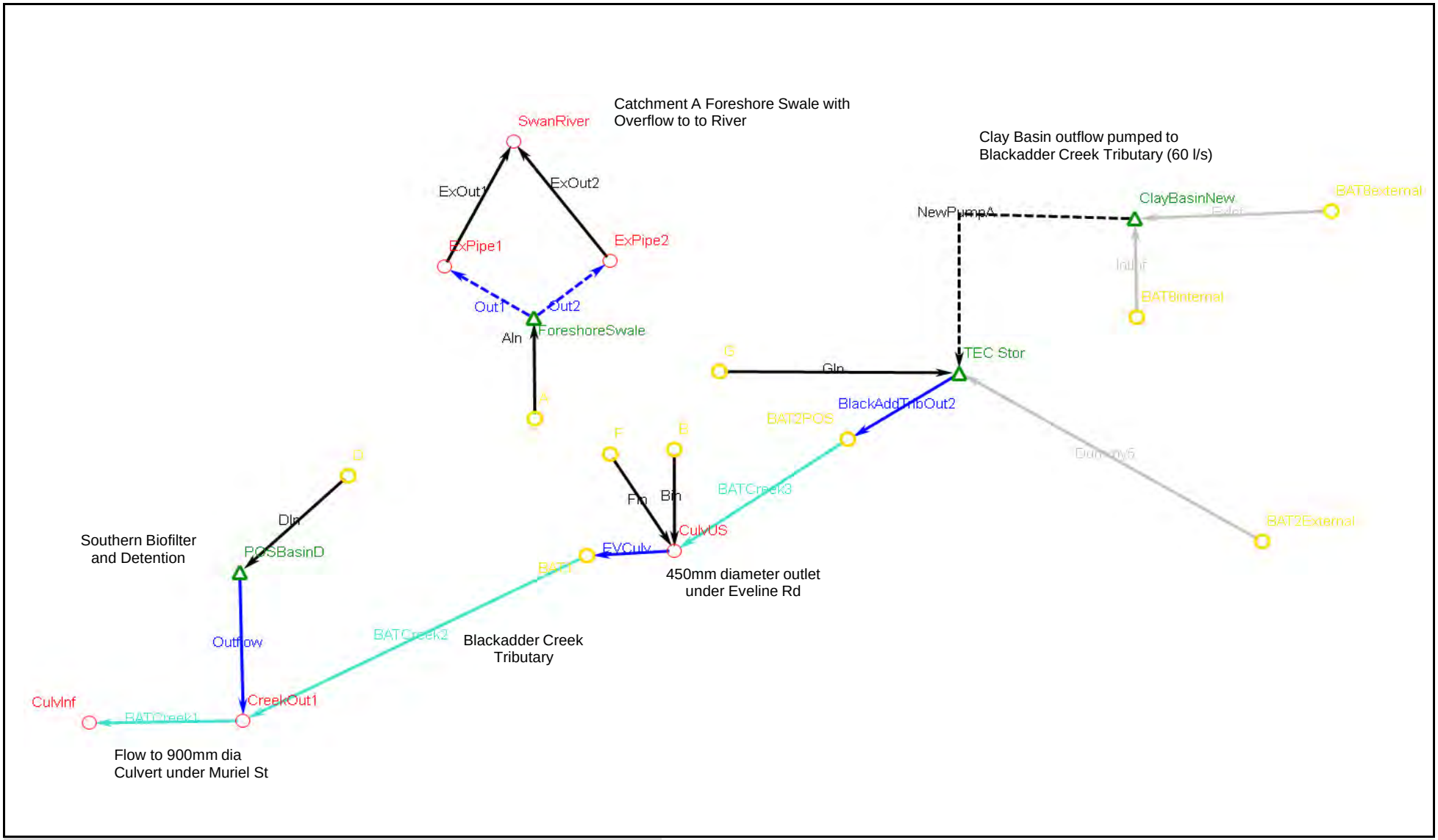
	Duration	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
1	1 min	1.6	1.8	2.4	2.8	3.2	3.8	4.3
2	2 min	2.8	3.1	4.1	4.7	5.4	6.4	7.2
3	3 min	3.8	4.2	5.5	6.4	7.3	8.7	9.8
4	4 min	4.6	5.1	6.7	7.8	9.0	10.7	12.1
5	5 min	5.3	5.9	7.7	9.1	10.4	12.4	14.0
6	10 min	7.8	8.6	11.4	13.4	15.5	18.3	20.6
7	15 min	9.4	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

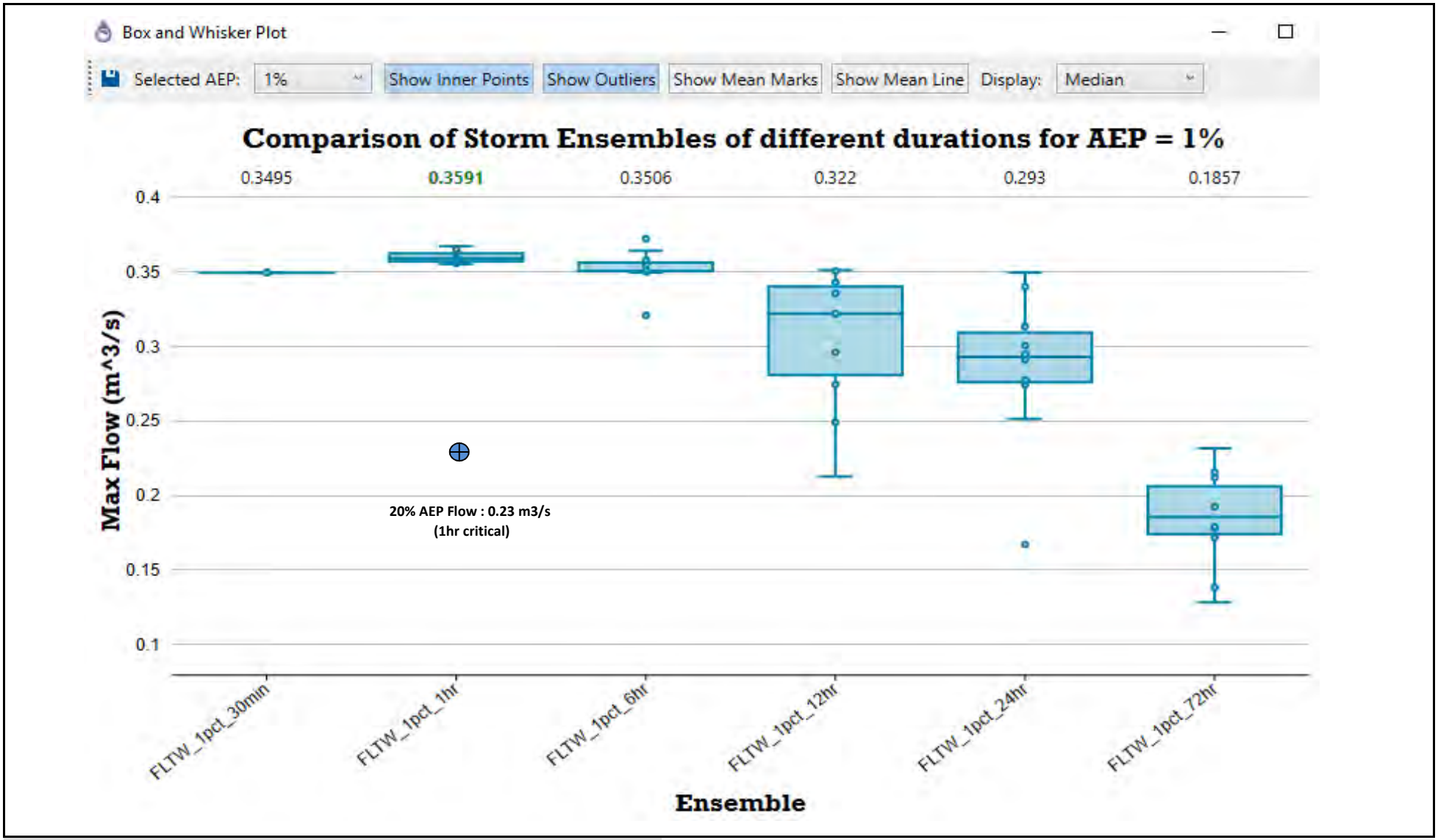
	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
Maximum of All Events							
Residential Lots	21%	23%	30%	34%	37%	42%	44%
Roads	69%	69%	69%	74%	77%	81%	84%
TEC	10%	12%	16%	18%	20%	22%	23%
POS/Foreshore	11%	13%	17%	19%	20%	22%	23%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	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	**31%**	33%	**38%**	**42%**	45%	49%	**52%**

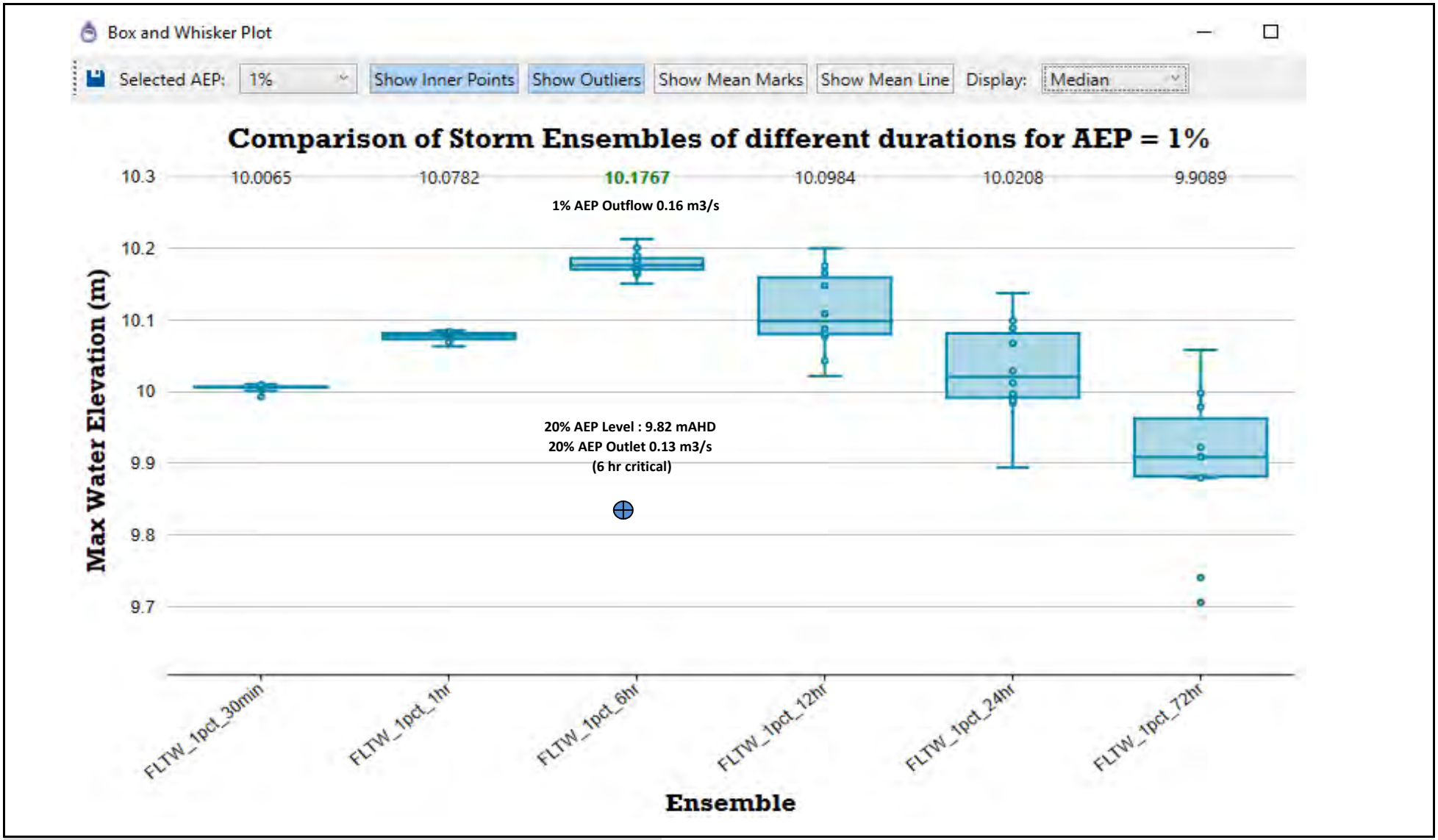
Event Selector	**12**	**6 hour**					
Residential Lots	18%	21%	28%	33%	37%	41%	44%
Roads	67%	67%	68%	73%	77%	81%	84%
TEC	9%	10%	15%	17%	19%	21%	22%
POS/Foreshore	10%	11%	16%	18%	20%	22%	23%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%
combined total	**30%**	32%	**37%**	**42%**	45%	49%	**52%**

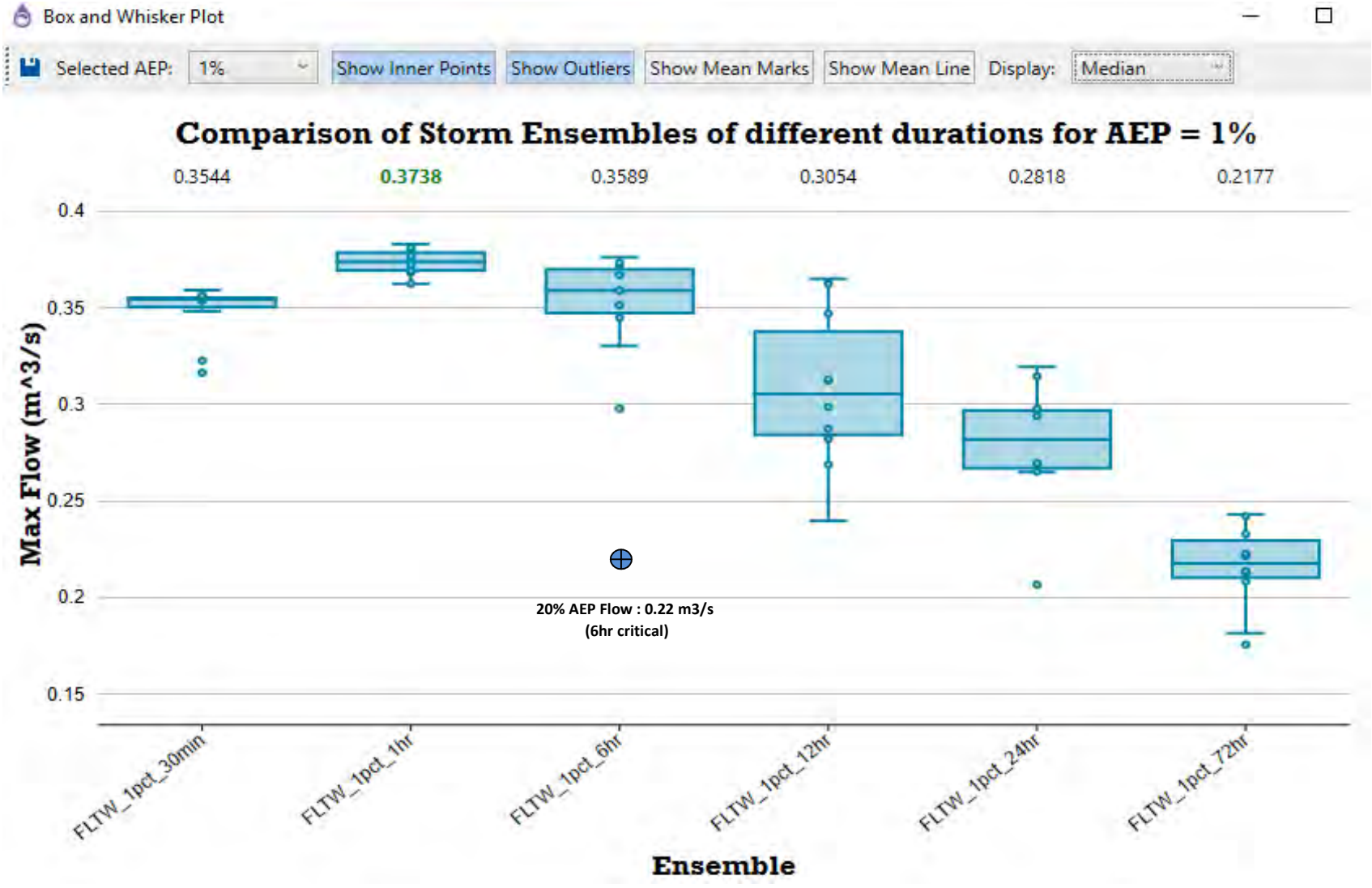
Date: 9/4/2019 Job No H19054



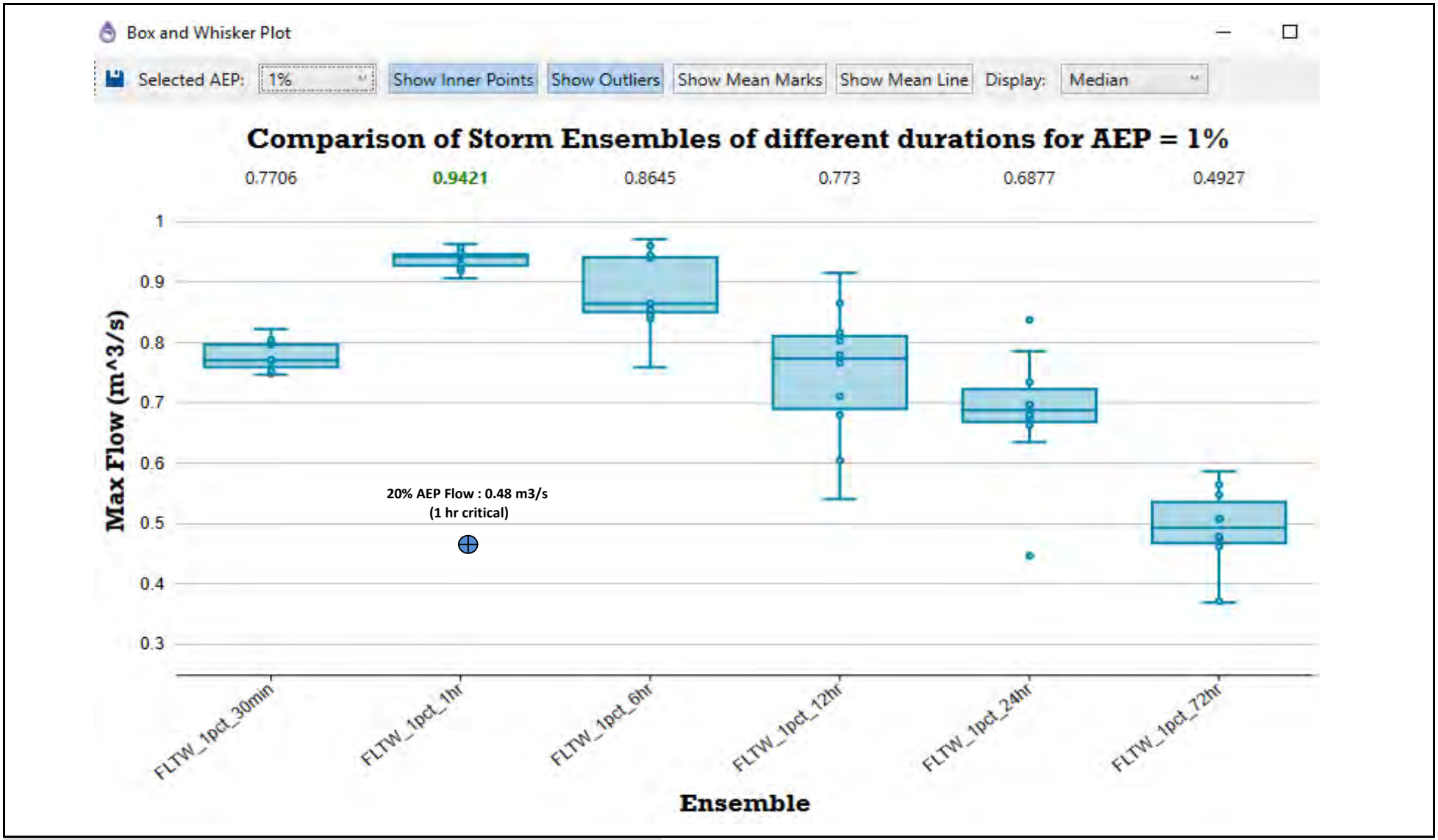
Blue links represent site outflows, yellow nodes catchments, triangles are storage nodes

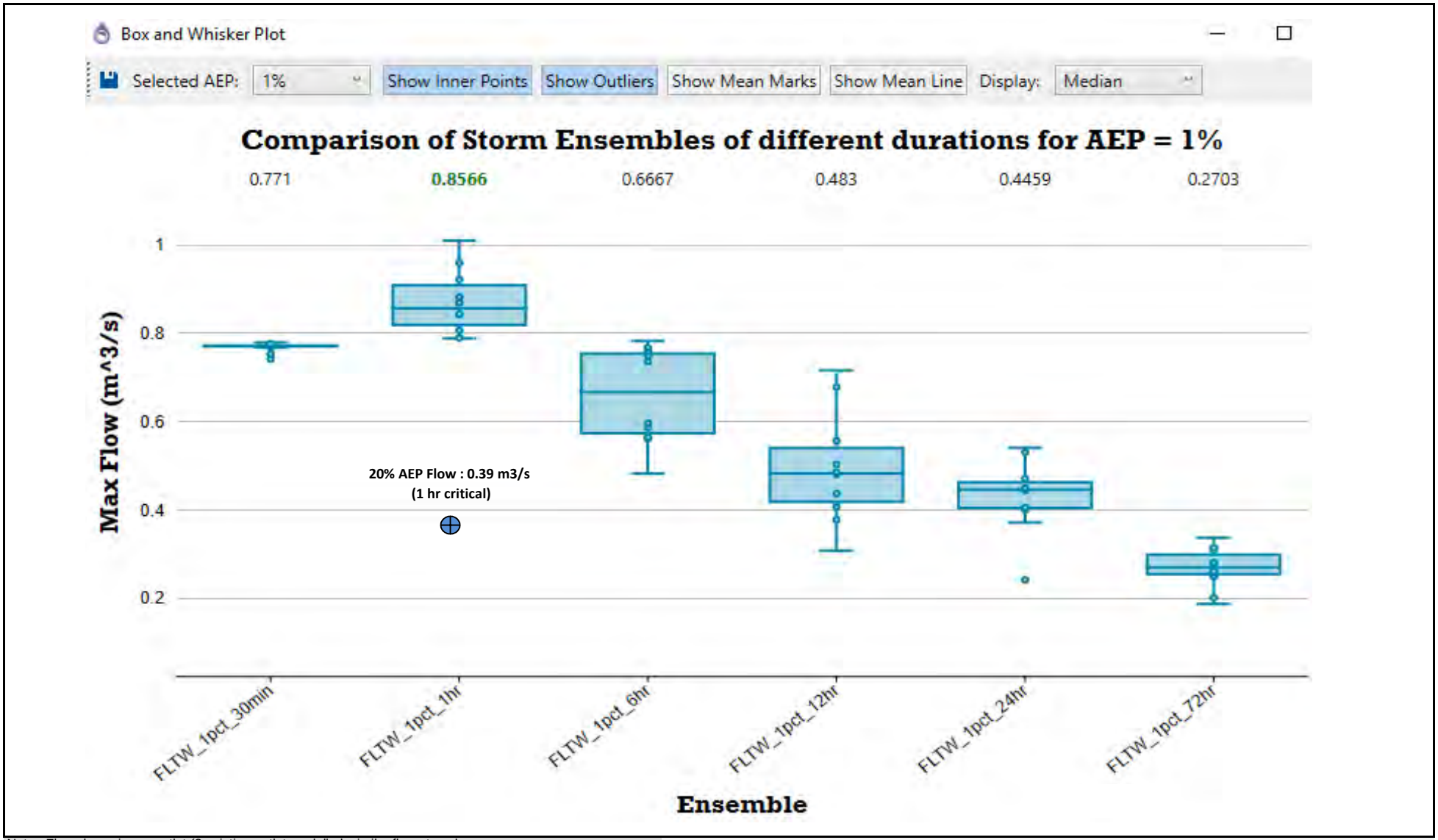

Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
0.3495
0.3591
0.3506
0.322
0.293
0.1857
Max Flow (m^3/s)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
20% AEP Flow : 0.23 m3/s
(1hr critical)
FLTW_1pct_30min
FLTW_1pct_1hr
FLTW_1pct_6hr
FLTW_1pct_12hr
FLTW_1pct_24hr
FLTW_1pct_72hr
Ensemble


Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
10.3
10.2
10.1
10
9.9
9.8
9.7
Max Water Elevation (m)
10.0065
10.0782
10.1767
10.0984
10.0208
9.9089
1% AEP Outflow 0.16 m3/s
20% AEP Level : 9.82 mAHD
20% AEP Outlet 0.13 m3/s
(6 hr critical)
FLTW_1pct_30min
FLTW_1pct_1hr
FLTW_1pct_6hr
FLTW_1pct_12hr
FLTW_1pct_24hr
FLTW_1pct_72hr
Ensemble


Box and Whisker Plot
Selected AEP: 1%
Show Inner Points
Show Outliers
Show Mean Marks
Show Mean Line
Display: Median
Comparison of Storm Ensembles of different durations for AEP = 1%
0.3544
0.3738
0.3589
0.3054
0.2818
0.2177
Max Flow (m^3/s)
0.4
0.35
0.3
0.25
0.2
0.15
20% AEP Flow : 0.22 m3/s
(6hr critical)
FLTW_1pct_30min
FLTW_1pct_1hr
FLTW_1pct_6hr
FLTW_1pct_12hr
FLTW_1pct_24hr
FLTW_1pct_72hr
Ensemble

Date: 9/4/2019 Job No H19054





Note : Flow shown is per outlet (2 existing outlet modelled, similar flow at each

APPENDIX **L**
Engineering Drawings

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 “A” or “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.

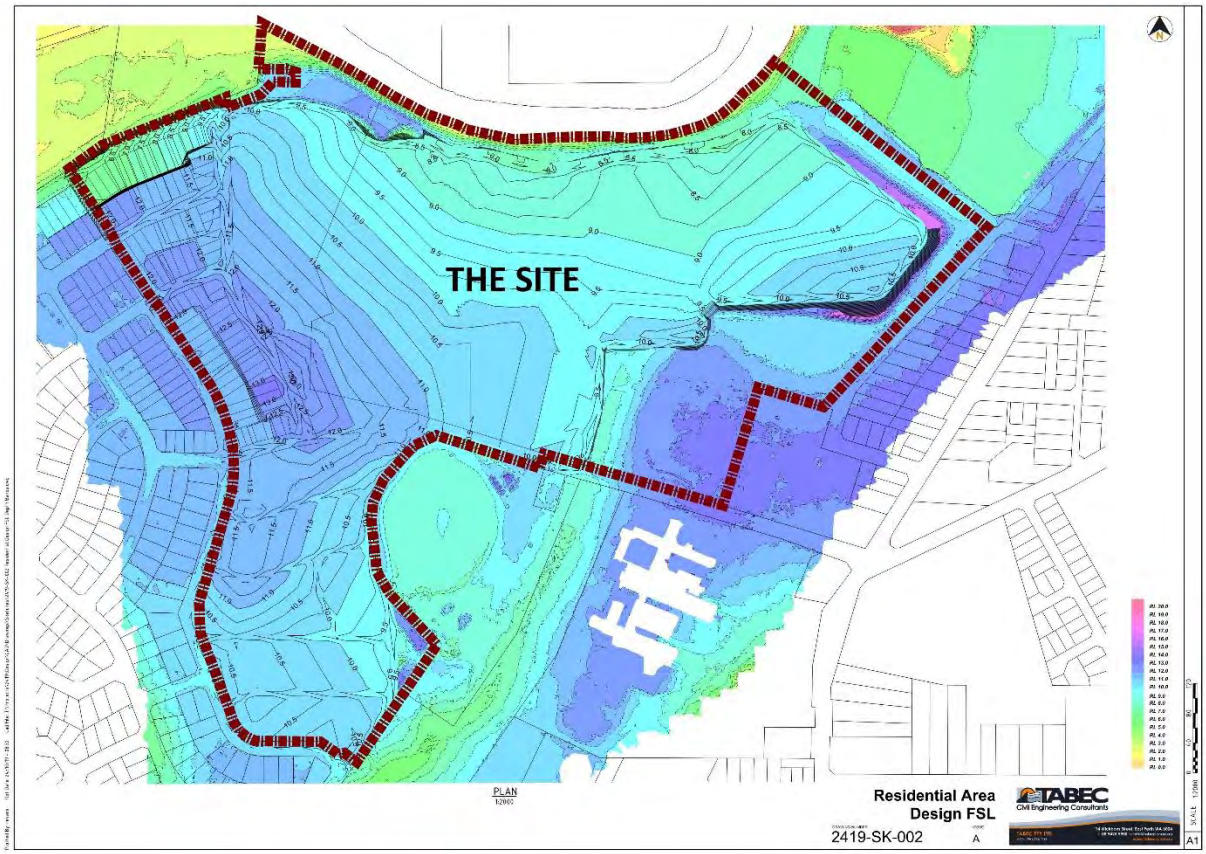
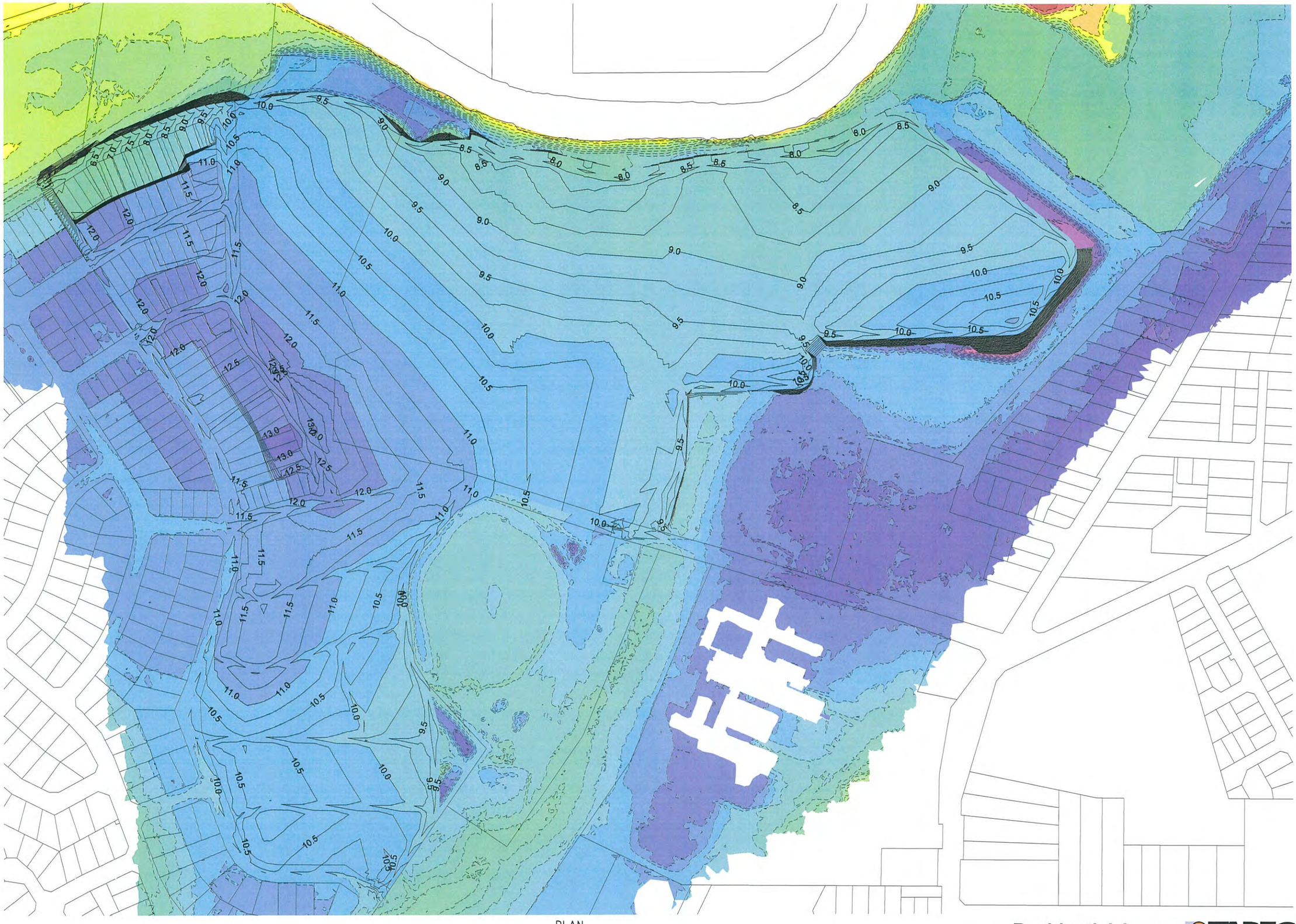


Figure 7 – Concept Bulk Earthworks Design (TABEC, July 2019)



PLAN
1:2000

Residential Area Design FSL

DRAWING NUMBER
2419-SK-002

ISSUE
A

SCALE 1:2000
0 40 80 120

A1

TABEC
Civil Engineering Consultants

TABEC PTY LTD
ACN 090 796 204
14 Wickham Street, East Perth WA 6004
t 08 9425 5900 e info@tabec.com.au
www.tabec.com.au

Plotted By: revans Plot Date: 24/10/19 - 08:31 Cad File: T:\Projects\2419\Design\CAD\Drawings\Sketches\2419-SK-002 Residential Design FSL Depth Bands.dwg

abn 93 697 380 883
suite 6b 103 rokeby rd subiaco wa 6008
PO Box 1055 subiaco wa 6904
p 08 9382 8683 f 08 9382 8712
www.hyd2o.com.au

Appendix E

Inundated clay pit Native Vegetation Clearing Permit (CPS 8745/1)

GOVERNMENT OF WESTERN AUSTRALIA

CLEARING PERMIT

Granted under section 51E of the Environmental Protection Act 1986

Purpose Permit number:	CPS 8745/1
Permit Holder:	Boral Bricks Western Australia Pty Ltd (t/a Midland Brick)
Duration of Permit:	17 April 2020 – 17 April 2025

The Permit Holder is authorised to clear native vegetation subject to the following conditions of this Permit.

PART I – CLEARING AUTHORISED

1. **Purpose for which clearing may be done**
   Clearing for the purpose of expanding the existing hardstand and storage areas for the brickworks facility.

2. **Land on which clearing is to be done**
   Lot 103 on Deposited Plan 54208, Middle Swan.

3. **Area of Clearing**
   The Permit Holder must not clear more than 1.92 hectares of native vegetation within the area hatched yellow on attached Plan 8745/1.

4. **Application**
   This Permit allows the Permit Holder to authorise persons, including employees, contractors and agents of the Permit Holder, to clear native vegetation for the purposes of this Permit subject to compliance with the conditions of this Permit and approval from the Permit Holder.

PART II – MANAGEMENT CONDITIONS

5. **Avoid, minimise and reduce the impacts and extent of clearing**
   In determining the amount of native vegetation to be cleared authorised under this Permit, the Permit Holder must have regard to the following principles, set out in order of preference:
   (a) avoid the clearing of native vegetation;
   (b) minimise the amount of native vegetation to be cleared; and
   (c) reduce the impact of clearing on any environmental value.

6. **Weed control**
   When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of *weeds:*
   (a) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;
   (b) ensure that no weed-affected soil, mulch, fill or other material is brought into the area to be cleared;
   (c) restrict the movement of machines and other vehicles to the limits of the areas to be cleared; and
   (d) At least once in each 12 month period for the term of this Permit, the Permit Holder must remove or kill any weeds growing within areas cleared under this Permit.

PART III - RECORD KEEPING AND REPORTING

7. Records must be kept

The Permit Holder must maintain the following records for activities done pursuant to this Permit, in relation to the clearing of native vegetation authorised under this Permit:

(a) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;
(b) the date that the area was cleared;
(c) the size of the area cleared (in hectares);
(d) purpose for which clearing was undertaken: and
(e) actions taken to minimise the risk of the introduction and spread of weeds in accordance with condition 6 of this Permit.

8. Reporting

The Permit Holder must provide to the *CEO* the records required under Condition 7 of this Permit, when requested by the *CEO*.

DEFINITIONS

The following meanings are given to terms used in this Permit:

CEO: means the Chief Executive Officer of the Department responsible for the administration of the clearing provisions under the *Environmental Protection Act 1986*;

fill means material used to increase the ground level, or fill a hollow;

weed/s means any plant -

(a) that is a declared pest under section 22 of the *Biosecurity and Agriculture Management Act 2007*; or
(b) published in the Department of Environment and Conservation Regional Weed Assessments, regardless of ranking; or
(c) not indigenous to the area concerned.

Ryan Mincham
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Ryan Mincham
MANAGER
NATIVE VEGETATION REGULATION

Officer delegated under Section 20
of the Environmental Protection Act 1986

18 March 2020

Plan 8745/1

Legend

CPS layers
CPS areas approved to clear

base layers
Road Centrelines

LGA Boundaries (LGATE-233)

0 20 40 60 80 100 m

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Ryan Mincham
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Officer delegated under section 20 of the Environmental Protection Act 1986

GOVERNMENT OF WESTERN AUSTRALIA

Government of Western Australia
Department of Water and Environmental Regulation

Clearing Permit Decision Report

1. Application details

Permit application details

Permit application No.: 8745/1
Permit type: Purpose Permit

Applicant details

Applicant's name: Boral Bricks Western Australia Pty Ltd
Application received date: 27 November 2019

Property details

Property: Lot 103 on Deposited Plan 54208
Local Government Authority: City of Swan
Localities: Middle Swan

Application

Clearing Area (ha)	No. Trees	Method of Clearing	For the purpose of:
1.92		Mechanical Removal	To expand the existing hardstand/storage area for the brickworks facility.

Decision on application

Decision on Permit Application: Grant
Decision Date: 18 March 2020

Reasons for Decision:

The clearing permit application was received on 27 November 2019 and has been assessed against the clearing principles, planning instruments and other matters in accordance with section 51O of the *Environmental Protection Act 1986* (EP Act). It has been concluded that the proposed clearing is at variance with principle (f), may be at variance with principle (b), and is not likely to be at variance with the remaining clearing principles.

In determining to grant a clearing permit, the Delegated Officer gave consideration to the completely degraded condition of the vegetation (Keighery 1994), attributed to historical disturbance which has reduced the environmental values within the application area. The proposed clearing has the potential to provide ecological benefit to adjacent areas of native vegetation through the removal of a variety of weed species.

Given the above, the Delegated Officer has determined that the proposed clearing is unlikely to lead to any unacceptable risk to the environment.

2. Site Information

Clearing Description

The application area is 4.95 hectares of which approximately 3.03 hectares comprises inundated disused clay-pit, cleared hardstand/storage areas and internal roads. The amount of vegetation proposed to be cleared within the application area is approximately 1.92 hectares. Vegetated areas proposed to be cleared are regrowth, with the application area having been previously cleared, sometimes repeatedly over the past fifty years. Mechanical removal of all the vegetation within the application area and filling of the historic clay-pit is proposed for the expansion of the existing hardstand and storage areas for the operating brickworks facility.

Vegetation Description

The vegetation within the application area is mapped as the following Heddle vegetation complex:

Swan Complex: Fringing woodland of *Eucalyptus rudis* (Flooded Gum) - *Melaleuca rhaphiophylla* (Swamp Paperbark) with localised occurrence of low open forest of *Casuarina obesa* (Swamp Sheoak) and *Melaleuca cuticularis* (Saltwater Paperbark).

Vegetation Condition

Completely Degraded: The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs (Keighery, 1994).

Soil and Landform Type:

The application area is mapped as the following soil types:

Acl&Ac – Andrew clay loam-clay, Very shallow brown clay loam or clay over yellow-brown and grey mottled clay. (Mapping unit: 254WhV2) (the northern application area);

Pcl – Pyrton clay loam (Swan), Shallow brown mottled clay loam over layers of fine sand and mottled loam. (Mapping unit 213jPY_Pcl) (North western portion of application area).

VC – Valley complex (Pinjarra), Variable soils associated with drainage lines. (Mapping unit: 213Pj_VC) (North eastern portion of application area).

BL – Bellvue loam (Pinjarra), Shallow brown clay loam over yellow-brown mottled clay. (Mapping unit: 213PjBL_Bl) (Southern most section of application area).

CP – Clay-pits (Pinjarra), (Mapping unit: 213PjW_CLAY-PIT) (South west application area).

Bcl&Bc – Bellvue clay loam-clay (pinjarra), described as Shallow yellow-brown clay or clay loam over variable yellow-brown mottled clay. May contain gravels (DPIRD, 2017). (Mapping unit: 213jAn_Acl&Ac) (Most of the application area, appart from eastern most and northern most areas).

Comments:

The local area referred to in the assessment of this application is defined as a 10 kilometre radius measured from the centre of the application area. The local area contains approximately 25 per cent native vegetation cover.

Vegetation condition was assessed based on the findings of the Flora and Vegetation Assessment surveys by Emerge Associates (2019a & 2019b), as well as site photographs supplied by Emerge Associates.

Figures 1 - 7

Figure 1: Area mapped as remnant vegetation in north of application area, completely degraded condition. Note: the large eucalyptus trees are not native to the Swan Coastal Plain. Completely degraded condition.

Figure 2: Drain in northern part of application area within area mapped as remnant vegetation showing *Typha orientalis* and young eucalyptus trees - not native to the Swan Coastal Plain and. Completely degraded condition.

Figure 3: Waterbody used by fauna including western snake necked turtle, showing fountain grass (*Cenchrus setaceus*) in the foreground. Completely degraded condition.

Figure 4: Vegetation in eastern part of application area showing *Typha orientalis* and some young eucalyptus trees which area not native to the Swan Coastal Plain and invasive couch grass (*Cynodon dactylon*). Completely degraded condition.

Figure 5: Earthworks in the northern part of the application area, adjacent to completely degraded vegetation.

Figure 6: Existing earthworks and fill within application area

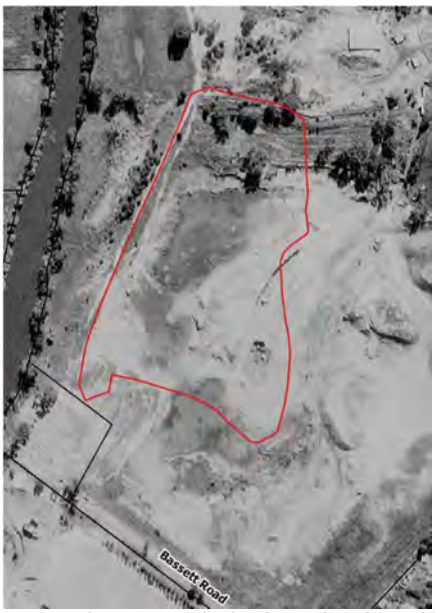

Figure 7: Area extensively cleared – photo 1974

3. Assessment of application against clearing principles planning matters and other relevant matters

(a) Native vegetation should not be cleared if it comprises a high level of biological diversity.

Proposed clearing is not likely to be at variance with this principle

Although the application area is mapped as the Swan Complex vegetation complex, and the northern portion of the area is mapped as remnant vegetation, based on the information provided from on-site survey reports, photographs, current and historical aerial photography and available databases, it is considered highly unlikely that the application area supports any significant species biodiversity.

A floristic survey conducted by Emerge Associates (2019a) identified that the vegetation within the application area is dominated by non-native vegetation with scattered native plants in a 'completely degraded' condition (Figure 1 and Figure 2). Given no intact native plant communities were identified, no priority or threatened ecological communities are considered to occur within the application area. Most of the application area is currently cleared and the entire area has been heavily disturbed by earthworks in the past, including the excavation of the clay-pit and the formation of the soak in the north of the application area. Figure 5 and Figure 6 show earthworks and completely degraded vegetation, Figure 7 shows historical clearing throughout the entire application area and Plan 8745/1 (attached) shows the current inundated clay-pit.

Serious weed infestation and continuous disturbance from the operating brickworks significantly reduces the likelihood of priority or threatened species being present. Weed species that dominate the ground cover include couch grass (*Cynodon dactylon*) (Figure 4) and fountain grass (*Cenchrus setaceus*) (Figure 3). Eucalyptus trees that are not native to the area make up much of the vegetation (Figure 1 and Figure 2). Removal of the vegetation within the application area may result in a reduction of risk from a highly weed laden area, which may have environmental impacts upon surrounding environments such as the Swan River conservation area and the Gnangara Mound ecological linkage to the west.

According to available databases, 62 threatened flora species and 277 priority flora species have been recorded within the local area, with the closest priority species (*Thysanotus glaucus*) being approximately 500 metres away. No priority or threatened flora species are recorded on databases within the application area and none were observed during on-site surveys (Emerge, 2019a). Threatened flora are discussed in Principle (c).

The soil types mapped in the application area correspond with soils associated with some priority species, for example *Thysanotus glaucus* which is recorded on soil type CP – Clay-pits (Pinjarra) which makes up a small part of the western portion of the application area closest to the brickworks. However, because of the 'completely degraded' condition of the vegetation from impacts associated with historical clearing and continued disturbance from the surrounding heavy industrial area, biological diversity is minimal within the application area (Emerge, 2019a). Figure 7 provides illustration of historical clearing, with the entire application area extensively cleared by 1974. Due to the 'completely degraded' vegetation condition, it is very unlikely that any priority species occur within the application area.

No Commonwealth listed threatened ecological communities (TEC) or State listed priority ecological communities (PEC) are mapped within the application area. The closest PEC (SCP21c – Low lying *Banksia attenuata* woodlands or shrublands) is approximately 2.3 kilometres away, with the closest threatened ecological community (SCP20c Shrublands and woodlands of the eastern side of the Swan Coastal Plain) being approximately 2.4 kilometres from the application area. The vegetation within the application area is not representative of either of these ecological communities.

The small extent of the application area which is immediately surrounded by heavy industrial activity and significant historical disturbance has resulted in all of the vegetation in the application area being in a 'completely degraded' condition, therefore providing poor habitat for fauna species. As a result, the application area does not support a high level of fauna diversity (Emerge, 2019c). The application area does not contain native vegetation which supports a high level of fauna diversity.

Based on the above, the proposed clearing is not likely to be at variance with this Principle.

(b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna.

Proposed clearing may be at variance with this principle

According to available databases, 35 fauna species listed as being of conservation significance under the the Wildlife Conservation (Specially Protected Fauna) Notice 2018 have been recorded within the local area. Of these, three species of black cockatoo, including Carnaby's cockatoo (*Calyptorhynchus latirostris*) have potential to occur within the application area.

Available databases record the nearest confirmed Black cockatoo roost as being over seven kilometres south-east of the application area, with the nearest confirmed Carnaby's cockatoo breeding site located approximately 12.7 kilometres east of the application area. The level 1 Fauna and Targeted Black Cockatoo Assessment (Emerge, 2019c) identified three fauna habitats within the application area; 'scattered native and non-native trees and shrubs', 'cleared area' and 'water body'. Historical disturbance has significantly compromised the former habitat, and the application area does not provide significant breeding or foraging habitat for the three threatened species of black cockatoos due to the lack of preferred foraging plant species and suitable breeding trees (native eucalypt trees with diameter at breast height (DBH) ≥50 cm). The site is not considered to contain any roosting habitat of local or regional importance to Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) or Baudin's Black Cockatoo (*Calyptorhynchus baudinii*), due to the scattered nature and limited number of large trees, in addition to the absence of any evidence of roosting activity.

The site does contain a number of mature flooded gum trees (*Eucalyptus rudis*) and other eucalypt trees such as red river gum (*Eucalyptus camaldulensis*). There is limited evidence that these species are foraged upon by species of Black cockatoo, however they are not priority species for foraging, breeding or roosting and no evidence of use by black cockatoos within the application area was observed (DEC, 2011; Emerge, 2019c). The Emerge targeted survey (Emerge, 2019c) found no evidence of Black cockatoo roosting, such as branch clippings, droppings and moulted feathers and no anecdotal records of Black cockatoo's roosting within the site were reported by Midland Brick staff (Emerge, 2019c).

Observations made by employees of Midland Brick and a level 1 Fauna Assessment that was conducted in November 2019 by Emerge Associates (2019c) indicate the potential presence of the Western snake-necked turtle *Chelodina* (*Macrodiremys*) *colliei* (*C. colliei*) within the application area .

Although the native vegetation is in a completely degraded condition, it may provide cover to female South-western snake-necked turtles when they leave the waterbody to lay eggs, which is part of their biological life cycle. The South-western snake-necked turtle is considered near threatened by the International Union for Conservation of Nature (IUCN, 2020) and is protected under the *Biodiversity Conservation Act 2016 (BC Act).* The most recent survey of 35 urban wetlands revealed populations of *C. colliei* in Perth wetlands are alarmingly low and often have male dominated populations due to female turtles being killed by vehicular traffic and foxes when searching for suitable egg laying locations (DWER, 2020). Additionally a study conducted on the impact of urbanisation on the South-western snake necked turtle found that land use change has impacted relative abundance and population structures of the species in urban wetlands. The study identified that the accessibility of vegetation surrounding urban wetlands was a significant factor impacting upon the abundances of *C. colliei* and the presence of juveniles within the populations, likely owing to providing suitable nesting sites. This suggests that populations are declining through lack of recruitment (Santoro, 2017).

It should be noted that the waterbody is located within a heavy industrial area, surrounded by cleared hardstand and traffic within an operational brickworks. Emerge Associates have confirmed that the proponent has committed to engaging experts from Murdoch University under advice from the Department of Biodiversity, Conservation and Attractions (DBCA) to undertake a relocation program to transfer resident turtles to an appropriate waterbody nearby (Emerge, A1871926). Given the waterbody is in a high risk area for travelling female *C. colliei*, relocation of the species and filling of the clay-pit to prevent future colonisation is a considered to be an acceptable outcome.

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. One ecological linkage, the Gnangara Mound ecological linkage to the west intersects a small portion of the application area, this area is predominantly cleared road surface and a small section of 'completely degraded' vegetation. Vegetation outside the Boral Brickworks along the Swan River is in far better condition and is more contiguous with the Gnangara Mound ecological linkage, so it is not considered that this small section of 'completely degraded vegetation fringing the clay-pit provides any significant contribution to the ecological linkage.

The application area may comprise part of a habitat which is significant for South-western snake-necked turtle breeding purposes. Any relocation of turtles by suitably qualified personnel will mitigate the impacts of the proposed clearing on this species.

Based on the above, the proposed clearing may be at variance to this principle.

(c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, Threatened flora.

Proposed clearing is not likely to be at variance with this principle

The detailed flora and vegetation survey did not identify any threatened flora species within the application area. In addition, there are no records of threatened flora species within the application area. A database search conducted over the application area identified several threatened species as having potential to occur in the application area, based on landscape and soil mapping. However, the field survey conducted by Emerge Associates (2019b) determined that the application area does not provide suitable habitat for the identified species due to the high level of historical disturbance and predominantly 'completely degraded' vegetation condition.

As no threatened flora species have been identified within the application area, it is unlikely that any threatened flora will occur and the proposed clearing is not likely to be at variance with Principle (c).

(d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

Proposed clearing is not likely to be at variance with this principle

A database search indicated that no State listed threatened ecological communities (TEC) are mapped within the application area. There are ten TEC's within the local area, the nearest located approximately 2.4 kilometres from the application area:

- Shrublands and woodlands of the eastern side of the Swan Coastal Plain (floristic community type 20c as originally described in in Gibson et al. (1994)) which is listed as an 'endangered' TEC under the *EPBC Act* and as a 'critically endangered' TEC under the *BC Act*.

As previously discussed, the flora and vegetation survey (Emerge, 2019b), determined that due to the high level of disturbance through vegetation clearing, no representative floristic communities are present. As no State listed TECs have been identified within the application area, the proposed clearing is not likely to be at variance with Principle (d).

(e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Proposed clearing is not likely to be at variance with this principle

The local area contains approximately 25 per cent native vegetation cover.

The national objectives and targets for biodiversity conservation in Australia has a target to prevent clearance of ecological communities with an extent below 30 per cent of that present pre-1750, below which species loss appears to accelerate exponentially at an ecosystem level (Commonwealth of Australia, 2001). The Environmental Protection Authority (EPA) recognises the Perth Metropolitan Region to be a constrained area, within which a minimum 10 per cent representation threshold for ecological communities is recommended (EPA, 2008). As the application area is within a constrained area, the 10 per cent threshold applies in this instance.

Although the available databases show that there may be remnant vegetation in the northern portion of the application area, historical aerial photography and on-site photography provided by Emerge Associates shows that this area has been heavily disturbed over the years and that the vegetation present in this area is not remnant vegetation, but rather regrowth of predominantly non-native species.

Based on the results of the flora and vegetation survey, vegetation within the application area is not an intact plant community, given the significant previous clearing and historical and ongoing industrial land uses, which have resulted in its 'completely degraded' condition (Emerge, 2019b). This assessment of the vegetation condition is well depicted in on-ground photographs of the area within the vegetation survey report, as well as additional photos provided by. As the vegetated areas within the application area are not considered to represent remnant native vegetation, are unlikely to provide any significant ecological linkage functionality and do not represent significant habitat for flora or fauna, the application area is not considered to be a significant remnant within an extensively cleared area

Based on the above, the proposed clearing is not likely to be at variance with Principle (e).

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

Proposed clearing is at variance with this principle

The *Geomorphic Wetlands of the Swan Coastal Plain* dataset does not identify any mapped wetlands within the application area. However through assessment it was identified that vegetation within the application area is growing in an environment associated with a wetland, that being an artificial drain/soak constructed within the last twenty years, as well as the inundated historic clay-pit.

As is illustrated in historical aerial photography (Figure 7), the clay-pit, is a sizable body of water comprising about 3.03 hectares of the application area. Amongst the predominantly weed and introduced species that surround the waterbody, there are sporadic examples of native riparian vegetation, notably *Typha orientalis* and *Eucalyptus rudis* (Flooded Gum). The proposed clearing of a weed infested area which has been previously cleared is unlikely to have a significant impact. Additionally clearing this vegetation will remove the environmental threats associated with a weed infested area.

A drain or constructed soak occurs in the northern part of the application area, within the area mapped as remnant vegetation. The artificial drain can be seen in aerial photography but is noticeably absent in an earlier aerial photograph (Figure 7). There is no historical evidence of this drain prior to 2000. According to supporting documents provided by Emerge, it is possible that the drain was not deliberately constructed but is simply a low point within the application area where water has accumulated and was never a natural watercourse. Nonetheless, the area has been colonised by *Typha orientalis,* a native wetland species. A small amount of vegetation planted by Midland Brick over the past 10-20 years is also present around this area, in particular *Eucalyptus camaldulensis* (river red gum) and *Eucalyptus rudis* (flooded gum)(Emerge, 2019a).

Based on the above, the proposed clearing is at variance with Principle (f).

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Proposed clearing is not likely to be at variance with this principle

Six soil types have been mapped within the application area. These are described as:

- **AcI&Ac – Andrew clay loam-clay,** Very shallow brown clay loam or clay over yellow-brown and grey mottled clay. (Mapping unit: 254WhV2) (the northern application area);

- **Pcl – Pyrton clay loam (Swan),** Shallow brown mottled clay loam over layers of fine sand and mottled loam. (Mapping unit 213jPY_Pcl) (North western portion of application area).

- **VC – Valley complex (Pinjarra),** Variable soils associated with drainage lines. (Mapping unit: 213Pj_VC) (North eastern portion of application area).

- **BL – Bellvue loam (Pinjarra),** Shallow brown clay loam over yellow-brown mottled clay. (Mapping unit: 213PjBL_Bl) (Southern most section of application area).

- **CP – Clay-pits (Panjarra),** (Mapping unit: 213PjW_CLAY-PIT) (South west section of the application area).

- **Bcl&Bc – Bellvue clay loam-clay (pinjarra),** described as Shallow yellow-brown clay or clay loam over variable yellow-brown mottled clay. May contain gravels (DPIRD, 2017). (Mapping unit: 213jAn_AcI&Ac) (Most of the application area, apart from eastern most and northern most areas).

All soil types mapped within the project area have a wind and water erosion risk below 3%, except for VC – Valley complex (Pinjarra). The area of this soil type within the application area is almost entirely cleared and either bituminised or hardstand. The small remainder of the soil type that is not cleared (about 0.05 hectares) is currently part of the open infiltration sump in the northern part of the application area and surrounding vegetation. However it is highly unlikely that this area is representative of this soil type due to historical earthworks including the spread of waste material, including discarded and broken bricks from the brickworks which can be seen in Figure 6. During clearing and earthworks, there will be a period within which the underlying soils may be exposed. However as most of the area is already cleared or comprises an existing waterbody, the increased risks of erosion are not considered to be of environmental significance.

Currently the clay-pit receives water directly from rainfall, in addition to stormwater runoff from the surrounding un-vegetated hardstand. As the clay-pit will be filled to make way for hardstand, two swales will be constructed within the application area to receive surface water runoff. The draining of surface water into the swales will minimise the potential for surface water to contribute to erosion and sedimentation to the surrounding environment. The swales will include a pumped system to allow for water to be occasionally used in dust suppression on site, with excess water during high rainfall periods being transferred to the existing stormwater management system, which includes an oil-water separator and sequence of sedimentation ponds before reporting to a tributary of the Swan River (Emerge, 2019b).

In addition the purpose of this clearing will result in all six mapped soil types being covered by hardstand using clean fill which will prevent the exposure of these mapped soil types from wind or water and other land degradation impacts. Given the small area of vegetation proposed to be cleared, it is not likely to have any impacts with regard to subsurface land degradation or flooding, especially considering the nearby significantly larger and contiguous vegetation within the Swan River conservation area.

Based on the above, the proposed clearing is not likely to be at variance with Principle (g).

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

Proposed clearing is not likely to be at variance with this principle

According to available databases, the nearest conservation area is the Swan River Reserve, which is approximately 50 metres west of the application area.

The proposed clearing may indirectly impact on the environmental values of the Swan River conservation area through the spread or introduction of weed species. Noting the size of the application area and the extensive infestation of weed species, clearing of this vegetation is unlikely to have a significant impact on the environmental values of the nearby conservation area. Clearing may in fact have a positive effect by the removal of weed species such as couch grass (*Cynodon dactylon*) (Figure 4) and fountain grass (*Cenchrus setaceus*) (Figure 3) by reducing the proliferation of seed dispersion. A weed management condition will mitigate impacts to nearby conservation areas.

Based on the above, the proposed clearing is not likely to be at variance with Principle (h)

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Proposed clearing is not likely to be at variance with this principle

The application area is already highly disturbed and given the relatively small area of vegetation coverage, it is not considered that the existing vegetation significantly contributes to the protection of ground or surface water. The application area will not be exposed after clearing as the area will be made into a compacted hardstand area using clean fill and water infiltration will be minimal. Surface water is currently directed to the existing clay-pit and existing surface water management system, which is described above.

Based on the above, the proposed clearing is not likely to be at variance with Principle (i)

(j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

Proposed clearing is not likely to be at variance with this principle

As discussed in principle (g), the six mapped soil types within the application area will not be exposed to wind or water as a result of any clearing, as the area will be made into a compacted hardstand area using clean fill. Therefore, the flooding risk susceptibility of the mapped soil types will not be relevant to the final land use.

The area will also have internal surface water drainage management, therefore it is unlikely flooding from stormwater will be an issue. Stormwater and surface runoff within the catchment will be contained and as described above will not result in significant impacts. Noting this, the removal of remnant vegetation from the application areas is not likely to contribute to flooding.

Based on the above, the proposed clearing is not likely to be at variance with Principle (j)

Planning instruments and other relevant matters.

As outlined under clearing principle (b), the western snake necked turtle (*C. collei*) is protected under the *BC Act*. A relocation licence issued by the DBCA is required to relocate the turtles under regulation 28 of the Biodiversity Conservation Regulations 2018. A licence must be issued to a person or organisation conducting the relocation, in this case personnel from Murdoch University for this specific relocation project. The licence application assessment process includes a review of competency in relation to the species and methods so that the fauna relocation is conducted by suitably qualified and experienced personnel. The release site must also be discussed with and confirmed as suitable by the DBCA regional office, prior to the submission of the licence application, and is usually a 'nearby suitable habitat'. In this case a wetland (natural of artificial) suitable in quality for freshwater turtles and with a maximum carrying capacity able to take the potential number of turtles to be relocated will be required (DBCA, 2020).

A development application has been approved by the City of Swan for hardstand construction and associated infrastructure, which is the purpose of this clearing permit.

No Aboriginal sites of significance have been mapped within the application area and the Lot within which clearing is to occur is freehold land.

The clearing permit application was advertised on the DWER website on 9 January 2020 with a 21 day submission period. No public submissions were received in relation to this application.

4. References

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Emerge Associates (2020) Email (A1871926), Re Turtle Relocation Commitment, 14 February 2020.

Emerge Associates (2019a) Technical memorandum Flora and Vegetation Assessment Part Lot 103 Great Northern Highway, Middle Swan.

Emerge Associates (2019b) Detailed Flora and Vegetation Assessment - Middle Swan Brickworks.

Emerge Associates (2019c) Level 1 Fauna and Targeted Black Cockatoo Assessment - Middle Swan.

International Union for Conservation of Nature (IUCN) (2020).

Keighery, B.J. (1994) Bushland Plant Survey: A Guide to Plant Community Survey for the Community. Wildflower Society of WA (Inc). Nedlands, Western Australia.

Land insights (2018) Clearing Permit Application Lot 103 Great Northern Highway, Middle Swan.

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5. GIS Datasets

- Aboriginal Sites of Significance
- Clearing Regulations - Environmentally Sensitive Areas
- Carnaby's cockatoo: breeding, roosting, feeding
- Geomorphic Wetlands, Swan Coastal Plain
- Hydrology, linear
- IBRA Australia
- Land for Wildlife
- PDWSA, CAWSA, RIWI Act Areas
- Remnant vegetation
- Soils, state wide
- Town Planning Scheme Zones